SOLAR CROP DRYER

By

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Introduction

Drying of farm crops is one of the most important farm practices. It is done either through simple sun-drying or with the use of artificial dryers. The traditional method of direct sun-drying on mats, concrete pavements and side streets is the most popular method because of its low cost requirements. However, uncontrolled weather conditions, lack of specialized structures to protect crops from animal and insect attacks, and spillage due to handling lead to product loss and quality deterioration.

These problems can be overcome by using artificial dryers. With structures for protecting the crop, the danger of exposure to rain, dust and insects becomes very minimal. Conventional artificial dryers make use of kerosene, bunker fuel and gasoline as sources of heat energy for the drying process. But with the spiraling cost of fuel the use of such dryers becomes more and more impractical.

With these in mind and in keeping with the heightened energy consciousness of our times, the UPLB Solar Crop Dryers Research Group developed a dryer which makes use of energy that is cheap, permanent and readily available—solar energy. The UPLB Solar Dryer, shown in Fig. 1, is designed to dry palay, corn, legumes and with slight design modifications, fishery products.

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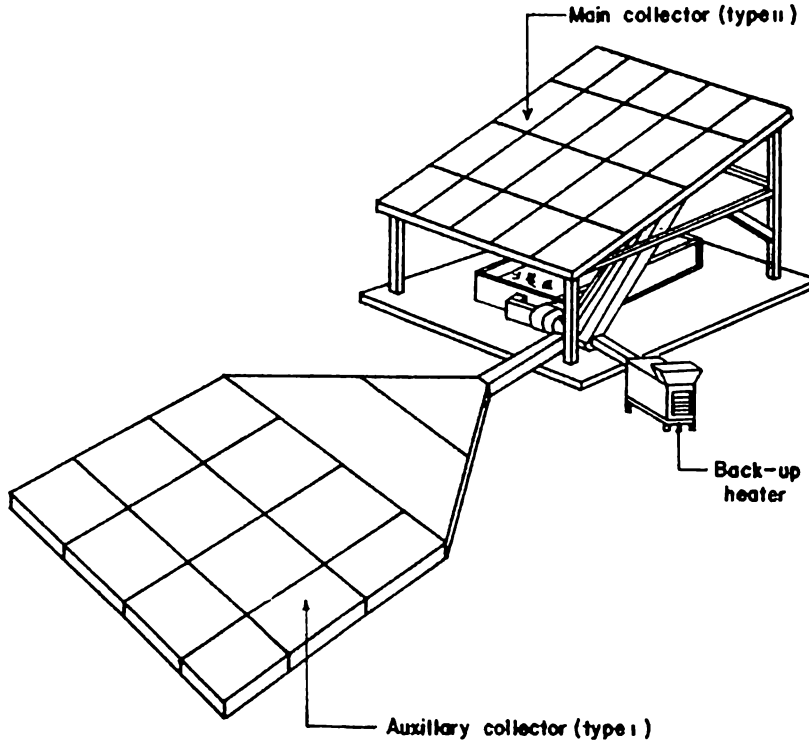


FIG. 1. PERSPECTIVE VIEW OF THE TWO TONS BATCH TYPE SOLAR DRYER.

Dryer Components

The two-ton batch type solar dryer has four major components: (1) collector and direct system; (2) blower and power drive assembly; (3) drying bin; and (4) back-up heater. The specifications for these components are dictated by the drying requirements of the products and available solar insulation.

Air Heating Collectors

Air heating collectors form the most critical part of the dryer. Although several designs are available, a simple design was developed using locally available materials. The collector has three major parts: (a) the collector glazing which traps solar radiation while preventing convective heat losses, (b) the absorber plate where radiant energy is converted to thermal energy which is then transferred to air passing under the plate, and (c) the insulator which prevents heat losses. Air passes between the absorber plate and insulator.

Glazing materials can either be glass or plastic for solar collectors. Glass is expensive and is not readily available in the market. Of the possible plastic material, polyethylene films proved to be sufficient. However, owing to the tendency of polyethylene to deteriorate from prolonged exposure to solar radiation, the glazing material should be removed everytime the dryer is not in operation.

Several materials have been suggested for use as plates including copper, aluminum and especially-treated metals to improve solar absorption efficiency. Plain GI sheets painted dull black, however, proved to be an economical and effective absorber for heating air. The GI roofing, commonly found in houses could therefore be converted into collectors.

The backing and insulator of the collector prototypes are ordinary 1/2 inch thick plywood. Although plywood is not a perfect insulator, it provides strength needed in supporting the absorber and glazing.

Blower and Power Drive Assembly

The blower must have the following specifications: 3000 cfm capacity with 1 inch suction and exhaust pressures. The motor must be 3 hp, 3 ϕ, 220 volts AC with magnetic starter. Power can also be provided by either a 7 hp gasoline or 5 hp diesel engine in the absence of electric motors.

