Photo: Authors

The solar coffee dryer is made from locally available wood and plastic. The trays are made from wood and steel mesh.

Developing a solar dryer for coffee

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Coffee is a very important crop in Mexico, both economically and socially. Mexico produces between three and six percent of the world's coffee and nearly half of this coffee is grown by peasant and native farmers with less than five hectares of land. For these small-scale farmers, coffee is their main source of income. Chiapas and Oaxaca are the major coffee producing states and though most of the farmers have no more than two hectares under cultivation, they contribute nearly 43 percent of the national production.

Drying is a critical aspect of coffee processing, since the quality and price of the coffee beans depends on how dry they are and also on the way in which they have been dried. Even though coffee has been cultivated for decades and, in the case of Chiapas and Oaxaca, by native people with ancient traditions, the technologies used for drying are very limited. More than a dozen drying methods are used in different areas, ranging from a wooden dryer where the coffee is placed on boards and exposed to smoke, to the spreading of beans wherever there is space: on a straw mat, on a sack or a piece of canvas on the ground, on an awning, under a bed or even in a rented courtyard in a nearby town. Coffee beans are also sometimes dried in wood-burning ovens or in gas dryers. However, the most common practice among small-scale producers is to dry the coffee outdoors, directly on a cement surface.

The moisture content of a fresh coffee bean is between 50 and 75 percent of its total weight, depending on the variety and condition of the bean. Dry coffee beans usually contain between 15 and 25 percent moisture, but the recommended moisture content for storage and sale is 12 percent. A low moisture content is the most important factor in maintaining the quality of the beans during storage, as moist beans provide an ideal environment for insects and for the development of micro- organisms. A high moisture content during storage is therefore certain to ruin the taste and appearance of the coffee.

Development of rural technology: a solar coffee dryer

In 2001, as part of a Master's programme, *El Colegio de la Frontera Sur* (ECOSUR) initiated a participatory research process to develop a solar coffee dryer with a group of organic coffee producers. The project took place in the *ejido* (a system of communal land tenure) of Tziscan, Chiapas, in the Lagos de Montebello region.

A fundamental part of the process was the exchange of ideas and dialogue between different disciplines and traditions. To start with, other technologies using solar energy to dry agricultural produce were reviewed and similarities with coffee drying were identified. The information was shared, discussed and analyzed within the group, providing the opportunity to establish the most appropriate economic and operational criteria for design. The students stayed with the producers during the project, and the daily contact made it possible to have frequent discussions and take into account the experience and know-how of the producers. The problems of the courtyard drying system were also discussed and in a collective discussion, it was decided to build a small dryer on a raised platform – the way coffee was dried in ancient times.

Based on previous experience with the construction and management of greenhouses, it was decided to use a similar construction. To make optimal use of solar energy, the dryer was set up in accordance with the position of the sun during the coffee harvesting season. The first model was built, tested and evaluated as satisfactory by the group. The model was considered appropriate for the standard of quality required, and offered advantages both for the product and for processing, compared to the traditional method of drying coffee on a cement surface.

During 2002 - 2003, to evaluate the design and operation of the prototype and to help disseminate the new technology, a project was organized together with fourteen peasant organizations, comprising 4500 families of Tzotzil, Tzeltal and Chuje natives. Demonstration models were built in the different communities and the peasant organizations involved were responsible for construction, start-up and evaluation of the dryers through the farmer-to-farmer approach, thereby ensuring the appropriateness of the technology. Care was taken to respect the farmers' contributions as well as their organization methods, decision-making structures, and organized labour practices. As a result, they became jointly responsible for the project and spontaneously took the initiative to build more dryers and to negotiate financing to disseminate the technology among their colleagues. So far, more than a dozen organizations in Chiapas and one in Oaxaca have built nearly 500 coffee dryers, adjusted and adapted to each location.

