Construction and maintenance of Solar Fish Drier

This Technical brief details the basic construction techniques as well as the material, equipment, skills and labour requirements necessary to construct a low cost solar fish drier suitable for the small scale dry fish producers of Sri Lanka.

Introduction

Initiatives to improve the productivity and quality standards of the local dry fish industry is important for several reasons. Firstly, fish, including dry fish, is the most important source of protein, accounting for 65% of the protein intake of the average Sri Lankan consumer. With the gradual increase in population, the demand for fish and processed fish is also steadily increasing. Secondly, it is estimated that Sri Lanka imports about 28,000t of dry fish annually, (Ministry of Fisheries and Aquatic Resources - Fisheries Strategy Document 2005), amounting to a significant outflow of foreign currency from the country. Improving the local dry fish industry can help save at least a portion of this outflow of foreign currency. Thirdly, dry fish is an important source of income for the small scale coastal fisheries communities of Sri Lanka

Dry fish production mainly consists of micro level cottage enterprises, carried out predominantly by fisherwomen as a supplementary source of income. As such, the quantities produced tend to be low. Furthermore due to the long drawn drying process, the moisture retained creates an ideal environment for growth of fungi. The practice of drying the fish in the open under the sun affects the hygienic conditions of the dried fish, due to the high risk of contamination with dust particles and harmful contaminants.

However, the scale of the average dry fish enterprise precludes the introduction of sophisticated methods of fish preservation. The high capital requirement and the fuel cost of many of the high-tech dryers makes it unaffordable and impractical for the small scale dry fish producer. Furthermore, social factors such as attitudes, lifestyle and behaviour makes it difficult to introduce radical changes to conventional drying methods.

Practical Action started with the general understanding that there was a need for a low cost, low technology means for producing larger quantities of high quality dry fish. Through a combination of community and expert consultation, Practical Action innovated a solution in the form of a solar powered fish dryer. The use of solar energy means that the cost of energy is zero. It's simple design makes the cost of installation low, especially since most of the material can be easily sourced locally. The dryer is sealed to avoid contamination. The maintenance cost is minimal, and it allows for faster drying compared to the conventional drying methods.

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The twomodels of driers developed are,

