



MANUAL FOR CONSTRUCTION AND OPERATION OF **SOLAR GREENHOUSE**



INTRODUCTION

Importance of solar greenhouse construction

Tajikistan is mountainous country, with 93% of its territory consisting of mountains. Although only a small part of the country's flat areas is suitable for agriculture, it counts for main source of income for almost 70% of population. Most of the produced agricultural crops go to household tables, and part of it is sold at local markets, which to some degree, contributes to food security of the country.

Tajikistan is mountainous Lately, because of increasing prices for agricultural inputs and the growing population, country, with 93% of its territory consisting of mountains. Although only a small part of the country's flat areas is efficient solar greenhouses .

- suitable for agriculture, it The manual consists of the following main sections:
- counts for main source of 1. Construction of solar greenhouses;
- income for almost 70% of 2. Operation of solar greenhouses;
- population. Most of the pro- 3. Contact information of promoters and artisans (engineers) for construction of solar greenhouse in Ayni and Asht districts, Sugd province.

to household tables, and This manual is developed within the frame of the project "Increasing income generation of rural households and improving living condition of poor population of Sugd province" by the European Union through GERES. Although this manual is developed mainly for dehkans from Ayni and Asht districts of Sugd province, dehkans from other districts with similar topography and climate as in the above mentioned districts, can also benefit from it.

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1. SOLAR GREENHOUSE

Efficient technology for cultivation and production of early vegetables in autumn, winter and early spring.

A solar greenhouse is a type of greenhouse in which you can grow early vegetables in autumn, winter and early spring. Usually, people grow tomatoes, cucumbers, greens, early vegetable seedlings as well as beans for secondary crops. Greenhouses are usually built South-facing . During the day, heat from the sun is concentrated on the crop. It does not use any additional heating equipment for cultivation, because at night, during the cold season, the top of it can be covered with special straw mattresses. This prevents energy waste and heat loss.



A greenhouse saves energy and helps the environment.

2. CONSTRUCTION OF A SOLAR GREENHOUSE

Following all these steps during construction guarantees high productivity of your greenhouse.



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32.1. SELECTING WHICH TYPE OFGREENHOUSE

Selecting which type of greenhouse is the first step you must make in constructing a solar greenhouse. This manual presents two types of solar greenhouses. Both types of greenhouse also have sub-types. You can select the type you like best.

Opti	on A.	Option B.				
Option A1.	Option A2.	Option B1.	Option B2.			
Size: 10 m x 5 m Area (0,005 ha) With iron frame With brick walls on east, west and north Cost- 12,401.96 TJS	Size: 10 m x 5 m Area (0,005 ha) With wooden frame With brick walls on east, west and north Cost -11,767.96 TJS	Size: 20 m x 5 m Area (0,001 ha) With iron frame With brick walls on east, west and north Cost - 20,757.00 TJS	Size: 10 m x 5 m Area (0,005 ha) With wooden frame With brick walls on east, west and north Cost - 20,029.00 TJS			

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2.2. PROCURING CONSTRUCTION MATE-RIALS (COST ESTIMATE)

	Meas-	.				Meas-			Tatalasat	Option A1.
# Expenditure items	unit		Price	lotal cost	# Expenditure item	Unit	Unit			Size 10 m x 5 m
1 Preparing soil with tractor or manually				3 Wall					With iron frame	
Labor cost	m³	25	50	1250						
Calculation				1250	Labor cost for laying bricks	piece	3240	0.15	486	Cost of expenditure is
2 Foundation					Labor cost for plastoring (only					estimated in Tajik So-
Labor cost	m²	16.56	25	414	from outside)	m²	14.41	6	86.46	moni.
Labor cost for filling the wall	m.				Construction materials:					
above foundation off the ground with soil	length.	2,5	20	50	Mud brick size	nioco	32/10	03	972	
Construction materials					0.25x0.12x0.065m	piece	3240	0.5	572	
Stone	M ³	9	70	630	Clay (mud) for plastering	m³	2,5	70	175	
Sand	M ³	3	70	210			7-	-		
Cement	t	1.75	900	1575	Insulation (hay or sawdust) +	sack	40	7	280	
Hydro insulation roofing material	roll	1	80	80	piastei					
Calculation				2959	Calculation				1999.46	

