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Documentation of Indigenous Storage Practices of Pulse Seed

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Abstract: Storage of pulse seed is a crucial postharvest operation. But storage practices vary over local natural resources, climate and culture of the society. This study assessed indigenous storage system of pulse seeds in six selected pulse growing districts in Bangladesh. Data were collected from 180 sample farmers through survey method and multistage stratified random sampling technique was followed to select these farmers. It was observed that farmers mostly cultivated mungbean, grass pea, lentil, chickpea, blackgram and pea of which mungbean, lentil and grasspea covered 84% of the total pulse crop cultivation. Sun drying was found to be the most commonly practiced traditional seed drying system, accounting for 100% of the respondents. A number of storage materials were used in the survey areas of which plastic drum was found to be the mostly adopted storage materials. Survey farmers were found to treat seed before storing it for future use. Overall, 42% of the total surveyed farmers used neem leaves as treating materials while 24% did not apply any treatment. These indigenous methods are useful for sustenance and compose a prominent role in the development of agriculture. It would be wise to keep an eye and encourage indigenous practices extensively for self-sustenance with a goal to diminish paucity and starvation among native folks and enhance use of locally available cheaper sources where it is adoptable, cost effective and prolong storage life of seed.

Keywords: Indigenous storage practices; Pulse seeds; Storage life; Storage structure; Seed treatment.

INTRODUCTION

Pulse plays an important role in people's diet and can help to give balanced nutrition where pulses are effective protein producers and require few resources (Havlin *et al*., 2014). It is a good source of protein and has low glycemic index (FAO, 2016), free of gluten and can be used as a functional food (Rao, 2002). Pulses are important crops for ensuring food security, fighting with malnutrition, alleviating poverty, improving human health and increasing agricultural sustainability (Garg and Geetanjali, 2007). Azevedo *et al*., (2003) reported that seed storage is a fundamental practices where physiological seed quality is controlled and it is a method for preserving the seed viability and keeping their vigour at a reasonable level between planting and harvesting. Bortey *et al*., (2016) stated that seed viability is affected due to seed storage period because seed viability decreases directly proportionally to time and viability was influenced by seed storage environments such as temperature and relative humidity in addition to storage period (Sisman, 2005). Indigenous seed storage is an environmentally friendly and plays an important role in preventing losses which are caused mainly due to insect pests, pathogens and rodents. Bangladesh's grain production has steadily increased due to advances in technology, but postharvest loss is constant at around 10%. Losses during storage, accounts for around 6% of the total losses as proper storage facilities are not available (Karthikeyan *et al*., 2009). In is estimated that 60-70 % of food grains are stored by the farmers for their own consumption (Prakash *et. al*., 2016). 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 seed produced in the farmer's field is stored at home level in indigenous storage structures and seeds are protected at home level by using indigenous technology (Dhaliwal and Gupta, 2010). It has been reported (Karthikeyan *et al.,* 2009) that various synthetic pesticides have been applied to protect stored grains and other agricultural products from insect infestation but it is matter of sorrow that their massive use has imposed so many detrimental effects on the environment and cause intoxication of non-targeting organisms However, these chemicals are declared ecologically unsafe because these persist for longer periods in the environment and enter into the food chain. Kausarmilik and Rizwana, (2014) reported that certain insect pests have acquired resistance against most of the insecticides. To eradicate the worst effect of synthetic pesticides, it is the best way to practice indigenous seed storage where seed storage containers are made of locally available materials and vary in design, shape, size, and function (Kanwar and Sharma, 2003) for protecting the seeds from insect pest attack. Therefore, the indigenous seed storage practices should be documented and find out the suitable and the most effective practices of pulse seeds which can be used by the present and subsequent generations.

MATERIALS AND METHODS

Selection of study area and sample size

Selection of the study area is an important step in conducting any research. Six districts namely Madaripur, Faridpur, Jashore, Pabna, Barishal and Patuakhali were purposively selected based on intensity of pulses crop production. One upazila was selected from each of the selected district. Multistage stratified random sampling method was followed to select the survey farmers from each of the selected upazila. 30 pulse crop farmers were selected from one upazila to conduct the survey. Thus, in total 180 pulse farmer were taken under consideration for conducting the final survey.

Preparation of the survey schedule

Field survey was undertaken to different three locations using the multistage stratified random sampling method to record the desired information from the respondents. Local people were communicated during the visit for collecting the information regarding all the details through one to one discussion. The details information where pertaining to the storage structure, type of materials used for construction, method of construction, longevity of seed storage, types of crops with management practices were collected from the farmer's and was documented accordingly and compared.