- Stationary Drier
- Mobile (Collapsible) Drier

Stationary Drier

Picture: stationary type solar drier

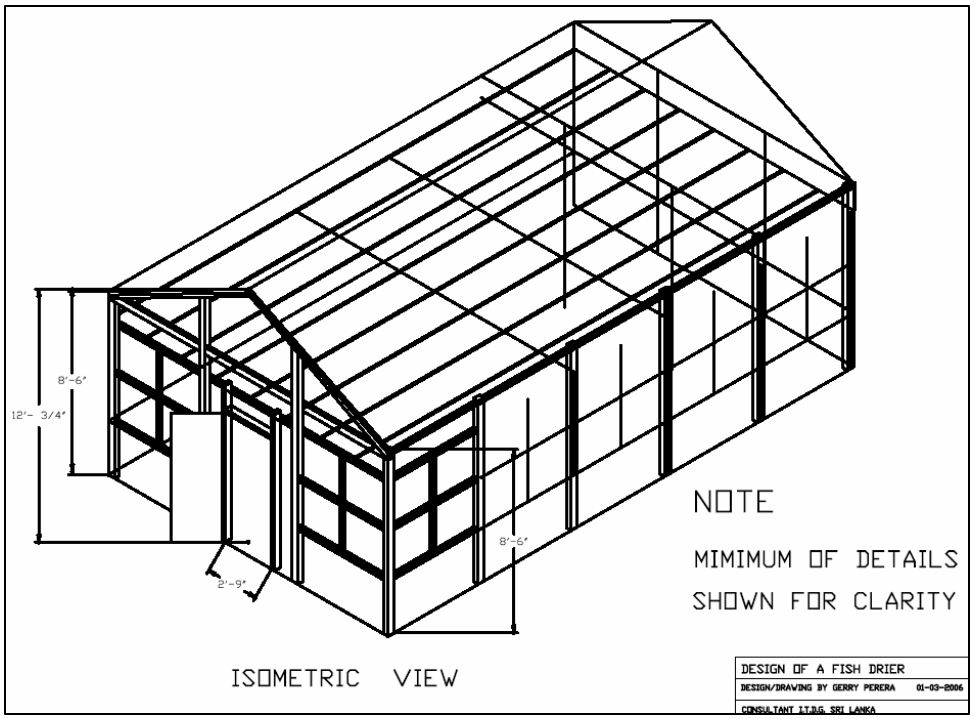
Above stationary solar drier

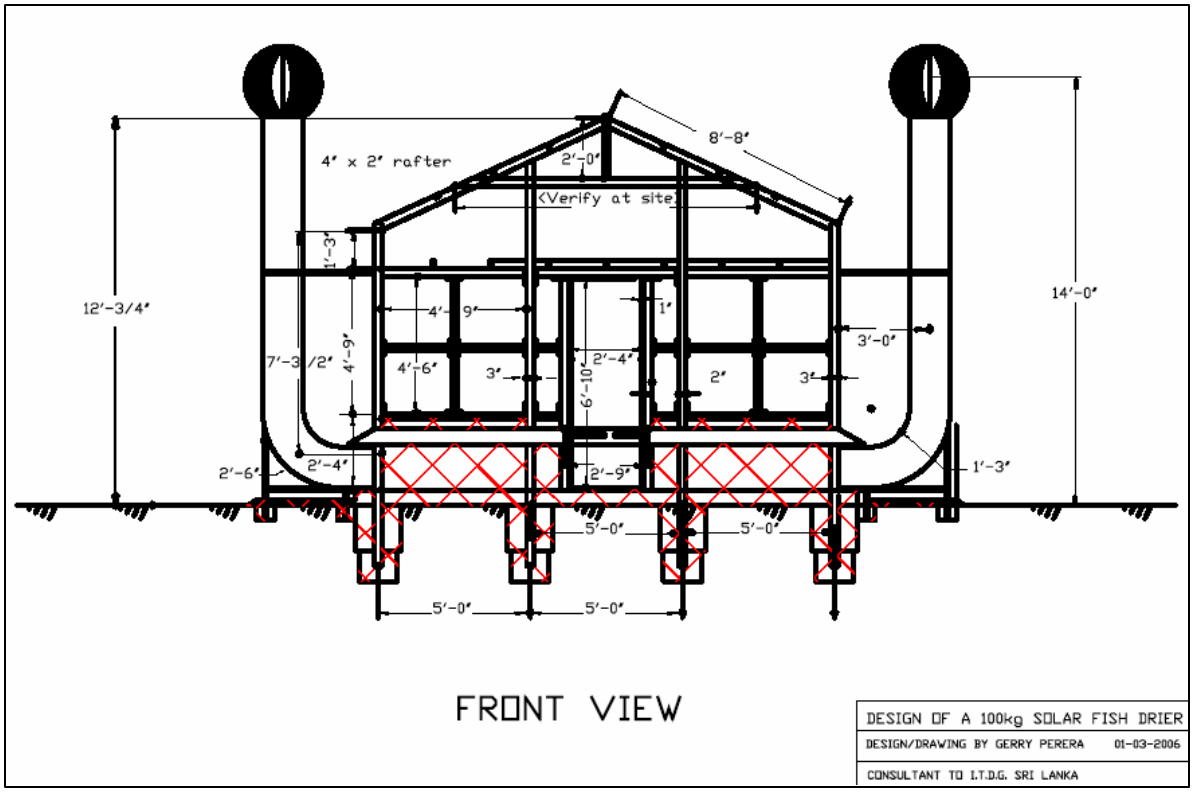
The structure of this drier is very similar to a gable roofed green house. It is a structure 25.4ft in length and 15.4ft in width. The height of the eaves is 8.6ft and the ridge is 12' ¾" in height. The floor is elevated from the ground level and constructed of paved brick and covered with a cement rendering. Brick walls with a height of 2'6" are erected on the four sides to support the structure. The inner side of the walls is plastered to prevent breeding and harbouring of insects while the outer side is painted black, for greater heat absorption and retention.

Two ducts and two chimneys are fixed on the upper ends of the roof ventilators. These are also painted black so as to augment the expulsion of the spent air. The heat collection device is made of 08 metal trenches, painted black on the inner side, facing the sun. The roof is covered with a polythene cover and is supported on a weather proof, seasoned timber framework. These trenches are located 1'3" below the eaves. The idea behind designing the heat collector in the form of trenches (each trench loaded with black coloured metal chips), is to facilitate storage and releasing of heat during cloudy spells, thus offsetting the vagaries of temperature fluctuations.

The capacity of this drier is 100 Kg per batch.