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Option A1.		Meas-					Meas-			
Size 10 m x 5 m	# Expenditure item	urement	Q-ty	Price	Total Cost	# Expenditure item	urement	Q-ty	Price	Total co
With iron carcass		unit					unit			
	4 Roof					5 Front carcass				
Cost of expenditure is	Welding labor cost	person/ day	3	100	300	Welding labor cost	person/ day	3	100	300
estimated in Tajik So-	Labor cost for insulating with sand	ł				Construction materials:				
moni	(soil) and with galvanized corru- gated sheet	m²	25	15	375	Plastic pipe for under the column	m.	3	40	120
	Construction materials:					Profile 4cm x 6cm for column and	_			
	Plastic pipes filled with cement to					beam	т.тул.	15	15	225
	support columns	m.length	3	40	120	Corner brace 40mm	m.	48	8	384
	Iron pipe Ø76mm used as beam and columns in the frame	m.	17	28	476	Crosspiece for top of window 12mm	m.	10	2,2	22
	Corner brace 40mm	m.	62	8	496	Electrode 2-3 мм	piece	100	0,2	20
	Paint for wood	kg	4	12	48	Disc for angle grinder	piece	1	6	6
	Crosspiece support bars for roof 12mm	m.length	50	2,2	110	Lintel for foundation and rooftop	m.	20	5	100
	Electrode for welding 2-3 mm	piece	100	0,2	20	to attach plastic sheet Schrix Sch	iengtii.			
	Disc for angle grinder	piece	1	6	6	Plastic sheet 0,8 x 1.5 m	m.	12	15	180
	Straw	bunch	44	3	132	Wire with 2mm diameter	kg	4	8	32
	Soil for making clay plaster	m³	1.2	70	84	Twine	m.	60	0.8	18
	Wire with 2mm diameter	kg	4	8	32	i wine	length	00	0,0	40
	Lintol 4cm y Ecm (frame under the	2				Calculation				1437
	galvanized corrugated sheet)	m.	40	4,5	180	6 Night insulation				
	Galvanized corrugated sheet		12	40	570	Labor cost for installing	person/ day	0.5	100	50
	(2.5m length and 0.95m width)	m.	12	48	570	Construction materials:				
	Screws	κг.	1	15	15	Ready made insulation materials				
	Drainage	т.тӯл.	11	7	77	(with consideration of Transpor-		45	11	495
	Calculation				3047	tation cost)				
						Calculation				545

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\$	Expenditure item	Meas- urement unit	Q-ty	Price	Total cost	# Expenditure item	Meas- urement unit	Q-ty
7	Installing door and windows	<u> </u>				Ready made windows with glass-	piece	1
	Labor cost for installing windows and door	person/ day	1	100	100	es of 0.5m x 0.6m size.	nair	1
_	Construction materials for door:					Handle	piece	1
	Creaniana 2000 - 10000 - 0000	Security Bolt	Security Bolt	piece	1			
_	Crosspiece 3cm x 10cm x 6m	m.iengtn	6	10	60	Iron grate	Meter	1
	Door with 1.8m x 0.7m size	m.	1	200	200	Nails for door and windows	kg	1,5
	Hinge	pair	1	10	10	Paint for door and windows	kg	2
	Handle	piece	2	5	10			
	Security Bolt	piece	1	3	3	Calculation		
	Construction materials for win-					8 Transportation cost		
	dow					Total		
	Crosspiece 3cmx 10cm x 6m	m.length	4.5	10	45			
	Lintel 5cm x 5 cm	m.length	5.5	5	27,5			
	Insulation (Styrofoam)	m²	1	15	15			
	Hinge	pair	1	10	10			
	Galvanized sheet	m²	1	25	25			
	Construction material for win- dows							
	Crosspiece 3cm x 10cm x 6m to cover the top of the window	m. Iength	4	10	40			

