geres

MANUAL FOR CONSTRUCTON AND OPERATION OF

BIOCLIMATIC CELLAR

INTRODUCTION

One of the main revenue sources for rural populations in Sugd province is growing and selling fruits and vegetables. Unfortunately, this business is seasonal. During harvest, farmers sell their crops for a very low price. Farmers can, however, store their crops in a Bioclimatic Cellar and sell their harvest for a profit.

In accordance with findings from surveys conducted among residents of jamoats, rural populations store their crop in the traditional way. The harvest is stored in empty barns or underground, such as in wells. Such storage areas, which contain a high level of humidity, do not protect the crop from a cold wave. This results in a waste of 30-40% of crop.

To solve the above mentioned problem, GERES developed a design for bioclimatic cellars for farmers. This manual gives detailed information about the construction and operation of bioclimatic cellars. In such bioclimatic cellars, farmers can store vegetables, such as potatoes, onions, beets and turnips as well as fruits, such as apples, quinces, and pears. Farmers then will be able to sell their crops in winter for higher prices thus increasing their household income.

TABLE OF CONTENTS

1. BIOCLIMATIC CELLAR

...Is used for storing fruits and vegetables clean and fresh for longer period.

For rural residents, whose main source of income is from growing and selling fruits and vegetables, French organization GERES offers construction of bioclimatic cellars, which are adapted to our climate and can be used in Afghanistan and India as well.

Bioclimatic cellars from GERES are different from traditional cellars because of their added hallway and ventilation windows and pipes, which are important for air circulation.

Walls of such underground construction are built from stones and ventilation pipes are made from plastic. It is important to note that ventilation system inside the cellar operates without any fan or any engine which is a bonus for possible times of energy crisis. The volume and size of a bioclimatic cellar depends on the farmers' financial resources and amount of crop being stored.

This manual provides information for three types of bioclimatic cellar:

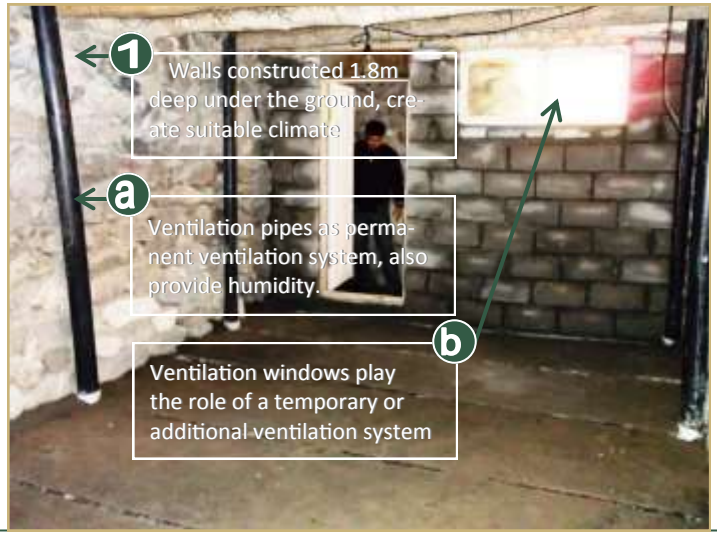
1. 5.2 m x 4.2 m – for storing 4 tons of potatoes
2. 7.8 m x 4.2 m- for storing 10 tons potatoes
3. 10.8 m x 4.2 m - for storing 20 tons of potatoes.

2. CONSTRUCTION OF A BIOCLIMATIC CELLAR

Following all the steps during construction guarantees successful operation of your bioclimatic cellar.

Principles for operation of bioclimatic cellar

1. The underground cellar stores produce at a moderate temperature year round.
2. Provide humidity in the air through:
   a) permanent ventilation of air (through ventilation pipe);
   b) Temporary ventilation of air (through ventilation windows).



To take advantage of these principles, follow the steps outlined below:

Step 1
Select type of cellar

Step 2
Procure construction materials (Cost estimate)

Step 3
Select location and draw design of cellar.

Step 4
Build walls of cellar

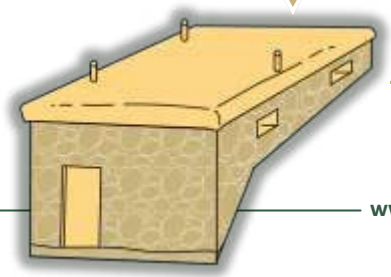
Step 5
Attach ventilation pipes

Step 6
Install doors and ventilation windows

Step 7
Cover the roof

Step 8
Lay the floors

By following these steps you can construct a bioclimatic cellar.



Step 1

2.1. SELECTING TYPE OF CELLAR

When deciding which type of cellar you would like it is important to take the following factors into consideration:

- How much money do you have in your budget?
- Do you have enough space for constructing a cellar?

If you have all the required resources and space, then select one of the types of cellar described below.

Depending on volume and size, a bioclimatic cellar can be of three types::

For 4 ton crop	For 10 ton crop	For 20 ton crop
Size: *5.2m x 4.2m.*	***Size:*** *7.8 x 4.2m.*	***Size:*** *10.8 x 4.2m.*
Volume*: for storing 4 tons of potatoes*	***Volume****: for storing 10 tons of potatoes or 7 tons of apples*	***Volume****: for storing up to 20 tons of potatoes*
Price: 13165.78 TJS	*Price:* ***17230.67 TJS***	***Price: 21937.04 TJS***

Step 2

2.2. PROCURING CONSTRUCTION MATERIALS (COST ESTIMATE)

For construction of bioclimatic cellar procure the following materials:

- Stone;
- Sand;
- Cement;
- Gravel
- Soil;
- Plastic pipes with 100mm diameter;
- Plastic elbow for pipe with 100mm diameter;
- Glue for plastic pipes;
- Cap for ventilation pipe ;
- Plank with 3cm x 10cm x 6m size (for top of the door and ventilation windows);
- Plank for door and window frame;
- Batten 5cm x 5cm (for terrace);
- Galvanized sheet;
- Hinge
- Handle
- Lock
- Lock with hinges
- Nails

If you construct the Bioclimatic Cellar using your own labor you can save money. Otherwise you must include the cost of hired labor in your budget.

Required materials and costs are shown in the next pages.

