

## **A Study on the Assessment of Improved Potato Storage Facilities in Bangladesh**

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### **Abstract**

A research study was conducted to assess the improved potato storage facilities in Bangladesh. Secondary data were collected for five improved potato storage facilities related to their storage performance such as temperature, relative humidity, storage losses etc. Storage performance was evaluated by comparing performance parameters of each storage. Results revealed that storage facilities like improved potato storage bin and improved evaporative cooling bin need further modification and research. Storage losses of natural improved storage and innovative ambient potato storage facilities can be reduced by adopting proper post-harvest management. It also indicates that evaporative cooling chamber performed well than any other improved potato storage facilities considering the storage environment, storage losses and farmers' economic aspects.

**Key words:** Potato storage, Temperature, Relative humidity, Storage losses, Storage cost.

### **1. Introduction**

The production of potato in Bangladesh is greatly influenced by many post-harvest problems such as storage, price fluctuation, demand for potato etc. Among them preservation of potato is key problem for the growers. Not all farmers can avail the facility of cold storages due to their financial insolvency and most of the traditional storage methods are inefficient. Under ordinary conditions, potato, a semi-perishable commodity, cannot be easily stored, particularly in the plains and tropical areas where high temperatures and dry weather prevails following harvest. Therefore, proper storage facilities are essential to sustain increased potato production. Among different problems has created by rapid production of potato, storage problems are the most acute. To overcome the problem maintenance of required temperature and relative humidity for potatoes during storage is important. In addition, the design of storage facilities needs to build according to the standards. The four main outlets for stored potatoes are seed potatoes, household consumption, the processing industry and potatoes as raw material for the production of starch or alcohol. Choice of storage method must be considered as per requirements for each purpose. To remain viable and competitive, processors demand high quality potatoes from producers.

Therefore, the producers must provide a storage atmosphere that can maintain high tuber quality throughout the storage period.

There are generally three different types of potato storage facilities in Bangladesh. They are: i) traditional storage, ii) cold storage, iii) improved storage. Usually farmers use the various traditional storage methods and improved storage methods for consumption and both in private and government sectors potatoes are stored in cold storage for seed purpose. In traditional or indigenous storage, there is problem in maintaining desired temperature and relative humidity. Moreover, the quality of stored potato is low and more susceptible to pest (insects and rodents). The storage losses are high as well. Therefore, there is scope to improve traditional storage facilities considering the problems, which have been taken into account designing good storage structure is known as improved potato storage facility. The problem can be solved by applying various engineering approaches and recent innovation of storage technology. However, low cost improved potato storage is a relatively new term in our country. Few storage facilities were designed and developed mostly in different laboratories and research centers. Therefore, there is need for assessment of improved storage facilities for the farmers and intermediaries considering the financial

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conditions and the year round climate conditions in Bangladesh. Considering the problems stated above the specific objectives of the study are: i) to evaluate overall performance of improved potato storage facilities, ii) to recommend the suitable facility for farm household.

## 2. Overview of Potato Storage Management

Management of stored potatoes divided into several stages as (Brook *et al.*, 1995): Equalization and drying phase, wound healing phase, preconditioning phase, cooling phase, holding phase, reconditioning phase. Now in Bangladesh the potato storage management system can be described as following (Hossain and Ali, 2000):

- i. In Bangladesh, drying process usually done in natural condition under shade because there is positive vapor-pressure deficit exists. The drying process is over as soon as all the tubers are free from surface moisture.
- ii. Then curing is done two times. One time in the field after hum pulling where potatoes are kept under loose soil for 7-10 days, then drawn from the dry and loose soil by spade or country plough. Immediately after drawn, potatoes are brought under shade to avoid contact of sunlight. Potatoes are kept under the shade for 10-15 days in a pile of 0.3 m height until complete curing and each 1-2 days pile potatoes are put upside down for better treatment.
- iii. Cooling is a vital function for storage management in Bangladesh. In traditional method, potatoes are kept in ambient air in the cooler part of dwelling house or in the basket having provision of aeration or natural ventilation.
- iv. Various holding temperature of potato in our country is varied with the intended use of the tuber. The holding temperature of potato tuber need to be 2-2.8°C for using it as a seed. Temperature ranges between 7-12°C for consumption and processing purpose. The relative humidity of the air must be above 95% irrespective of the intended use.
- v. In traditional method no heating up and reconditioning method needed. However, in cold storage, pre-heating before unloading is done to 12-15°C for 1-2 days and by fan for 1 day.

