Seed Storage Techniques - A Primer

The Revitalizing Rainfed Agriculture Network (RRAN) is a growing network of civil society organizations, research institutions, policy makers, donors and individuals engaged in evolving a differentiated agricultural policy with enhanced public investments and support system for rainfed areas in India. The Comprehensive Pilots (CPs) are part of the RRA Network's action research programme that seeks to establish evidence and experience on the ground, in support of the various propositions that the Network has developed. In order to offer support for CPs a set of organizations have been identified as Nodes on specific identified themes such as – seeds, soils, water, millets, fisheries, livestock, credit, markets and institutions.

The Centre for Indian Knowledge Systems (CIKS) has been identified and functioning as the nodal anchor for the theme of seeds. A series of booklets is being published on various technical and institutional aspects of seed systems to build the capacity of the CPs as well as various field groups who are involved in the efforts to build community managed seed systems.

This book explains in detail various principles and methods of seed storage. Factors affecting storage, care and preparation before storage have been discussed. Several insect traps that could be used in storage godown both to monitor and trap pests have also been explained. There are also sections on rodent control, bird control besides control of microorganisms. Details about several seed storage structures have also been provided.

Centre for Indian Knowledge Systems, Chennai
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Revitalising Rainfed Agriculture Network
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PREFACE

The Revitalizing Rainfed Agriculture Network (RRAN) is a growing network of civil society organizations, research institutions, policy makers, donors and individuals engaged in evolving a differentiated agricultural policy with enhanced public investments and support system for rainfed areas in India. Based on the vast experience on the ground and analysis of issues, RRA Network is evolving specific propositions on various aspects of rainfed agriculture such as seeds, soils, water, crop systems, millets, livestock, fisheries, credit, markets and institutions. The Comprehensive Pilots (CPs) are part of the RRA Network's action research programme that seeks to establish evidence and experience on the ground, in support of the various propositions that the Network has developed. In order to offer support for CPs a set of organizations have been identified as Nodes on specific identified themes such as – seeds, soils, water, millets, fisheries, livestock, credit, markets and institutions.

The Centre for Indian Knowledge Systems (CIKS) has been identified and functioning as the nodal anchor for the theme of seeds. The CPs started functioning in the year 2012 and in June 2012 the seed node convened a meeting of representatives of CPs for an inception workshop in Chennai. During this workshop the CPs shared their proposals and plans of work as well as their thinking about the work that they plan to undertake in the area of seeds. Presentations were made during the workshop on how to undertake a situation analysis with respect to seeds, the elements of designing a robust seed system for rainfed areas and also about undertaking a planning exercise through which each CP can proceed towards the establishment of a robust community managed seed system in its area of work. A part of the workshop was to identify the specific needs expressed by each of the CPs in terms of the support and help they would need in the area of seeds. A beginning was made in terms of the capacity building exercise through a series of presentations.

Beginning from the early part of the year 2012 Dr. G. Venkat Raman of the Seed node had started making a series of visits to various CPs. During the visits he provided help and assistance to the CPs for performing situation analysis, evolving a plan for a robust seed system for the area undertaking capacity building exercises and also trying to create linkages between the groups and scientists and institutions who could provide technical support. During this process he also identified various needs in the form of topics on which training and capacity building was required.

Subsequently, on two different occasions when the seed node team met the CPs – in Bagli in Madhya Pradesh in November 2012 and in Tiptur in Karnataka in December 2012 there were opportunities to review the progress of each CP as well as provide technical inputs and training. Earlier this year, towards the end of July 2013 a workshop was held by the seed node in the CIKS Technology Resource Centre in the Kancheepuram district of Tamil Nadu. In this workshop a series of technical trainings were provided on various aspects of seeds. The training was not only in the

form of lectures and presentations but also included field work, experiments, visits to government and private seed farms and seed production centres as well as meetings with the officials of the Directorate of Agriculture and Seed Certification departments. During these meetings drafts of some of the technical training modules that were prepared were circulated and comments and suggestions were sought from the CPs. Based on these efforts and also building upon discussions that took place during the visits to CPs a set of topics had been identified to produce training modules. We expect this process to be dynamic and interactive so that changes can be made based on the suggestions received from the various user groups. A series of reports and books that have been circulated and discussed as drafts and presentations are now being brought out as publications.

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Chennai, December 2013

About this Book

This book explains in detail various principles and methods of seed storage. Factors affecting storage, care and preparation before storage have been discussed. Several insect traps that could be used in storage godown both to monitor and trap pests have also been explained. There are also sections on rodent control, bird control besides control of microorganisms. Details about several seed storage structures have also been provided.

CONTENTS

INTRODUCTION

Seeds should have a good storage facility, since seeds are the main genetic linkage between two generations of a plant species. Seeds should be stored in such a manner, that its germination capacity and vigour should not decline. In temperate regions, seeds can be stored at ambient conditions for longer period, whereas in tropical and sub tropical regions parameters such as temperature and moisture should be adjusted as per the requirement to preserve the seed vigour.

Nearly 30% of the seeds are lost during storage period due to insects, rodents and microorganisms. The storage period begins right at the time of attainment of the physiological maturity of seeds in the field till it is planted in the next season. Care should be taken to preserve the germination capacity, viability and vigour of the seeds. This manual explains various principles and methods of seed storage.

Steps in Seed Storage

The major steps involved in seed storage are,

- Dry and cool storage conditions.
- Protection from pests.
- Sanitation of seed storage area.
- Drying of seeds before storing.
- Storing well cleaned seeds in the storage godown.

Different Stages of Seeds Storage

The storage of seeds is initiated at the time of attainment of physiological maturity and maintained till the next sowing season. Hence, the different stages involved in seed storage are as follows:

- Period from physiological maturity to harvest.
- Period from harvest to packaging.
- Period from packaging to storing.
- Period from storing to marketing of seeds.
- On farm storage (Purchased seeds used for planting in the field).

