Research Article
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Indigenous practices for eco-friendly storage of food grains and seeds

Abstract

Agriculture is the chief occupation of the people all over the world and in India, of the total population; More than 70% depends on agriculture for their livelihood. India's grain production has steadily increased due to advances in technology, but post-harvest loss is constant at 10%. Losses during storage, accounts for around 6% of the total losses as proper storage facilities are not available. Grain storage plays an important role in preventing losses which are caused mainly by insect pests, pathogens and rodents. Even though chemical control of stored product pest is predominant, traditional pest control practices are still continued especially in rural areas. It is estimated that 60-70% of food grain produced in the country is stored at home level in indigenous storage structures. Hence, a study was undertaken to collect and document traditional storage practices followed by the farmers of Thoopalli, Kamatampalli and Segalapalli villages of Srinivaspura taluk, Kolar District and Mylandlahalli, Kuruburu and Kurtahalli villages of Chintamanitaluk, Chickballapura, Chickballapura District of Karnataka State. Data were collected from various farmers by personnel contact. The twenty four important traditional storage practices followed by the farmers were as

i. Sun drying of grains,
ii. Use of ash,
iii. Red soil coating method,
iv. Plastering of storage bins with clay and cow dung,
v. Storage of pulses with common salt,
vi. Turmeric application method,
vii. Use of garlic cloves,
viii. Mixing of leaves,
ix. Stepping method or Stamping method,
x. Use of salt and chilli powder,
xi. Use of Neem (Margosa) leaves,
xii. Use of Neem (Margosa)leaves and dry chillies,
xiii. Use of Neem Oil /Margosa oil,
xiv. Use of camphor,
xv. Use of castor powder,
xvi. Sand mixture method,
xvii. Use of dried red chillies,
xviii. Use of lime powder,
xix. Use of matchbox,
xx. Fumigation of the godown /store rooms,
xxi. Use of Neem (Margosa) seed powder,
xxii. Use of ginger rhizome,
xxiii. Use of custard apple seed powder and
xxiv. Use of Tulsi (basil) seeds.

Keywords: grain storage, indigenous practices, traditional storage

Volume 3 Issue 4 - 2016

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Received: November 16, 2015 | **Published:** April 21, 2016

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Introduction

Agriculture is the chief occupation of the people all over the world and in India, of the total population; more than 70% depends on agriculture for their livelihood. India's grain production has steadily increased due to advances in technology, but postharvest loss is constant at 10%. Losses during storage, accounts for around 6% of the total losses as proper storage facilities are not available.[1] Grain storage plays an important role in preventing losses which are caused mainly due to insect pests, pathogens and rodents.

Though chemical control of stored product pest is predominant, traditional pest control practices are still continued especially in rural areas. It is estimated that 60-70% of food grain produced in the country is stored at home level in indigenous storage structures and food grains are protected in home level by using indigenous technology (Knowledge).[2] Indigenous knowledge is the knowledge, skill or technology gathered by local masses during direct interaction of human beings with the environment. Indigenous practices are passed on from generations and are an outcome of elder's wisdom and experience as a result of their close contact and deep knowledge of their environment.[3]

During the last few decades, various synthetic pesticides have been applied to protect stored grains and other agricultural products from insect infestation, but their massive use has imposed so many detrimental effects on the environment and cause intoxication of non-targeting organisms.[1] However, these chemicals are declared ecologically unsafe because these persist for longer period in the environment and enter in to the food chain. It has been reported[4] that certain insect pests have acquired resistance against most of the insecticides. To overcome the ill effects of synthetic pesticides, the best alternative is to going back for adopting Indigenous Traditional Knowledge for protecting the food grains and seeds from insect pest attack. Hence the Indigenous Traditional Knowledge should be documented at each and every instance which can be used by the present and next generation.

Methodology

The present study documents the traditional practices of storage of food grains and seeds in Thoopalli, Kamatampalli and Segalapalli villages of Srinivaspura taluk, Kolar District and Mylandlahalli, Kuruburu and Kurtahalli villages of Chintamani taluk, Chickballapura District of Karnataka State. Detailed information given by experienced, practitioner farmers (210 families) were documented. In total, 210 families in different villages of Karnataka, India constituted the population of the study. In view of the small size of the population, a total enumeration method was adopted. Questionnaires were the main instrument used for data collection. Two hundred seventy eight copies of the questionnaires were administered while 210 copies were completed and found usable, giving a return rate of 75.5%. The questionnaires were complemented with an informal interview with the head librarians of eight of the libraries. The discussion which centred on AIK policy, funding, equipment and technical knowledge was frank and revealing. Data collected with the questionnaire were analysed and interpreted using Statistical Package for the Social Sciences (SPSS) and frequency counts and percentages.