Drying Bin

The grain holding bin can be made of marine plywood 4 x 8 feet by 3/4 inch thick. The perforated sheet metal bottom may be obtained from metal products manufacturers.

Back-up Heater

The choice of back-up heater is a serious consideration for continuous dryer operation. Agro-waste furnaces using rice hull, rice straw and wood charcoal or kerosene burners can be used. Extensive research is being done in this area. The final choice of back-up heater will depend on the availability of agro-waste materials. When the solar dryer, for example, is used in farms which are far from rice mills, the use of rice straw could have cost advantages over rice hull. Where there are rice mills, the use of rice hull prove to be economical as auxillary heat source.

Bill of Materials of the UPLB Two Ton Batch Type Solar Dryer (576 ft^2 collector area)

A. Drying or Holding Bin

Quantity	Description	Amount
4 pcs.	perforated/lanced flooring #24 x 3' x 6'	P 480.00
5 pcs.	plywood, 3/4" x 4' x 8'	725.00
2 pcs.	plywood, 1/4" x 4' x 8'	96.00
24 pcs.	lumber, 2" x 2" x 12'	552.24
2 pcs.	lumber, 2" x 4" x 12'	87.10
12 pcs.	lumber, 2" x 3" x 12'	196.84
200 pcs.	carriage bolt and nuts 3/8" ϕ x 3"	400.00
50 pcs.	carriage bolt and nuts 3/8" ϕ x 4-1/2"	100.00
4 kgs.	C W N #3	30.00
2 kgs.	C W N #2	15.00
1 kg.	C W N #1-1/2	7.00
3 gal.	paint, sunshine yellow	225.00
3 gal.	paint thinner	81.00
1 pc.	dial thermometer	100.00
		P 3,065.00

B. Blower and Engine Assembly P 6,000.00

C. Collector, Ducts, Framing and Foundation

145 yds.	3 mil polyethylene sheet	P 1,015.00
18 pcs.	4' x 8' ga. 26 plain GI sheet	2,430.00
18 pcs.	1/2" x 4' x 8' marine plywood	2,402.00
5 pcs.	1/2" x 4' x 8' ordinary plywood	670.00
120 pcs.	1" x 2" x 12' SAS lumber	1,305.60
13 pcs.	2" x 6" x 12' lumber	848.64
13 pcs.	2" x 6" x 8' lumber	353.86
8 pcs.	2" x 6" x 18' lumber	783.36
4 pcs.	2" x 10" x 24' lumber	870.40
4 pcs.	2" x 6" x 16' post	348.16
6 pcs.	3" x 4" x 8' lumber	261.12
8 pcs.	3" x 4" x 10' lumber	435.20
8 pcs.	1/4" x 2" x 24' post strap	48.00
8 pcs.	1/2" ϕ x 7" bolts and nuts	40.00
12 pcs.	1/2" ϕ x 8" bolts and nuts	60.00
15 kgs.	C W N #4	112.50
15 kgs.	C W N #3	112.50
20 kgs.	C W N #2	150.00
10 kgs.	C W N #1-1/2	75.00
10 gal.	flat black lacquer paint	700.00
10 gal.	lacquer thinner	320.00
20 kgs.	flat-head GI sheet nails	240.00
6 gal.	roof cement	750.00
2 m^3	gravel #4	260.00
2 m^3	fine sand	260.00
5 bags	cement	175.00
		P15,026.34

Cost Estimates of a Two-Ton Batch Type Solar Dryer

I. Initial Cost

A. Material

1. Grain/Holding Bin	P 3,065.68
2. Blower/Engine Ass.	6,000.68
3. Collector, duct, frame & foundation	15,026.34
	P24,092.02

B. Labor

INITIAL COST	9,230.79
	P33,322.81

II. Maintenance/Operating Cost (10 yrs x 100 days/year)

A. Maintenance (5% pa.)	P16,153.80
B. Oil and grease for blower motor	250.00
C. Diesel fuel or electric bills	12,500.00
	P28,903.80

III. Total Cost (for ten years) P62,226.61

Capacity

40 cavans per batch of 8 hours
1 load each day — 40 cavans
One harvest season — 100 days/year
40 x 100 — 4,000 cavans/year
4,000 x 10 — 40,000 cavans/10 years

Cost of Drying Per Cavan:

A. Capital Cost = total capital cost in 10 years
÷ capital in 10 years
$= \frac{62,226.61}{40,000}$
= P1.55/cavan

B. Energy Cost

1. Oil and lubricants
= P8/batch of 40 cavans
= P0.20 per cavan

Total Cost of Drying Per Cavan = P2.06

Construction of a Two-Ton Batch Type Solar Dryer

The UPLB solar dryer is constructed in such a way that the collector acts as a roof for the entire structure. Under the collector are the drying bin, blower and engine. A system of ducts brings the heated air from the collector to the bin.