Storage in the godown is highly influenced by external environmental conditions. All other stages should be monitored and care should be taken to ensure the physical purity, germination viability and vigour of the seeds.

FACTORS AFFECTING STORAGE

Factors that affect stored grains can be classified into internal and external factors. Internal factors include kind and variety of seeds, seed quality and moisture content. The term external factor denotes relative humidity, provenance, temperature and activity of insects and other microorganisms in the storage area.

Internal Factors

1. Kind and variety of seeds

Seed storage is greatly influenced by the kind and variety of the seeds. Some seeds have short storage life (Eg. groundnut, soyabean), some have medium storage life (Eg. wheat, cotton) and while some like rice and beans can be stored for longer period. Generally, starchy seeds due to their hygroscopic nature (ability to retain moisture content) can be stored for a longer period of time when compared to oil or proteinaceous seeds.

2. Quality of the seeds

Quality of the seeds can be greatly influenced by various environmental conditions from the stage of physiological maturity to harvest. Factors like soil health, availability of nutrients to the plant, nutrient deficiency during plant growth, damage by pest and diseases may affect the quality of the seeds before harvesting. Seeds which are subjected to weathering process may lose their germination viability due to the mechanical damage. Healthy, plumpy and undamaged seeds can be stored for a longer period of time when compared to damaged and deteriorated seeds.

3. Moisture content of the seeds

The most important factor influencing viability of the seeds during storage is the moisture content of the seeds. If the moisture content of the seed is more, it harbours frequent growth of molds and attack by pests. Seeds with more than 14% of moisture content deteriorate quickly, whereas very low moisture content is also detrimental to seed quality.

According to Harringtom's thumb rule, a 1% decrease in seed moisture content doubles the potential of the seed. This rule is applicable only at a moisture range of 5-14%, because moisture level below 5% causes physiochemical changes in the seeds, whereas above 14% it is prone to insect and mold attack. Another rule states that with every 5^{o}C decrease in storage temperature, seed life is doubled. It holds good for temperature range of 0 - 50^{o}C. The safe moisture content depends on the storage period, type of storage structure, variety of seeds and type of packaging materials used. Eg. if cereals are to be stored in open storage, moisture content of 10% is suitable; if it is in sealed containers then the seeds are to be dried up to 4 - 8% of moisture content. The safe moisture levels of some seeds are as follows.

Crop	Maximum moisture content
Millets	12%
Paddy	13%
Cowpea	9%
Pulses	9%
Maize and Sorghum	12%

External Factors

1. Relative humidity (RH) and temperature

Seeds are hygroscopic in nature. Hence they attain specific moisture content when subjected to a given level of atmospheric humidity at a particular temperature. This is called moisture equilibrium content. This moisture equilibrium content varies from seeds to seeds. Generally it is lower in oily seeds than that of the starchy seeds even at the same relative humidity and temperature. Seeds should be stored in dry and cool conditions in order to ensure the quality of the seeds during storage.

2. Provenance

Seeds harvested from different climatic regions and at different times show differences in viability. The seeds harvested from an area of high RH and temperature at the time of seed maturation or harvest can be stored for lesser period than the seeds from low RH and moderate temperature area.

3. Activity of insects and other microorganisms

Bacteria, fungi, mites, insects, rodents and birds may affect the seeds in storage. Bacteria do not show any significant effect on the stored seeds, since it needs water for its proliferation. Storage fungi like *Aspergillus* and *Penicillium* infect the seeds and produce mycotoxins that will deteriorate the seed quality. Insects and mites cause severe damage especially in warm and humid conditions. Birds and rodents cause huge loss of seeds during storage period.

The general RH and temperature for multiplication of various biological organisms in seed storage is as follows,

organism	temperature (^{o}c)		relative humidity (%)
	range for multiplication	optimum range	
Insects	21-24	27-37	30-95
Mites	8-31	19-31	60-100
Fungi	8-80	20-40	60-100
Microbes	8-80	26-28	91-100

Classification of Seeds based on Storage

Seeds can be categorized into three types based on the longevity of the seeds during storage,

1. Orthodox seeds
2. Intermediate seeds
3. Recalcitrant seeds

1. Orthodox seeds

Orthodox seeds are also called long lived seeds. They can be stored for a relatively longer period. They can be dried up to 5% moisture level without any injury and can also withstand freezing temperatures. Eg. Rice, Maize etc.

2. Intermediate seeds

These seeds can also be stored for longer period, but it cannot withstand low temperature. It tolerates the drying to low moisture level. Eg. Legumes, Papaya, Citrus etc.

3. Recalcitrant seeds

Recalcitrant seeds can be stored only for a short span of time. Since it cannot be dried to less than 30% moisture level, chances of pest and disease incidence is more. It cannot withstand drying under direct sun. These seeds never get into dormancy stage, but continue to enter into the next stage of germination. Eg. Mango, Jack etc.

CARE AND PREPARATION BEFORE STORAGE

Seeds should be dried to optimum moisture level, less than 12% for starchy seeds and less than 9% for oily seeds. Seeds should be cleaned thoroughly and should be free from trash, insect and microbial damage. If the relative humidity is low or maintainable, then the seeds can be stored in paper envelopes. Storage containers should be reasonably inexpensive, airtight with low thermal conductivity. Storage containers should be moisture proof which includes sealed tins or aluminium cans, glass jars with gasket lids.

Selection and maintenance of storage godown

Storage area should be easily accessible for loading and unloading operations. The storage area should be relatively moisture proof which is necessary for the maintenance of seed moisture content. The godown should be clean and dry. Storage area should be termite and rodent proof. There should not be any cracks or holes in the wall and floor of the storage godown. Disinfestation is done by spraying neem oil solution - 200 ml of neem oil should be mixed with 2 litres of water. It is recommended for a single storage room of 200 square feet. After spraying neem oil solution, the rooms can be fumigated with the powder of sweet flag rhizome *(Acorus calamus)*. Before stacking the seeds or grains, the storage godowns or rooms and storage structures or receptacle should be cleaned and made free from insects.