Results and discussion

India has become self-sufficient in food grains production due to advances in technology, but a post harvest loss is constant at 10%.[3] Stored grain pests causes heavy losses to stored grains and pulses all over the world.[2] Even though chemical methods of management of storage pests are highly successful, still farmers are using traditional methods of storage. The readily available and low cost items like ash, sand, salt, camphor and plants etc. are being used by the rural peoples for grains/seeds storage because such practices are not only user-friendly but also increases shelf life of food grains and seeds. Traditional practices followed by farmers of Karnataka for storage of food grains and seeds are expressed in percentage (Table 1) (Table 2) Some important traditional practices followed by farmers of Karnataka for storage of food grains and seeds are:

Table 1 Traditional practices followed by farmers of Karnataka for storage of food grains and seeds

Sl. No.	Storage practice	Percent
1	Sun drying of grains	92
2	Use of ash	78
3	Sand application method	60
4	Plastering of storage bins with clay and cow dung	76.67
5	Storage of pulses with common salt	61.33
6	Turmeric application method	50
7	Use of garlic cloves	42
8	Mixing of leaves	50.67
9	Stepping method or Stamping method	34
10	Use of salt and chilli powder	28.67
11	Use of Neem leaves	50
12	Use of Neem leaves and dry chillies	70
13	Use of Neem Oil	58
14	Use of camphor	16
15	Use of castor powder	14
16	Sand mixture method	20
17	Use of dried red chillies	43.33
18	Use of lime powder	15.33
19	Use of matchbox	9.33
20	Fumigation of the godown	10
21	Use of Neem seed powder	7.33
22	Use of ginger rhizome	8.67
23	Use of custard apple seed powder	5.33
24	Use of Tulsi seeds.	2.67

Citation: Prakash BG, Raghavendra KV, Gowthami R, et al. Indigenous practices for eco-friendly storage of food grains and seeds. *Adv Plants Agric Res.* 2016;3(4):101–107. DOI: 10.15406/apar.2016.03.00101

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Table 2 Major storage pests attacking storage of food grains and seeds

Major storage pests	Scientific name	Family	Order	Crop
Rice weevil	*Sitophilus oryzae,*	Curculionidae	Coleoptera	Rice, maize
Lesser grain borer	*Rhyzopertha dominica*	Bostrychidae	Coleoptera	Rice and millets
Pulse beetle	*Callosobruchus chinensis, Bruchidae*		Coleoptera	Pulses –Red gram(Cajanus cajan), Bengal gram(Cicer arietinum), Black gram (Vigna mungo), Green gram(Vigna radiata)
Red flour beetle	*Tribolium castaneum*, Tribolium confusum	Tenebrionidae	Coleoptera	Wheat flour, pulses
Rice moth	*Corcyra cephalonica*	Galleriidae	Lepidoptera	Rice, maize, gram, groundnut
Khapra beetle	*Trogoderma granarium*	Dermestidae	Coleoptera	Wheat, maize, rice, flour

Sun drying of grains

Sun drying is the common traditional practice followed by the farmers (92.00%) before grains and pulses storage. If moisture content is high, they are dried for longer duration in sun before storing it.

i. **Farmer's view:** To protect from storage insect pests, easy to follow due to lesser work during summer.

ii. **Scientific rationale:** Sun drying destroys existing insect pests and their different stages.[5] Sun drying helps to reduce spoilage and also enhance the dormancy period of grains.[5] Optimum grain moisture (10-12%) is necessary for proper storage of food grains/seeds.

iii. **Target crops:** Almost all crops which are stored for longer periods.

Use of ash

Seeds are filled in earthen pots to its 3/4 volume and rest 1/4 volumes filled by wood or cow dung ash. If grains are to be stored for a longer period, then after 6months the grains and pots are sun-dried and again filled with fresh ash. 78.00 % of the farmers are following this method.

