SOLAR DRYING SOLUTIONS FOR INDIGENOUS COMMUNITIES OF THE RAINFOREST REGION OF CHIAPAS, MEXICO

Maria Cristina Martínez Sosa
S.S.S. Coordinadora de Cafeticultores Yaxalwitz
S.C.L.C., Chiapas
292230,
sssyaxalwitz@yahoo.com.mx

César Estrada Aguilar
S.S.S. Coordinadora de Cafetic
Yaxalwitz
S.C.L.C., Chiapas
292230,
sssyaxalwitz@yahoo.com.m

ABSTRACT

S.S.S. Coordinadora de Cafeticultores Yaxalwitz (Yaxalwitz) is an indigenous cooperative society of small coffee growers that have been working together for the last four years for the sustainable development of the of the northern rainforest region of Mexico. In the last years a solar coffee dryers participative research experience project was developed for the cooperative society jointly with Victor Berrueta Soriano and Foro para el Desarrollo Sustentable A.C. The first phase was spent developing solar dryers designs that would be both effective and practical in the rainforest communities where money and materials are hard to obtain. The second phase was involving the members of the rainforest communities while implementing the technology in the communities, improving the designs to adapt them better to the social and natural conditions of the rainforest communities. This paper includes the findings and accomplishments of both phases.

Keywords: solar dryer, coffee, indigenous society, cooperative society, participative research.

1. INTRODUCTION

Yaxalwitz involves today 120 families (around 960 people) that as part of their project for improving the social and natural conditions of their communities have been trying out alternative methods for drying their coffee and cooking their food with solar energy and wood-saving stoves.

In the last three years, there have been different proposals for solar dryers of coffee that have been put to use in the communities, where solar dryers have been built and bettered. This project has been a successful effort to bridge the gap between technological development and community development. The solar ovens and the solar coffee dryers have been designed and built jointly by engineers and indigenous coffee growers. We hope that sharing our experience with the use of these technologies will generate future interest of other cooperative societies. The participative process for using solar drying required integration of many different perspectives from members of the communities and outside experts. We hope that our adaptations of this technologies will be approached by other growers looking for an environmental friendly application and a chance for socio-economic development and that they become available to an even wider audience.

2. BACKGROUND

The drying process of the coffee grain is the progressive loss of humidity of the coffee grain. The coffee harvesting process starts with picking the coffee cherry from the tree, taking out the pulp, washing, fermenting and drying the coffee grain. The humidity level of a coffee cherry is between 50 and 70% of the total weight of the grain and a high quality coffee grain has to have only 12% of humidity. For coffee producers, the drying process of the coffee is critical for obtaining a good quality and a good price for their product. The drying process of the coffee grain is very important for keeping the quality of the coffee, because it reduces the humidity content of the grain in order to be stored and impedes the germination of the seed.

Traditionally, coffee is dried in the open air over cement plots or plastic squares. The grains are exposed directly to the sun during several hours for two or three days, and the grains are moved periodically, in order for the coffee to be dried evenly. This method has the inconvenience that the producers can not dry their coffee if it is raining, they have to continually be protecting it from dust, water and animals such as chickens and dogs, they have to pick up all the coffee grains at dusk to avoid the risk of rain at night and the humidity produced at dew and it limits their mobility during several days of the coffee harvest.

Molds will grow on the grain if the coffee gets wet while it is drying, taking away from the producers the opportunity of selling their product as quality coffee.

3. THIS PROJECT

Producers have been looking for a long time for different options for drying their coffee, some of them used aluminum trays that they put over a wooden structure, in order to keep the coffee away from the soil, but this method has the problem that the aluminum tray accelerates the outer drying of the coffee, keeping the inner part of the grain humid. Others used fuel or gas dryers that are expensive, hard to transport to the rainforest communities and produced an ecological damage because they contaminated the air.

For these reasons, the coffee producers of the Yaxalwitz were looking for an alternative that was ecologically friendly, effective and practical in the rainforest communities where money and materials are hard to obtain.
This alternative was found when the engineer Victor Berrueta Soriano, designed a solar dryer model, that was tested and evaluated with the indigenous producers from the cooperative society SSS Los Lagos de Colores of Tziscao, Chiapas and further modifications were made to adapt the coffee dryer to the needs of each producer.

3.1 Solar Coffee Dryer

There are many applications that use solar energy to dry or dehydrate agricultural products; one is the solar dryer.
A solar coffee dryer transforms solar energy into heat that helps diminish the humidity of the coffee grains; the quantity of water that can be reduced by evaporation from the coffee grains depends mainly on the air temperature and the velocity of air circulation.

The model of Berrueta Soriano provided advantages in terms of the quality of the product and the drying process, making the process easier for the women and old men that usually take care of the drying of the coffee grains.

3.2 A Participative Research Experience

In the rainforest community of Aurora Grande in the municipality of Chilón, Chiapas in Mexico a solar model was designed and built based on the initial model of Berrueta Soriano and adapted to the local conditions based in a participative research process. This process aimed not only to having a useful technological alternative for the drying of the coffee grains, but also creating new work methodologies in the indigenous communities of the rainforest that encourage and empower them to use their local resources for contributing for the sustainable development of the region.