price Total cost

664.50 12401.96

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Option A2.	# Expenditure items	Meas-	Quantity	Price	Total cost	# Expenditure items	Meas- urement O	uantity	Price	Total cost
Size 10 m x 5 m		unit	Quantity		rotar cost		unit	,		
with wooden frame	1 Preparing soil with tractor or ma	1 Preparing soil with tractor or manually				Labor cost for insulation + soil	m ²	25	15	375
	Labor cost	m³	25	50	1250	+galvanized corrugated sheet		23	-13	575
Cost of expenditures are	Calculation				1250	Materials:				
estimated in Tajik So-	2 Foundation					Plastic pipe filled with concrete to	m.length	2	40	80
moni	Labor cost	m²	16,56	25	414	stabilize columns				
	Labor cost for filling the wall	mlongth	25	20	50	Wooden columns with 150mm diameter	m.length	8	20	160
	with soil	m.iengtii	2,5	20	50	Beam with 150mm diameter	m.	10	20	200
	Construction materials					Cross beam 120mm x 40mm x 6m	piece	8	52	416
	Stone	m ³	9	70	630	Lintel 40mm x 40mm.	m.length	40	4	160
	Sand	m ³	3	70	210	Straw	bunch	44	3	132
	Cement	+	1 75	900	1575	Soil for plastering	m ³	1,2	70	84
	Hydro insulation roofing material	roll	1	65	65	Wire with 2mm diameters	kg	4	8	32
	Calculation	1011	-	0.5	2944	Nails	kg	3	8	24
	3 Wall				2311	Lintel 4cm x 5cm to install roof				100
	Labor cost	niece	3240	0.15	486	from galvanized sheet	m.	40	4,5	180
	Labor cost for plastering (from	m ²	14.41	6	86,46	Galvanized corrugated sheet	niece	12	48	
	outside only)					(length 2.5м, width 0.95m)	piece	12	40	
	Materials:					Screw	kg	1	15	15
	Mud brick of 0.25x0.12x0.65m size	piece.	3240	0.3	972	Gutter for drainage	m.length	11	7	77
	Soil for making clay plaster	m³	2.5	90	225	Calculation				2711
	Insulation (hay or sawdust) +	sack	40	7	280	5 Front frame				
	plastering	JUCK		<u> </u>	200	Labor cost for putting up the	person/	2	100	200
	Calculation				2049.40	beams	day	2	100	200
	4 Roof					Materials				
	Labor cost for putting up the beams	person/ day	2	100	200	Plastic pipe	m.length	2	40	80

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#	Expenditure items	Meas- uremen t unit	Quantity	Price	Total cost
	Wooden columns with 150mm diameter (you can use the lefto- vers remaining after measuring and cutting the big columns)	m.	0	0	0
	Beam with 120mm diameter	m.lengt h	10	15	150
	Cross beam 100mm x 40 mm x 4m	m.lengt h	10	29	290
	Lintel for attaching plastic from foundation to top of wooden roof 5cm x 5cm	m.lengt h	20	5	100
	Plastic sheet 1mkm x 6 m	m.lengt h	12	15	180
	Nail	kg	3	8	24
	Wire with 2mm diameter	kg	4	8	32
	Twine	m.lengt h	60	0.8	48
	Calculation				1104
6	Night insulation				
	Labor cost for installing	person/ day	0,5	100	50
	Material:				
	Insulation material (including Transportation cost)	m²	45	11	495
	Calculation				545
7	Installing door and windows				
	Labor cost for putting up beams	person/ day	1	100	100
	Construction materials for door				

ŧ	Expenditure items	Meas- uremen t unit	Quantity	Price	Total cost
	Crosspiece 3cm x 10cm x 6m	m. Iength	6	10	60
	Ready door with 1.8m x 0.7m size.	piece	1	200	200
	Hinge	pair	1	10	10
	Handle	piece	2	5	10
	Security Bolt	piece	1	3	3
	Construction materials for window	v:			
	Plank 3cm x 10cm x 6m.	m. Iength	4,5	10	45
	Crosspiece 5cm x 5 cm	m.	5,5	5	27,5
	Insulation (Styrofoam)	m²	1	15	15
	Hinge	pair	1	10	10
	Galvanized sheet	m²	1	25	25
	Construction material for window	s:			
	Crosspiece 3cm x 10cm x 6m	m. Iength	4	10	40
	Window 0.5m x 0.6m size.	piece	1	70	70
	Hinge	pair	1	5	5
	Handle	piece	1	5	5
	Security Bolt	piece	1	2	2
	Chicken wire to keep out birds	m. Iength	1	5	5
	Nails for door and windows	kg	1,5	8	12
	Paint for door and windows	kg	2	10	20
	Calculation				664,5
3	Transportation cost				500
0	TAL				11767.96

