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# KOPERNIK PROJECT REPORT

## INCREASING FARMER INCOMES: SOLAR DRYING SOLUTIONS PHASE TWO

## SUMMARY

In the first phase of the project in 2016, Kopernik built a solar dryer and tested it with copra and cashews on Adonara Island, Larantuka, East Nusa Tenggara. From this experiment, Kopernik found that the solar dryer could dry larger quantities of agricultural produce more quickly while using less space. However, the cost of building the solar dryer with a 1000 kg capacity was expensive, and some materials used were not locally available.

Applying our lessons learned from the first phase, Kopernik designed a new model for Ile Padung Village, Larantuka, East Nusa Tenggara to dry cashews. This version was smaller, more economical, easier to build and exclusively used locally available materials. Kopernik used this model to develop a Solar Dryer Manual (please see pdf attached) which we have published and publicly shared. This step-by-step guide will allow farmers, cooperatives and NGOs to construct this particular model themselves. The manual can also be used as a base and will allow partners to adapt and customise the design for different commodities, capacities and special requirements. The functionality of this solar dryer was tested by conducting side-by-side tests comparing the current method of drying using an electric oven, versus drying using a combination of the solar dryer and the electric oven.

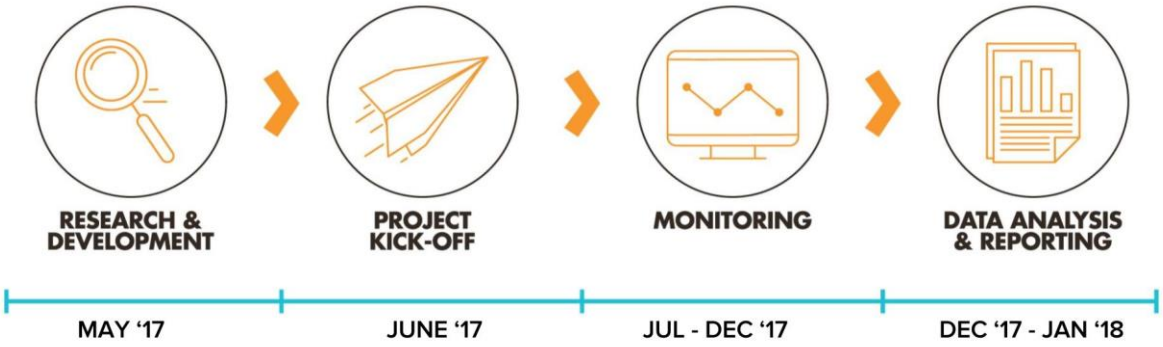
Kopernik hypothesized that using a solar dryer would be more cost-effective than using an electric oven for drying cashews. Kopernik measured the time taken to dry soft skin cashews (second stage drying) in the K-dryer, with the aim of reaching a 14 percent moisture level. We also recorded the production cost for each of the two drying methods.

Our experiment concluded that the solar dryer could:

- Effectively reduce the drying time for the second stage of drying by up to 90 percent- from 90 hours to 5 hours;
- Reduce the cost of electricity across all stages of drying by up to 71 percent - from US$105.46 to US$30.13;
- Reach a 14.6 percent moisture level for soft skin cashews against the optimal moisture level of 14 to 15 percent for stage two drying[1].

[1] Cashew Nut Processing: Sources Of Environmental Pollution And Standards. 2011. International Journal of Agriculture Sciences

## TIMELINE




## CONTEXT

Cashew plantations in Indonesia were first introduced in the 1970s for a national afforestation program for dry climatic conditions as found in East Nusa Tenggara province[2]. More recently, the purpose of planting cashews has shifted from afforestation to business development which has increased cashew production. In 2016, it was estimated that Indonesia produced 131,302 tons of cashews from 531,154 hectares of planted land[3], making up 2.7 percent of total global production[4]. Combined with Bali, East Nusa Tenggara accounts for 44 percent of the total cashew plantation area across the country[5].

Before selling cashews to the market, there are usually three stages of processing. Each of these stages involves a stage of the drying process. Our local partner, *Koperasi Punaliput*, conducts the second and third stages themselves but the first stage is performed by the farmer before selling to the cooperative.

For the first stage, the cashews are collected and removed from the cashew apple and are dried in the traditional way under the sun. The farmer then removes the cashew from the shell but a soft skin remains around the cashew nut. These cashews are called soft-skin cashews and *Koperasi Punaliput* purchase them from the farmers in this form. For the second stage of drying, the cooperative dries the soft skin cashews using an electric oven before removing the soft-skin, which is called a white cashew. For the third stage, the cooperative dries the white cashew in an electric oven once again before creating the finished product.