For 4 tons

Size:
5,2m x 4,2m

Cost of expenditure is estimated in Tajik Somoni

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
1	**Excavating the ground either by tractor or manually**				
	Labor cost for excavating the ground	m^3	40	50	2000
	Calculation				**2000**
2	**Wall**				
	Labor cost for picking stones	m^2	49	25	1225
	Labor cost for building portions of walls above ground	m^3	8	15	120
	Materials:				
	Stone	m^3	28	70	1960
	Sand	m^3	7	70	490
	Cement	т	1,82	1100	2002
	Ruberoid (hydro insulation)	roll	1	80	80
	Soil	m^3	1	70	70
	Calculation				**5947**
3	**Roof**				
	Labor Cost	person/ day	5	100	500
	Materials:				
	Beam 150mm x 50mm x 6m.	piece	7	68	476
	Plank 100mm x 20mm x 6m	piece	23	21,6	496,80
	Reed	bundle	23	3	69
	Ruberoid	roll	1	80	80
	Soil	m^3	1,3	70	91
	Nails	kg	4	8	32
	pipe(d=100mm)	m.length	2	15	30
	Calculation				**1774,80**

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
4	**Floor**				
	Labor Cost	person/ day	1	100	100
	Materials:				
	Gravel	m^3	1,6	70	112
	Cement	t	0,13	1100	143
	Sand	m^3	0,4	70	28
	Calculation				**383**
5	**Ventilation**				
	Labor Cost	person/ day	0,5	100	50
	Materials:				
	Plastic pipes with 100mm diameter	m.length	20	16	320
	Plastic elbow joint with 100mm diameter	piece	3	10	30
	Glue for plastic pipe	piece	1	20	20
	Cap for the top of ventilation pipe	piece	3	15	45
	Paint for cap	piece	1	5	5
	Calculation				**465**
6	**Stairs**				
	Labor Cost	person/ day	2	100	200
	Materials:				
	Gravel	m^3	0,3	70	21
	Cement	t	0,05	1100	55
	Sand	m^3	0,1	70	7
	Calculation				**283**

#	Expenditure item	Meas-urement unit	Q-ty	Price	Total Cost
7	**Installing door and windows**				
	Labor cost for putting up beams and constructing windows	person/ day	1	100	100
	Materials for constructing door:				
	Plank 150mmx 50mmx 6m (for top of door and windows)	piece	2	81	162
	Ready door	piece	2	230	460
	Ready windows with glass 500mm x 700mm size	piece	1	75	75
	Batten 5cm x 5cm	m.length	7	5	35
	Galvanized sheet	m^2	1,2	25	30
	Hinge	pair	3	8	24
	Handle	piece	5	5	25
	Shutter	piece	2	3	6
	Lock with Hinges	piece	1	10	10
	Nail for door and windows	kg	1	8	8
	Calculation				**935,00**
8	**Transportation cost**				**500,00**
TOTAL					**12287,80**

For 10 tons

Size:
7.8m x 4.2m

Cost of expenditure is estimated in Tajik Somoni

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
1	**Excavating ground either with tractor or manually**				
	Labor cost for excavating the ground	m^3	59	50	2950
	Calculation				**2950**
2	**Wall**				
	Labor cost for picking stones	m^2	63,56	25	1589
	Labor cost for building portions of walls above the ground	m^3	10	15	150
	Materials:				
	Stone	m^3	36	70	2520
	Sand	m^3	9	70	630
	Cement	т	2,3	1100	2530
	Ruberoid (hydro insulation)	roll	1	80	80
	Soil	m^3	1,26	70	88,2
	Calculation				**7587,20**
3	**Roof**				
	Labor Cost	person/ day	7,5	100	750
	Materials:				
	Plank 150mm x 50mm x 6m.	piece	11	68	748
	Plank 100mm x 20mm x 6m.	piece	30	21,6	648
	Reed	bundle	66	3	198
	Ruberoid	roll	2	80	160
	Soil	m^3	1,95	70	136,5
	Nail	kg	6	8	48
	pipe(d=100mm)	m.length	2	15	30
	Calculation				**2718,50**

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
4	**Floor**				
	Labor Cost	person/ day	2	100	200
	Materials:				
	Gravel	m^3	2,4	70	168
	Cement	т	0,2	1100	220
	Sand	m^3	0,48	70	33,6
	Calculation				**621,60**
5	**Ventilation**				
	Labor Cost	person/ day	1	100	100
	Materials:				
	Plastic pipe with 100mm diameter	m.length	34	16	544
	Plastic elbow joint with 100mm diameter	piece	5	10	50
	Glue for plastic pipe	piece	2	20	40
	Cap for ventilation pipe	piece	5	15	75
	Pain for cap	piece	1	5	5
	Calculation				**814**
6	**Stairs**				
	Labor Cost	person/ day	2	100	200
	Materials:				
	Gravel	m^3	0,3	70	21
	Cement	т	0,05	1100	55
	Sand	m^3	0,1	70	7
	Calculation				**283**

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
7	**Installing door and windows**				
	Labor cost for putting up beams and constructing windows	person/ day	1	100	100
	Construction materials for door:				
	Plank 150mm x 50mm x 6m.	piece	2	81	162
	Door	piece	2	230	460
	Windows with glasses 500mm x 700mm size	piece	2	75	150
	Batten 5cm x 5cm (for hallway door overhang)	m.length	7	5	35
	Galvanized sheet	m^2	1,2	25	30
	Hinge	pair	4	8	32
	Handle	piece	6	5	30
	Shutter	piece	2	3	6
	Lock with hinges	piece	1	10	10
	Nail for door and windows	kg	1	8	8
	Calculation				**1023,00**
8	**Transportation cost**				**500,00**
TOTAL					**16597,30**