Farmer's view: Wide range of storage pests are controlled for 6-10months.

Scientific rationale

i. Ash contains silica which interferes with insect feeding and also hinders fungal pathogen multiplication.

ii. Ash dust reduces the relative humidity of the storage condition and also dries the seed surface.[6]

iii. Egg laying and larval development of the storage pests could be hampered because ash dust covers the grain seeds.[6]

iv. Also affect the insect movement to search for mating partners and friction of the dust particles with the insect's cuticle leads to desiccation and hampers the development of the pests.[6]

Target crops: Pulses

Red soil coating method

Red soil and water are mixed to form a paste in a container. Seeds are transferred into this pot and mixed well so that the soil completely adheres to the seeds. Seeds are dried under shade. Seeds are transferred into a gunny bag and tied tightly and stored in dark. 60.00% of the farmers are following this method.

Farmer's view: Wide range of storage pests will be controlled.

Scientific rationale

i. As the red soil covers the grains and seeds the insect could not able to feed, lay eggs as it acts as a barrier.[7]

ii. Soil absorbs left out moisture in the seeds and grains and avoids spoilage.[7]

iii. Improves germination.

Target crops: Pulses, ragi, maize

Plastering of storage bins with clay and cow dung

Storage bins made of bamboo will be plastered with clay and cow dung which prevents insect attack from outside. 76.67% of the farmers are following this method.

Farmer's view: To reduce moisture content.

Scientific rationale:

i. Soil absorbs left out moisture in the seeds and grains and avoids spoilage.

ii. Soil and cow dung paste acts as a barrier between seeds, grains and insects.

iii. Cow dung acts as a repellent for storage insect pests.

Target crops: Pulses

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Storage of pulses with common salt

Common table salt at about 200 grams of salt was mixed manually in one kg of pulse was followed to store pulses for a period of 6-8 months. 61.33% of the farmers are following this method.

Farmer's view: Insects are kept away from the stored grains.

Scientific rationale

i. Salt has an abrasive action on the skin of insects thereby preventing their movement inside the storage containers and as a result their growth in the storage containers/bins/boxes is inhibited.[8]

ii. Salt has a hygroscopic and insecticidal property.[6]

iii. Salt helps in keeping the grain dry by absorbing the moisture thus avoiding spoilage and hence aid in safe storage.[3]

Target crops: Red gram, Bengal gram, Black gram, Green gram and other pulses and legumes.

Turmeric application method

Turmeric powder is another good alternative method to prevent the grains from insects and pests. Grains and seeds are mixed with turmeric powder before storing them in containers or jute bags. This treatment provides protection for up to 6-8months and is equally safe for consumption. 50% of the farmers are following this method.

Farmer's view: Easy method and kills the storage pests.

Scientific rationale

i. Turmerones and arturmerone are the components which act as insect repellent in turmeric. Its strong smell and insecticidal properties keep the insects away from food grains.[9]

Target crops: Pulses and cereals

Use of garlic cloves

Garlic cloves are kept in layers in the storage bins filled with seeds. Garlic cloves acts as a repellent for several pests.

Farmer's view: Easily available and acts as a repellent.

Scientific rationale: diallyl di-sulphide, diallyl tri-sulphide and diallyl sulphide are the major compounds present in Garlic has anti-feedant, bactericidal, fungicidal, insecticidal, nematicidal and repellent properties.[10]

Target crops: Pulses, Ragi, Paddy, Maize

Mixing of leaves

Leaves having insecticidal property like Neem/Margosa (*Azadirchta indica*), Nirgandi/Chinese chaste tree (*Vitex nigundo*), Madar/Calotropis etc., are collected and dried under shade till it becomes papery. These leaves are mixed with seeds and fill in the bags or storage bin.

Farmer's view: Leaves are readily available at low cost and used for management of wide range of storage pests.

Scientific rationale: Leaves of Neem/Margosa (*Azadirchta indica*), Nirgandi/Chinese chaste tree *Vitex nigundo*, Madar/Calotropis etc., has very good insecticidal properties and also acts as antifeedents, repellents and growth inhibitors of storage pests.[11–16]

Target crops: Pulses and cereals

Stepping method or Stamping method

Seeds are filled in the plastic bags and are tied with a thread tightly. Repeated stamping of the bag will avoid pest attack and also destroys the eggs and maggots that are already present in the seeds.

