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Kathmandu University
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Project Proposal

Construction of Root Cellar for Community

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ABSTRACT:

Nepal is an agro-based country; though, there is food insecurity because of lack of food preservation. So, farmers have to face problem of price differentials between harvest time and marketing time, preventing the smooth supply of farm products in local market in profitable way. Different organizations have planned and built mini cellar cold storage. But economical, eco-friendly, scientific and efficient ones can be built with proper research and study on this very topic. A root cellar is a structure which is designed to keep vegetables and some fruits at a stable, cool temperature which will prevent them from rotting and it will come to great use to mainly the farmers in our country as refrigeration of hundreds of kilos of foods for preservation (using electrical energy) is not an economical solution. So, with Community Grant Application Project at KU we can design and build model root cellar for the welfare of the community.
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I. RATIONALE:

Nepal is an agro-based country. Although more than 80% populations’ main occupation is farming, Nepal has food insecurity. According to data of FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO), Nepal has produced 3.2 million tons of vegetables and 0.79 million tons of fruits in 2011 and 25% - 30% got spoiled because of lack food preservation. Also, due to unawareness of the techniques of food preservation and failure to bring proper methods to practice, farmers have to face problem of price differentials between harvest time and marketing time. So, preservation of food can smooth the supply of farm products in local market in a profitable way. So, preservation of food for future use is today’s hot issue for Nepal. Different organizations like Support Activities for Poor Producers of Nepal (SAPPROS Nepal), Nepalese Farming Institute (NFI), and other have planned and started to build mini cellar cold storage for the farmer. Most of this project has been launched on the rural area of Nepal. Some mini cellar cold storage has been build and started to store apples.

Nepal has failed to make any radical progress in the field of food preservation (building of root cellar) due to lack of sufficient budgeting and awareness. Because of which R&D in this field has been less. AsCommunity Grant Application Project at KU has the purpose to serve the needs of community based project development in Nepal. This will help to develop expertise in community based project. It will also help in the development of community in the country.

To build an economical, ecofriendly, effective and efficient root cellar by using renewable source of energy (earth) for the community for preserving their farm products for their future use.

This project goals to design and build an economical, ecofriendly, effective and efficient root cellar (a structure which is designed to keep vegetables and some fruits at a stable, cool temperature which will prevent them from rotting) by using renewable source of energy (earth) for the community for preserving their farm products for their future use.

II. OBJECTIVES:

- To design and build economical, ecofriendly, effective and efficient root cellar for community.
- To preserve home grown products for future use using renewable energy.

III. SCOPE:

- This project will help community for storing their foods for future use.
- This project will also help in the development of root cellar working in the country.
- This project can solve the price differentials between harvest time and marketing time.
- This project can smooth the supply of farm products in local market in a profitable way.
III. LIMITATION:

- Lack of prior experiences and expertise in model testing is the significant limitation of this project.
1. LITERATURE REVIEW:

1.1 Root Cellar

A root cellar is a structure which is designed to keep vegetables and some fruits at a stable, cool temperature which will prevent them from rotting. They keep food from freezing during the winter and keep food cool during the summer months to prevent spoilage. Root cellars were once a necessary fixture in any home where people wanted to be able to eat vegetables and fruits during the winter, and they are often present in older homes built through the early 20th century in Europe. In addition to being used to store fruit and vegetables, a root cellar can also be a useful place to store dairy products, grains, and a variety of other foodstuffs.

Root cellars take advantage of the earth as a natural source of insulation and coolness. A typical root cellar can either be dug as a pit independent of a house or another structure, or it may be built under a home, barn, or similar structure. Since deep holes are naturally cooler than the area around the surface of the earth, a root cellar will be cooler than the ambient air temperature by design, and several features can make a root cellar even colder.

Classically, a root cellar is installed in an area which is already cold, such as a north-facing hill in the Northern Hemisphere, and it may be shaded by trees and buildings. Thick insulation such as stone, brick, and straw may be used to keep a root cellar's temperature stable, while ventilation shafts pull cold air up, keeping a constant flow of cool air going through the root cellar.

1.2 History of Root Cellar

Before the arrival of refrigeration, the root cellar would have been the place to find everything from potatoes to bacon. Preserved foods like cured meats and pickled vegetables were often stored in the root cellar to ensure that their temperatures stayed stable during storage, while potatoes, turnips, carrots, cabbage, apples, and so forth were put into the root cellar as is and carefully packed to prevent sprouting or rotting.

Root cellars have also historically been used to age cheese, store dairy products, and so forth. On farms, root cellars ensured that people had steady access to a balanced diet throughout the year, even in areas where snow covered the ground during the winter, making farming impossible. The root cellar could also be used to store animal feed. In urban areas, people stored excess food in their root cellars so that they could eat well even during lean periods without paying stratospheric grocery bills for out of season foods.