For 20 tons

Size:
10.8m x 4.2m

Cost of expenditure is estimated in Tajik Somoni

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
1	**Excavating ground either with tractor or manually**				
	Labor cost for excavating the ground	m^3	82	50	4100
	Calculation				**4100,00**
2	**Wall**				
	Labor cost for building portions of wall above ground	m^2	75	25	1875
	Labor cost for accumulation layers of walls above the ground	m^3	15	15	**225**
	Materials:				
	Stone	m^3	46	70	3220
	Sand	m^3	11,5	70	805
	Cement	т	3	1100	3300
	Ruberoid (hydro insulation)	m^2	1	80	80
	Soil	m^3	1,63	70	114,1
	Calculation				**9619,10**
3	**Roof**				
	Labor Cost	person/ day	10	100	1000
	Materials:				
	Plank 150mm x 50mm x 6m.	piece	13	68	884
	Plank 100mm x 20mm x 6m.	piece	35	21,6	756
	Reed	bundle	46	3	138
	Ruberoid	roll	3	80	240
	Soil	m3	2,6	70	182
	Nail	kg	8	8	64
	pipe d=100mm)	m.length	2	15	30
	Calculation				**3294,00**

#	Expenditure item	Measurement unit	Q-ty	Price	Total Cost
4	**Floor**				
	Labor Cost	person/ day	3	100	300
	Materials:				
	Gravel	m^3	3,2	70	224
	Cement	т	0,3	1100	330
	Sand	m^3	0,64	70	44,8
	Calculation				**898,8**
5	**Ventilation**				
	Labor Cost	person/ day	1,5	100	150
	Materials:				
	Plastic pipe with 100mm diameter	m.length	55	16	880
	Plastic elbow joint with100mm diameter	piece	5	10	50
	Glue for plastic pipes	piece	2	20	40
	Cap for ventilation pipe	piece	9	15	135
	Paint for cap	piece	2	5	10
	Calculation				**1255**
6	**Stairs**				
	Labor Cost	person/ day	1	100	100
	Materials:				
	Gravel	m^3	0,3	70	21
	Cement	т	0,05	1100	55
	Sand	m^3	0,1	70	7
	Calculation				**283**

#	Expenditure item	Meas-urement unit	Q-ty	Price	Total Cost
7	**Installing door and windows**				
	Labor cost for putting up beams and construction of windows .	person/ day	1	100	100
	Construction Materials for Door				
	Plank 150mm x 50mm 6m (for the top of door and windows)	piece	2	81	162
	Door	piece	2	230	460
	Windows with glass 500mm x 700mm size	piece	2	75	150
	Batten 5cm x 5cm (for hallway overhang)	m.length	7	5	35
	Galvanized sheet slate	m2	1,2	25	30
	Hinge	pair	4	8	32
	Handle	piece	6	5	30
	Shutter	piece	2	3	6
	Lock with hinge	piece	1	10	10
	Nail for door and windows	kg	1	8	8
	Calculation				**1023,00**
8	**Transportation cost**				**500,00**
TOTAL					**20872,90**

Step 3

2.3. SELECTING LOCATION AND DRAWING DESIGN OF CELLAR

After you have selected the type of cellar you want and procured all the needed construction materials, select a location where you will construct it and draw its design. While selecting location, it is recommended to consider the following factors:

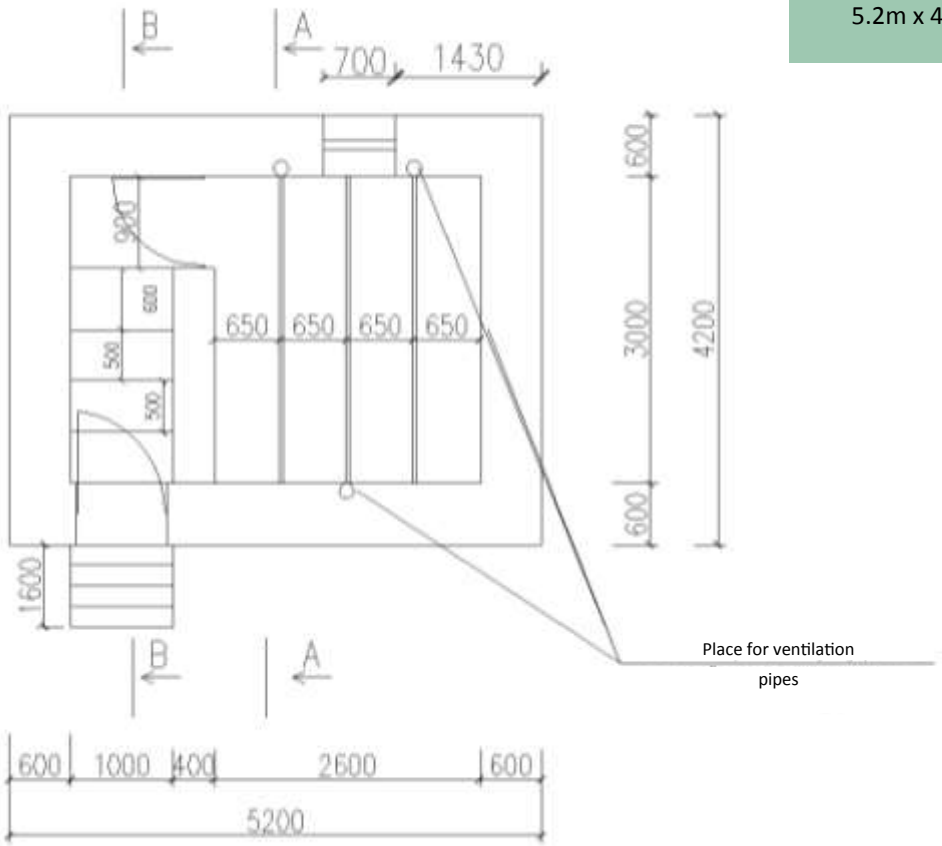
Construct the Bioclimatic cellar away from humid areas, as humidity will cause produce to rot. Farmers may only build a cellar on land which is explicitly legally their own.
Designs for each type of bioclimatic cellar are shown in the next pages.

Because the three sizes of cellars all have the same depth, height, and width, the cross sections of cellar height and depth on the next 3 pages feature a 4 ton cellar, but can also be used in the design of a 10 and 20 ton cellar.