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Q-ty

28,56

2,5

14.4

2.75

1.5

day

Price

0.15

0.3

Total

Cost

Option B1. Size 20 m x 5 m	# Expenditure item	Meas- urement unit	
with Iron carcass	1 Preparing soil with tractor or mar	nually	
	Labor cost	m3	
Cost of expenditure is	Calculation		
estimated in Tajik So-	2 Foundation		
moni	Labor cost	m²	
	Labor cost for filling the wall above foundation off the ground with soil	m.length	
	Construction materials		
	Stone	m³	
	Sand	m³	
	Cement	t	
	Hydro insullation roofing material	roll	
	Calculation		
	3 Wall		
	Labor cost	piece	
	Labor cost for plastering (from outside only)	m²	
	Materials:		
	Mud brick of 0.25x0.12x0.65m size	piece	
	Soil for making clay plaster	m ³	
	Insulation (hay or sawdust) + plastering	sack	
	Calculation		
	4 Roof		
	Labor cost for welding	person/	

# Expenditure item	Meas- urement unit	Q-ty	Price	Total Cost
Labor cost for insulation + plas- tering+galvanized corrugated sheet	m²	50	15	750
Material:				
Plastic pipe filled with cement to stabilize columns	m. length.	5	40	200
Iron pipe of Ø76mm diameter used as beams and columns in the frame	m. length.	31	28	868
Corner brace 40mm	m.	123	8	984
Crosspiece Bar 12mm	m.	100	2.2	220
Electrode 2-3 mm	piece	200	0.2	40
Disc for corner grinder	piece	2	6	16
Straw	bunch	80	3	240
Soil (clay) for plastering	m³	2,4	70	168
Wire with 2mm diameter	kg	6	8	48
Lintel 4cm x 5cm to attach metal sheet walls	m.length	80	4.5	360
Galvanized corrugated sheet (with 2.5m length and 0.95m width)	piece	24	48	1152
Screw	kg	2	15	30
Gutter	m. length	21	7	147
Calculation				5719
5 Front carcass of greenhouse				
Labor cost for welding	person/ day	4	100	400
Materials:				
Plastic pipe for under the column	m. length	5	40	200

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#	Expenditure item	Meas- urement unit	Q-ty	Price	Total Cost	# Expenditure item	Meas- urement unit	Q-ty
	Square iron beams 4cm x 6cm fo column and beam	r m. length.	28	15	420	Ready door with size of 1.8m x 0.7m.	piece	1
	Corner brace 40mm	m. Iength.	96	8	768	Hinge Handle	pair	1
	Paint for frame	kg	6	12	72	Security Bolt	piece	1
	Crosspiece 12mm	m. Iength.	20	2,2	44	Construction materials for build	ing two win	dows:
	Electrode 2-3 mm	piece	100	0,2	20	Plank 3cm x 10cm x 6m	length.	9
	Disc for corner grinder	piece	2	6	12	Crosspiece 5cm x 5cm	m. length	11
	Crosspiece for the top of founda-			_		Insulation (Styrofoam)	m²	2
	tion and top of roof carcass 5cm	m.length.	40	5	200	Hinge	pair	2
_	Plastic 1mkm x 6 m	m, length	22	15	330	Zinc coated tin plate	m²	2
	Wire with 2mm diameter	kg	6	8	48	Construction materials for con-		
	Twine	m. length	120	0.8	96	struction of windows:		
	Calculation				2210	Crosspiece 3cm x 10cm x 6m	m. length	4
6	Night insulation							
	Labor cost for installation	Person/ day	1	100	100	Window Size 0.5mx 0.6m	piece	1
	Materials:					Hinge	pair	1
	Ready insulation (with considera-	2	00		000	Handle	piece	1
	tion of Transportation cost)	m	90	11	990	Security Bolt	piece	1
	Calculation				1090	Wire mesh to keep out birds	m.	1
7	Installing the windows					Noile for windows and do an	length.	4 5
	Labor cost for timbering	Person/	1.5	100	150	Nalls for Windows and door	Kg	1.5
	Construction motorials for the co	day					ĸg	2
_	Construction materials for door:					8 Transportation cost		
	(connector)	m. length.	6	10	60	TOTAL		

Total

Cost

Price

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Option B2.

