Case study about field trial responses of the zero energy storage system

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Abstract: A low cost 'Zero Energy Cool Chamber (ZECC)' has been developed for storing fruits and vegetables by using passive evaporative mechanism. This paper presents the results of a survey on the farmer's opinion regarding the exploitation of zero energy storage system. This survey was conducted at Mymensingh district of Bangladesh from 2011 to 2012 and it also revealed that most of the farmers sell their produce to the middlemen just after the harvest. Lack of transportation facility, shortage of energy supply and lack of investment on storage, lower price of vegetables during the harvesting season, farmers in the rural areas often sell their products to the middleman or in the local market at low prices. They are not even able to get the return of invested money of cultivating vegetables or fruits. As a result, higher percentage of poverty level remains in farmer's community. They demanded low cost storage system such as zero energy storage system which doesn't require electricity for operating to store their agricultural produces.

Keywords: agricultural produces, storage, farmer's perception, quality, benefit, Bangladesh

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1 Introduction

Agriculture in Bangladesh is the single largest producing sector of the national economy. More than 80% of the total population is engaged in agriculture, 57% of the labor force is engaged in the crop sector which represents about 78% of the value addition in the agricultural sector and more than 50% of the population depends on agriculture for their livelihoods. Bangladesh is blessed with about 90 kinds of vegetables and fruits almost throughout the country and grown all the year round. According to BBS (2011), Bangladesh produced more than 6.279 million tons of fruits and vegetables during 2010-2011. Mymensingh is the northern district of Bangladesh bordered on the north by India and lies between 24°02′03″ and 25°25′56″ north latitude and 89°39′00″ and 91°15′35″ east longitude. It has a total land area of about 1,243,900 acre, out of which 761,506 acres are under cultivation. The total irrigated area of Mymensingh district is about 69%. The maximum of annual average temperature is 33.3°C, and the minimum is 12°C and annual rainfall is 2,174 mm. The area is favorable for production of all major crops, fruits and vegetables. During 2009-2010, annual production of 24,003 tons of bananas, 13,745 tons of pineapples, 1,515 tons of wood apples, 18,936 tons of mangos, 60,566 t of jackfruit, 3,222 tons of papayas, 10,142 tons of green papayas, 6,000 tons of different types of vegetables, 3,392 tons of tomatoes, 6,281 tons of eggplant fruits were recorded in this part of the country.

The main disadvantages of these fruits and vegetables are vulnerability against high temperature. But, consumer preference greatly varies based on freshness, color, size and shape. The postharvest losses of fruits and vegetables are nearly 25% due to inadequate postharvest handling practices and non-availability of

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storage facilities (Quddus and Mia, 2010). There is a necessity to prevent the waste of fresh fruits and vegetables during storage by adopting newer storage techniques. For this purpose, an ecofriendly new storage system called "Zero energy cool chamber (ZECC)" has been developed and then extended to the farmers' fields from the viewpoints of low cost and energy-saving. The present study was, therefore, undertaken to evaluate and asses the perceptions of fruit and vegetable farmer's about status, problems and prospects of ZECC.

In this storage system, liquid water molecules of the brick wall cooler becomes gas under the influence of outside air through a process that uses energy to change the physical state. Heat moves from higher temperature of air and brick walls to lower temperature of the moistened sand and zeolite mixture due to convection and conduction, respectively. During this conversion process the surrounding temperature decreased. This cooling temperature by the effect of evaporation, cooled the inside temperature of the ZECC bellow the dry-bulb temperature. This is because of the result of a combined effect of underground temperature, the moist inside wall and watering. As a result, the inside air temperature of the ZECC becomes cooler (Islam et al., 2012). Temperature and relative humidity (RH) in the storage chamber are important environmental factors affecting the ripening process of fruits and the final quality (Islam and Morimoto, 2012; USAID, 2009; Singh and Satapathy, 2006; Roy and Pal, 1991. It has been reported that applying ZECC could reduce the water loss of the fruits and vegetables during storage (Ganesan et al., 2004; Rajeswari et al., 2011). In a country characterized by semi-arid region, it is viable to use ZECC system to retain freshness longer during storage.