Fumigation of the godown

For fumigation of the storage area, the following things are required:

Vessel with a wide mouth made of iron, aluminium or mud, rope, coal, *Vaividangam* / sweet flag, leaves of *Vitex* (five - leaved chaste tree / *Nochi*) / Neem / *Leucas* (common leucas / *Thumbai*)

The following procedure should be followed for fumigating the storage godown:

Take hot coal in a vessel with a wide mouth. Take any two types of green leaves of Neem / Chaste tree / Common leucas / Holy basil in equal quantities and put it on hot coal. At the time of fumigation, the windows and doors of the seed storage godown should be closed tightly to avoid the entry of fresh air. Keep the vessel with hot coal and leaves at the centre of the storage godown. There should not be any gunny bags or easily inflammable material up to 3 ft around the fumigation vessel. The fumigation should be done only during evening hours. The fumigation vessel should be kept in the room for 30 minutes to 1 hour depending upon the size of the room. The dead moths and insects should be cleared from the storage godown next day morning. Fumigation process should be done once a month during storage period.

Natural Products Used in Storage Pest Control

1. Neem products in pest control

- Take required amount of neem, pongamia and vitex leaves and shade dry it till it becomes papery. Seeds are filled up to ¾th of a storage bin and covered with a clean cloth. Mix the above leaves and spread a handfull on the surface of the seeds in the storage bag or bin. This method can also be followed in bigger storage containers.

- Neem oil can be mixed with the seeds at the rate of 2% by the weight of the seed. Using oil is more effective than the leaves.
- Seeds can be stored by mixing with Neem oil (2-3 ml / kg of seed). 50 kg gunny bags of any seeds need 150 ml of the oil for mixing.
- Neem seed powder can be mixed at the rate of 1% to the volume of the seed. This is practiced for the control of khapra beetles, rice weevils etc. which is found in storage.
- Mix 30 gms of ginger rhizome powder and 50 gms of neem kernel powder with 1 kg of any of the pulse variety such as cowpea, soya bean, redgram etc.
- The following practice is a traditional measure followed by several farmers for storage pest control. Spread the leaves of Neem and Pungam layer by layer over a cloth placed in a vessel for 1/4 feet. Then fill the vessel with seeds up to the surface level and cover it with a thick layer of sand to prevent pest attack.
- Seed coat of Mahua *(Madhuca latifolia)* @ 1-1.5 kg per kg of paddy seed is mixed before storage.

2. Other plant products in pest control

- Mix 50 grams of custard apple seed powder with 1 kg of any of the pulse variety like soya bean, cowpea, redgram, etc., to prevent the attack of the pulse beetle.
- Mix the seeds of Maize, Wheat etc., with dried fruits and leaves of *Vantulsi* (wild Tulsi - *Ocimum*) at the ratio of 1:100 to prevent from the weevils in storage.
- Store cereals and millets in bags or baskets made from the date palm fronds and after mixing it with neem leaves and ash. Plaster the top portion with cow dung to prevent the entry and spread of insects.
- Mix blackgram seeds with mustard oil @ 10-15 ml per kg of seeds and store it in earthen pots covered with dry cloth.

3. Wood ash in storage pest control

Wood ash is a safe and effective pest control material. Mix equal quantity of seed and wood ash to prevent the attack of beetles and other storage pests. *Lantana camara* leaf ash is very effective against pests attacking the sprouts of stored potato.

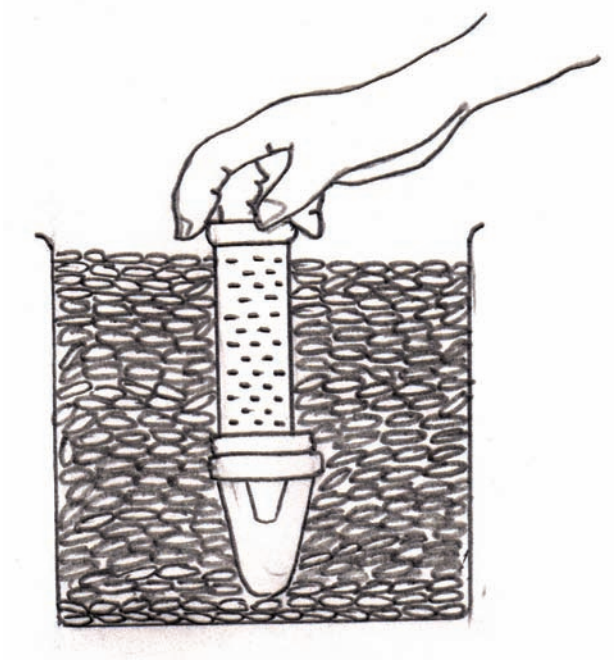
INSECT TRAPS FOR STORAGE GODOWN

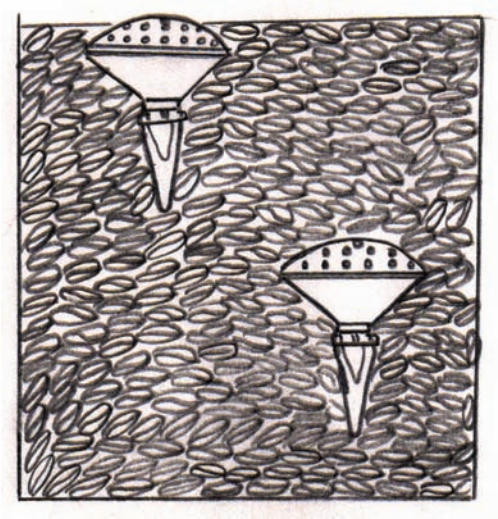
Timely detection of storage pests plays a major role in the control measures. In order to detect the insects the following traps developed by the Tamil Nadu Agricultural University, Coimbatore can be used in the storage godowns.