For our local partner, using an oven for the second and third stages of drying can be expensive. The electric oven only has a 40 kg capacity and the electricity is costly. It can also be an ineffective process when there are frequent power outages.

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[2] Integrated Production Practices of Cashew in Indonesia. Published by Food Agricultural Organization.

[3] Tree Crop Estate Statistics of Indonesia (2015). Published by the Directorate General of Estate Crops of Indonesia.

[4] Food and Agriculture Organization of the United Nation

[5] Tree Crop Estate Statistics of Indonesia (2015). Published by the Directorate General of Estate Crops of Indonesia.



*Image 3. Left: Fresh cashews growing from the cashew apple. Right: Dried shell cashews*

## LOCATION




## HYPOTHESIS

We hypothesized that using a solar dryer to assist in the drying process would be more cost effective than using an electric oven for cashew farmers.

## METHODOLOGY

In this project, we built a solar dryer to aid the drying process of soft skin cashews. This solar dryer was used for the second stage of drying. The electric oven was still required in the final stage of drying because of its flexibility to set a specific temperature for drying white cashews.

Our experiment compared the traditional method of drying cashews using an electric oven versus drying using a combination of the electric oven and the solar dryer. We measured and compared the following indicators:

1. The time required to dry the soft skin cashews in the K-dryer;
2. The moisture content in the soft skin cashew after the drying process (using a moisture meter);
3. The difference in electricity cost between drying with the K-dryer and drying with the electric oven.

**K-Dryer**

This solar dryer was designed and built by Kopernik from locally available materials. It used polycarbonate sheeting that absorbed and trapped heat from the sun. Gravel was added to the base of the dryer to store heat more effectively and further increase the temperature. The dryer has four racks, each with seven to 13 layers, allowing farmers to dry a maximum of 300 kg of cashews per drying cycle (image one and two). The solar dryer protects the commodity from contaminants and can be used during the rainy season.



*Image 1. The K-Dryer is made with locally available materials: the walls and roof are made from polycarbonate*



*Image 2. The dryer has four drying racks with seven to 13 layers, allowing a total capacity of 300 kg of cashews in one drying cycle.*

## FINDINGS

### The Drying Performance

The electric oven has a 40 kg capacity and at full capacity requires 12 hours to dry the cashews in one drying cycle. Meanwhile, the solar dryer has a 300 kg capacity and only needs five hours to dry at full capacity during the dry season. The solar dryer is therefore 90 percent faster at drying 300 kg of cashews compared to the electric oven for stage two drying.

In addition, during the rainy season, when local farmers are not typically able to dry shell cashews outside under the sun, Kopernik's local partner buys fresh shell cashews and uses the solar dryer. Although it takes longer to finish drying the shell cashews inside the solar dryer during rainy season compared to dry season, it is a valuable option compared to not drying the cashews at all.

Kopernik's local partner reported that shell cashews dried with the solar dryer were more evenly dried and did not require flipping. As a result, the kernels were more likely to stay whole during the peeling process, while cashews traditionally dried tended to split into two or more pieces, which has an effect on the final sale price of the cashew. Whole white cashews have a 17 percent higher price (IDR180,000/kg or ~US$12.60) than split white cashews (IDR150,000/kg or ~US$10.50).

### Moisture Level

Based on the collected data, the soft skin cashew moisture level after drying in the solar dryer is 14.6 percent. This is within the global industry standard for cashew processing of 14 to 15 percent moisture level for second stage drying[6].

However, the farmer wanted to reach a 10 percent moisture level in the second stage and prefers to transfer the solar-dried soft skin cashews to the electric oven to reduce the moisture level further. This farmer would like to control the temperature for the final stage of the drying process which he is not able to do with the solar dryer. For this farmer, the solar dryer, while aiding the drying process, is not able to completely replace the electric oven.