2 Materials and methods

This study was conducted at Mymensingh district of Bangladesh from November 2010 to May 2012. To probe into the objectives of the present research, farmer's perspectives in defining their concerns in ZECC storage of fruits and vegetables were investigated. This is because to achieve the best performance of the newly developed storage system, it is necessary to consider the farmer's view. Total 50 ZECC were constructed for demonstration trials. In this context, pre and post ZECC system demonstration survey were conducted to find out problems in storage of fruits or vegetables and feasibility of ZECC, including their application, acceptability and profitability to the local market. About 100 respondents (head of the households) were selected randomly for pre demonstration trial survey. The sample size was determined by using a simple random sampling procedure of probability sampling. A questionnaire was used to collect the primary data from the responded farmers by direct question, focus group discussion and individual face-to-face interview while explanations were done whenever it was necessary. The information supplied by the respondents was recorded and checked carefully in order to minimize errors. The data were processed and analyzed across respondents for comparison, using the SPSS software package. The contents of the questionnaire are presented as follows.

Main contents of the questionnaire for pre demonstration trial of the ZECC:

1. Which types of agricultural produces do you cultivate?

2. What storage method do you use for storing fruits and vegetables?

3. Explain the cause of deteriorations of fruits and vegetables.

4. What do you think about the ZECC storage system?

Main contents of questionnaire for post demonstration trial of the ZECC:

1. Feelings about use - when asked what they liked to use ZECC?

2. Where do you want to use ZECC?

3. Are you satisfied with the ZECC storage?

If yes, reason for satisfaction?

If no, what are the problems?

4. What is your opinion about the design of ZECC?

5. Are you satisfied about the provided instructions and information during field trials?

6. What benefits you achieved during the exploitation of the ZECC?

3 Results and discussion

3.1 Pre-demonstration trial perspective

3.1.1 Fruits and vegetables grown in the selected area

Survey results revealed that farmers were growing a number of vegetables and fruits. However, a majority of them were inclined towards growing jackfruit (98%), followed by wood apple (70%), mango (50%), guava (42%), ber (35%), lichi (25%), lemon (25%), banana (23%) and papaya (13%) fruit (Figure 1). Similarly, major vegetables grown in the area were brinjal (98%), bottle gourd (64%), bitter gourd (60%), hyacinth bean (55%), tomato (45%), pumpkin (44%), cucumber (37%), cauliflower (33%), carrot (32%), and ladies finger (30%) as is shown in Figure 2.

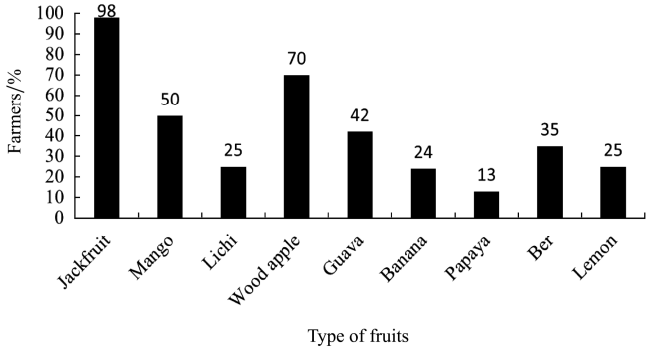


Figure 1 Percent of farmers cultivating fruits in sampled area

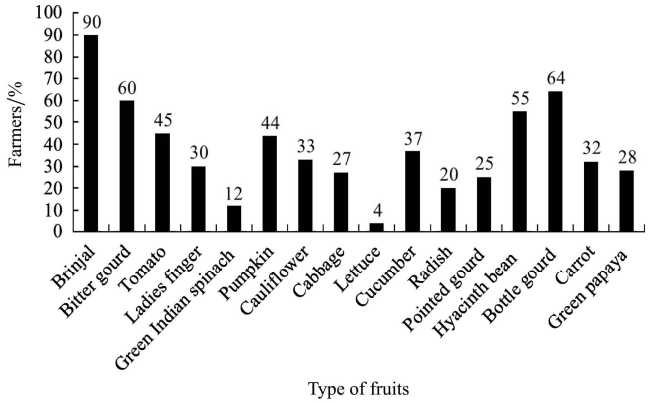


Figure 2 Percent of farmers cultivating vegetables in sampled area

3.1.2 Storage method used in the selected area

Due to unavailability and lack of technical know-how about storage methods, most of the farmers sell their fruits (60%) to the middleman just after harvest to avoid any deterioration and financial loss. However, among different methods practiced locally, sun drying is the most popular method by 75% of the contacted farmers (Figure 3). Very few growers are also using bamboo or mud made structure for drying (10%) and 15% have no idea about any type of storage system for fruits.

Similar to vegetables, most of the farmers sell all their vegetables (80%) immediately after harvest due to unavailability of proper storage facilities (Figure 4). However, only a small number of farmers (25%) opted for storage of vegetables by sun drying method, and followed by (5%) bamboo or mud made structure. A majority of the farmers (99%) of the sampled population had no access of storage facility.