1. Orientation

The latitude of the site where the dryer will be set up must be known prior to construction. In areas enjoying clear conditions during dryer use, the angle of inclination of the collector panels must be equal to this latitude.

2. Solar Collectors

The total collector area would depend on the intensity of solar insulation at the dryer site. Other factors that would affect area are the amount of produce to be dried and the degree of drying desired. Whatever the area, the following guidelines should be adopted to obtain greater efficiency.

a) The air channel within the collector should not be less than 9 feet nor more than 12 feet in length from the point where ambient air enters to the outlet duct.

b) The depth of the air channels should not be more than 2 inches. The width may vary as long as design and construction permits.

c) The air channels and collector panels should be air tight to prevent heat losses.

The collector can be nailed or bolted in place and for easy installation, the collector panel or frame can be fabricated on the ground without the GI sheet absorber and polyethylene sheet cover. It is then hoisted in place and anchored. These panels should be painted black. The GI sheet absorber should also be painted black back to back and then installed. After this, the collector assembly is covered with the polyethylene sheets taking care that there are no leaks between the joints of the panels and air channels.

The air intake holes of the collector panels must be covered with wire screen to prevent entry of rodents, bats and foreign bodies that may hamper the flow of air inside the collector.

Materials used in the construction of flat plate collectors include 4 x 8 feet by 1/2 inch thick plywood as backing, 1 x 2 inch SAS lumber as air channel divider and GI sheet absorber support. Placed 2 inches above the GI sheet is the polyethylene sheet. This serves as a cover of the absorber to trap more heat. The air collecting ducts are made of 1/2 inch thick plywood.

3. *Drying Bin*

The grain holding bin has a floor area of 72 sq. feet (6 ft. x 12 ft.) and has a depth of 18 inches from the top to the perforated or lanced metal flooring. The bottom floor is 1/4 inch thick plywood stiffened by 2 inch x 2 inch lumber. One end wall contains a hole where the blower assembly is fit in. Two or three side ports or windows where dried grain can be unloaded should be installed.