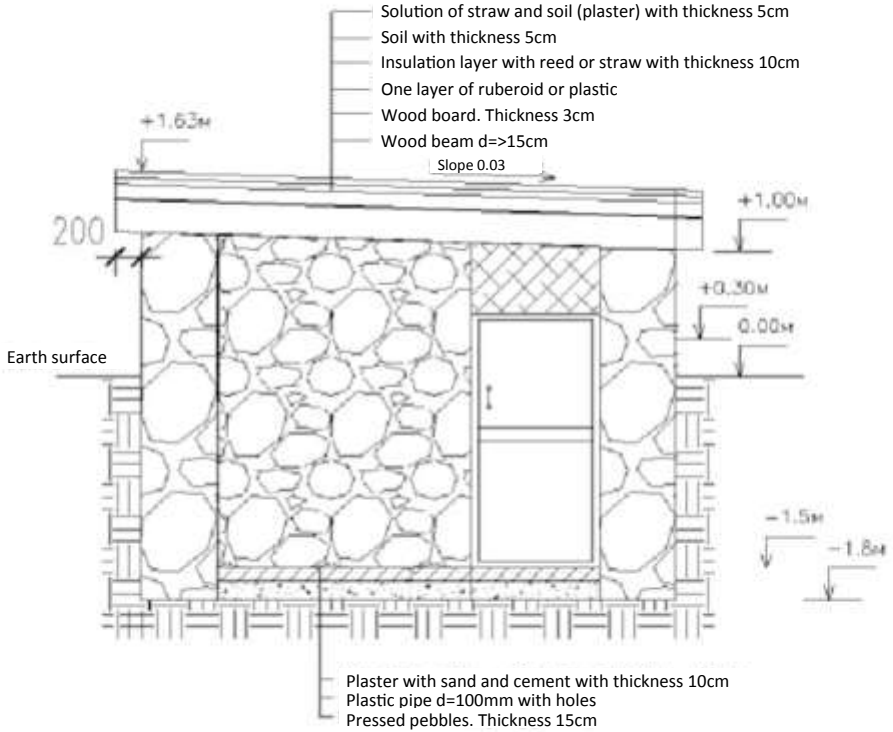
DESIGN OF BIOCLIMATIC CELLAR FOR 4 TONS CROP