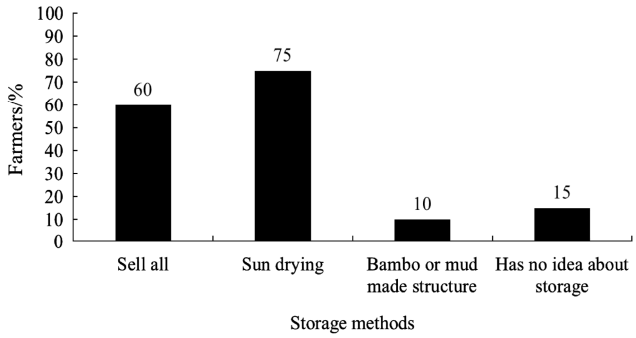


Figure 3 Percent of farmers using fruits storages methods in sampled area

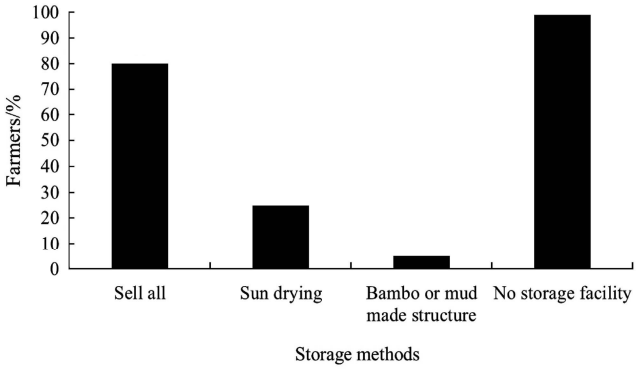


Figure 4 Percent of farmers using vegetables storages methods in sampled area

3.1.3 Cause of deteriorations of fruits and vegetables

It has been observed from the data that the majority of growers mentioned deterioration in fruits and vegetables after harvesting (Figure 5). The major factors quoted were lack of storage facility (93%), postharvest diseases (85%) that resulted in rotten, bad flavored and inferior quality of fruits and vegetables and lack of knowledge of postharvest treatment (80%). The results were shown in the figure 5 as below.

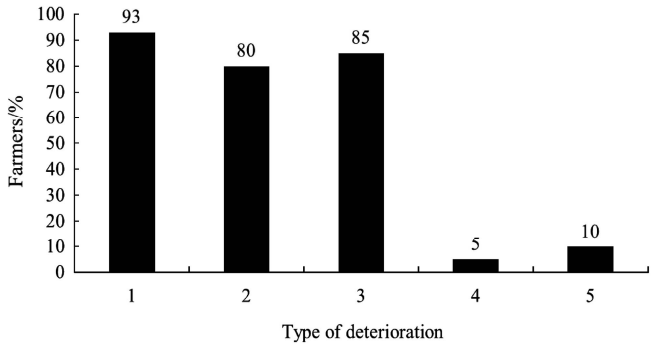


Figure 5 Percent of farmers cited types of deterioration of fruits and vegetables in sampled area

3.1.4 Farmers' perception of the characteristics and demand for storage techniques

When asked to profile their observation about the ZECC storage system, most participants (95%) were not satisfied about the current storage methods (It was shown asTable 1). But when asked about the storage system which they like to use in the future, 75% considered that the storage system should be of low operating cost, followed by easy handling (65%) and low installation cost (65%).

Table 1 Perception about the proposed ZECC storage system before pre demonstration trial

Participants	Value
Are satisfied with the storage system they currently used	5%
Consider the storage system they use to be 'low installation cost'	65%
Consider the storage system they use to be 'Low operating cost'	75%
Consider the storage system they use to be 'Easy handling'	70%
Consider the storage system they use to be 'Eco friendly'	30%
Feel dissatisfied, or worried about their current storage system	95%

3.2 Post demonstration trial perspective

3.2.1 The location of use

The largest number of respondents (60%) indicated that they like to use ZECC in the back yard of their house (Figure 6). Because backyard is unused and women can easily access there followed by the fact that it is attached to their house. About 20% of farmers like to operate it in their field followed by inside the kitchen (10%), in the local market (6%) and 4% others.

3.2.2 Percent of farmers satisfied with ZECC storage methods used for fruits and vegetables

About 75% of the contacted farmers were satisfied with the performance of the ZECC system for storing fruits and vegetables (Figure 7). It was because the prevalence of advantages in storage such as increasing shelf life of fruits and vegetables and quality (Islam et al, 2012). Only 15% were dissatisfied because it was not able to store fruits and vegetables with bulk quantities.