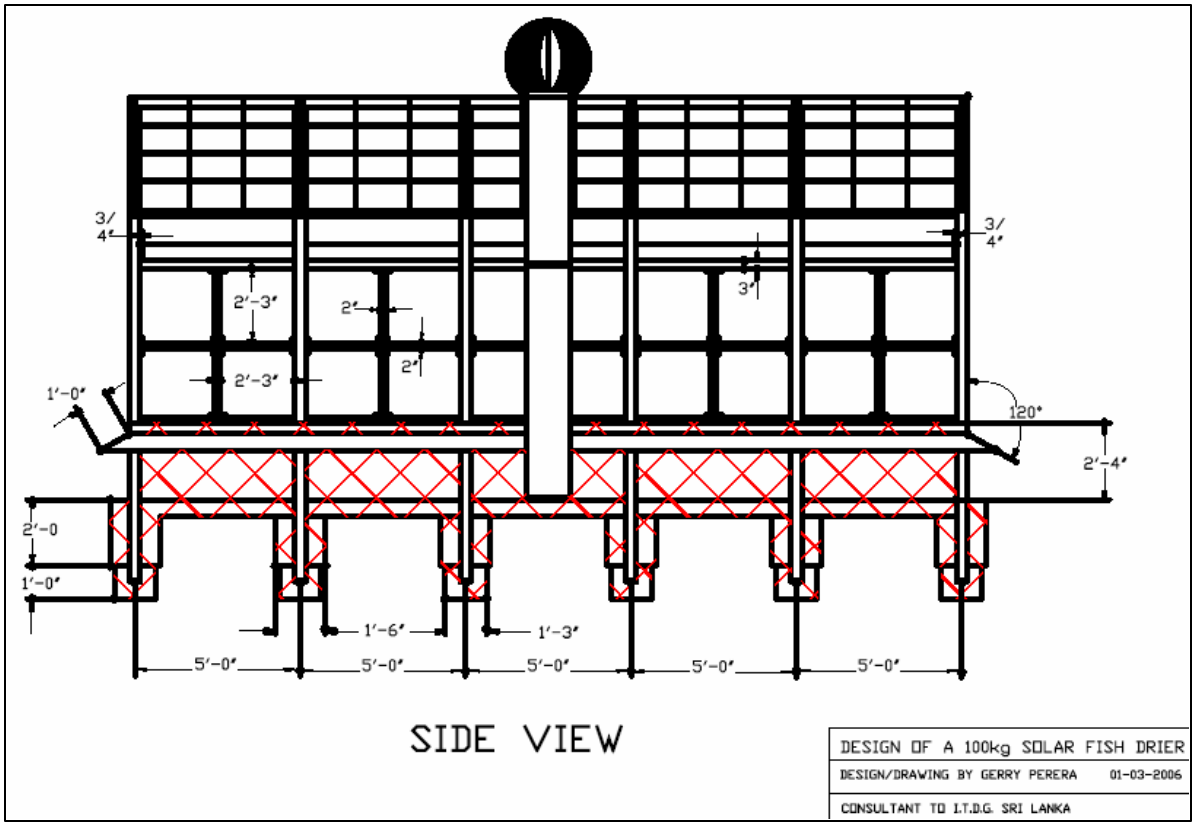
Isometric view of the drier





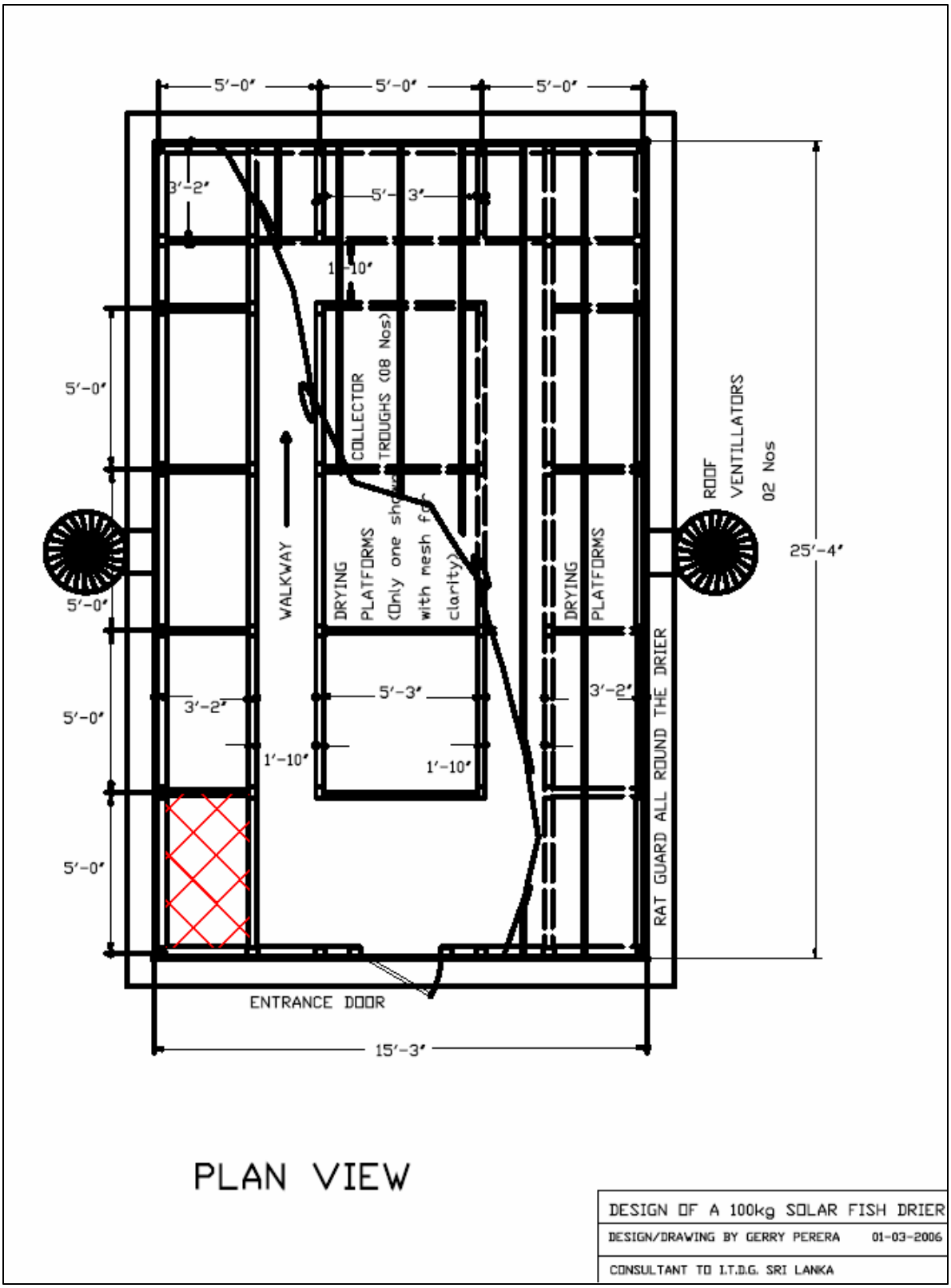
FRONT VIEW

DESIGN OF A 100kg SOLAR FISH DRIER	
DESIGN/DRAWING BY GERRY PERERA	01-03-2006
CONSULTANT TO I.T.D.G. SRI LANKA	



SIDE VIEW

DESIGN OF A 100kg SOLAR FISH DRIER	
DESIGN/DRAWING BY GERRY PERERA	01-03-2006
CONSULTANT TO I.T.D.G. SRI LANKA	


5'-0"
5'-0"
5'-0"
3'-2"
5'-3"
1'-10"
5'-0"
COLLECTOR TROUGHS (08 Nos)
DRYING PLATFORMS (Only one shown with mesh for clarity)
WALKWAY
ROOF VENTILLATORS 02 Nos
25'-4"
5'-0"
DRYING PLATFORMS
5'-0"
3'-2"
5'-3"
3'-2"
1'-10"
1'-10"
5'-0"
RAT GUARD ALL ROUND THE DRIER
ENTRANCE DOOR
15'-3"
PLAN VIEW
DESIGN OF A 100kg SOLAR FISH DRIER
DESIGN/DRAWING BY GERRY PERERA 01-03-2006
CONSULTANT TO I.T.D.G. SRI LANKA