For 4 tons

Size:
5.2m x 4.2m



CROSS SECTION A-A



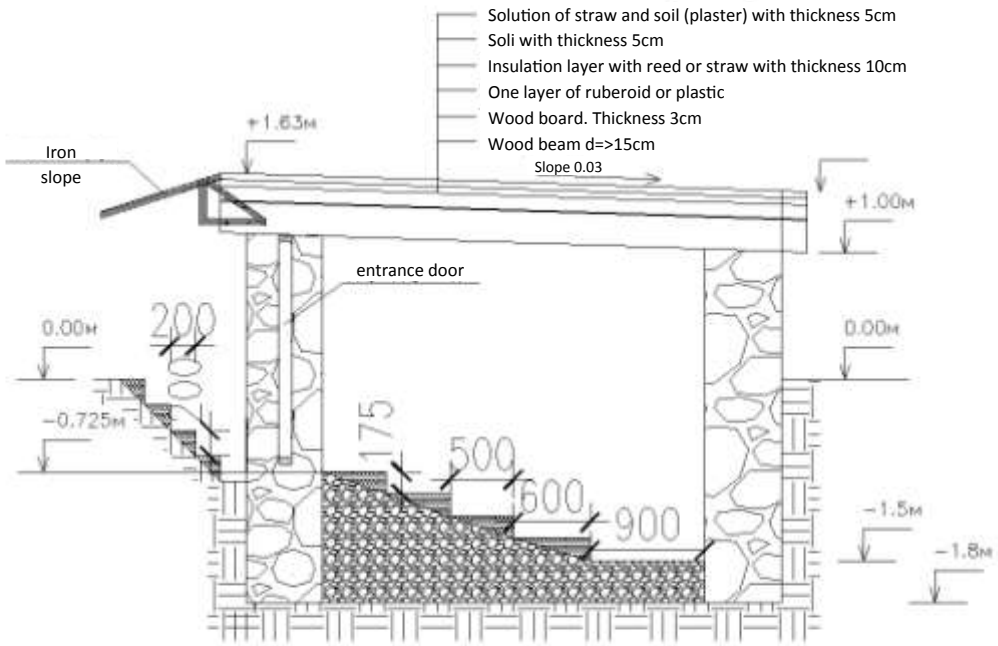
For 4 tons

Size:
5.2m x 4.2m

CROSS SECTION B-B

For 4 tons

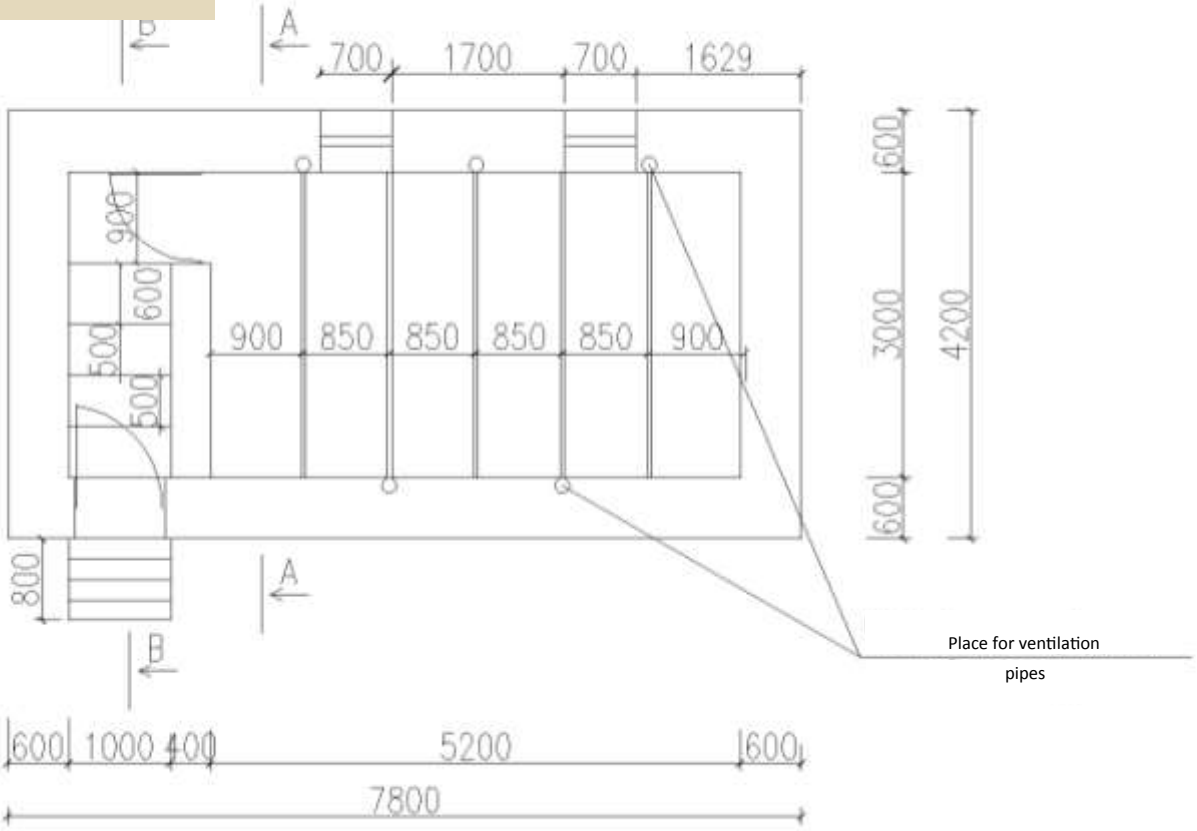
Size:
5.2m x 4.2m



For 10 tons

Size:
7.8m x 4.2m

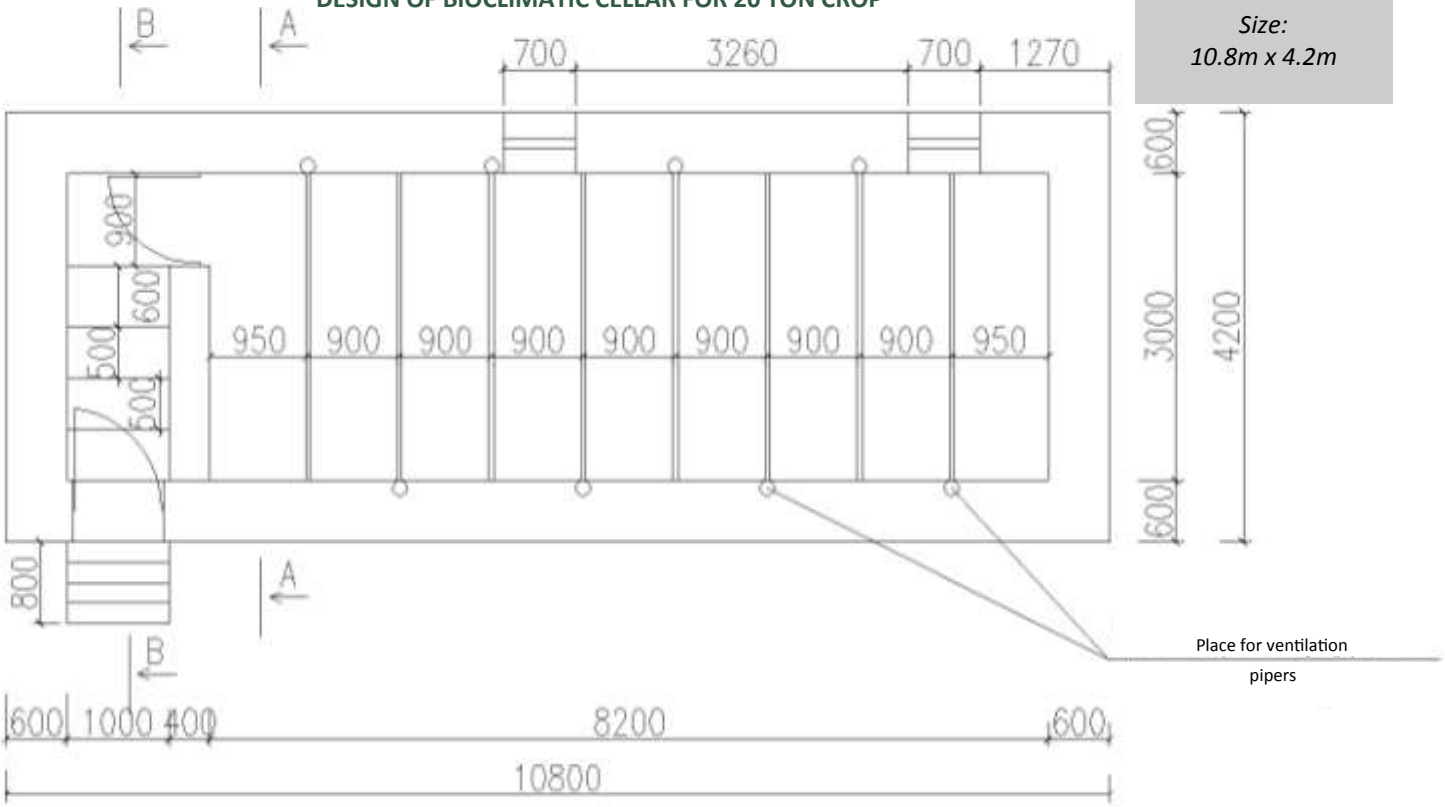
DESIGN OF BIOCLIMATIC CELLAR FOR 10 TON CROP



DESIGN OF BIOCLIMATIC CELLAR FOR 20 TON CROP

For 20 tons

Size:
10.8m x 4.2m

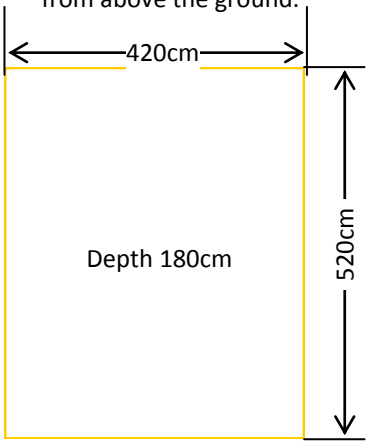


Step 4

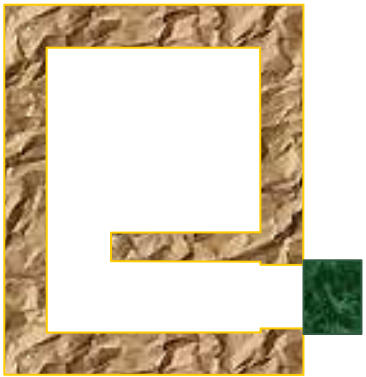
2.4. BUILDING THE WALLS OF THE CELLAR WITH A HALLWAY

Methodology of building walls for cellar for 4 tons crop is shown as example.