1. TNAU insect probe trap
2. TNAU pit fall trap
3. TNAU 2 in 1 trap for pulse beetle
4. Indicator device
5. Automatic insect removal bin

1. TNAU insect probe trap

The insect trap should be kept in paddy or wheat bags vertically with the plastic cone downside. The round red cap should be placed at the level of the seed or grain. Insects will move towards air and enter into the main tube through the holes. Soon after its entry, it falls into the white detachable cone at the bottom, which can be unscrewed once a week to remove the insects. This trap can be placed on top of 6 inches of the seed or grain, where the insect activity is more during initial stage of storage. It can remove nearly 80% of the insects within 10-20 days.



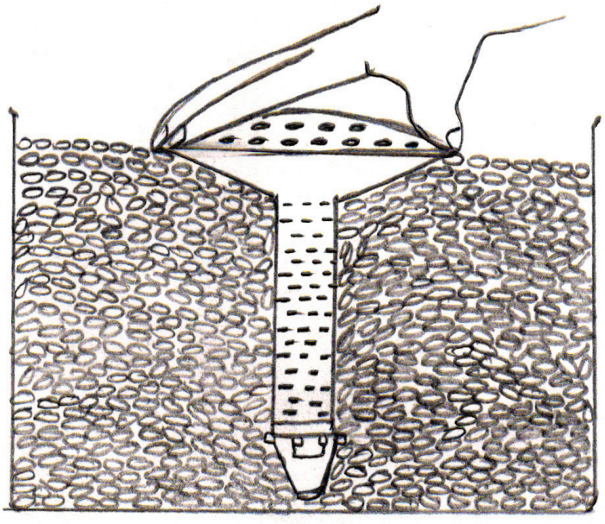


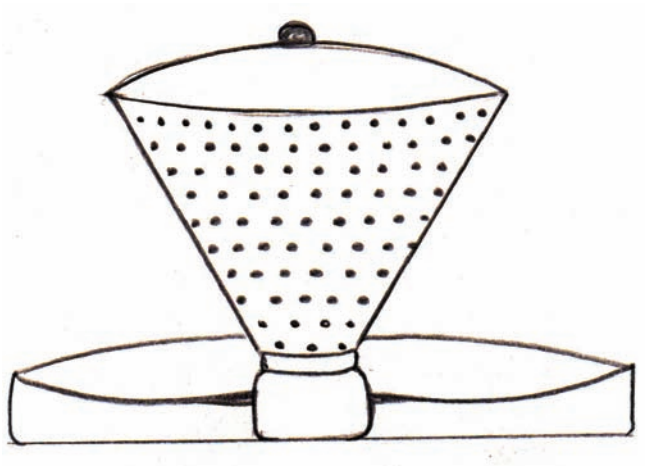
2. TNAU pit fall trap

This trap is easy to handle and looks like a top. Top of the trap has minute 3 mm perforations and a cone shaped bottom. The inner side of the cone is coated with a sticky material to hold the trapped insects. This trap should be kept immersed in the storage structure and once the insects enters into it will get trapped in the sticky material.

3. TNAU 2 in 1 model trap

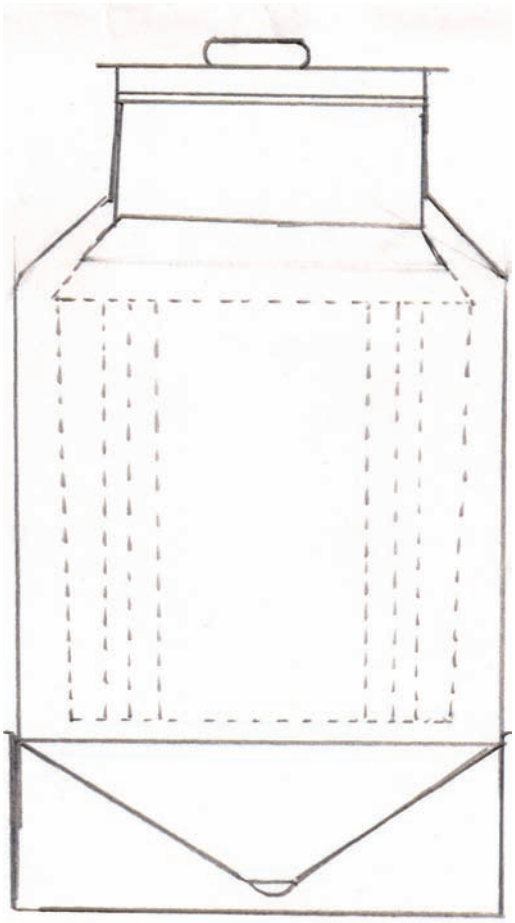
- This trap contains the perforated tube, collecting tube, cone shaped pit fall trap, perforated lid and bottom tapering cone.
- It is suited for trapping the pulse beetles





4. Indicator device

It consists of a cone shaped perforated cup with a lid at the top. The cup is fixed with a container coated with a sticky material. Before storing pulse or cereals, 200 gms of the material should be taken in the cup. If it has any pest infestation, pests start emerging and slip into the trapping container. By observing the pest in the container, stored materials in the main storage can be sun-dried. 3mm perforated cups can be used for pulses and 2 mm cups for cereals.



5. TNAU Automatic insect removal bin

The storage bin has as outer container, inner perforated container, collection vessel and a lid. Seeds or grains can be stored in the inner container and the space between the inner and outer covering is well aerated. Insects enter the perforation and reach the aerated area. They fall into the collection vessel and can be removed. This type of bin can be used for storing paddy and pulses to get rid of storage pests like rice weevil, lesser grain borer, red flour beetle, saw toothed beetle etc. This type of bin is available in 2, 5, 25, 100 and 500 kg capacities.