Size 20 m x 5 m With wooden carcass

Cost of expenditure is estimated in Tajik Somoni

# Expenditure item	urement unit	Q-ty	Price	Total Cost	# E
1 Preparing soil by tractor or manu	ally				L
Labor cost	m3	50	50	2500	t
Calculation				2500	S
2 Foundation					I
Labor cost	m²	28,56	25	714	F
Labor cost for filling the wall above foundation with soil	m.length	2,5	30	75	f V E
Construction materials					C
Stone	m³	14.4	70	1008	х
Sand	m³	5	70	350	C
Cement	t	2.75	900	2475	S
Hydro insullation roofing material	roll	1.5	80	120	S
Calculation				4742	١
3 Wall					١
Labor cost	piece	5040	0.15	756	C
Labor cost	m²	26	6	156	e r
Materials:	piece	5040	0.3	1512	(
Mud brick of 0.25x0.12x0.65m	m³	5	70	350	F
Soil for making clay plaster	sack	55	7	385	5 \
Calculation				3159	
4 Roof					L
Labor cost for putting up wooden	person/				I
beams	day	3	100	300	F
					f

Price	Total Cost	# Expenditure item	Meas- urement unit	Q-ty	Price	Total Cost
50	2500 2500	Labor cost for insulation + plas- tering + galvanized corrugated sheet	m²	50	15	750
		Materials				
25	714	Plastic pipe filled with concrete for supporting columns	m.	5	40	200
30	75	Wooden pipe with 150mm diam- eter	m. length.	16	20	320
		Bean with 150mm diameter	m. length	20	20	400
70	1008	Cross beam with 120mmx 40mm x 6 m diameter.	piece	16	52	832
70	350	Crosspiece with 40mm x 40mm	m. length	80	4	320
900	2475	Straw	bunch	80	3	240
80	120	Sand	m³	2,4	70	168
	4742	Wire with 2mm diameter	kg	6	8	48
		Nail	kg	6	8	48
0.15 6	756 156	Crosspiece with 4cm x 5cm diam- eter (carcass under the galva- nized corrugated sheet)	m. length	80	4,5	360
0.3	1512	Galvanized corrugated sheet (length 2.5m, width 0.95m)	piece	24	48	1152
		Ready made drainage pipe	m.	21	7	147
70	350	Screw	kg	2	15	30
-	205	Calculation				5315
/	385	5 Wooden Frame				
	3159	Labor cost for putting up beams	person/ day	2	100	200
100	200	Materials:				
100	300	Plastic pipes filled with cement for supporting columns	m. length	5	40	200

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# Expenditure item	Meas- urement unit	Q-ty	Price	Total Cost	# Expenditure item
Wooden columns with 150mm diameter (you can use the lefto-	m.	0	0	0	Crosspiece for door 3cr 6m
and cutting the big columns)	iengui.				Door size 1.8m x 0.7m
Beam with 120mm diameter	m.	20	10	200	Hinge
	length.				Handle
Cross beam , 100mm x 40 mm x	piece	20	29	580	Security Bolt
4111					Construction material
from foundation to roof 5cm x	m.	40	5	200	Crosspiece for windows
5cm	length.	40	J	200	
	m.	22			Inculation (Styrofoam)
Plastic1mkm x 6 m	length.		15	330	Hinge
Wire with 2mm diameter	kg	6	8	48	Galvanized sheet
- 1	m.	120	0.0	06	Construction materials
Iwine	length.	120	0,8	96	dows
Nail	kg	4	8	32	Windows Crosspiece 30
Calculation				1886	x 6m
6 Night insulation					Windows size 0.5m x 0
Labor cost for installation	Person/	1	100	100	Windows Size 0.5m x 0.
	day	-	100	100	Hinge
Material:					Handle
Night insulation materials: Trans					Security Bolt
portation cost included	m²	90	11	990	Wire mesh to keep out
					Nails for windows
Calculation				1090	Paint for windows
7 Installing door and windows					Calculation
Labor cost for putting up wooden	Person/	1,5	100	150	8 Transportation cost
beams	day				TOTAL
Construction materials for door					