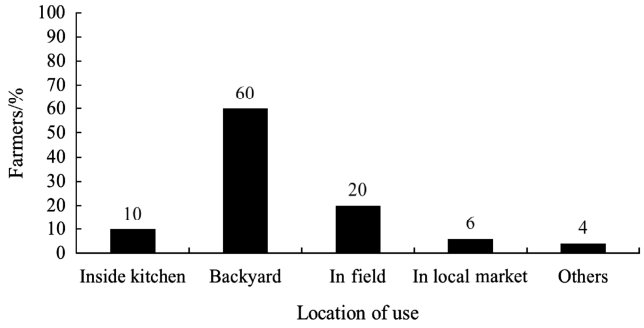
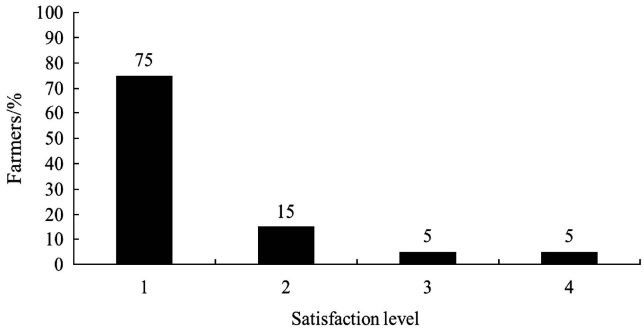


Figure 6 Location of use



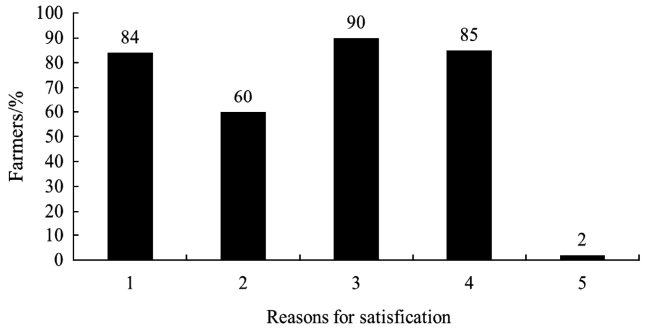
Note: 1- Very satisfied; 2- Very unsatisfied; 3- Satisfied; 4-Dissatisfied; 5- To some extent; 6- Neutral

Figure 7 Satisfaction with the use of zero energy cool chamber

3.2.3 Reasons for satisfaction and gender issue

The main reasons for satisfaction (Figure 8) were easy handling and maintenance level of easy exploitation (84%) followed by no requirement of electricity (90%) and low installation cost (85%). Almost 60% of respondents exposed that increasing interest of gender participation in agriculture activities. In case of most farmer families, young and middle aged men were mostly engaged in agricultural works. The elderly men and both young and elderly women were mostly looked after the livestock and homestead activities. In rice based farming system, men had higher participation in farm related activities compared to women. Moreover, in case of the access and control over resources (both in household and agricultural production) young and elder men play a major role. The situation for women involvement in fruit and vegetable and livestock based farming systems was better than that of rice based. Women are partially

engaged in postharvest operation which requires less labor. Involving women for maintaining ZECC based post-harvest farming system will improve the farmers' overall economic condition by reducing the loss of fruits and vegetables. It will also increase the daily uptake of fruits and vegetables which will reduce the malnutrition problem in the rural areas of Bangladesh.



Note: 1- Handling and maintenance is comfortable; 2- Involvement of women; 3- No need of electricity; 4- Low installation cost; 5- Others

Figure 8 Reasons for satisfaction

3.2.4 Farmers opinion about the design of ZECC system

Participants had positive experiences using the ZECC (Figure 9). Most indicated that it was comfortable to use (90%) and only 8% participants felt discomfort during the exploitation because of its size and shape, while only 2% refused to make any comments.

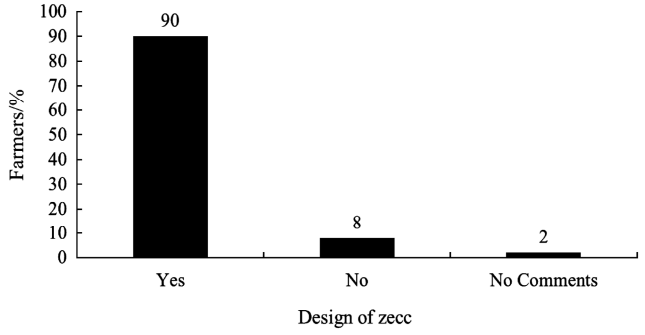
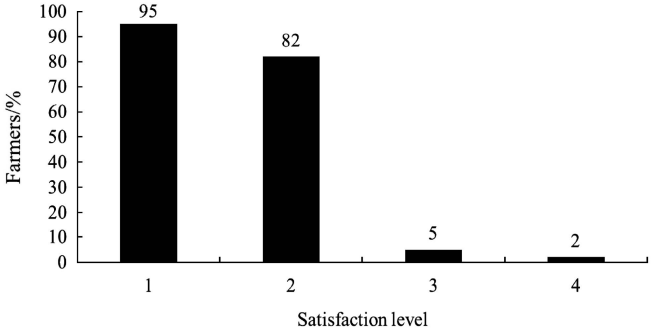