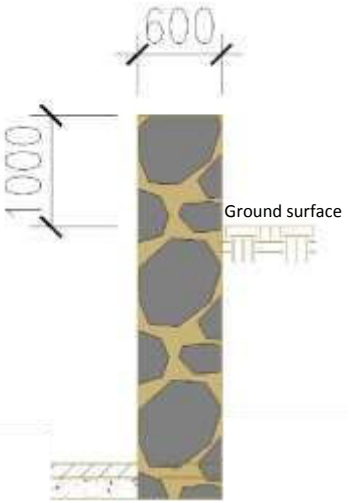
1. First, excavate the land of selected location 180cm deep from above the ground.



2. Then, build the base of the wall from stone, as shown in the picture. The base should be 60cm thick.



3. Lay a stone wall starting at a depth of 180cm and build the wall until it is 1m tall above the ground.



4. While building the wall, leave a place for the ventilation pipe.

5. The hallway will help keep the air inside the cellar at moderate level. It won't let the cold wind enter the cellar.

Step 5

2.5. ATTACHING VENTILATION PIPES

Ventilation pipes serve as a permanent ventilation system.

1. Attach plastic pipes with 100mm diameter to the side walls from bottom up-

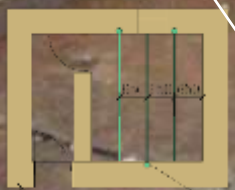
2. The same size of pipes will be placed under the plaster floor.

3. Leave 65 cm intervals between the pipes on the floor.

4. Make a hole in the upper part of the pipes on the floor with 42 cm intervals between each hole.

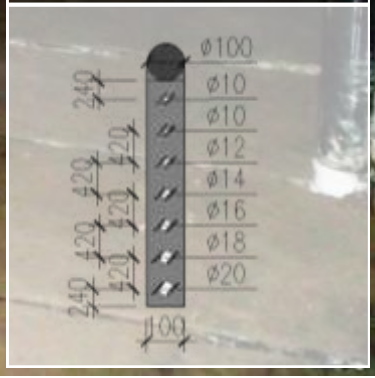
5. In each pipe, make 7 holes. Diameter of each hole is different from the others. Hole on elbow side is 10mm and at the end part, 20 mm. (see in the picture).

6. Then attach the floor and wall pipes by plastic elbow with 100mm diameter.



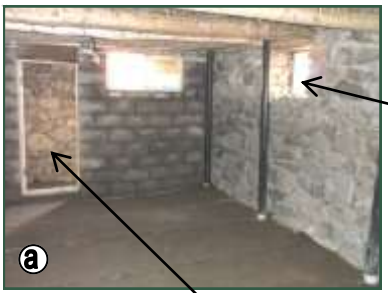
65cm

42cm



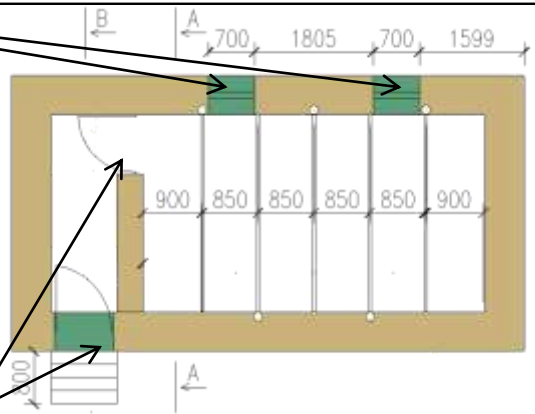
Step 6

2.6. INSTALLING DOORS AND VENTILATION WINDOWS



① For a 4 ton cellar, install 1 window. For 10 and 20 tons cellar, use 2 windows. Use wooden double glazed windows with size 70cm in width and 50 cm in height to open.

② The cellar should have 2 doors:
a) for entrance to hallway;
b) for entrance to cellar.
Doors are made from planks with size 175cm x 90cm.



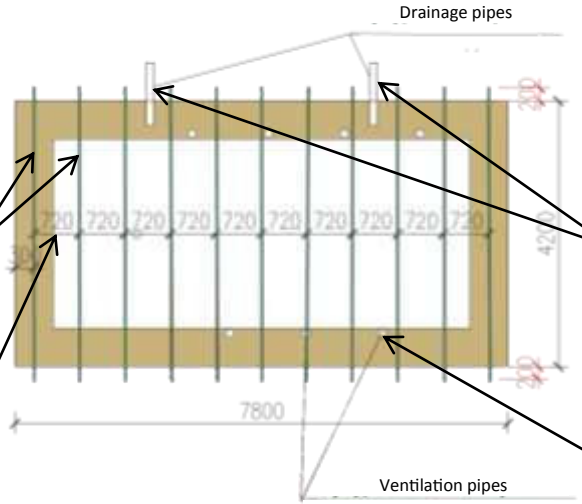
Windows serve as an additional ventilation system.