### 2.1 Identification of performance parameters of improved potato storage for assessment

From the above discussion of potato storage management in Bangladesh following performance parameters were identified for assessment.

#### 2.1.1 Temperature

Optimal holding temperatures for potatoes in storage depend on the potato variety and the intended end use of the product. Potato is mainly stored in our country from March-April, when the ambient temperature is quite high in our country. Therefore, storage temperature is an important parameter for storage performance. An increase or decrease in potato storage temperatures can minimize disease development. By reducing holding temperature, many storage disease problems can be minimized. Higher temperatures increase the tuber respiration rate, thereby decreasing detrimentally high reducing sugar concentrations.

#### 2.1.2 Relative humidity

During storage proper humidity, monitoring inside the store is essential. Low humidity cause shrinkage in the potato tubers and over high humidity cause condensation inside the storage. Shrinkage loss in storage is directly proportional to the length of the storage season and inversely proportional to the relative humidity conditions maintained within that storage. Low relative humidity will lead to shrinkage and weight loss while too high. However, in practice, the relative humidity is kept between 90 to 96% (Rastovski, 1987).

#### 2.1.3 Ventilation

Ventilation is the most important factor for maintaining correct temperature, relative humidity and air quality in the storage. High ventilation rates increases transpiration losses. Ventilation can be either a passive system (i.e. natural ventilation) or an active system using fans for forced ventilation. Evaporative cooling is often part of a fan ventilation system. A good control system of ventilation provides stable temperature and relative humidity during storage.

#### 2.1.4 Power resources

Resources like water, electricity, fuel, gas, solar energy, water energy etc. can be used in storage for

providing good climate and for reducing storage cost. Solar and wind energy is a potential source of natural energy. Surface water or ground water can be used for cooling and humidifying purposes.

### 2.1.5 Storage losses

The storage losses to which potato is subjected include (1) respiration, (2) transpiration or water loss, (3) sprouting after dormancy is over, (4) rotting or spoilage (5) change in chemical composition and (6) damage from pests. In general, storage loss is 12-30% in traditional storage methods and 2.5% in cold storages (Rahman, 1993). The storage loss is 3-5 times higher in July than that was by June in case of traditional method in 5 months storage time whereas highest loss in September-October in case of cold storage in 10 months storage from March. The storage loss is very low in March for both cases, which is the period of just after harvesting (Saha, 2006).

### 2.1.6 Economics of storage

For estimation of the economic viability of the store cost details of the materials, equipment, labour etc. prevailing at the time of construction were taken and storage cost per kg was worked out based on estimated values of potatoes at the time of storage until end of storage.

## 3. Methodology

Five improved potato storage facilities selected for the assessment and their short description is given below:

### 3.1 Natural improved storage structure

An improvised well-ventilated thatch house measuring 3.5 m x 4 m x 4 m was designed and developed with several stairs, 0.75 m-1.0 m between stairs. It situated at the Tuber Crops Research Sub-Centre, Bangladesh Agricultural Research Institute (BARI), Munshigonj. The tubers can be stored under natural condition in each stair staking in layers of 0.25-0.30 m for 4 months without significant storage loss in such storage house (Fig. 1).

### 3.2 Evaporative cooling chamber

The evaporative cooling chamber was built at the workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University,

Mymensingh (Fig. 2). It was built with interior and exterior walls made of bricks. The dimensions of the chamber are 2.12 m x 1.52 m x 0.91 m and 0.10 m gap between the exterior and interior walls were filled with ordinary sand, which was kept wet by water. It was built with interior and exterior walls made of bricks. The roof was made of a timber frame covered with straw that provided good ventilation. Several numbers of saline packets (wasted) were used to drip water into the sand to keep continuous moisture.