Figure 9 Farmer's opinion about the design of ZECC system

3.2.5 Instructions and information during the demonstration trial

Most participants were satisfied with the amount of information provided to them about know- how of the ZECC (Figure 10). About 95% stated that the information provided was sufficient followed by 82% who felt that the instruction for operating the ZECC was helpful, and some (5%) recommendations included more comprehensive demonstrations.

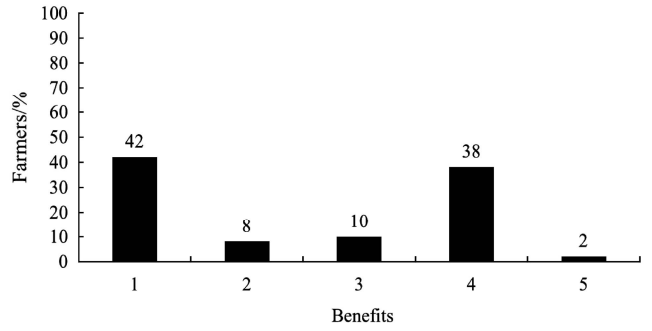


Note: 1- Sufficient information; 2- Instruction was helpful; 3- Recommendation; 4- Others

Figure 10 Satisfaction over the information and instruction provided during demonstration trial

3.2.6 Benefits of using the ZECC system

A sizeable portion of the farmers (42%) were satisfied with the storage capability of unsold fruits and vegetables (Figure 11). The other major factors quoted by farmers (38%) were the improvement of the bargaining capacity which is directly related with their financial benefits.

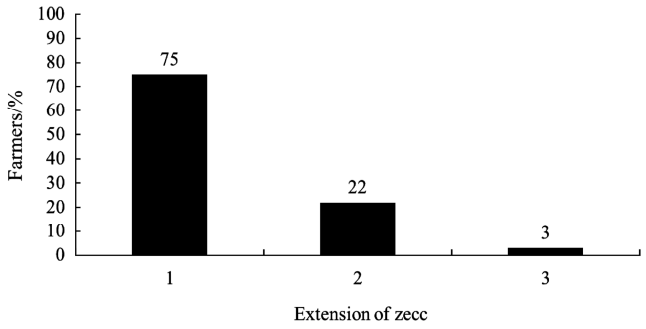


Note: 1- Capable to store unsold fruits and vegetables; 2- Improve the quality; 3- Food security improved; 4- Bargaining capacity improved; 5-Others

Figure 11 Benefits of the ZECC

3.2.7 Recommendations for dissemination

Most participants (75) would recommend the ZECC to others (Figure 12). However, only 22% of respondents said they would think of the necessity of talking about the ZECC to others, and fewer (3%) refused to make any comments. Establishment of cold storage for the preservation of fruits and vegetables involves not only huge investment and infrastructure but also less feasible under many circumstances. Moreover, installation of ZECC requires less initial investment, no need of electricity and less skill to operate it.



Note: 1- Recommend others; 2-Feel necessity to recommend others; 3- Refused to make any comments

Figure 12 Benefits of the ZECC.

4 Conclusion

Bangladesh is not a country for conventional cold storage. In light of its poverty condition and frequent power shutdown, the expansion of permanent conventional storage is not a sustainable choice. An appropriate low cost sustainable storage solution within the rural farmer's financial ability is to construct ZECC which has to be both operational friendly and environmentally sound. ZECC can contribute to changing the rural agricultural based society as an effective approach to develop household-based low cost fruits and vegetables storage in this country. Farmer's community gave a positive respond about the use of ZECC in Bangladesh. To disseminate this newer technology, several training program were also arranged during the demonstration trial, where participant learnt about the necessity and benefit of ZECC for their daily livelihood. From a gender perspective, this study also improved the social position of women. So ZECC technology is very suitable to be promoted in Bangladesh.

Acknowledgements

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