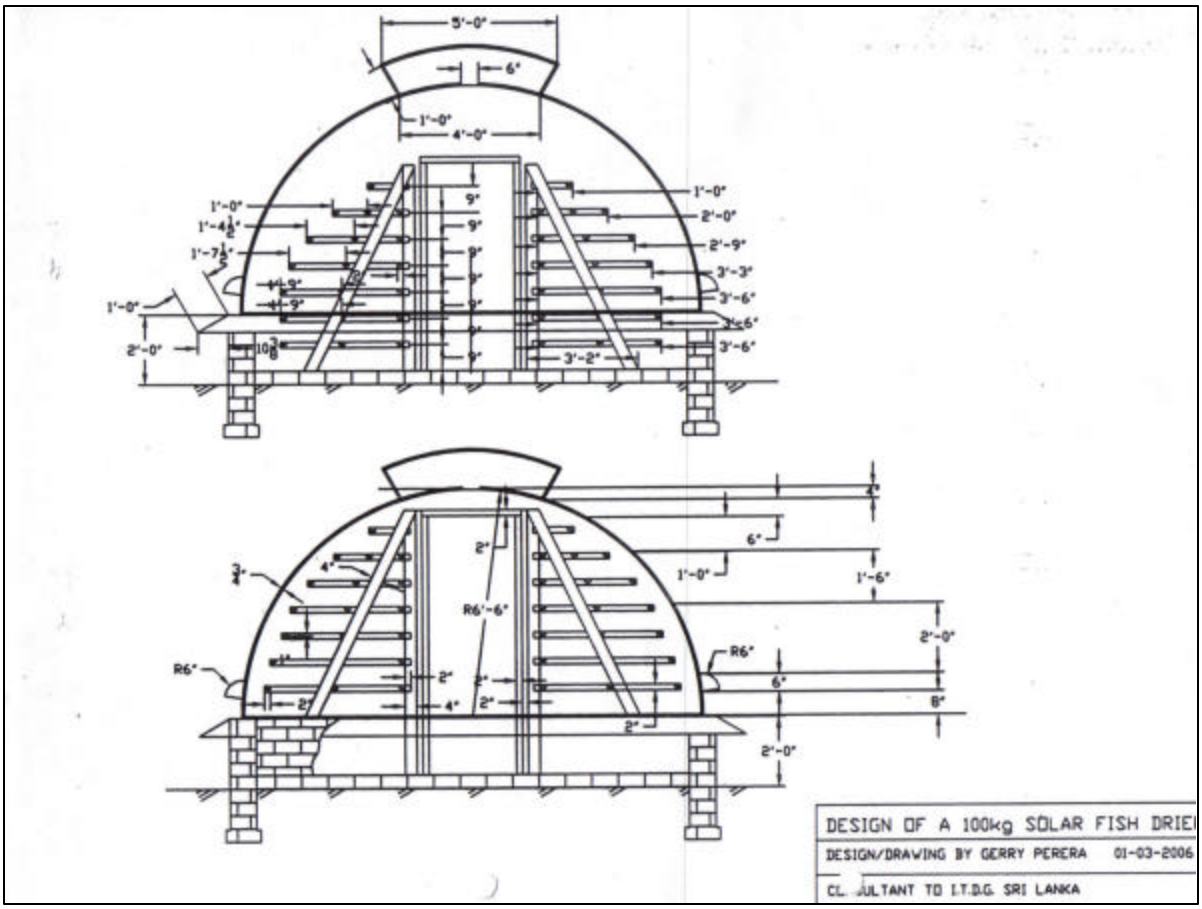
Mobile (collapsible) Drier

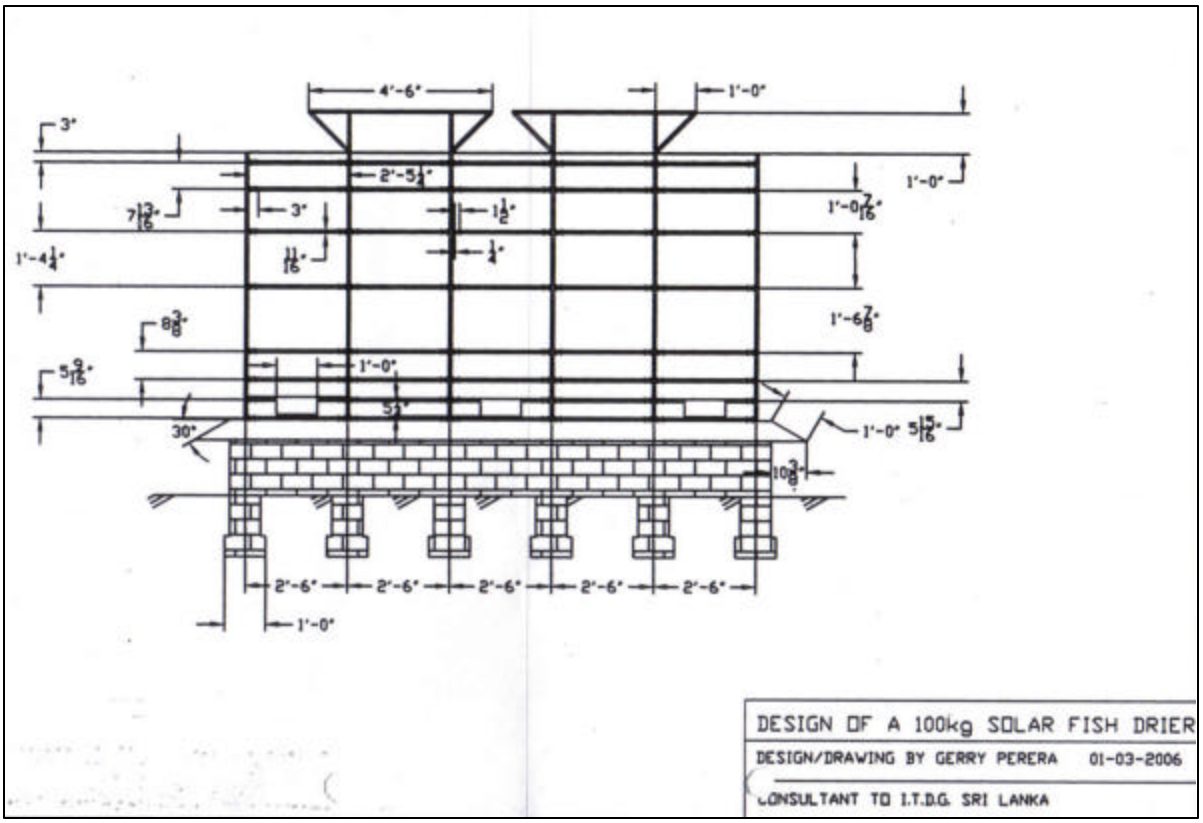
Above: Mobile (collapsible) solar dryer

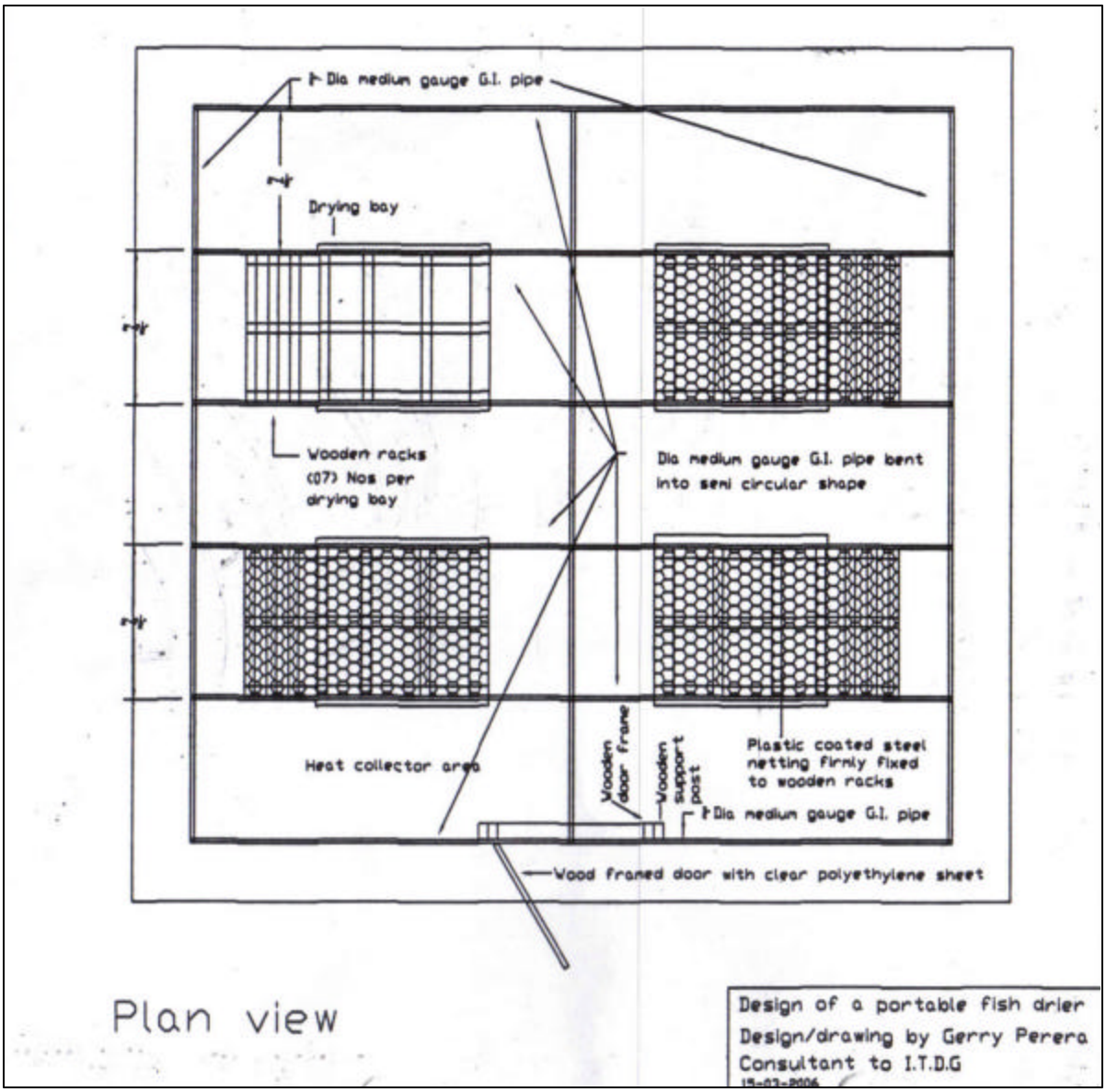
The structure of this dryer is very similar to the conventional agricultural poly tunnels. It is 12'6" in length and 10'4" in width. The height at the apex is 6'4". The door is polythene clad, and is lockable. The floor is elevated from ground level and is rendered using black cement. The base of the drier sits on a 12" high 9" thick wall, and is protected by a rodent guard. It has four moveable, wooden racks with cascading shelves, each fixed with seven shelves made of plastic netting, which serves as the drying surfaces. The space provision in and around the racks facilitates easy loading and unloading.

The capacity of this drier is 50 kg per batch.

Isometric drawing of the drier




4'-6"
1'-0"
3"
2'-5½"
1'-0"
7 13/16"
3"
1½"
1'-0 7/16"
1'-4½"
11/16"
¼"
8 3/8"
1'-6 7/8"
5 9/16"
1'-0"
30°
1'-0"
5 15/16"
10 3/8"
2'-6"
2'-6"
2'-6"
2'-6"
2'-6"
1'-0"
DESIGN OF A 100kg SOLAR FISH DRIER
DESIGN/DRAWING BY GERRY PERERA 01-03-2006
CONSULTANT TO I.T.D.G. SRI LANKA



Material requirement and cost

The BOQs at the two types of fish dries as follow.