In modern days, root cellars continue to be used for the storage of fruits and vegetables, and a growing interest in natural preservation techniques and small scale farming in the early 21st century led to a revival of the root cellar in some communities. A well designed root cellar can entirely replace a refrigerator for the storage of food, saving a substantial amount of money in utility bills. So, a root cellar is an easy, inexpensive, and cool way to store root crops, winter squash, and some other homegrown produce.
2. **PRINCIPLE OF ROOT CELLAR:**

- A root cellar is any storage location that uses natural cooling, insulating, and humidifying properties of the earth.
- To work properly, a root cellar must be able to hold a temperature of 32º to 40º F and a humidity level of 85 to 95 percent.
- The cool temperature slows the release of ethylene gas and stops the growth of microorganisms that cause decomposition.
- The humidity level prevents loss of moisture through evaporation—and the withering looks that go along with it.

**Table 1: Chart for storing vegetables:**

<table>
<thead>
<tr>
<th>Vegetables</th>
<th>Ideal Storage Temperature (°F)</th>
<th>Relative Humidity (%)</th>
<th>Average Storage Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>32</td>
<td>95</td>
<td>3-4 months</td>
</tr>
<tr>
<td>Carrots</td>
<td>32</td>
<td>90-95</td>
<td>4-6 months</td>
</tr>
<tr>
<td>Garlic</td>
<td>32</td>
<td>65-70</td>
<td>6-7 months</td>
</tr>
<tr>
<td>Onions</td>
<td>32</td>
<td>65-70</td>
<td>5-8 months</td>
</tr>
<tr>
<td>Potatoes</td>
<td>38-40</td>
<td>90</td>
<td>5-8 months</td>
</tr>
<tr>
<td>Pumpkins</td>
<td>50-55</td>
<td>70-75</td>
<td>2-3 months</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>55-60</td>
<td>85-90</td>
<td>4-6 months</td>
</tr>
<tr>
<td>Turnips</td>
<td>32</td>
<td>90-95</td>
<td>4-5 months</td>
</tr>
<tr>
<td>Winter squash</td>
<td>50-55</td>
<td>70-75</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

For creating the best atmosphere in a root cellar, we need to consider these:

- Complete temperature stability is reached about 10 feet (3 m) deep.
- A root cellar shouldn’t be dug near a large tree because the tree’s roots can be difficult to dig through and they will eventually grow and crack the cellar walls.
- Inside, wooden shelving, bins, and platforms are the norm, as wood does not conduct heat and cold as rapidly as metal does.
- Air circulation is critical for minimizing airborne mold, so shelves should stand 1 to 3 inches (3 to 8 cm) away from the walls.
- For outdoor root cellars, packed earth is the preferred flooring. Concrete works well and is practical for a cellar.
- Every root cellar needs a thermometer and a hygrometer (to measure temperature and humidity, respectively), which should be checked daily, if possible.
- Heat is usually regulated using ventilation to the outside or an exhaust pipe—usually to allow cold air in, often on fall nights to get the temperature down.
3. BUILDING PROCEDURE:

- Cellar is dug down into the ground or horizontally into a hillside. Another option is to create a bury suitable containers such as metal garbage cans or barrels, leaving about 4 inches exposed at the top. Heap earth around the circumference and then to cover the lid with straw or mulch and a sheet of plastic to keep everything dry.
- Building the other two walls with stud and board. (The best method is to use the foundation walls on the northeast corner for two sides.)
- The interior walls, ceiling, and door (and any pipes or ducts) are insulated to keep the heat out.
- A ventilation system allows to cool, pass fresh air from the outside into the root cellar and stale air to be exhausted out.
- We should bear in mind that lower shelves will be cooler and wetter, while higher shelves will be warmer and dryer. So, we should arrange and space our shelves to suit the items that will likely be stored on them.
4. COMPONENTS:

4.1 Ventilation System

Ventilation system is essential to store food without spoiling. To create good ventilation, two pipes through the outside wall are needed—one should be at the highest point of the room.

Ventilation system creates a siphon; cool air is denser than warm air and will collect in low spots. If the air outside the root cellar is cooler than the air inside, the siphon will allow warm air to be drawn out and cool air to flow in. As outside temperatures fluctuate, we'll get almost continuous air change while keeping the temperature as low as possible.

A valve plays a vital role in ventilation system to stop the siphon. If the outside temperature goes way below freezing, we will need to close both valves (at least partially).

4.2 Building the wall

The walls can be built out of just about anything, but, due to the moist conditions; we should use earth-bags or other rot-resistant wood for framing and some moisture-resistant wall board or brick & cements.