Farmer's view: Easy method and does not requires any ingredients.

Scientific rationale: Stamping helps to disturb insects and kills the immature and adult stages of insects.

Target crops: Pulses

Use of salt and chilli powder

250grams common salt and 250grams dry chilli powder are mixed with 20kg seeds and filled it into a plastic bag or bin.

Farmer's view: Insects are kept away from the stored grains and an easy method of storage

Scientific rationale: The pungent nature of chilli shows repellent effect on insects and salt has a hygroscopic and insecticidal property.[9,17]

Target crops: Pulses

Use of Neem/Margosa leaves

Neem/Margosa leaves are collected from the trees and dried in shade and mixed with seeds/grains and stored in gunny bags or bins.

Farmer's view: It is safe, cheap and effective method.

Scientific rationale

i. Neem/Margosa contains bitter principles called meliacins like azardiracin, nimbin, salannin, meliantriol etc., and acts as anti-feedants against several pests.

ii. The active ingredient azadirachtin, found in neem/Margosa leaves, acts as an insect repellent and insect feeding inhibitor and sterilant, antifungal and nontoxic qualities.[12–16]

Target crops: Paddy, pulses, Ragi

Use of neem/margosa leaves and dry chillies

Neem leaves and driedred chillies are placed in the bins or bags containing seeds.

Farmer's view: Seeds and grains can be protected from pests and pathogens.

Scientific rationale

i. Neem/Margosa contains bitter principles called meliacins like azardiracin, nimbin, salannin, meliantriol etc., and acts as anti-feedants against several pests.[12–16]

ii. Active ingredient azadirachtin, found in Neem leaves, acts as an insect repellent and insect feeding inhibitor and sterilant, antifungal and has nontoxic qualities.[12–16]

iii. Pungency of dried red chillies keeps away the insect pests.[6]

Target crops: Paddy, little millets, pulses

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Use of neem/margosa oil

Neem/Margosa oil is manually applied on pulses to coat every grain uniformly.

Farmer's view: The bitter taste of Neem/Margosa gives protection to their seeds and grains against pests and pathogens.

Scientific rationale

i. Neem/Margosa oil acts as repellent to many insects such as beetles, moths and weevils. Neem oil kills insects at the egg stage itself thereby saving the legumes.[18]

ii. Neem/Margosa oil has several properties like repellence, feeding, and ovi-positional deterrence, growth inhabitation etc. and it almost kills the insect even at its egg stage, so that infestation stops from the early stage itself.[6]

Target crops: Pulses

Use of Camphor

2gram of camphor is placed per 5kg of grain in the jute gunny bag which can be stored up to 3months. After 3months again the grains are sun dried and fresh camphor is kept in the bag. Camphor evaporates over time when stored. To prevent this, grains of pepper are placed along with camphor in the container.

Farmer's view: Easy method to control storage pests.

Scientific rationale: Camphor inside the storage bag repels the pests due to the strong odour emanated from camphor.

Target crops: Cereals and pulses

Use of Castor powder

Bean seeds are dried in sun for some time. Some small quantities of castor seeds are placed in a bowl, roasted for some time and ground into powder. 1/4kg Castor powder is mixed with 1kg beans seeds and stored it in a mud pot. The lid of the pot is closed and sealed it with cow dung to avoid aeration.

Farmer's view: Insects are kept away from the beans.

Scientific rationale

i. The oily nature of castor powder which is coated to the grains will form a slippery surface which avoids the egg laying by female insects upon seeds.[19]

ii. It also acts as feeding deterrent and repellent and hence grains are protected from insect pest attack.

Target crops: Beans, Pigeon pea

Sand mixture method

A thick layer of sand is added at the base of the mud potand sundried seeds are spread over this sand. Again sand is added over the seeds. The same process of filling sand-seed mixture layer by layer is continued till it reaches up to the brim of the pot. The container is closed with a lid and it is air tightened with cow dung paste.

Farmer's view: Seeds are protected from the pest attack, easy and safe method.

Scientific rationale

i. The sand particles act as an abrasive agent of insect cuticle and hence kill the insect pests.

ii. It also acts as a barrier between seeds and insects and hence protects the seeds from pest attack.

iii. Cow dung at the top of the pot acts as a repellent.