Characteristics of the solar coffee dryer

The dryer is built like a greenhouse, consisting mainly of a wooden frame covered by durable greenhouse plastic, developed to withstand the weather and also deterioration caused by the sun. The roof can be either flat or sloping. It is advisable to leave a space of 40 - 70 cm just above the ground uncovered and to have some openings near the roof so that the air can circulate. Platforms made of wood and steel mesh are placed inside the dryer for spreading out the beans. It is possible to have one, two or three levels, depending on requirements. A space of at least 50 cm between each level is recommended for easy access and to allow air circulation.

The air inside the dryer is heated by the sun, reducing its relative humidity. The hot dry air circulates around the damp coffee beans, absorbs the water and gradually dries the beans. The air keeps circulating because of the difference in temperature between the inside and outside of the dryer – the hot air rises out of the openings near the roof and is replaced by cold air entering via the openings near the ground.

Evaluation of the technology

Farmers from the different organizations evaluated the dryer during construction and use and it became clear that the dryer had several advantages compared with the drying on cement surfaces. The physical work of spreading, turning and collecting the beans was reduced by 50 percent and the raised platform made the work of picking and separating the beans much easier. This is particularly important for women and children, who usually carry out this work.

The quality of the grain beans was also improved as the moisture content of the beans was reduced, avoiding moisture stains and the development of mildew, which negatively affects the taste of the coffee. The beans were cleaner because they did not come in contact with dust or earth, and contamination from animal excrement or other refuse was avoided. No unpleasant smell was transmitted to the grain (which occurs in gas dryers) and the drying time was reduced by 40 percent. Finally, the dryer can be used for many different purposes.

During the evaluation, the experience and adaptations made by the farmers reduced the construction time and the cost by as much as 35 percent.

Acceptance of the technology

One of the reasons why an innovation is socially accepted is the diversification of its uses or services. The dryer proved to be useful for many purposes in the daily lives of farmers. So far, in addition to drying coffee, it has been used to dry clothes, covers and all kinds of fabrics that need to be washed, thus reducing the concerns and work load of the women (who usually do the washing). It is also useful for drying basic grains such as corn and beans, for ripening bananas and other fruit, as a store room – particularly for fuelwood, as a nesting place for poultry and even as lodging for guests.

Men and women evaluate the coffee drying process differently. Women are mainly concerned with the physical work involved in the drying process, whereas men mainly focus on the quality of the grain and the time required before the coffee is ready to be stored and sold. These differences are reflected in the parameters the producers established to evaluate the dryer, such as the decrease in physical work and the elimination of risks that reduce the quality of the beans.

Lessons learnt

The solar drier is very simple to build and to operate, it is low-cost, it uses local or easily obtainable materials and it incorporates the local knowledge of the farmers. The technology has therefore been accepted and adopted and the farmers have used their creativity in developing innovative alternative uses.

During the process of developing the solar coffee dryer, we discovered that alternative technologies not only have to suit the social and economic conditions, but they must also fulfil a number of other requirements: They should build on and incorporate local knowledge; they should not contaminate the environment or be harmful to people's health; they should be simple to build and use easily obtainable materials; and they should be simple to operate – repairs and maintenance work should not pose a problem.

To ensure that all these criteria were fulfilled in the design of the solar dryer it was important to involve the farmers throughout the whole process. The farmers were involved from the very start and their organization and decision-making methods were respected; farmer' ideas and innovations were included in the design and their local knowledge valued. In addition, the start-up and evaluation of the technology was left in the hands of the farmers, with the use of the farmers' own methods to transfer the technology.

We believe that the results of this process will be sustainable as it has strengthened the farmer's situation in many different ways: culturally, as the use of traditional knowledge strengthens the farmer's identity; financially, as the improved quality of the beans means better prices; politically, as the farmer's organizational capacity has been strengthened through the self-managed process. Working conditions for women and children have improved and many other positive social changes have also taken place as a result of this integrated process. ■

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