The research was based on a six-steps method:
First, a comparative analysis was made of the different ways of drying coffee that the producers already knew, and the advantages and disadvantages of each method were presented and discussed.

Second, the alternative of the solar coffee dryer was presented by Berrueta Soriano and the experience with the SSS Los Lagos de Colores was analyzed and discussed in situ with producers from this cooperative society.

Third, the producers from Yaxalwitz proposed ideas in which the model presented could be bettered and adapted to their local conditions, and they designed a prototype of a model that they could build.
Fourth, the new model was built by the producers with modifications made while constructing it.

Fifth, the solar dryer was tried during the coffee harvest time alongside coffee dried in the traditional cement plot used for coffee drying. Results were compared in quality and time required for the drying by the producers.

Sixth, the experience was discussed after the coffee harvest by the producers, and ways of bettering this prototype were analyzed and will be tested in the next coffee harvest in order to continue this participative research experience.

3.3. Initial Considerations For An Alternative Coffee Drying Method

The most popular method for drying coffee is on a cement plot. This method has the advantages that is does not cause pollution, the solar dried coffee maintains a good color and quality and anybody can do the drying.

But it also has several disadvantages: it takes a long time, it requires good climate conditions, the grains have to be constantly moved to have an equal drying, it has to be stored every night to avoid the early morning dew and, because the cement plot is cold in the mornings, the producer has to wait every day until the plot has been warmed by the sun. That takes some hours out of the available hours of sun per day.

After an initial discussion of the drying methods that the producers knew from experience, it was agreed that they wanted an alternative that used the principles of the cement dryer for coffee and diminish its disadvantages, based on the following arguments:
First, cement is expensive and hard to get to the indigenous communities from the rainforest, because of its weight and the bad roads that connect with the cities where it can be obtained.

Second, producers could profit more from the solar energy if they were able to use all the available hours of sun light to dry their coffee, that with the cement plot are diminished because the producers have to wait two or three hours until the cement is warm to extend the coffee grains over it.

Third, in order to contribute to keeping the natural resources of the communities and avoid ecological damage, it was important for the communities to look for alternatives that used renewable energy.

Fourth, because of the local conditions, an option was required that was easy to use, easy to make and if necessary, easy to repair without having to hire an outside expert to do the job,.

3.4 Solar Coffe Dryer Characteristics

The solar coffee dryer is based on the greenhouse model and consist basically of a rectangular wooden structure that is covered on the outside by a special kind of plastic used in greenhouses that is treated to withstand the degradation caused by the solar rays.
It is constructed like a small house with windows and a door to control the air circulation and in the interior wood and steel stools are built on which to place the coffee.

The solar dryer principle is to warm the air in the interior of the greenhouse, diminishing in this way the humidity of the coffee grain. The warm air in contact with the humid coffee grains tends to absorb the water of the grain, drying it. Because of the difference between the air in the interior of the dryer and the exterior, there is an air circulation created by natural convection that helps the coffee grain to lose its humidity gradually,

3.5 General Diagram Of The Solar Dryer

The diagram of the first solar dryer designed by Berrueta Soriano and tried with the SSS Los Lagos de Colores is shown in Fig. 1:

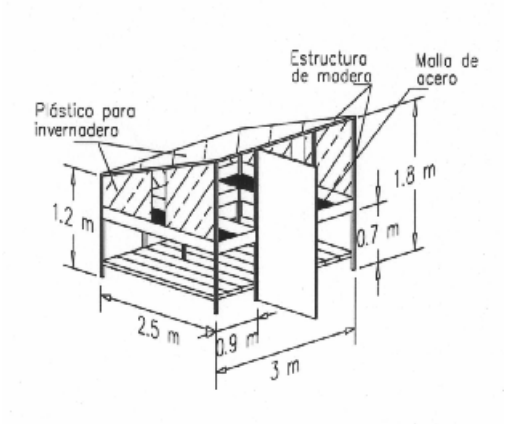

Fig. 1 Diagram of solar coffee dryer

The building considerations were:

1. The coffee should not be at floor level, rather the ideal height should be 70 cm over the floor level. This makes more comfortable the coffee selection by the producer, avoids the contamination by animals like chicken and dogs that could walk over the coffee grains, avoids the humidity of the soil and allows a better circulation of the hot air for a better drying of the coffee.
2. A construction similar to a greenhouse was recommended, in order to profit more from the solar heat, and in this greenhouse it was mentioned that it should have windows and a door, in order to control the air circulation and to be able to close the dryer at nights and in case of rain.
3. The solar dryer should be orientated towards the south, in order to profit more from the solar energy because it follows the sun's trajectory during the day.
4. It is very important to search for an adequate place for the dryer where there are no shadows and where the sun rays fall directly over the dryer during the day.

This model was modified by the producers of Yaxalwitz in the community of Aurora Grande and built and adapted to their local conditions, taking in account also the recommendations made by the producers of SSS Los Lagos de Colores and the comments made by the coffee producers of the rainforest communities.