Data Collection and Analysis

The study was based on primary data collected through face to face interview which needs considerable time. Data collection started from March 2021 and it was completed by June 2021. Data were collected by the researcher himself and two scientific assistants from the seed technology division of BARI helped to do it. Repeated visits and communications were made for collecting necessary information. In most cases tabular method of analysis was done. Both descriptive and inferential statistics were used to fulfill the objectives.

RESULTS AND DISCUSSION

Demographic information of the respondents

Age categories of the surveyed farmers were categorized into four different age groups viz. 15-30 years, 31-45 years, 46-60 years and above 60 years. It was evident from Table 1 that the majority of the respondents (35%) were in between 46-60 years followed by 31-45 years (34%) and 15-30 years (18%). Table 1 also reflects that 13% of the sample respondent's age were above 60 years.

In (Table 1) shows the literary status of the survey respondents where educational attainment was categorized into five different groups. It was found that half of the sample respondents' educational attainment was primary level education. Besides, 27% of them completed high school level education. Only 3% of the sample respondents completed degree level education. Farm size of the ample respondents has enumerated in the Table 1 where majority of the respondents were small (82%) and 15% of them were medium and only 3% of them were large farm categories. (Table 1).

Cultivation of own land in response to own cultivable land

Among the participants 42% respondents cultivate pulse crop in 25-50% of their own cultivable land and 31% respondents cultivate pulse crop in above 75% of their own cultivable land. 10% and 17% respondents cultivated pulse crops in below 25% and 51-75% of their own cultivable land respectively. (Table 1).

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Table 1. Profile of the respondent farmers in the study areas

Particulars	% of respondents
1. Age	
15-30 years	18
31-45 years	34
46-60 years	35.0
Above 60 years	13.0
2. Literacy status (%)	
Can sign only and Primary level (Class I-V)	50
High School level (Class VI-VIII)	27
Secondary level (VIII-X)	13
Higher secondary level (HSC)	7
Degree & above	3
3. Farm size (%) (BBS 2021)	
Small (0.05 - 2.49 acres)	82
Medium (2.50-7.49 acres)	15
Large (7.50 acres and above)	3
4. Percentages of pulse crop cultivation in response to own cultivable land	
Below 25%	10
26% to 50%	42
51% to 75%	17
above 75%	31

Cultivation of pulse crop in response to other cultivated crops

In (Table 2) shows cultivation of different pulse crops in response to individual pulse crops. It was evident from the study that mungbean was found to be cultivated in Barishal and Patuakhali district accounted for 100% of the sample farmers. Grasspea was cultivated mostly in Madaripur and Faridpur district and it was cultivated by 80% and 83% of the total surveyed farmers respectively. Faridpur and Jashore were the two major lentil growing areas where 90% and 97% of the respondents cultivate lentil respectively. On the other hand, chickpea was not so much popular among the cultivators. It was found to be cultivated mostly in Madaripur, Faridpur, Jashore and Barisal district accounted for 13%, 10%, 17% and 3% respectively. Blackgram was cultivated mostly in Pabna district (30%) followed by 17% in Jashore district and 10% in Faridpur district. No blackgram farmer was found in Barisal and Patuakhali district. Pea was found to be cultivated mostly in Faridpur district (23%) followed by Jashore (17%) and Pabna district. Likewise, Blackgram, no pea farmer was found in Barisal and Patuakhali district. Considering the cumulative percentage of pulse crop in documented area it can be divided into two groups, major pulse crop (mungbean, grass pea and lentil) and minor pulse crop (chickpea, black gram and pea). Lentil (30.68%), grass pea (24.52%) and mungbean (28.46%) occupied almost 84% of the pulse crop cultivation. Chickpea, Blackgram and pea occupies the rest of the area accounted for 4.34% to 5.95% (Fig. 1).

Table 2. Cultivation of pulse crop in response to individual pulse crops

	Farmer responded (%)*					
Pulse crops	**Madaripur**	**Faridpur**	**Jashore**	**Pabna**	**Barishal**	**Patuakhali**
Mung bean	3	6	30	43	100	100
Grass pea	80	83	7	33	40	0
Lentil	27	90	97	73	17	0
Chickpea	13	10	17	0	3	0
Blackgram	3	10	17	30	0	0
Pea	6	23	17	13	0	0

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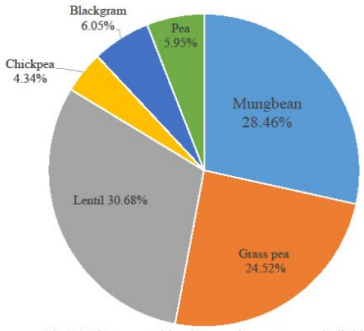