RODENT CONTROL

Rats live in all our dwelling places. They eat food grains and seeds that are stored in the house and also in the storage godown. They shed droppings on the grain while they are eating it and can also spread diseases like plague, rat fever etc., in human beings which are quite dangerous. There are a variety of rats which cause damage to stored products. They are the house rat, house mouse, Norway rat, smaller bandicoot and larger bandicoot. A variety of physical, mechanical and cultural techniques can be followed for its control. Percentage of damage caused by rodents during storage is 2.50%.

Physical Methods

Rat proofing

The rat problem can be solved to a great extent if the entry of rats is prevented in houses, stores and godowns. This can be done by building rat proof godowns. The following should be kept in mind while constructing or selecting godowns.

- Godowns should be away from habitation.
- They should be constructed on higher plinth area.
- The godown should be a concrete structure.
- Trees or its branches should not be overhanging on the godowns' roof.
- Metal or wire mesh should be fitted on all windows, ventilators, gutters and drains.
- The manholes should be covered properly.
- The clearance between door and floors should not be more than ¼ inch. The door should also be provided with a 9 inch metal sheet lining at the bottom.
- The foundation of the storage place should be 3 feet above the ground level.
- Walls and floors should be plastered with smooth cement. Any rat hole which is observed must be immediately closed with cement and if the hole is big enough it should be filled with glass pieces.
- Automatic door closers should be provided to prevent the rat entry.
- Regular sanitation and inspection of godown is essential for effective rat control.
- Water stagnation close to the godown should be avoided.
- Hygiene and sanitation
- Timbers, bricks, papers, leaves or any rubbish material near the storage godown should be removed well before storage and cleaned.
- Empty storage containers should be cleaned then and there or removed from the storage godown immediately.

Mechanical traps

In case of storage godown wooden cage or mice cage can be used for the control of rats. Bait is used in the trap to attract the rat to come into the trap. Bait may be any food like pieces of meat, dried fish, bread etc., that rats like to eat. Rats like the bait when it has sugar, molasses, or some sweet food, dry fish, coconut piece, onion etc. Check the trap or cage daily and make sure the bait is still there. Once the rat is caught into it, dip the cage into water to kill the trapped rat. After every usage, wash the trap thoroughly before next usage.

Indigenous methods of rat control

- Place unripe papaya fruit pieces in the corner of the storage godown. When rats eat these fruits, the mouth tissues get damaged due to the chemical substance in the papaya fruit. For one room, we can keep 2-3 pieces of the fruit.
- Take 2-3 kg of castor leaves and add 3 litres of water. Boil for half an hour and filter the extract. Take 2-3 kg of sorghum seeds and add it to the above extract. Boil it again for half an hour. Take these seeds in a vessel and keep it in the corner of the storage rooms. Rats feed on these and die.

CONTROL OF BIRDS AND MICROORGANISMS

Bird control

About 0.85% of loss of grains at storage level is caused by birds. Birds cause appreciable damage in fields and also in stores. They are also responsible for spoilage, contamination with excreta, feathers and dead bodies in fields and godowns. They create a great nuisance and unhygienic condition in warehouses. Godowns can be made bird proof by equipping windows, ventilators and other entries with wire meshes. Strips of nylon or polythene can also be used for scaring birds near the godowns. Remove the nests of the house sparrow or pigeon found near the storage area.

Attack by microorganisms and their control

Various micro organisms affect stored grains such as fungi, bacteria, yeast, actinomycetes and protozoa. Out of all these microorganisms fungi is responsible for maximum damage / spoilage of seeds in storage. When a fungus is present, it causes off odour, kernel discolouration, loss of nutritive value and loss in viability. Fungi may also produce certain poisonous substances which are harmful and may be fatal to human beings, animals, poultry etc.

The environmental conditions that favours the development of fungi are,

Moisture content above 12%. A temperature of 30 – 32^{o}C. The degree to which the grain/seed has been previously infected with fungi. The amount of foreign matter such as dirt, dust, chaff etc., present in the stored product. Oxygen content in the storage godown and the condition of the seed stored.

Control measures

Moisture content of the seed/grain should be reduced to a safe level. By doing this the chances of fungal growth is minimized. The safe level of moisture content for wheat and rice are 12% and 13% respectively. Reduction of moisture content can be done either by sun drying or with the help of grain dryers. Reduction of temperature to a range of 23^{o}C – 30^{o}C helps in the reduction of storage fungal growth.

The best ways to avoid damage from microorganisms during storage are, to clean the food grains / seeds before storage. The seeds and food grains should be dried to an optimum level before storage. The food grains should be placed in receptacles where moisture increase is minimum during rainy season. The godowns should also beaurated on sunny days.

SEED STORAGE STRUCTURES

Seed storage is an important process in maintaining the viability and vigour of the seeds during storage period. Different storage structures are available based on the duration of the seed storage. Storage structures can be classified into indigenous structures and modern structures.

Indigenous methods/structures

1. Gourd casing

Traditional method of seed storage is use of outer casing of gourd vegetables. These are used to store the seeds of vegetable crops. In some cases, gourd shaped vessels made of clay or gourd shaped baskets are also used for storage. If it is a basket, then it should be tightly plastered with mud.

2. Kuthir

Farmers store the cereals in tall mud pots or bins, which is known as kuthir in Tamil. These are made up of clay soil and plant fibres. Sometimes husks of cereal crops can also be mixed with clay to make the storage structure stronger. The mud pot of about 1 - 3m height has a narrow opening at the top and covered with a tight lid. Seeds and grains can be stored in it can be taken out only through the top opening.