Expenditure item	Meas- urement unit	Q-ty	Price	Total Cost
Crosspiece for door 3cm x 10cm x 6m	m. length.	6	10	60
Door size 1.8m x 0.7m	piece	1	200	200
Hinge	чpair	1	10	10
Handle	piece	2	5	10
Security Bolt	piece	1	3	3
Construction material for two up	per window	vs		
Crosspiece for windows 3cm x 10cmx 6m	m. Iength.	9	10	90
Lintel 5cm x 5cm	m. length	11	5	55
Insulation (Styrofoam)	m2	2	15	30
Hinge	pair	2	10	20
Galvanized sheet	m2	2	25	50
Construction materials for win- dows				
Windows Crosspiece 3cm x 10cm x 6m	m. Iength.	4	10	40
Windows size 0.5m x 0.6m	piece	1	70	70
Hinge	pair	1	5	5
Handle	piece	1	5	5
Security Bolt	piece	1	2	2
Wire mesh to keep out birds	m.	1	5	5
Nails for windows	kg	1,5	8	12
Paint for windows	kg	2	10	20
Calculation				837.00
3 Transportation cost				500.00
DTAL				20029.00

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2.3. SELECTING LOCATION AND LAY-ING THE FOUNDATION

When selecting a location for solar green house construction, consider the following:

a) Access to irrigation.

The land must be irrigated and must be available for your use. The land must be close to a source of water.

b) Access to sun light. The greenhouse must be constructed in a d) Wind place where *it can get* at least 6 hours of sun light during the day.

c) Underground water must be low.

The land chosen must be well above the water table, because crops must be cultivated to a depth of 1 meter.

The greenhouse must be constructed in a place safe from strong

winds.

e) Positioning of greenhouse.

The greenhouse must face south. Use a compass to determine the direction.

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As it is shown in the picture, the sun is strongest in the south year-round.

Therefore, while selecting a location for the greenhouse try to make it face the south. In special cases, greenhouses can be positioned $\pm 30^{\circ}$ from the south.



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▼ South ≈ ±30°

Option A1.

Size 10 m x 5 m With iron frame

CROSS SECTION A-A

Size 10 m x 5 m With iron frame

Option A1.





CROSS SECTION B-B

.

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Option A1.

Size 10 m x 5 m With iron frame



▼ South ≈ ±30°

. . . .

CROSS SECTION A-A

. 2





Size 10 m x 5 m With wooden frame

Option A2.



.

GENERAL PLAN



v South ≈ ±30°

Option B1.

Size 20 m x 5 m With iron frame

Option B1.

Size 20 m x 5 m With iron frame





. . . .

CROSS SECTION B-B



Option B1.

Size 20 m x 5 m With iron frame

GENERAL SCHEME

Size 20 m x 5 m With wooden frame

Option B2.



▼ South ≈ ±30°

CROSS SECTION A-A



.



Size 20 m x 5 m With wooden frame

Option B2.



. . . .

4. CONSTRUCTION OF FOUNDATION OF GREENHOUSE

- The foundation is a key part of the construction. The foundation of the walls must be first drafted on the ground and then the ground must be excavated 50 cm deep.
- The foundation is mostly built from stone, with a mixture of sand and cement between the stone. (if stone is not available, concrete can be used).
- The size of the foundation for each option of solar greenhouse is shown below:

General area	Option A1.	Option A2.	Option B1.	Option B2.
From east to west	10 m.	10m.	20m.	20m.
From north to south	5m.	5m.	5m.	5m.

Height and thickness							
Eastern, western and northern foundation	0,60m. x 0,60m.	0,60m. x 0,60m.	0,60m. x 0,60m.	0,60m. x 0,60m.			
Southern foundation	0,60m. x 0,20m.	0,60m. x 0,20m.	0,60m. x 0,20m.	0,60m. x 0,20m.			
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General view of foundation during construction of solar greenhouse.

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2.5 BUILDING EASTERN, WESTERN AND NORTHERN WALLS OF THE GREENHOUSE

It is important to build the walls correctly by following the requirements below.

Length of walls	OptionA1.	Option A2.	Option B1.	Option B2.				
Eastern and western walls	5m.	5m.	5m.	5m.				
Northern walls	10m.	10m.	20m.	20m.				
Height and thickness								
Eastern and western walls	1,70m. from above ground / 0,56m.	1,70m.from above the ground / 0,56m.	1,70m.from above the ground / 0,56m.	1,70m.from above the ground / 0,56m.				
Northern walls	0,80m. From above the ground/ 0,56m.	0,80m.from above the ground / 0,56m.	0,80m.from above the ground / 0,56m.	0,80m.from above the ground / 0,56m.				
Southern walls	N/A	N/A	N/A	N/A				
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Greenhouse walls must be built from mud or mud-bricks. The wall must consist of three rows:

First row:	Second row:	Third row:	
Inside wall — must be 24 cm thick.	Outside wall — Insulation wall. Must be 12 cm thick.	Is laid between the space of two walls with 10 cm thickness.	
		Eaa are wa spa tion	aving s a betw IIs ma ace for n.
			Contraction of the

Leaving some area between the walls makes space for insulation

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To link the first and the second layers together, fasten it with wire or wood with 6 mm diameter. After building walls, insulate the space between the walls with hay, wood sawdust, or Styrofoam. (Using tree leaves is not recommended, as it decomposes in short while.)