Fig 1. Pulse crop cultivation rate in response to individual crop

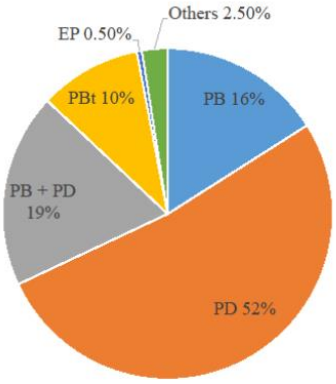

Fig 2. Seed storage material

PB>Polythene bag, PD>Plastic drum, PB+PD> Polythene bag + Plastic drum, PBt> Plastic bottle, EP> Earthen pot

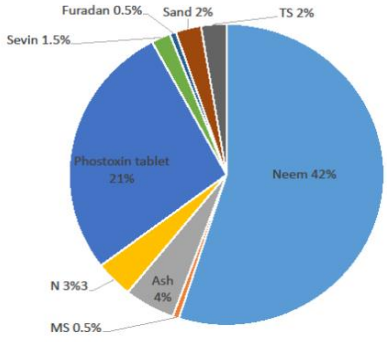

Fig 3. Different seed treating materials

**N>Naphthalene, MS>Mehogoni seed, TS>Tamarind seed

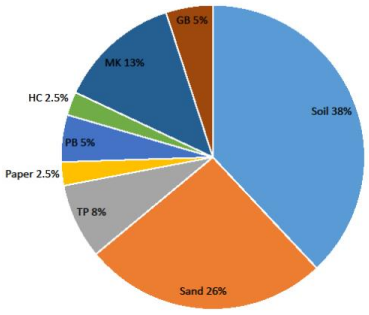

Fig.4 Different media used for germination test

***HC> Husk of coconut, PB>Pseudostem of banana, TP> Tissue paper, MK> Man Kochu, HC> Husk of coconut, GB> Gunny bag

Methods of seed drying and seed moisture determination

Seed drying methods

One of the common traditional indigenous practice is sun drying followed by all the surveyed farmers (100%) before stored it for future use. If moisture content is high, they are dried for a longer duration in the sunlight before storing it. (Table 3). Protecting from insect and pest during storing time and easy to follow due to availability of sun heat. Sun drying destroys existing insect pests and their different stages. Sun drying helps to reduce spoilage and also enhance the dormancy period of seeds. (Kumar and Parmar, 1997). Optimum pulse seed storage moisture (8-10%) is necessary for proper storage of pulse seeds. All the surveyed (100%) respondents practiced moisture determination test. Of them, by biting the seeds was the mostly practiced method of moisture determination test. Some of them determined their seed moisture by both biting and rubbing of seeds between two the palms. (Table 3).

Table 3. Seed drying methods and system of moisture determination of the respondents

Seed drying methods	
Sun drying	100%
Moisture determination	100%
System of moisture determination (Multiple correspondent)	
Biting	100%
Rubbing of seeds between two palms	3%

Seed Storage material in different areas

Seed storage materials highly differ from location to location. Polythene bag/ plastic Sac, Plastic drum, and Polythene bag plus Plastic drum were more common in all areas. Plastic bottles were found popular in Pabna region and Polythene bag/plastic sac was found more popular in Jashore region. Earthen pot, Brass pitcher and Matka were found almost abolished from all areas. Plastic drum was found more popular in all regions except Madaripur. In Madaripur region farmers put their seeds in polythene bag first and then stored these in Plastic drum. (Table 4). From the farmer's view seeds stored in plastic drum and polythene bag plus plastic drum were effective for storage of pulse seed up to next growing season with minimum or

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zero infestation of insects and zero infection of storage pathogens. Properly dried seeds kept in plastic drum and in polythene bag + plastic drum remain airtight where insects and pathogens did not find their favorable environment for multiplication or remain active. Considering the cumulative percentage of storage material in the documented area it can be mentioned that plastic drums are well adopted by the respondents and it occupies 52% of total. Some use both polythene bag and plastic drum (19%) and 16% of respondents use only polythene bag/plastic sac. The earlier traditional practices like earthen pot, matka, brass pitcher etc. are becoming less popular day by day and it ranges from 0.5-2.5% only. (Fig 2).