3. Kodambae

These structures are built close to the houses of the farmers. Big stones are placed in a concentric manner at the base of the floor. Wooden sticks are placed over the stones to form a platform over the stones. The structure is round in shape. Side walls of about 1 metre height are built using mud (red soil) or cement and bricks. On the top of the cylindrical structure a conical shaped roof is built using bamboo sticks or coconut fronds. In the roof an opening is made with a wooden board for a person to enter and collect the seeds as and when needed. Farmers use ladders to climb over the roof and to collect the seeds. The conical tip of the roof is covered with an inverted pot in order to avoid the seepage of rain water inside the storage structure. Capacity of such kodambae is 1000 kgs.

4. Thombarai

This type of storage structure is built using *Acacia* (thorn tree) wood and is rectangular in shape. It is built at a height of 1 m from the ground level with four supporting wooden pillars at the bottom. The top of the structure has a small door with an opening for collecting and for pouring the seeds. After filling the grains, straw is spread over the top and sealed with mud. This structure is useful for preventing the seeds from storage pests and also from rodents. Capacity of such storage container is 1000 kgs.

5. Earthen pots

Earthen pots made of clay to a convenient size are used from olden days for storage purpose. Walls of the pots are coated with clay and the mouth of the pot is closed with stiff cow dung paste reinforced with cloth. Pots are arranged vertically one over the other depending upon the size of the pot. Capacity of the pot varies according to the size of the pots.

6. Mara thombai

This type of wooden structure is used to protect the seeds / grains from insects, moisture, mold growth and from the attack of birds and rodents. The wall of rectangular thombai is made using wooden boards to a height of 1.5 – 2 m and is built 80 cms above the ground level and supported with four wooden poles. The whole unit is split into 4 equal parts and each unit is used as a drawer for storage purpose. Tight wooden board is placed at the top as a roofing material. Small outlet provided at the base is used for the removal of seeds from the storage structure. Capacity of such storage container is 1000 kgs.

7. Kalangiyam

Rectangular brick walls are constructed with the strong concrete base inside the farmers house. The walls are smoothly plastered to avoid the entry of insects and their larvae. The wooden lid at the top is used for the loading and unloading of the storage materials. Dimensions and capacity of the structure may vary depending upon the farmers requirement.

8. Puri

It is constructed with the help of paddy straw over a hard surface of the ground after a layer of loose

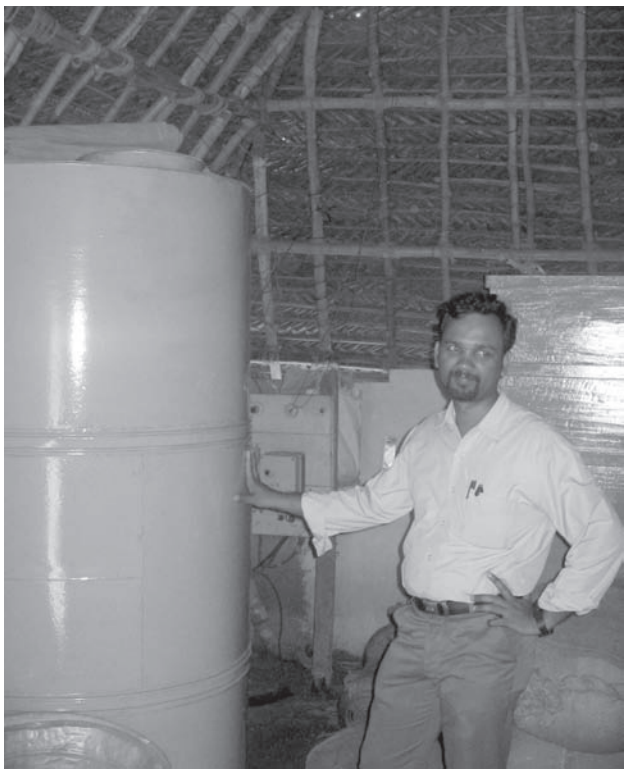
straw provided at the bottom. This is done in order to prevent the absorbance of moisture from the ground. After loading the seeds the structure has to be covered with straw in such a way to form a conical roof. It is easily prone to damage by rodents, hence the side wall can be built with the help of brick/cement concrete. Capacity of such storage container is 3 – 20 metric tonnes.

9. Gunny bags

Gunny bags are used for storing seeds which is durable and inexpensive. They are easy to handle and it allows the circulation of air that keep the seeds cool. They can be stacked in the household area itself. No special storage area is required for storing in gunny bags. Well before storage, gunny bags should be treated with 10% neem kernel solution. Soak the gunny bags in neem kernel extract for 15 minutes and shade dry before use. New gunny bags should be soaked for 30 minutes. Dried bags are used for storing the seeds. Seeds can be protected from pest attack up to 4 months. After 4 months, seeds are to be dried and the bags are to be treated with neem kernel extract again. Capacity of the bag varies from 10 – 75 kgs.

Preparation of neem kernel extract

Take 3- 5 kg of neem kernels or 10 kg of neem cake and gently pound them into powder and place it in an earthen pot. Add 10 litres of water and tie the mouth of the pot securely with a cloth. After three days, filter the solution to obtain the 6–7 litres of extract. Dilute 1 litre of extract with 9 litres of water to get a 10% neem kernel solution.



Modern Storage Structures

1. Pusa bin

It is built with the help of unburnt brick. A polyethylene sheet is placed in between two brick walls to make it air tight. The inlet is at the top for loading and for unloading and the outlet is at the bottom of the bin. Bins are constructed by few layers of burnt bricks plastered with cement at the bottom to avoid rodent damage.

2. Storage in metal drums

Farmers use metal drums for storing sorghum, maize, millets and groundnuts. The capacity of the drum is 600 kgs and it should be clean and dry before storage. Seeds are filled in the drum using funnel and closed tightly with a cap. Seeds can be protected from rodent damage and the drums can be easily fumigated to protect the seeds from pest attack. Capacity of such storage container is 600 kgs.