Advantages

1. Utilizes non-polluting and permanent energy source.

2. Uses smaller area to dry the same volume of produce as compared to traditional sun drying.

3. Has shorter drying time than direct sun-drying.

4. Provides protective structure against unpredictable weather conditions, rodent and insect attacks.

5. Cost of drying is cheaper compared to petroleum-fed dryers.

6. Drying temperatures can be regulated.

7. Products dried are of good quality and safe for long term storage.

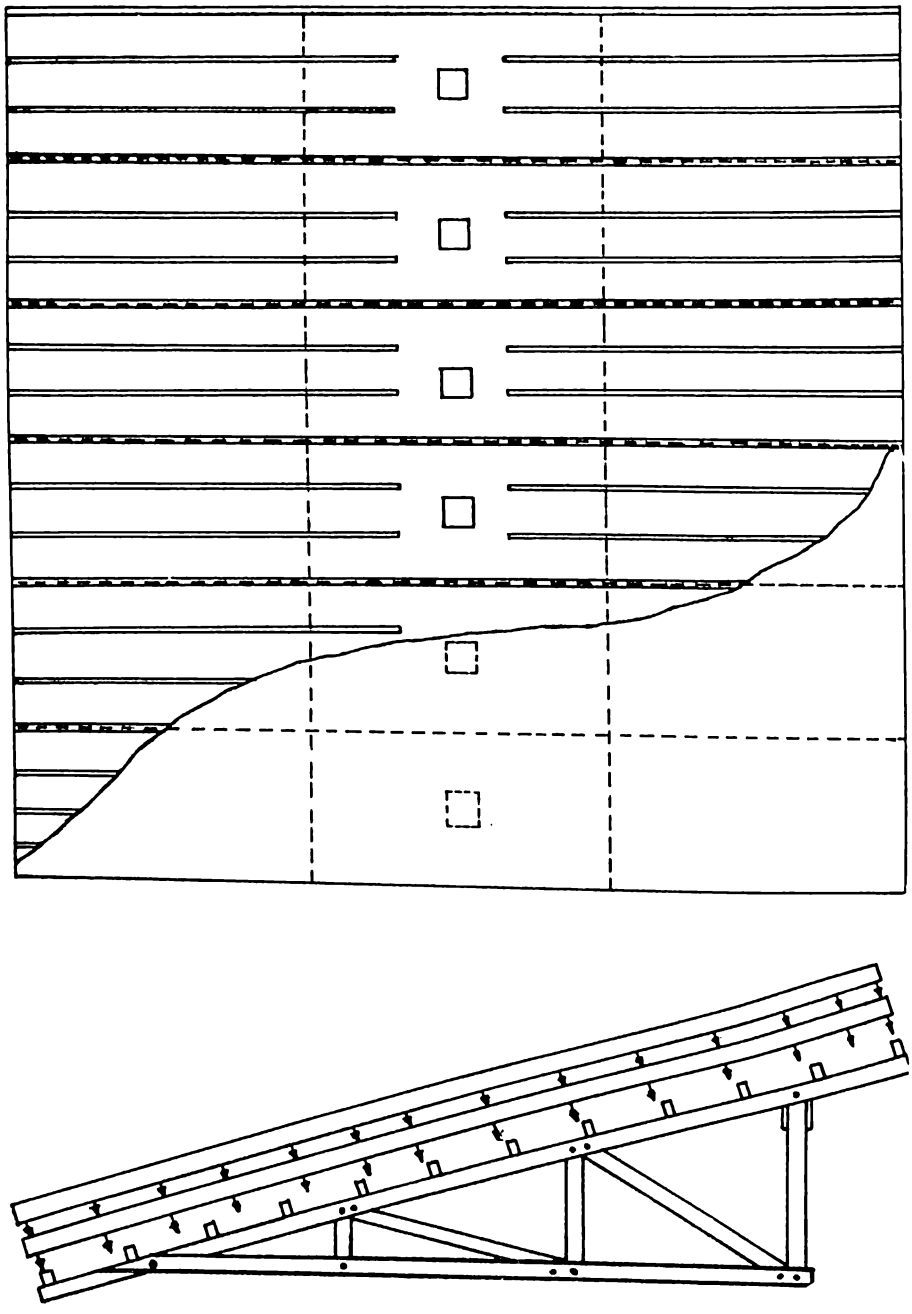
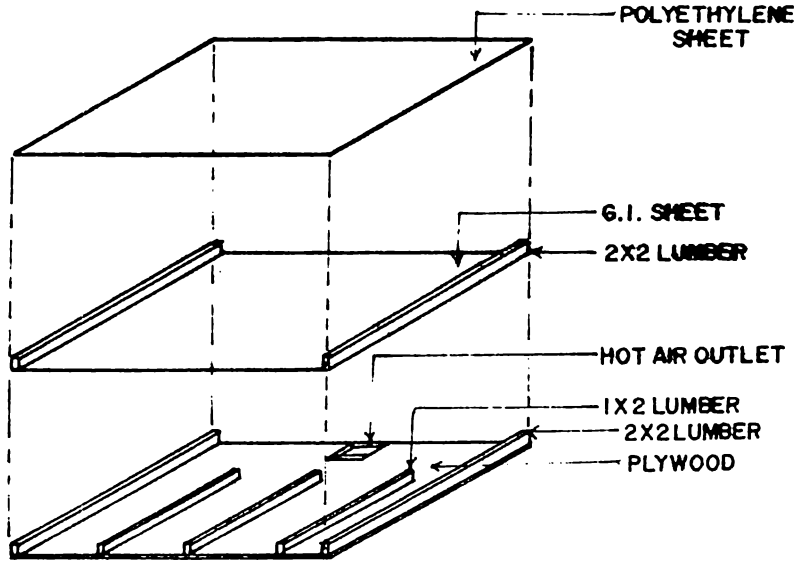


FIG. 2. SOLAR COLLECTOR USED IN ISABELA FIELD SITE



EXPLODED VIEW, SOLAR PANEL COLLECTOR

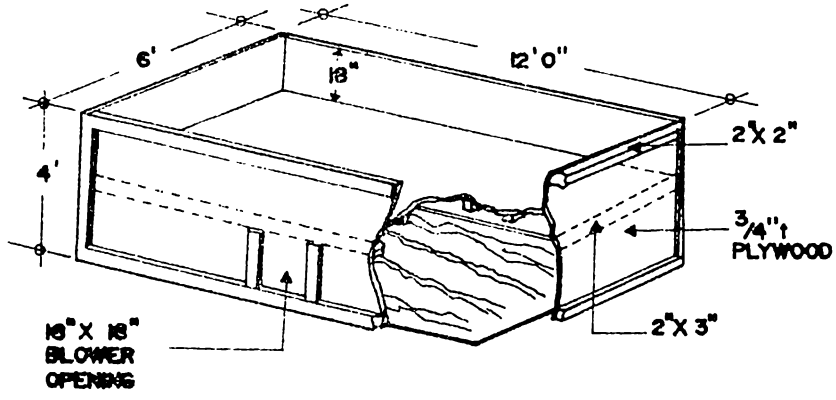


Fig. 4 . DRYING BIN DETAILS

Scale 1:50