Table 4. Seed Storage material in different areas

Seed Storage material	Farmer responded (%)*					
	Madaripur	Faridpur	Jashore	Pabna	Barishal	Patuakhali
Polythin bag/ plastic Sac	20	3	60	13	10	3
Plastic drum	17	90	40	63	70	77
Polythene bag + Plastic drum	60	20	17	10	7	17
Plastic bottle	0	0	-	57	7	3
Earthen pot	3	0	-	-	-	-
Others (Brass pitcher and Matka)	7	7	-	3	-	-

* multiple responses

Seed treating materials during seed storage

Majority of the respondents (57%) in Patuakhali region do not use any seed treating materials. Farmers of Madaripur and Faridpur region generally like to treat their seed, but a moderate number of farmers of these areas do not treat their seed. A very few farmers of Barishal region (7%), Jashore region (10%) and only 1% farmer of Pabna region does not treat their seed during storage. (Table 5). Considering the cumulative percentage of seed treating materials neem leaves occupies most of the area (42%). Phostoxin tablets (21%) are becoming more popular day by day and adopted very rapidly by the farmers. Earlier traditional practice of using ash, sand and mahogany seed is still practiced by some farmers and it ranges from 2-4%. Though sevin powder, furadan and naphthalene are available in local markets but not yet can take place in farmer's preference. (Fig 3).

Use of Neem leaves

Neem leaves are collected from the trees and dried in shade and mixed with seeds and stored in a plastic sac, plastic drum or in polythene bag plus plastic drum. Neem leaves were recorded as one of the most common seed treating materials during storage period. Most of the farmers use dried neem leaves, some of them use fresh neem leaves directly to the seed. According to farmers' opinions, using neem leaves either directly or by using these after drying does not differ much. 37% to 67% respondents use neem leaves as seed treating material in different areas of Bangladesh except Patuakhali region. In Faridpur and Jashore region Farmers use neem leaves mostly 67% and 63%, respectively. Farmers use neem leaves moderately in other documentation areas. (Table 5). From farmer's view, it is safe, cheap and effective method and from scientific rationale Neem contains bitter principles called meliacins like azardirachtin, nimbin, nimbicidin, salannin, meliantriol etc., and acts as anti-feedants against several pests. The active ingredient azadirachtin, found in neem leaves, acts as an insect repellent and insect feeding inhibitor and sterilant, antifungal and nontoxic qualities (Kwasi et al., 2011)

Use of Ash

Seeds are filled in a plastic drum to its 3/4 volume and rest 1/4 volumes filled by wood or cow dung ash. If seeds are to be stored for a longer period, then after 6 months the seeds and drums are sun-dried and again filled with fresh ash. 12% farmers of Madaripur and 10% farmers of Pabna are following this method. (Table 5). From farmer's view it is wide range of storage pests are controlled for 6-10 months and from scientific rationale ash dust reduces the relative humidity of the storage condition and also dries the seed surface (Rekha and Padmakar, 2014). Also affect the insect movement and interferes in mate searching and friction of the dust particles with the insect's cuticle leads to desiccation and hampers the development of the pests (Rekha and Padmakar, 2014).

Use of dried seeds of mahogany and tamarind

Dried seeds of mahogany and tamarind are mixed with the seeds and these seeds are stored in containers. Use of mahogany seed was recorded only in Jashore region (3%) and use of Tamarind seed was recorded in Madaripur and Patuakhali region (6% and 10% respectively). (Table 5). From farmer's view the seeds are protected from the pest attack and from scientific rationale pungency of dried seeds of mahogany and tamarind keeps away the pests (Rekha and Padmakar, 2014)

Sand mixture method

A thick layer of sand is added at the base of the drum of the sun dried seeds and is spread over. Again sand is added

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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 drum. The container is closed with a lid and it is air tightened with its cover.

Sand is most commonly used in Pabna region. 13% of the total respondents use this practice. But this method is not adopted by the farmers of other regions. (Table 5). From farmer's view seeds are protected from the pest attack, an easy and safe method and from scientific rationale the sand particles act as an abrasive agent of insect cuticle and hence kill the insect pests. It also acts as a barrier between seeds and insects and hence protects the seeds from pest attack.

Use of Fumigation tablets and insecticides

Before storing the seeds in the drum or plastic sac or in plastic bottles farmers use different types of Fumigation tablets and insecticides namely phostoxin tablet, naphthalene, sevin powder, furadan etc. Most of the farmers prefer phostoxin tablets as a seed treating material during the period of storage. Use of phostoxin tablets ranges from 3-50% in different regions (except Faridpur region). In the southern belt (Barishal and Patuakhali region) majority of the farmers use this fumigating tablet ranging from 33-50%. Naphthalene, sevin powder and furadan are not much popular seed treating material but used in different locations sporadically. Of them furadan and sevin powder are used only in Faridpur region. (Table 4). From farmer's view preventing the pest attack upon seeds/grains and scientific rationale Phostoxin tablet, naphthalene and insecticides helps in killing the hibernating stages of stored insect pests present in cracks and crevices and creates an inoculum free storage facility.