Fig. 1: Improved natural storage (Hoque, 2011)

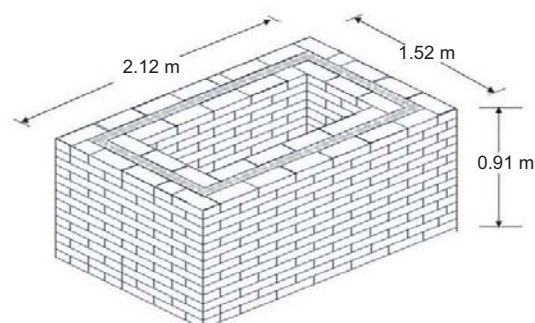


Fig. 2: Isometric view of the evaporative cooling chamber (Emon *et al.*, 2011)

### 3.3 Innovative potato storage structure

“Innovative Potato Storage” that is a component of the CIP/AVRDC horticulture project in Bangladesh funded by USAID Bangladesh provided to the Horticulture Innovation Lab through the International

Potato Center (CIP). In the districts of Jessore and Barisal, a small type of potato storage was piloted with traditional materials available locally. For the construction of the small “Ambient Type Potato Storage” in the designated areas, the project used local materials such as bamboo, straw, and locally made concrete (Fig. 3).



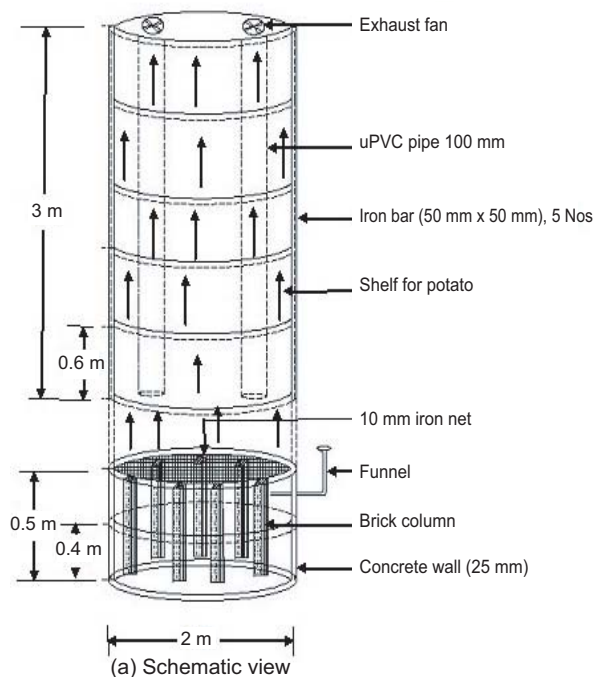
Fig. 3: Innovative potato storage structure (Reid *et al.*, 2011)

### 3.4 Improved potato storage bin

The improved potato storage bin was built at workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. It works on the principle of evaporative cooling. Improved Evaporative Cooling System (ECS) store was constructed using locally available material such as cement, sand and M.S. rod. Reinforced cement concrete and bricks were used to build the evaporative chamber having 2.0 m diameter and 0.5 m height at the bottom of the store (Fig. 4a & 4b).

### 3.5 Improved evaporative cooling bin

Improved Evaporative Cooling System (ECS) was constructed using locally available material such as bamboos, sliced wood, plastic paper and dhari at the workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. Six water jars were placed at below the shelf with cool water for cooling and moist. To facilitate evaporation and successive cooling action, one exhaust fan that powered by AC connection was used. The height and breath of the experimental



(b) Pictorial view

Fig. 4: (a) & (b). Improved potato storage bin (Monirul, 2013)

storage structure were 2.6 m and 1.0 m, respectively and the height of each shelf was 0.4 m. An experimental prototype of the bin and its cooling chamber were shown in Fig. 5.

