Renewable energy-based fruit dryers[1]

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I. INTRODUCTION

Drying of fruit is important for long-term storage without further deterioration in the quality of the product.

In rural areas, drying is accomplished by direct exposure to the sun because it is relatively easy. However it is dependent on weather conditions and is susceptible to contamination.

The University of the Philippines Los Baños in collaboration with the Asian Institute of Technology under the project *"Drying Systems for Rural and Urban Poor"* developed a multi-commodity drying system that enhances the energy of the sun and protects the crop from dust, dirt and insect attack. A biomass furnace will serve as an alternative source of energy, especially when there is minimal or no sunshine available and during rainy seasons.

The project intends to create a range of drying systems that can be used in the rural areas to provide livelihood and increase nutritional value from better quality products. It also intends to develop a drying strategic plan that can be used for other commodities and other countries as well.

II. PROJECT OBJECTIVES

The general objective of the project is the development, demonstration and dissemination of agricultural multi-commodity drying systems using renewable energy resources for rural-based communities. Some of the specific objectives are:

1. Develop and demonstrate solar/ biomass multi-commodity drying systems at selected rural-based communities;
2. Identify and categorize the market potential for both drying system and dried products; and
3. Provide a strategic plan for the commercialization of the multi-commodity drying system.

III. DESCRIPTION OF THE FRUIT DRYERS

A. RETs fruit dryer (Model FD-50)

This cabinet type dryer has three main components: (1) drying chamber, (2) solar collector, and (3) biomass gasifier stove.

The drying chamber has 30 aluminum wire screen trays that hold the products in place during drying. A polyethylene plastic screen, which is much cheaper, can also be used as an alternative to the aluminum tray material. The capacity of the dryer depends on the type of fruit to be dried. For pineapple, the dryer has a maximum capacity of 50-kg sliced fruit per batch.

There are two sources of heat available for the dryer: solar collector and biomass gasifier stove.

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Solar Collector

The collector, which is a flat plate type, has an air collection gap of 5 cm and an insulation of about 8 cm thick. The absorbing surface, which receives insolation, is a matte black painted metal sheet. A single Plexiglas cover with a thickness of 1/8" was positioned above the absorber. This is attached at the backside of the drying chamber at an angle of 15°. The fan inside the chamber forces the ambient air to pass through the collector and rise up to the fruits being dried.

Biomass Gasifier Stove

The biomass gasifier stove on the other hand is provided to assist in the drying operation whenever solar insolation is insufficient and unavailable. This is composed of four main components: fuel storage hopper, reaction chamber, primary air inlet and combustion chamber.

The hopper is positioned vertically on top of the reactor where producer gas is produced. An ash collector is provided at the bottom of the reaction chamber. A primary air inlet is attached at one side of the reactor, which supplies air to the chamber. On the opposite side is the combustion chamber where the gas produced in the reactor is burned and flue gas is generated. A sliding plate is provided at the bottom of the combustion chamber for the supply of secondary air needed for combustion.

The gasifier stove, which was adapted from Asian Institute of Technology, consumes about 2.0 kg per hour of coconut shell/ wood charcoal and can provide a drying air temperature of up to 60°C. The temperature can be controlled through a sliding plate provided in the duct that connects the chamber and the furnace. Other specification of the fruit dryer is shown in the table below.

Table 1. Dryer Specifications of FD-50

Capacity per batch	50-kg sliced fruit
Dryer dimension	140 x 100 x 269 cm
Number of trays	30
Tray dimension	98 x 50 cm
Tray material	Aluminum wire screen/ Polyethylene plastic screen
Fan airflow rate	0.16 m^3/s
Fan diameter	30.48 cm
Solar collector area	212 x 90 cm
Collector air gap	5 cm
Fuel of furnace	Coconut shell/ charcoal