Table 5. Seed treating materials during seed storage

Seed treatment material	Respondent farmers (%)						
	Madaripur	Faridpur	Jashore	Pabna	Barishal	Patuakhali	All areas (%)
Neem leaves	37	63	67	43	43	0	42
Ash	12	0	0	10	0	0	4
Mehogoni seed	0	0	3	0	0	0	1
Tamarind seed	6	0	0	0	0	10	3
Sand	0	0	0	13	0	0	2
Phostoxin tablet	3	0	17	23	50	33	21
Nepthalin	3	0	3	10	0	0	3
Sevin	0	10	0	0	0	0	2
Furadan	0	3	0	0	0	0	1
No treatment	42	24	10	1	7	57	24

Post storage germination test

There was no document recorded on pre-storage seed germination tests in any region. Majority of the farmers do not test their seed for germination after post storage also. The highest (83%) percentage of post storage germination test was recorded in Pabna region and the lowest (0%) was recorded in Barishal region. For germination tests farmers generally used soil and sand media. They also use many other mediums like tissue paper, pseudostem of banana, husk of coconut, man-kochu and gunny bag. Soil media is mostly used in Madaripur region (89%) and moderately in Pabna (36%) and Patuakhali (20%) region. Farmers of Faridpur (60%), Jashore (50%) and Patuakahli (40%) region prefer sand as germination testing material. Farmers of Faridpur region also prefer tissue paper for germination tests. Pseudostems of banana, man-kochu, Paper, husk of coconut and gunny bags were recorded location specific. Pseudostems of banana and man-kochu were recorded in Pabna and Jashore region. Paper was recorded only in Patuakhali fregion and husk of coconut was recorded only in Madaripur region (Table 6).

Considering the cumulative percentage of different media used for germination testing, soil and sand occupies around 64%, where soil occupies the majority portion (38%). In some areas germination testing is still done by their traditional methods like man-kochu and husk of coconut, but man-kochu is more popular and around 13% of the total respondents still practice it. The other media, namely gunny bags, tissue paper, paper etc. are not too common and farmers are not interested to adopt them. (Fig 4).

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Table 6. Post storage germination test

Procedure of germination test	Farmer responded (%) – Multiple correspondent													
	Madaripur		Faridpur		Jashore		Pabna		Barishal		Patuakhali		All areas (%)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	30	70	33	67	53	47	83	17	0	100	33	67		
Soil	89						36				20			
Sand			60		50		16				40			
Tissue Paper			40				7						39	61
Paper											20			
I. PSEUDOSTEM OF BANANA	11						14							
II. HUSK OF COCONUT	11													
III. MAN-KOCHU					44		40							
IV. GUNNY BAG					7						30			

*Pre-storage germination test > 0%

Insect infestation during storage and post storage germination rate

28% respondents reported insect infestation during storage period and the rest had found clean seed after storage period. If insect infestation occurred then farmers generally dried their seeds in high scorching sunlight from one to three times. In that case 73% farmers dried their seeds only one time and according to their opinion if they can do it properly seeds become insect free again. Considering the post storage germination rate farmers are satisfied with the result. In 96% cases respondents reported about 75% and above germination percentage. Only 4% reported below 75% germination % (Table 7). After the pulse crops is harvested, pulse grains are collected for sun dried, clean and packed in jute gunny bags.To protect from storage pests, farmers keep a weed plant, Naithulasi (Ocimum sp.) and chilli fruits with pulse grain where strong odor of Naithulasi (Ocimum sp.) and stringent smell of chilli helps to control storage pests like pulse beetle, lesser grain borer, flour beetles, etc. Pulses crops like black gram, green gram were mixed up with coconut oil and kept in containers made up of plastic or tin.

Table 7. Insect infestation rate and drying of seeds during storage, and post storage germination rate

Insect infestation (% on total)	Seed drying during storage period			Germination rate	
	Yes		No		
28	48%		52%	Above 75%	96%
	3 Times	5%			
	2 Times	22%		below 75%	4%
	1 Time	73%			

CONCLUSION

Indigenous storage practices are used by local people to make a living in a particular environment and is a valuable resource for development. Furthermore, indigenous practices for pulse seed storage is an eco-friendly, cheaper and locally available materials. From the study, 41% respondents are interested to adopt new technology and the rest are satisfied with their storage system. An appropriate and optimal blend of indigenous and modern wisdom would be the right answer for good impact and better utilization of the native knowledge by the rural artisans.

Conflict of Interest

There is no conflict of interest to declare.

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