Step 7

2.7. ROOFING THE CELLAR

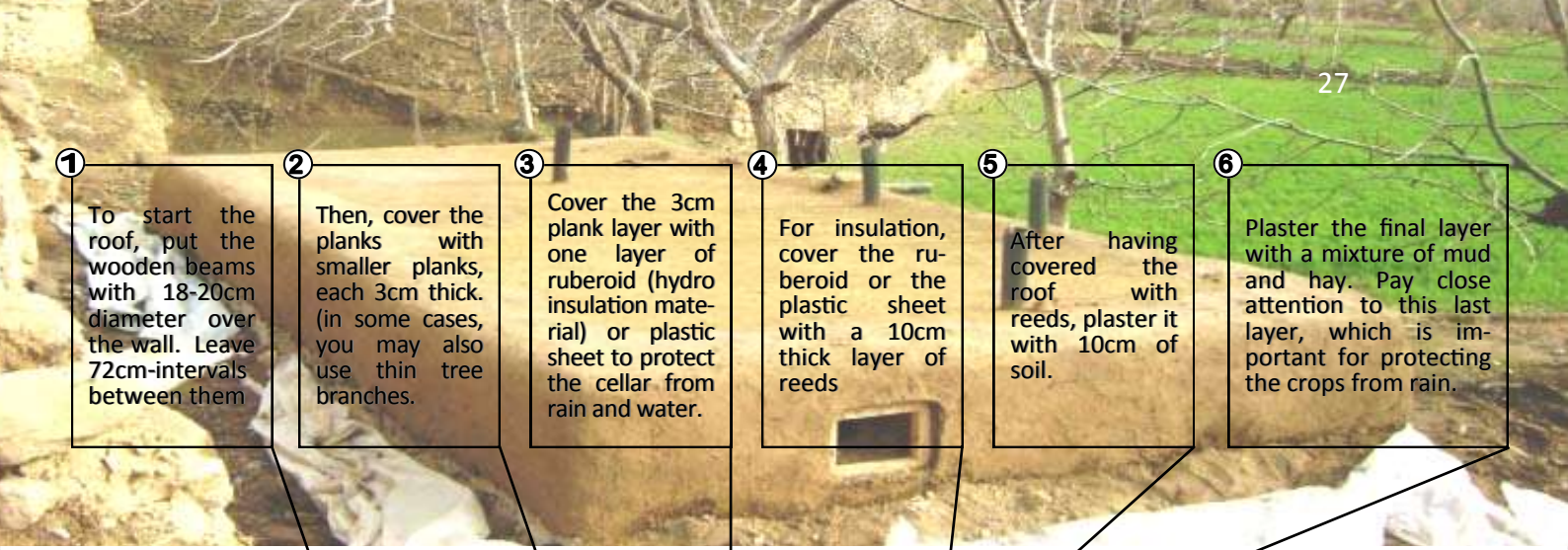
1. To cover the roof, place planks on top of the walls as shown in the picture. Length of the plank must be 4.6m.

2. Leave 72 cm intervals between each plank (use the design for consultation).



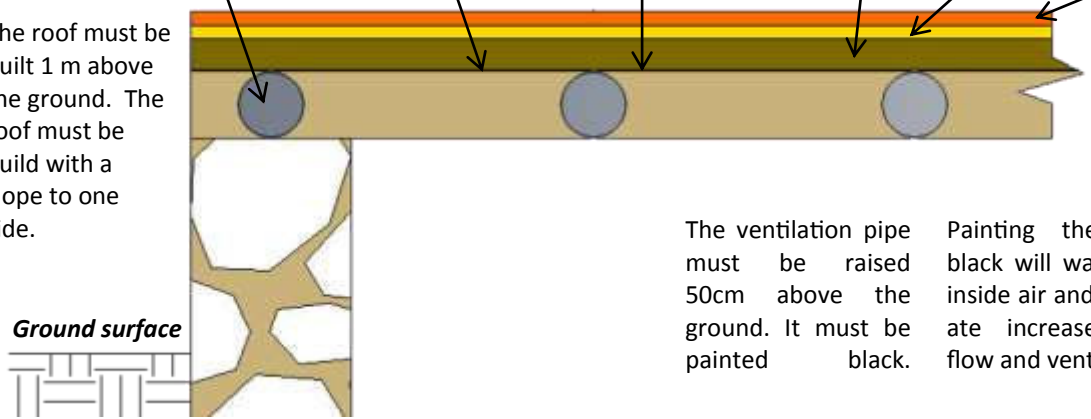
3. Place two drainage pipes on the roof with 100mm diameter and 1m of length.

4. The upper part of ventilation pipe which are attached to the wall, must go out through the roof.



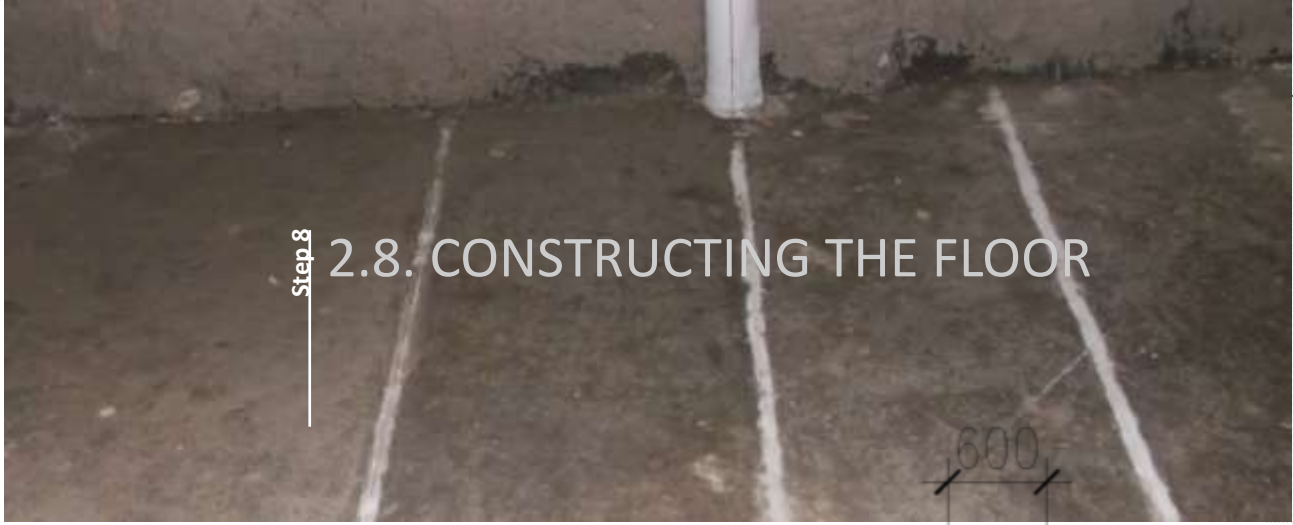
1. To start the roof, put the wooden beams with 18-20cm diameter over the wall. Leave 72cm-intervals between them
2. Then, cover the planks with smaller planks, each 3cm thick. (in some cases, you may also use thin tree branches.
3. Cover the 3cm plank layer with one layer of ruberoid (hydro insulation material) or plastic sheet to protect the cellar from rain and water.
4. For insulation, cover the ruberoid or the plastic sheet with a 10cm thick layer of reeds
5. After having covered the roof with reeds, plaster it with 10cm of soil.
6. Plaster the final layer with a mixture of mud and hay. Pay close attention to this last layer, which is important for protecting the crops from rain.