3. Storage in metal bins

For small scale storage, metal bins can be used. Bins are placed on the raised platform or cement base to protect the seepage of water from outer floor to inside the bin. Bins are light weight and easy to handle. Capacity of such storage container is 1000 kgs.

4. Pucca kothi

It is an indoor structure built with the help of burnt bricks and cement. It is constructed on an elevated floor and the walls should be plastered after embedding the polythene sheet to make it airtight. Inlet is at the top and the outlet is at the bottom of the structure. The inner layer should be reinforced with iron bars for strengthening the walls. This structure is used to maintain the moisture level of the stored product at the same level in which it is stored. Capacity varies according to the space available in rural houses.

5. Reinforced cement concrete ring bin

It is built with the help of cement concrete rings easily available in all areas. The rings are placed one over the other on the cement concrete roof with steel inlet opening on the roof. An outlet is provided either at the base or at the lower ring itself. The rings are joined together with the help of cement mortar. Capacity varies according to the diameter of each ring and number of rings used in each bin.

6. Gharelu thekka

The storage capacity of this structure ranges from 1 - 3 metric tonnes. The structure consists of metal base with fabricated 22 gauge sheets, rubberized cloth container and bamboo posts for lateral support. The height of the structure is 2 m. The structure is moisture proof and air tight and is suitable for periodical fumigation.

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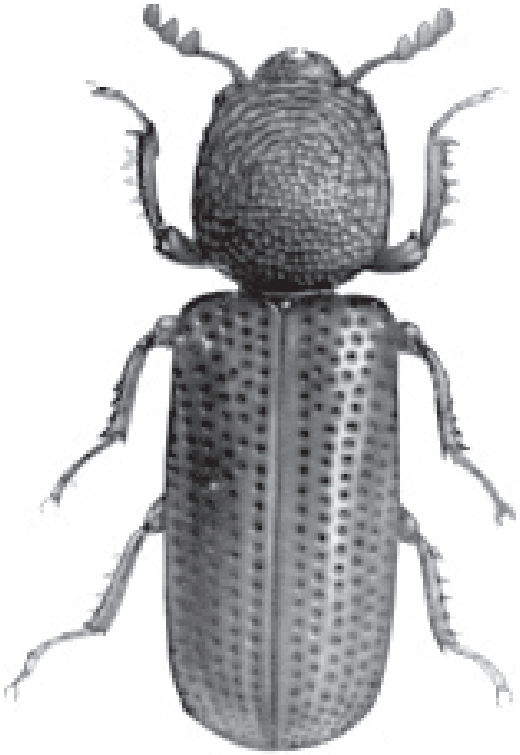
APPENDIX – I STORAGE PESTS

1. Lesser grain borer/ Hooded grain borer - *Rhizopertha dominica*

Adult insect is shiny, dark brown or black in colour. It has strong jaws which can cut even the wood pieces. It is about 2.5 to 3 mm in length. Larva crawls around the grains and eat the flour left by the boring of adult beetles. Adults bore holes in the grains. Both adult and larvae are voracious feeders and causes serious damage.

2. Saw-toothed grain beetle - *Oryzaephilus surinamensis*

Adult is a flattened beetle with a row of saw like sharp teeth on each side of the prothorax. Hence it is named as saw toothed grain beetle. It is dark brown in colour and 3.5 mm in length. Each female lays about 300 eggs in the crevices of the grain. Eggs are small, slender, cylindrical and white in colour. After 5 days, larvae emerge out. Larvae make cocoons of a gelatinous substance to which the food particles get adhered.

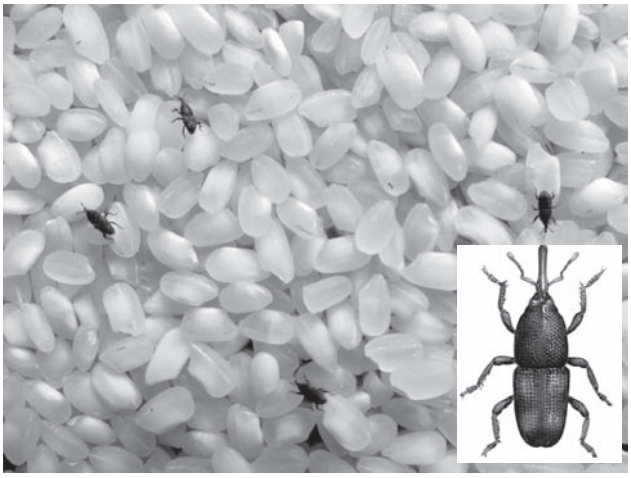


3. Angoumois grain moth / Paddy moth - *Sitotroga cerealella*

These pests inflict severe damage to unhusked paddy. It attacks all grains in storage and ripening grains of paddy, sorghum and ragi in the field. Adult insect is light, yellow-brown in colour. The forewings are pale yellow in colour and hind wings have grey pointed ends with fringes of hairs. The body measures 8-10 mm in length. Each female lays 50-100 eggs. It is laid on the surface of the grains in the field and also in storage. After few days the larvae emerge out and enter into the pupation stage. Larva is an internal borer of the whole grain, feeding on the starchy part. Adults emerge out in 4 – 7 days. Adults have a short life span

4. Rice weevil - *Sitophilus oryzae*

Adult is reddish-brown or black in colour. Each female lays about 150-300 eggs inside the grain kernel. Female makes a cavity on the grain and lays translucent eggs under the seed coat. The



hole is plugged with gelatinous secretion. From the eggs, tiny grubs emerge out. They are about 4 mm in length. They are white in colour and curved in appearance. The larval stage lasts for about 3 - 4 weeks. They actively feed inside the grains and are responsible for most of the damage. Grains with a moisture content of less than 10% are generally not attacked. The optimum temperature and relative humidity are 27°C - 31°C and 70% respectively.