[6] Cashew Nut Processing: Sources Of Environmental Pollution And Standards. 2011. International Journal of Agriculture Sciences

***Cost of Electricity Across All Stages of Drying***

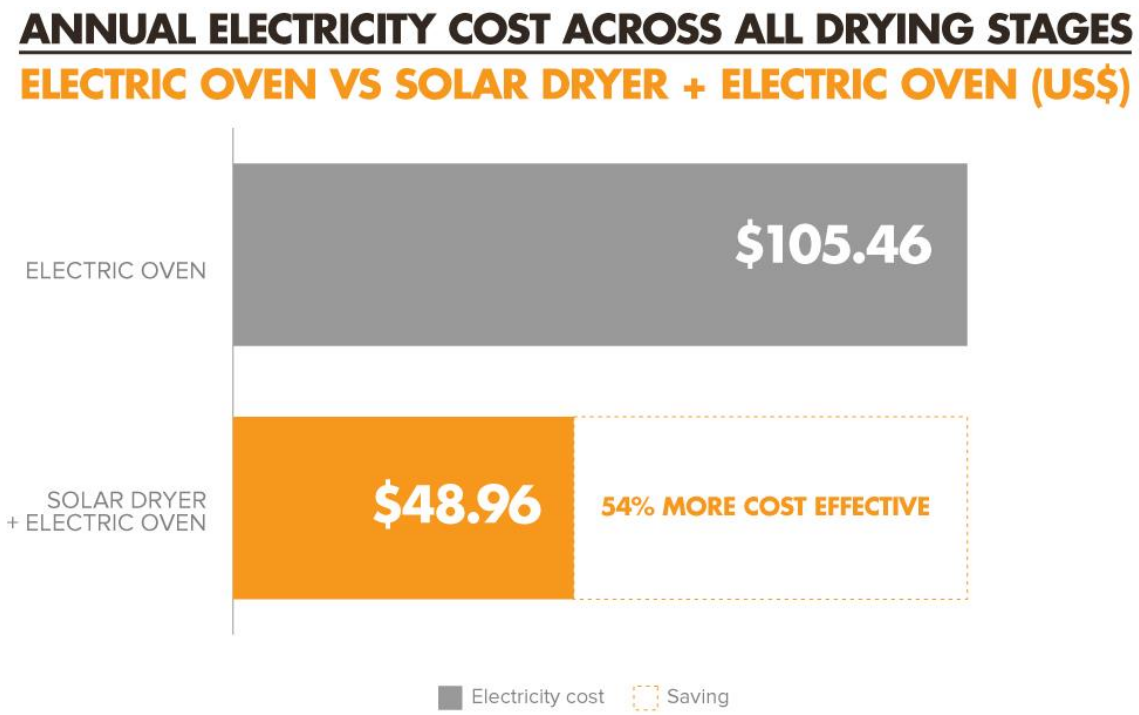



*Figure 1. Using the Solar Dryer with the electric oven is 54 percent more cost effective than using the electric oven alone*

Every year, our local partner conducts the drying process for the cashews over the course of four months. Our partner reported that the electricity expense while using an electric oven to complete all drying processes was IDR 350,000 (~US$26.37) monthly or IDR 1,400,000 (~US$105.46) annually. Assuming that there is one month of rainy season when the solar dryer cannot perform effectively, which would subsequently lead our local partner to return to the electric oven to complete both drying processes[7], the electricity expense was then reduced to IDR 650,000 (~US$48.96) annually. Based on that information, it means that our local partner can reduce the cost of electricity by up to 54 percent when using the solar dryer to replace the electric oven in the second stage of drying (Figure 1).

## CONCLUSION

Our experiment supported the hypothesis that using a solar dryer to complete the drying process for cashew farmers will be more cost effective than using an electric oven by reducing:

- The time needed to complete the second stage of the drying process by 90 percent by using both the solar dryer and electric oven compared to just using an electric oven.
- The total cost of electricity up to 54 percent.

[7] The solar dryer works in the the rainy season but takes a longer time, and our local partner did not want to wait that long so he moved the drying process back to the electric oven

**TESTIMONIAL :**

*This solar dryer has helped me to accelerate the cashew drying process in our cooperative, especially in the dry season. Furthermore, this solar dryer is an excellent tool to dry whole cashews. It can produce higher quality dried whole cashew beans compared to the traditional drying method. For future reference, please consider adding a solar panel that can produce more heat during the rainy season.*
- Gabriel Maran (Ebit), Head of Koperasi Punaliput Cooperative

## RECOMMENDATION

Based on the data that we collected, we recommend that:

1) Farmers add a solar panel to this solar dryer model to produce additional heat during the rainy season.
2) Kopernik test the first stage of drying with this modified solar dryer design to evaluate the time taken and the quality of the dried product compared to the traditional drying method.
3) Kopernik test the third stage of drying with the solar dryer to further reduce the electricity cost.

## LEARN MORE

*Kopernik's Improving Processing Technologies: Cacao Beans Phase One project experiments with a different model of solar dryer to dry cacao beans.*