Walls from the outside, must be fully plastered up to 5 cm.



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2.6. PREPARING AND INSTALLING THE ENTERING DOOR OF GREENHOUSE



The door is mainly built for entering the greenhouse. For installing the door, only few principles need to be considered.

The size of the door (height and width) is 160 cm x 90 cm.

- The door is usually made from a wooden plank.
- It is placed between the east walls of greenhouse.
- Also, it is recommended to place iron mesh wire inside the door. When the door is opened to let the air in, the grate will keep the livestock and birds away from entering the greenhouse.

2.7. PREPARING AND INSTALLING VENTILATION WINDOWS TO THE GREENHOUSE



Mesh wire prevents birds from flying into the greenhouse.



Windows on the walls are important for ventilation. Below are some principles of installing ventilation windows:

- The size of the window must be of 50 cm height x 60 cm width.
- The windows must be installed facing the door of the greenhouse, i.e. between the western walls. It is important for freshening the air of the greenhouse.
- Windows must be placed 65 cm above the ground.
- To prevent birds from flying into the greenhouse, it is recommended to install window bars or mesh wire to the window.

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2.8. COVERING THE NORTHERN PART OF THE ROOF AND INSTALLING WINDOWS ON THE ROOF OF THE GREENHOUSE

	Option A1.	Option A2.	Option B1.	Option B2.
Quantity of columns made from iron pipe (170 cm)	3	-	5	-
Number of wood columns (170cm)	-	2	-	5
Distance between the columns	2,20m	2,80m.	3,10cm.	3,1cm.
Number of cross iron bars for frame under the ceiling	16	-	35	-
Number of wood bars for the frame under the ceiling	-	16	-	35
Intervals between the iron and wood planks	0,50m.	0,50m.	0,50m.	0,50m.
Number of windows	1	1	2	2
Size of windows (length x widths)	1,20mx 0,90m	1,20m x 0,90m	1,20mx 0,90m	1,20m x 0,90m

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GENERAL SCHEME OF COVERING THE NORHERN PART OF THE ROOF (GALVANIZED SHEET SLATE IS USED ONLY WHEN NECESSARY)

- Support and roof beam are installed.
- Distance between the supports are brought in the liner.
- Ventilation windows are placed on the roof for air circulation and to reduce humidity.
- The upper part of the window is made from galvanized sheet and the inside part can be made from plywood.



Options A1., B1.

With iron frame





- 1. Installing columns and beam;
- 2. Placing iron or cross boards under the ceiling;
- 3. Placing twigs (sticks) in wood carcass or iron cross-pieces in an iron frame;
- 4. Placing straw for heat insulation;
- 5. Plastering the top of the straw;
- 6. If the roof is covered with enough plaster it will be water proof, and a metal sheet is not required.
- 7. If the roof is not sufficiently well plastered you may cover the roof with galvanized sheet after plastering.





2.9. COVERING THE SOUTHERN PART OF ROOF WITH PLASTIC

For covering the south part of the greenhouse follow these steps:

- Prepare greenhouse frame. The carcass can be made from iron, (Options A1, B1) or wood (Options A.2., B.2.) in accordance with the scheme shown in this manual (Follow the scheme).
- To prevent the polyethylene plastic from tearing, sand the edges of the wood or iron.
- Too keep the plastic in good

condition, you can put fabric between the plastic and edges of iron or wood.

- Purchase good quality polyethylene. (0.8 micron)
- Polyethylene must be tightly stretched over the carcass . If not to stretch it tight, it may get exposed to negative impact of wind.
- Polyethylene expands in heat

and shrinks in the cold. Therefore, the best time to cover the carcass is during afternoon sunlight.