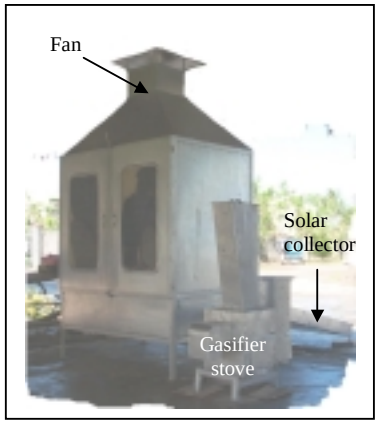

Figure 1. RETs fruit dryer Model FD-50

B. RETs fruit dryer (Model FD-200)

FD-200 is a tray type dryer that uses biomass energy. It has two movable tray carts consisting of 26 trays each. The capacity of the dryer depends on the type of fruit to be dried. In the case of mango, the dryer can accommodate a total capacity of 200 kilograms sliced fruit.

The drying chamber is made up of galvanized iron sheet metal with a gauge size of 18 framed by angular bars of sizes ranging from 1/8" x 1" to 3/16" x 1-1/2". An air distributor is positioned at the center of the chamber.

Rice Hull Furnace

The furnace has an air-to-air type heat exchanger that delivers clean drying air to the dryer. The heat exchanger is composed

of 27 boiler tubes with a diameter of 2-1/2" and arranged in regular triangular array. Its walls are made up of a mixture of cement, white ash and red volcanic cinder. It has a horizontal grate made of cast iron where combustion takes place.

An automatic butterfly feeder coupled with variable speed motor feeds rice hull into the combustion chamber. Primary air is added through an auxiliary blower. Ash discharging on the other hand is done manually.

A centrifugal blower delivers clean dry air to the dryer. Smoke is exhausted through a 6-inch diameter chimney.

Table 2. Dryer Specifications of FD-200

Capacity per batch	200-kg sliced fruit
Dryer dimension	290 x 137 x 200 cm
Number of trays	52
Tray dimension	95 x 98 cm
Fan diameter	35 cm
Fuel	Rice hull

Figure 2. RETs Fruit Dryer Model FD-200

IV. PILOT TESTING OF FRUIT DRYERS

A. Model FD-50

This dryer was pilot tested using pineapple fruit samples. No preservatives were added to the samples prior to drying. In this method, the drying operation lasted for 18 hours from a moisture content of 92 %wb, down to 20% wb. Around 10 kg-dried pineapple was recovered.

Sensory evaluation indicated that the dried fruit from the dryer is acceptable to consumers and comparable to the dried pineapple fruits in the market.

The value added to the pineapple product was calculated at about 34% using 312 pieces of pineapple (Formosa variety) that is being sold at Php4.00 per piece and the dried fruit at Php19.00 per 100-gram.

FD-50 was commissioned to MSS Multipurpose Cooperative located in Daet, Camarines Norte.

This dryer was also tested on Banaba leaves for medicinal application.

B. Model FD-200

Mango fruit samples were used in testing the fruit dryer. The samples were sliced, cooked and mixed with refined sugar and sodium metabisulfite prior to drying. From a moisture content of 66 %wb to 25 %wb, drying lasted for about 22 hours. Around 29-kg dried mangoes were recovered.

The dryer, which uses about 400 kg of fresh mangoes sold at Php15.00 per kilogram and Php40.00 per 100-gram for its dried product, has an estimated value addition of about 48%.

FD-200 was commissioned to HOMM Food Products located in Aritao, Nueva Vizcaya. The company owns an orchard planted with mangoes and oranges.

This dryer was also tested on "saba" banana.

V. CONCLUSION

With the development of the fruit dryer, the farmers of MSS Multipurpose Cooperative are now able to utilize their fist-sized pineapple fruits. For HOMM Food Products,

on the other hand, drying will not only extends the shelf life of their mangoes and other fruit crops but will also increase its value.

The fruit dryers were designed based on the following criteria: (1) the area has a considerable production of fruit crops, (2) availability of biomass resources within the site and neighboring areas, and (3) client's drying needs.

VI. ACKNOWLEDGEMENT

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VII. REFERENCES

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RETs Fruit Dryers: Training Manual