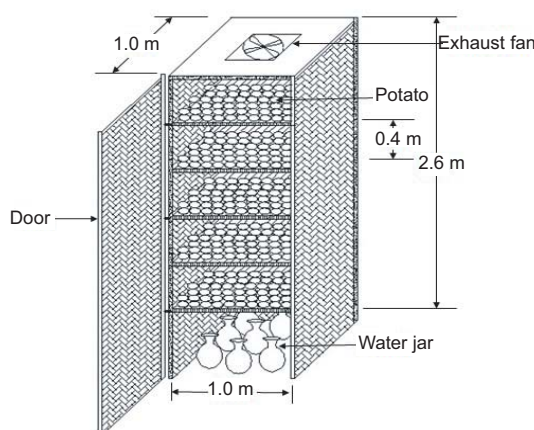


Fig. 5: Schematic view of the improved evaporative coolingbin (Raisul, 2014)

### 3.6 Data collection

Secondary data were collected from various sources that used to assess the performance of the selected storage facilities. The types of data obtained from various sources such as: Government publications, publication of foreign governments and international organizations, journals, project reports and publication of various organizations etc.

## 4. Results and Discussion

### 4.1 Comparison of the selected improved storage facilities

If farmer need to select between various improved storage facilities, they need to have idea on their performance. Table 1 shows different parameters of selected improved potato storage facilities.

Ventilation is required to maintain the temperature of stored potatoes at the selected level. Exhaust fan was used in both the improved evaporative cooling bin and improved potato storage bin. It is commonly known as forced ventilation process. All the other storage facilities here developed with the principle of natural convective ventilation. Both the improved evaporative cooling bin and improved potato storage bin were developed with the principle of evaporative cooling. Water energy was used in evaporative

cooling chamber. For running the exhaust fans solar energy was used in improved potato storage bin and an AC connection was used in improved evaporative cooling bin.

### 4.2 Temperature

Among the selected storage facilities natural improved storage structure and innovative potato storage structure were 'Ambient type'. Temperature of the storage was as same as ambient temperature. On the other hand, both evaporative cooling chamber and improved evaporative cooling bin reduced the ambient temperature and created a relatively cool environment inside the storage facilities. The highest, lowest and average temperature of the storage facilities are shown in Fig. 6.

### 4.3 Relative humidity

Relative humidity is a very crucial parameter for a humid country like Bangladesh. A profile was made with the help of the data on humidity of the improved storage facilities (Fig. 7). The profile showed that only evaporative cooling chamber can maintain the humidity required for the good storage.

### 4.4 Storage losses

The highest storage losses found in the innovative potato storage structure, as it was more of traditional type storage (Fig. 8). Wide range fluctuation of temperature and relative humidity increasing the storage losses in this structure. Improved evaporative cooling bin, evaporative cooling chamber and improved potato storage bin reduced the storage losses than traditional storage by maintaining lower temperature than other storage facility and high relative humidity closer to good storage condition.

### 4.5 Storage cost

A graphical representation made in Fig. 9. showing the storage cost for different improved facilities. Lowest cost for storing per kg of potato was found in natural improved storage structure due to low cost construction material. Improved potato storage bin cost for storing potato was highest. Because of installing exhaust fan and high price of construction material, the cost for storing potato was highest in this facility.

Table 1: Comparative parameter of selected storage facilities

| Selected potato storage facilities          | Capacity (kg)  | Power resources      | Capital cost (Tk) | Method of ventilation |
|---------------------------------------------|----------------|----------------------|-------------------|-----------------------|
| Natural improved storage structure          | 8000           | None                 | 20000             | Natural               |
| Evaporative cooling chamber                 | 1125           | Water                | 3450              | Natural               |
| Improved potato storage bin                 | 1000 (Approx.) | Water and solar      | 10000 (Approx.)   | Forced                |
| Improved evaporative cooling storage        | 500            | Water and electrical | 3590              | Forced                |
| Innovative ambient potato storage structure | N/A            | None                 | N/A               | Natural               |