Target crops: Pulses

Use of dried red chillies

Dried chillies are kept in a container filled with seeds poring bags.

i. **Farmer's view:** The seeds are protected from the pest attack.

ii. **Scientific rationale:** Pungency of dried red chillies keeps away the pests.[6]

iii. **Target crops:** Pulses, paddy

Use of Lime powder

Lime (Calcium carbonate) is powder and mixed uniformly with grains and stored them in gunny bags at dry place. Generally 10-15gms of lime is used for 1kg of grains.

Farmer's view: The rice grains are protected from the pest attack.

Scientific rationale: The lime has a repellent and antifeedant property and lime also prevents insects to get multiplied.[6]

Target crops: Cereals

Use of Matchbox

It is the oldest method generally used by the ladies at houses for storage of food grains. Match boxes are kept in layers. Generally 8-12 matchboxes kept at the middle, bottom and top of the container and tightly close the lid of the container.

Farmer's view: Seeds are protected from the pest attack.

Scientific rationale: Phosphorous in the matchsticks have strong repellent properties which help to avoid the infestation.[6]

Target crops: For almost all types of seeds/grains.

Fumigation of the godown (warehouse)

Before storing the seeds/grains the godowns (warehouses) are fumigated with leaves of Vitex, Neem ,Pongamia, etc.,

Farmer's view: Preventing the pest attack upon seeds/grains.

Scientific rationale: Fumigation helps in killing the hibernating stages of stored insect pests present in cracks and crevices and creates an inoculums free storage facility.

Target crops: all field crops

Use of Neem/Margosa seed powder

Neem seed powder is mixed at the rate of 1% to the volume of the seed.

Farmer's view: The bitter taste of Neem/Margosa gives protection to their seeds and grains against pests and pathogens.

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Scientific rationale: Neem has several properties like repellence, feeding, and ovipositional deterrence, growth inhabitation etc.[12–16]

Target crops: Pulses

Use of Ginger rhizome

30 grams of Ginger rhizome powder is mixed with 1 kg of pulse

Farmer's view: The Pungent taste of ginger gives protection to their seeds and grains against pests and pathogens.

Scientific rationale: Presence of alkaloids, anthocyanins, flavonoids, tannins in ginger makes ginger to act as anti feedant and repellent against pests.[20]

Target crops: Pulses

Use of Custard apple seed powder

50 grams of custard apple seed powder with 1 kg of any of the pulse are mixed to prevent the attack of the pulse beetle.

Farmer's view: Seeds are protected from the pest attack.

Scientific rationale

i. Repellent and oviposition deterrent property of custard apple seeds protects seeds/grains from bruchid attack.[19]

ii. The acetogenins present in custard apple seeds shows insecticidal and vermicidal effects.

Target crops: Pulses

Use of tulsi/basil seeds

The seeds of Maize are mixed with dried seeds and leaves of tulsi/basil (Ocimum sanctum)

Farmer's view: Protects the seeds from the weevil attack during storage.

Scientific rationale

i. Tulsi/basil has a very good repellent property.[19]

ii. The palmitric acid, linolenic acid, linoleic acid and stearic acid present in tulsi seeds have antifeedant and larvicidal effect.[19]

Target crops: Maize

Conclusion

Stored grain pests seriously damage food grains during storage. Several synthetic pesticides were used, but they have shown adverse effects on environment and persist for longer period in form of residues and entered in the food chain after utilization of products by organisms. Hence to replace these chemicals, safer eco-friendly and farmers friendly methods were evolved. Most of these practices are indigenous practices enhances utilisations of locally available materials. These methods protect the food grains, do not cause health hazards apart from being eco-friendly, cheaper and locally available materials. This collection of traditional agricultural knowledge/practices is of great significance in conserving and maintaining sustainability of the environment. Further it requires integration with modern scientific knowledge to generate a wide range of new ideas and practices for the betterment of the mankind. Although these all above discussed traditional agricultural knowledge/practices were available in the tribal setting but now not at reducing rate. So there is need to motivate the tribal farmers to use these practices as past to save the agricultural produce. Simultaneously these traditional agricultural knowledge/practices must be generalized among other farming communities of the country as well.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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