BOQ - Mobile Fish Drier

	Description	Quantity	Price
1	Bricks	500	1,300.00
2	Sand	1 1/2 Cubes	5,000.00
3	Cement	10 bags	6,000.00
4	Aluminum Flashing Plates	50 feet	2,500.00
5	Binding & Window Covers		2,000.00
6	G I Pipes 1 '	22	19,600.00
7	G I Pipes 1/2 "	2	1,600.00
8	Timber 4" x 2"	120 feet	15,600.00
9	Timber 2 X 1 "	780 feet	23,400.00
10	Steel Nails	500 GMS	100.00
11	Nuts & Bolts	12	1,020.00
12	Screw nails 2"	2 pkts	700.00
13	Lock & Hinges 4 X 3	2	1,200.00
14	Polythene	7 KGS	2,650.00
15	Chicken Mesh	1 meter	300.00
16	Mild Steel Plate 1/4 x 1/1/2		285.00
17	P V C Pipe		250.00
18	Cement - Black	2 KGS	500.00
19	Double Gum Tape	10	2,000.00
20	Plastic Chicken Net		1,500.00
21	Clearing, excavation of earth and laying of foundation cement, earth filling, ramming & compacting earth, and all masonry works		15,000.00
22	Fabrication of mobile solar fish dryer including all steel work		15,000.00
23	Installation of timber frames and all carpentry work		10,000.00
	Total		**127,505.00**

BOQ - Stationary Type Fish Drier

	Description	Unit	Qty	Rate	Amount
01	Clearing and preparation of the site	Allow		Sum	1,000.00
02	Excavation of earth in wall and cubes and column foundation	Cubes	3.00	550.00	1,650.00
03	Approved earth filling under floors			600.00	1,800.00
04	Cement concrete 1:2:4 (3/4) in column bases, positioning Kempas timber posts (4x4)	Cubes	1.00	20,000.00	20,000.00
05	Rubble work in foundation on cement motor1:5 up to DPC level	Cubes	1.4	12,000.00	16,800.00
06	¾" thick dam proof course in cement and sand 1:2	Sqrs	1.2	4,500.00	5,400.00
07	Concrete screed to entire floor including ramp in 1:3:5 (3/4") 3" thick	Cubes	1.5	19,000.00	28,500.00
08	4 ½" thick brick work in walls up to a height of	Sqrs	2.00	5,450.00	10,900.00
09	Supply and installation of timber frames				84,427.00
10	Covering of roof and sides above brick walls with clear polythene	M^2	8.0 x 20	8 x 20 m	24640.00
11	Fixing of drying platform using rolls		03	3500.00	10,500.00
12	Supply and installation of solar heat Aluminum sheeting and brass tracks	Lft	125	50.00	10,500.00
13	Supply and installation of timber frames with wooden door	1Nos			5,000.00
14	Supply installation of roof ventilators and chimney and ducting	2Nos			50,000.00
15	2.5 wide Aluminum sheeting	151 ft		40	6,000.00
16	8 mm threaded bar	8Nos		675	3,037.00
17	Steel washers for above (16)	260 Nos		2.00	520

18	Nuts for above (16)	260 Nos		2.50	650.00
19	Enamel paint black matt	2 L		570	1,140.00
20	Double sides reparering tapes	50 m		200m	6600.00
	Total				**301680.00**

The Fabrication Process

Stationery Solar Powered Fish Dryer

The following step by step process is recommended for the construction of the stationery solar powered fish dryer.

- **Selection of the site –** Avoid marshy, muddy lands. Sandy soil is best. The area needs to be levelled and have a proper drainage system. The area should have direct sunlight (unhindered by trees etc.) The dryer needs to be exposed to sunlight from 9.30a.m to 3.30 p.m to work efficiently.
- Select suitable workers - Call for offers from prospective artisans for fabrication of drier as per detailed working drawings. The skills of the artisans and the construction workers need to be assessed in the selection process.
- Clear and prepare site area - An area of at least twice the length and breadth of the dryer's structure should be cleared of scrub jungle.
- Excavate ditches to lay foundation - The soil should be excavated as per B.O.Q submitted for civil works.
- Erect the foundation walls, and timber columns in place as per B.O.Q.
- Prepare floor – Fill and ram the earth, adding water as required to compact the earth firmly and level the area.
- Construct half walls and fix chimneys- The chimneys need to be incorporated into theside walls and thus should be constructed simultaneously. The chimneys need to be fixed with inlet air ducts and roof ventilators. Next the rodent guard needs to be put in place right round the 2.5 ft half brick wal level. Plaster and smoothen both sides of the brick walls. Apply matt black paint on the exterior walls and outer side of the chimneys.
- Construct timber super structure – this serves as the framework for the upper walls and roof.
- Place the matt black coated metal collector plates on the support framework, making adequate provision for space between any two plates.
- Erect and fix framework
- Construct half walls and fix chimneys- The chimneys need to be incorporated into the side walls and thus should be contructed simulataneously. The chimneys need to be fixed with, inlet air ducts and roof ventilators. The in place. Next the rodent guard need to be put inplace right round the 2.5 ft half brick wall level. Plaster and smoothen both sides of the brick walls. Apply matt black paint on the exterior walls and outer side of the chimneys.