 To attach and keep polyethylene fastened, you can place sacks filled with sand on the roof. Also, you may tie the plastic with thread, to prevent it from destruction by wind.

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- View of carcass without polyethylene cover;
- 2. View of solar greenhouse covered by polyethylene;
- View of greenhouse with iron carcass covered inside with polyethylene;
- View of greenhouse with wood carcass inside covered with polyethylene;
- 5. Attaching and fastening polyethylene on the roof and doors.

MANUAL FOR CONSTRUCTION AND OPERATION OF SOLAR GREENHOUSE



3. OPERATION OF SOLAR GREENHOUSE

How to use solar greenhouse?

Solar greenhouse operate to collect daytime sunlight and walls keep the warmth and at night and pass it to plants.



<u>What air temperature and humidity level</u> must be inside the greenhouse?



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When is the best time to attach the polyethylene cover?

You need to cover the greenhouse with polyethylene plastic when outside temperature is around 10-15°C.

How to use the felt?

The felt is used during winter season for insulation purpose, i.e. to reduce waste of energy collected inside the greenhouse. It is used when there is not enough sun light shedding to the greenhouse. Usually it is used during night time when there is no sun. Put felt over the polyethylene.

Does it mean I cannot use the felt during daytime?

Felt can be used during daytime only during cold and cloudy weather, when there is no sun light.

If the weather gets even colder and felt does not help, what else can I use?

In such case, you can use fabric. Take fabric and place it inside the greenhouse, below polyethylene layer so that air can congested between fabric and plastic and create insulation.

Additional layer from fabric placed under the polyethylene plastic, helps for insulation.



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How should the greenhouse be ventilated?

During hot or warm weather, you can ventilate the greenhouse so that the inside air is fresh. Ventilation also reduces temperature when it is too hot inside.

For ventilation, you can use one of four methods:

- 1. Open door;
- 2. Open windows;
- 3. Open the roof window;
- 4. Partly open polyethylene.



When temperature is above 25 $^{\circ}$ C , ventilation is needed to reduce temperature and humidity level inside the greenhouse. This is done during summer spring and autumn.

When temperature is below 25 $^{\circ}$ C, close door and windows. Windows must be closed one hour before sunset.

How can I determine when ventilation is needed?

Ventilation is needed when water drops from vapor on polyethylene is increased, soil on the ground is moldy and temperature is above the average.

During which months can I use the greenhouse?

Schedule for planting in greenhouse

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Crop	greens	greens / cucumber			cucumber			green fertilizer*	green fertiliz- er	green fertilizer/ greenery	greens	greens
Operation	harvest	harvest/ plant	grow/ harvest		harv	vest		plant	grow	grow/ plant back into ground	plant/ harvest	harvest

* Green fertilizer - planting greens not for growing crop but for making compost fertilizer for soil.

How much profit can I make from using greenhouse?

Calculation of income, expenditure, and profit from greenhouse with 10m. x 5m size in one year.

Income	Quantity of harvest	Measuring unit	Average price** (TJS)	Income (TJS)	Total income (TJS)	
Cucumber	300	kg.	7.00	2100.00		
Green fertilizer	-	-	-	-	2925.00	
Greenery	825	bundle	1.00	825.00		
Expenditure	Seeding (TJS)	Plastic/ year (TJS)	Compost (TJS/ year)	Fertilizer (saltpeter) TJS/ year	Total expenditure (TJS)	
Cucumber	50.00			9.00		
Green fertilizer	20.00	100.00	0.00	0.00	198.00	
Greenery	10.00			9.00		
** All cost is taken from 2012 estimates.					Profit (TJS) 2727.00	

4. CONTACT INFORMATION OF MASTERS AND PROMOTERS

	Ayni district	Asht district
For construction of solar green- house, please contact:	Narzulloev Barot Address: Hayronbed village, Fondaryo jamoat, Phone: 92 848 77 60.	Karimov Rustam Address: Marhamat village, Oshoba jamoat Phone: 92 702 82 63
To purchase construction materi- als, please go to:	Sarvoda Construction Store Address: Sarvoda town (near hospi- tal)	Uppon village market Address: Upponi Bolo village, Oshoba jamoat.
For more information and consul- tation, please contact:	Sirojiddinov Asliddin jamoat Fondaryo Phone: 92-764-20-52.	Abdulloev Faizullo jamoat Oshoba Phone: 92-727-06-51.



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.



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