4.3 Covering the wall

Inside surface of wall can be covered with straw, dry leaves, wood, wool and etc. for insulation. Outer surface of wall can be covered with mud and grass for making cellar cool.

A root cellar does not need to be airtight, but the tighter it is, the more control we will have over the air quality and temperature.

4.4 Shelves

Shelves are the compartments of root cellar made of wood to put the food for storing. We should bear in mind that lower shelves will be cooler and wetter, while higher shelves will be warmer and dryer. So, we should arrange and space our shelves to suit the items that will likely be stored on them.

4.5 Door

A door is needed to open the root cellar without letting out the coldest, dampest air at the bottom of the root cellar.
4. PROBLEM STATEMENT:

Although Nepal is an agro-based country it has food insecurity. According to data of FAO, Nepal has produced 3.2 million tons of vegetables and 0.79 million tons of fruits in 2011 and 25% - 30% got spoiled because of lack food preservation. Also, due to unawareness of the techniques of food preservation and failure to bring proper methods to practice, farmers have to face problem of price differentials between harvest time and marketing time. So, preservation of food can smooth the supply of farm products in local market in a profitable way.

5. METHODOLOGY:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Stage</th>
<th>Goal</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Theoretical Foundation</td>
<td>Study about the different measures needed for root cellar making.</td>
<td>1.1 Literature review 1.2 Problem Formulation</td>
</tr>
<tr>
<td>2.</td>
<td>Site visit for problem recognition and solution</td>
<td>Site visit for building of root cellar</td>
<td>2.1 Site visit 2.2 Problem Identification</td>
</tr>
<tr>
<td>3.</td>
<td>Design</td>
<td>Detail design</td>
<td>3.1 Mathematical design</td>
</tr>
<tr>
<td>4.</td>
<td>Constructing/Modeling</td>
<td>Modeling of root cellar</td>
<td>5.1 Physical modeling of a root cellar</td>
</tr>
</tbody>
</table>

4. BUDGETING:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Items</th>
<th>Unit</th>
<th>Unit Rate</th>
<th>Total(in Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Earth-bags</td>
<td>100</td>
<td>50</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td>- Wood</td>
<td></td>
<td>700</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td>- Straw</td>
<td></td>
<td>1,000</td>
<td>7,000</td>
</tr>
<tr>
<td></td>
<td>- Cement</td>
<td></td>
<td>7,000</td>
<td>4,000</td>
</tr>
<tr>
<td></td>
<td>- Rod</td>
<td></td>
<td>7,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Labor Cost</td>
<td>10</td>
<td>700</td>
<td>7,000</td>
</tr>
<tr>
<td>3</td>
<td>Miscellaneous Cost</td>
<td>-</td>
<td></td>
<td>5,500</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>34,500</strong></td>
</tr>
</tbody>
</table>
### 5. WORKING SCHEDULE:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Stage</th>
<th>Goal</th>
<th>Activities</th>
<th>Time Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project Design</td>
<td>Selection of project title and supervisor</td>
<td>1.1 Coordination with supervisor and department to finalize project title</td>
<td>1-15th April</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.2 Submission and approval of Project Proposal</td>
<td>29th April-15th June</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.3 Starting of the Research Activities</td>
<td>16-22nd June</td>
</tr>
<tr>
<td>2</td>
<td>Theoretical Foundation</td>
<td>Study about the different measures needed for root cellar making</td>
<td>2.1 Literature review.</td>
<td>23rd June-20th July</td>
</tr>
<tr>
<td>3</td>
<td>Site visit and</td>
<td>Site visit of a root cellar</td>
<td>3.1 Collect relevant information about the site</td>
<td>21st July- 17th August</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Design</td>
<td>Detail Design</td>
<td>4.1 Mathematical design</td>
<td>18th August- 28th September</td>
</tr>
<tr>
<td>8</td>
<td>Constructing/Modeling</td>
<td></td>
<td>8.1 Physical Model</td>
<td>29th September-31st October</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8.2 Documentation of test results</td>
<td>1-16th November</td>
</tr>
<tr>
<td>9</td>
<td>Completion of project</td>
<td>Submission of report</td>
<td>9.1 Submission of final report and presentation</td>
<td>17-30th November</td>
</tr>
</tbody>
</table>
6. EXPECTED OUTCOMES:

We expect to build an economical, ecofriendly, effective and efficient root cellar by using renewable source of energy (earth) for the community for preserving their farm products for their future use.
WORK CITED


   http://www.organicgardening.com/learn-and-grow/building-root-cellar-your-home


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    http://www.organicgardening.com/cook/what-store-root-cellar