The larvae generally feed the endosperm which reduces the weight and the food value. The damaged grains are in turn attacked by bacteria, fungi and other insects. Moreover, the larva also produces large quantities of powdery excreta. This makes the grains dusty and it also creates unpleasant odour. Adults produce extra heat by their body cavities which increase heat in the bins and bags and this hastens breeding.

5. Drug store beetle - *Stegobium paniceum*

Adult is small, flat and reddish brown in colour. The entire body is covered with soft hairs. The body measures about 3 mm in length. Each female lays about 100 eggs on any dry food substance. After 8 days, the larvae emerge out. Larvae are very active and crawl in search of food. It is a general feeder attacking many kinds of stored grains. It tunnels into stored products like turmeric, ginger, coriander and dry vegetable matter. Both adult and larva are destructive.

6. Red flour beetle - *Tribolium castaneum*

Adult is small, flat and reddish brown in colour. The body measures about 3-4 mm in length. Each female lays about 400 - 500 eggs on dust and flour. It feeds and breeds on the same grain. Presence of unpleasant smell in the storage place is an indication of the infestation of this beetle.

7. Khapra beetle - *Trogoderma granarium*

Adult beetle is brown or black in colour. The body measures about 4 - 6 mm in length. Adult female lays about 80 - 120 eggs. After few days, the larvae emerge out. Damage is done mostly by the larva which reduces the grain quality. Excessive moulting of this particular species creates less market appeal due to insanitation caused by skins and hairs. (Overcrowding of larva also leads to unhygienic conditions in warehouses and godowns).

8. Pulse beetle - *Callosobruchus chinensis*

Adult beetle is small, reddish brown to black in colour. The body is abruptly round in shape. Each female lays wide elongated eggs. The larvae emerge out are yellowish white in colour. Optimum temperature required is 32°C and relative humidity is about 90% for the completion of the life cycle. It mainly attacks the pulses such as stored cowpea, grams, soya bean, channa, mung, toor etc. Hence it is named as "pulse beetle". It also infests the redgram pods at the field level.

Methods for storage

Germination and health of the seeds should be checked regularly. Seeds to be stored should be dried well to a safe moisture level before storage. Storing seeds in gunny bags is advisable, since it is durable and inexpensive. Other than gunny bags any dry, airtight containers like metal drums/bins, aluminium boxes can also be used for storing. The seed bags should not be placed on the floor directly. The storage bags can be made damp proof by providing bamboo poles or bamboo mats or wooden crates. Stack the gunny bags on platforms raised off the floor. If no wood or bricks are available to make a platform, the ground can be covered with plastic sheets. The raised platform is better than the plastic because it also allows air to flow under the gunny bag.Stack the gunny bags in a neat manner. Leave space between the gunny bags so that air can move freely between the sacks. The seed sacks should be placed one above the other and a maximum of

6-7 sacks can be stacked in a vertical row. The seed sacks arranged on wooden blocks should be kept away from the side walls in order to protect the moisture being absorbed from the walls.

The quality of the seeds should be checked once a month. Based on the result of the seed analysis, excess moisture should be removed by drying under the sun, which will prevent the incidence of pest and disease causing germs. To enhance the air circulation the seed bag stacks should be rearranged frequently in such a way to keep the lower bags in the top and vice-versa. The viability of seeds can be enhanced when stored in polyethylene bags instead of gunny bags. Each seed bag should have a proper label and necessary records should be maintained.

Freshly threshed pulse grains are to be dried for 3-5 days, cooled and stored in metal or plastic bins, large earthen pots or in cement storage structures covered with tight lids. Over the seed or grain, 3 cm of sieved sand should be applied and covered tightly with lid. This will prevent the entry and reproduction of bruchids in pulses. Groundnut pods should be dried up to 7-8% moisture content before storage. Poor, damaged, shriveled, fungus infected pods should be removed and pods should be stored in gunny bags. Polythene or polypropylene bags should be avoided because it restricts the air movement and initiates fungal growth. Rice seeds harvested during September – October months, can be sundried again during January - February to reduce the moisture content and to prevent insect damage. Seeds should be stored in an air tight container plastered with cow dung paste. This method of storage is called kottai in southern Tamil Nadu. Redgram seeds can be mixed with cow dung slurry and dried in shade before storage.

APPENDIX – II

COMMON AND SCIENTIFIC NAMES OF PLANTS

Sl. No.	English Name	Scientific Name
1.	Blackgram	*Vigna mungo*
2.	Castor	*Ricinus communis*
3.	Channa	*Cicer arietinum*
4.	Citrus	*Citrus limon*
5.	Common lantana	*Lantana camera*
6.	Cotton	*Gossypium spp.*
7.	Cowpea	*Vigna unguiculata*
8.	Custard apple	*Annona reticulata*
9.	Date palm	*Phoenix dactylifera*
10.	Ginger	*Zingiber officinale*
11.	Greengram/ Mung dhal	*Vigna radiata*
12.	Groundnut	*Arachis hypogea*
13.	Horse shoe Vitex	*Vitex negundo*
14.	Jack	*Artocarpus heterophllus*
15.	Mahua	*Madhuca latifolia*
16.	Maize	*Zea mays*
17.	Mango	*Mangifera indica*
18.	Mustard	*Brassica juncea*
19.	Neem	*Azadirachta indica*
20.	Paddy	*Oryza sativa*
21.	Papaya	*Carica papaya*
22.	Pungam	*Millettia pinnata*
23.	Redgram/Toor dhal	*Cajanus cajan*
24.	Sorghum	*Sorghum vulgare*
25.	Soyabean	*Glycinia max*
26.	Sweet flag	*Acorus calamus*
27.	Thorn tree	*Acacia*
28.	Thumbai	*Leucas aspera*
29.	Wheat	*Triticum aestivum*
30.	Wild tulsi	*Ocimum tenuiflorum*