\* N/A = Not available

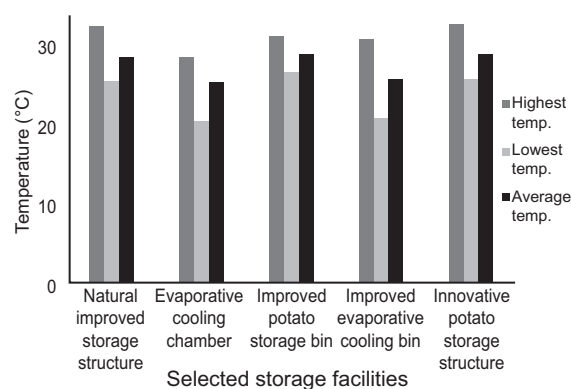


Fig. 6: Temperature profile of the storage facilities

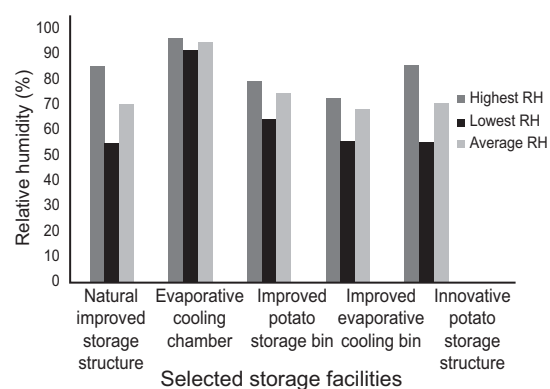


Fig. 7: RH profile of the storage facilities

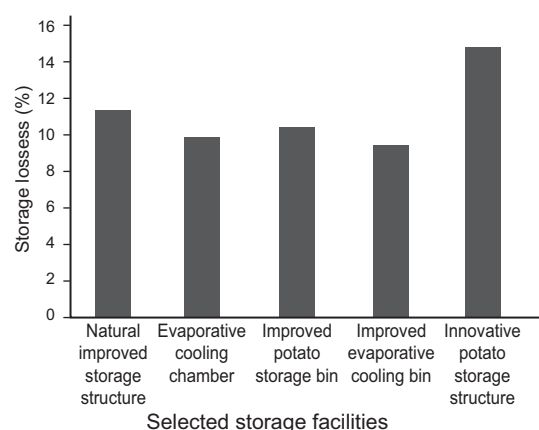


Fig. 8: Storage losses for selected storage facilities

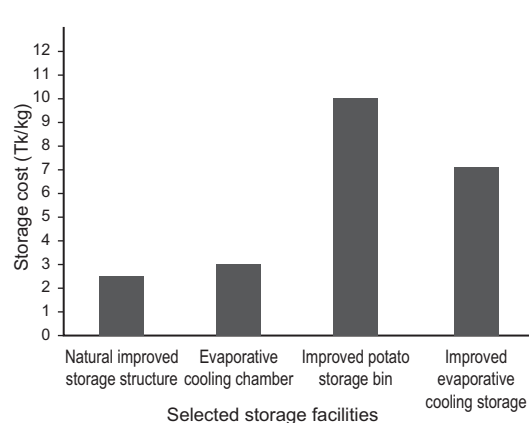


Fig. 9: Storage cost for selected storage facilities

## 5. Conclusion

From the results, it can conclude that evaporative cooling principle can be used as an effective method for storing potato. Both storage losses and costs were minimum in evaporative cooling storage facilities. Temperature and relative humidity were also very much close to the proper storage condition. Performance of improved evaporative cooling bin and improved potato storage bin were satisfactory

but the storage losses were higher than other storage facilities due to improper ventilation. Natural improved storage and innovative potato storage structure were made of low cost and available materials such as bamboo and straw. Ventilation of this kind of storage were good and no external use of energy made this storage facilities attractive to the farmers. But storage losses were very high in this kind of storage because of wide variation of temperature and relative humidity. After evaluating overall

performance of the various improved potato storage facilities, the result of this study indicated that evaporative cooling chamber is the suitable facility for farm household and small-scale farmers considering the storage losses and economic condition of the farmers in our country.

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