3.6 Construction Material and Tools

Materials for building a solar coffee dryer 6 meters long by 3 meters width as taught in situ by Berrueta Soriano:

Materials:

- 8 wooden posts 2.5 meters long
- 36 wooden rules 3 meters long
- Green house plastic (6 per 8 meters)
- 6 pieces of 4 x 4 Sifting net cloth (2.5mts per each stool of 90 centimeters width)

Tools:

- Hammer and nails of different measures (for mailing the wooden stools, the net cloth and the plastic)
- Hole digger
- Shovel and pick
- Leveling instrument
- Rubbers cut in squares of 3 cm x 3 cm for placing the plastic and avoid tearing.

These measures can vary depending of the needs of the producer and can be adapted to the local conditions.

3.7 Costs

The total cost of a solar coffe dryer is:

Material	Units	Quantity	Cost per unit (EUR)	Total cost
Green house plastic (cal 800)	Kg	20	5	100
Metal sifting net cloth	Meter	13	5	65
Nails	Kg	2	1	2
Wooden posts	Piece	8	5	30
Wooden rules	Piece	36	2.5	90
Workforce	Day of work	3	4	12
TOTAL				299

The cost of the solar dryer is low for coffee producers, because the tools are their usual working tools and the wooden posts and rules they can get it from their own coffee plantations. The only expenses come from the purchase of the green house, the nails and the 6 pieces of sifting net cloth, that amounts to a total of 167 Euros.

3.8 Construction Proccess Of The Solar Dryer

1. The wooden structure is mounted following the design measures
2. The plastic roof is placed
3. The wooden stools are built and placed
4. The structure is covered with the greenhouse plastic, leaving a window on each side and a door at the front

The solar dryer was tested with wet coffee and compared with wet coffee dried on a cement plot to observe the differences between them.

3.9 Benefits Of The Solar Dryer

Berrueta Soriano presented the following benefits of the solar dryer model to the coffee producers:

- The physical work required diminishes over 50% because the coffee doesn't has to be collected at night. That eliminated having to carry at least 60 kg of coffee grains twice a day (for putting the coffee out in the morning to dry in the cement plot and storing it away at night)
- The quality of the coffee is bettered because the end product is cleaner and without stains.
- The overall drying time diminished over 40%
- There were 35% savings compared to the construction of a cement plot
- The formation of mold is avoided because the coffee grains are not exposed to the rain
- The selection of the coffee grains is made easier because it is situated at a comfortable height for the coffee producer to chose the grains standing instead of the usual way of selection, where the producer is kneeling the whole time he is selecting the grains.

3.10 Discussion Of The Experience

Afterwards, the experience was discussed by the producers of Yaxalwitz and ways of bettering this prototype were analyzed and will be tested in the next coffee harvest in order to continue this participative research experience.

From the participative research experience we learned: First, each producer can change the design to fit their needs and incorporate the knowledge they already have about sun drying their coffee.

Second, for the producers that already have a cement plot, the dryer can be modified in order to continue using their cement plot but protected with the greenhouse plastic, and with a ditch built around it, in order to give some height to the coffee dryer and avoid rain wetting the grains.

Third, the materials can be further adapted to reduce costs and improve the quality of the coffee, for example for next year, wooden planks will be used instead of net cloth, because the net cloth has to be bought and the wood is part of their natural resources available in the rainforest communities.

Fourth, a dismounting system will be adapted, in order to be able to dismount the planks and take advantage of the space of the solar dryer for other uses during the year. For example to dry other products as fruits (mangoes, bananas, etc.), seeds (beans, corn, etc.) and vegetables, that can be sold as dehydrated products and bring an

extra income to the coffee producers while there is no coffee to be dried. Also it has been successfully tried for drying wood and clothes.
Fifth, the possibility is being analyzed of using the solar dryer as a greenhouse to cultivate vegetables for family consumption such as tomatoes, cabbage and cauliflower that because of the climate conditions are hard to cultivate outdoors.

4. CONCLUSION

The participative process for using solar drying required integration of many different perspectives from members of the communities and outside experts, and we learned that the involvement of the members of the cooperative society was a decisive factor for the adoption of technology in the communities, improving the designs to adapt them better to the social and natural conditions of the rainforest communities.
From the use and adoption of the solar coffee dryer we learned that the technology presented is simple to build and use, is low cost, uses local materials and is based in the previous knowledge of the coffee growers about the drying process. It is also adapted to fulfill a local need providing at the same time a participative tool that enables coffee growers to better their living conditions and work practices by a analyzing in detail the way they do a process - which elements can be bettered, the involvement of all the community in the discussion of ideas, and best practices exchange with other organizations. It also has started an interest in other alternative technologies that favor a more reasonable use of natural resources, such as wood saving stoves and solar ovens that have been tried in the communities and are starting a process of adaptation to the local needs that will bring further improvements to the living conditions of the communities involved in the project.

5. ACKNOGLEDGEMENTS

We wish to acknowledge Victor Berrueta Soriano for sharing the initial design of the solar coffee dryer with Yaxalwitz, S.S.S. Los Lagos de Colores for sharing their experiences with the use of the solar coffee dryer and Foro para el Desarrollo Sustentable A. for their technological and material support.