The roof must be built 1 m above the ground. The roof must be build with a slope to one side.



The ventilation pipe must be raised 50cm above the ground. It must be painted black.

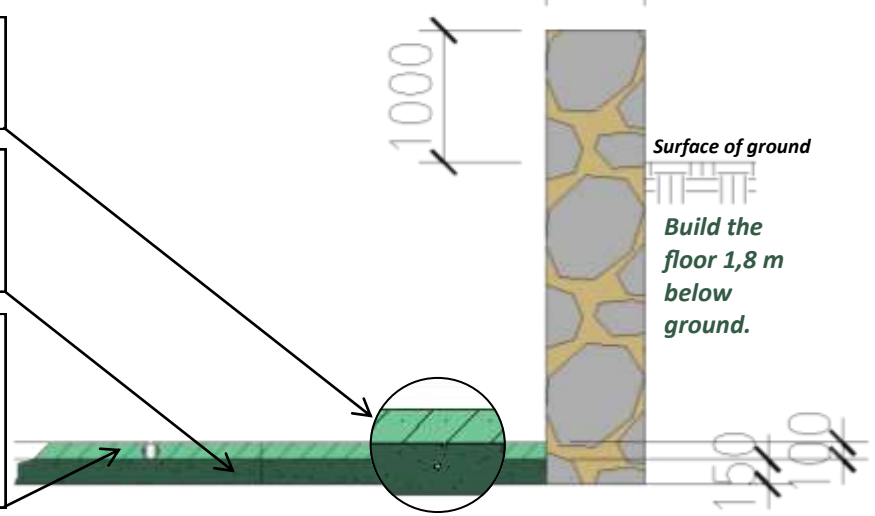
Painting the pipe black will warm the inside air and generate increased airflow and ventilation.



Step 8

2.8. CONSTRUCTING THE FLOOR

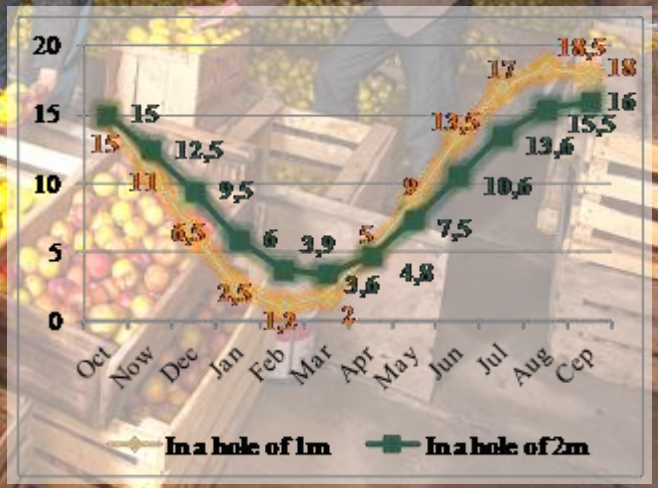
1. The floor is 25 cm thick. The top 10 cm is cement. .
2. The bottom layer of the floor is gravel, 15cm thick.
3. Lay a ventilation pipe in the top 10 cm of the floor. The ventilation holes should face up.



3. OPERATION OF BICLIMATIC CELLAR

1. How does a bioclimatic cellar operate?

- Ventilation occurs as a result of natural circulation of inside and outside air .
- Thick walls and insulated floors keeps the temperature at moderate level.



Underground temperature throughout the year

2. What can be stored in bioclimatic cellar and in what temperature?

Name of fruits and vegetables	Appropriate temperature (ºC)	Relative humidity (%)	Cannot be stored together
Potato	5 to 8	85-95	
Carrot	0.5 to 1	90-95+	
Onion	0 to 3	70 -75	
Apple	3 to 4	90-95	
Beat	0 to 1	90 95	
Turnip	0 to 1	90 95+	
Cabbage	0 to 1	94 97+	
Radish	0 to 1	95+	
Persimmon	0 to 1	85-95	Apple and Persimmon
Pomegranate	> 5 to 6	90-98	Apple and Pomegranate

3. How to freshen the air?

For a 4 ton bioclimatic cellar, operate the ventilation pipes in the following way: From November till March open just one pipe,

- In October, April and May open all the pipes
- If the humidity inside the cellar is above 95%, it is important to open windows.

In winter, spring and summer you can regulate the temperature with ventilation.

4. How to determine when to use ventilation?

Here are some signs ventilation is required:

- If the crop is dry to the touch, it means temperature levels inside the cellar are high and humidity level is low.
- If the crop is moist, it means the humidity level is too high.

In such cases, you should ventilate and refresh the air inside the cellar.

4. CONTACT INFORMATION OF PROMOTERS AND MASTERS

	Ayni district	Asht district
For construction of bio climatic cellar, please contact:	***Narzulloev Barot*** *Address: Hayronbed village, Fondaryo jamoat,* *Phone: 92 848 77 60.*	***Karimov Rustam*** *Address: Marhamat village, jamoat Oshoba.* *Phone: 92 702 82 63*
To purchase construction materials, please go to:	***Sarvoda Construction Store*** *Address: Sarvoda town (near hospital)*	***Uppon village market*** *Address: Upponi Bolo village, Oshoba jamoat.*
For more information and consultation, please contact:	***Sirojiddinov Asliddin*** *jamoat Fondaryo* *Phone: 92-764-20-52.*	***Abdulloev Faizullo*** *jamoat Oshoba* *Phone: 92-727-06-51.*

European Union | *French Development Agency* | *Women in Europe for a Common Future* | *German cooperation* | *Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH* | *UKAID* | *Abbé Pierre Foundation* | *Groupe Energies Renouvelables, Environnement et Solidarités* | *Agency for Support Development Process Nau*

This information is made possible by the support of the European Union. The contents are the sole responsibility of GERES and do not necessarily reflect the views of the European Union.

GERES - TAJIKISTAN
Address: 79 Hamza Hakimzoda Street, Dushanbe, Tajikistan
Phone: (+992) 37 880 65 64
E-mail: tajikistan@geres.eu
Web: www.geres.eu

Agency for Support Development Process Nau
Address: 20-34 Lenin Street, Khujand, Tajikistan
Phone: (+992 34) 224-53-20; 6-03-62
E-mail: office@agencynau.tj
Web: www.agencynau.tj