- Construct timber super structure – this serves as the framework for the upper walls and roof..
- Place the matt black coated metal collector plates on the support framework, making adequate provision for space between any two plates.
- Erect and fix framework

- Install G.I. wire support system for the roof
- 12. Apply double sided tape on the wooden framework
- 13. Stick on the "cut-to-size" polyethylene sheeting to the superstructure of the drier, using double sided adhesive tape so as to ensure it is air tight. As a protective measure, fix wooden beading over wooden framework using tintacks. Use G.I wires to support the chimneys.
- 14. Cement render and smoothen floor allowing for a gradient of 1 in 40 lengthwise and make provision for drainage outlets.
- 15. Install bird and insect proof netting over the air inlets. Provide hoods over these inlets to prevent rain water beating in.
- 16. Fix entrance door
- 17. Fix plastic coated G.I mes h on the supports for the drying platform.

Mobile Solar Powered Fish Dryer

- Selection of the site - avoid marshy, muddy lands. Sandy soil is best. The area needs to be levelled and have a proper drainage system. The area should have direct sunlight (unhindered by trees etc.) The dryer needs to be exposed to sunlight from 9.30 a.m to 3.30 p.m to work efficiently.
- Select suitable workers - Call for offers from prospective artisans for fabrication of drier as per detailed working drawings. The skills of the artisans and the construction workers need to be assessed in the selection process.
- Clear site -An area of at least twice the length and breadth should be cleared of scrub jungle.
- Excavate for the foundation- The soil should be excavated as per B.O.Q for civil works already submitted.
- Prepare floor – Fill and ram the earth, adding water as required to compact the earth firmly and level the area.
- Construct the half masonry wall
- Construct the cement rendered and paved floor. Ensure a gradient of 1 in 40 towards either of the long sides and provision of drain pipes
- Paint the external masonry walls and floor with matt black
- Erect the arches and roof vent structure
- Provide G.I wire support system for the roof
- Apply of the double sided tape to the superstructure.
- Apply the 'cut-to-size" polyethylene sheeting to the superstructure of the drier, using double sided adhesive tape already applied to the superstructure ensuring perfect air tightness. As a protective measure apply and fix wooden beading over superstructure using coach screws
- Apply bird and insect proof netting over the air inlets. Provide hoods over these inlets to prevent rain water from beating in.
- Fix the entrance door

Operation and Maintenance

Operation and maintenance of both driers are very simple. Operation merely involves loading a single layer of pre-processed fish (cleaned and salted) on to the drying platforms, turning the fish at the end each day and finally unloading the dried fish when they are fully dried. The maximum drying time would be 5 days for Tuna. For Herring or other smaller fish 2 ½ - 3 days would be sufficient.

Maintenance is only a matter replacing the polythene cover. This needs to be done every 3 to 4 months. It is the only item that needs replacing and amounts to approximately Rs. 2,000 per replacement and works out to about Rs., 24,000 annually. This cost however needs to be weighed against the benefits. The benefits in terms of higher quantity and price premium for quality covers this cost several times over.

The double sided adhesive tapes facilitate easy removal and replacement. If the cover is pre-prepared, the replacement should take less than a couple of hours. Both operation and maintenance can be handled by an unskilled worker.

Drying Conditions

Drying conditions of the two driers are more or less similar to the measured drying condition of the stationary type drier is given below

Average ambient temperature	36.0°C
Average ambient % R.H.	67.5 %
Average ambient wind velocity	0.5 m/sec
Maximum temperature within the drier	51
Minimum temperature within the drier	34
Average temperature within the drier	42.5
Average % R.H. within the drier	33.7 %
Average air flow through each chimney	0.3875 m

Advantages

- The simple design of the dryer enables
  - easy construction of the dryer using local workers
  - faster and easier adoption of the dryer
  - easy replication
- Material required can be easily sourced locally in almost any rural area.
- High durability - about 80% of the material used can last up to ten years.
- Can be replicated in diverse fisher community contexts.
- Installation cost is minimal.
- Maintenance cost is minimal.
- Drying time less than conventional method.
- Ensures a high quality hygienic product
- Minimum labour requirement for construction and maintenance.
- Could easily be scaled up or down to suit individual needs.
- High consumer preference for dry fish processed using the dryer.
- No unpleasant flavours, tangs or offensive odours.
- Could potentially be used for dryer dehydrating fruits, vegetables.