

SOLUTIONS LAB - PROJECT REPORT - EXPERIMENTATION PROJECT

IMPROVING PROCESSING TECHNOLOGIES: CACAO BEANS PHASE 1

CONTEXT

Situated in the western part of Tabanan regency, Angkah village covers an area of 1,802 km²¹ and is made up of mostly rice and plantation fields. Local economic activity relies heavily on agriculture, specifically commodities such as rice, cocoa, cloves and coconut. Tabanan regency produces 28% of Bali's annual cocoa harvest, making it Bali's second largest producer after Jembrana regency².

Angkah village has a population of 2,179³, consisting mainly of farmers who own small plantation fields and plantation workers. The farmers typically earn about half of their income from working on other plantations. It is common practice for farmers in Angkah village to form a working group, known as a UPH, *unit pengolahan hasil* or crop processing unit, where members coordinate their farming activities.

Farmers in Angkah own cacao plantations ranging in size from 0.15 Ha to 2 Ha, with an average size of 0.52 Ha. In a typical season, the cacao yield can reach up to 300Kg/Ha. This production volume is well below the national average of 1,000 Kg/Ha⁴. The peak cacao season lasts from May to September, and low season is typically from October until December.

Cacao production activities in Angkah village consist of pre-harvest and post-harvest activities, which are summarized in the following diagram. Pre-harvest activities include planting and maintenance followed by harvesting, this takes up to three days of work. Post-harvest processes, on the other hand, take a longer amount of time, particularly the fermentation and drying processes (Figure 1).



Figure 1. Schematic diagram for cacao value chain in Angkah village

In fact, most farmers in the area do not perform the fermentation process. The main reason is that fermentation is time intensive and farmers often do not have sufficient knowledge of the post-harvest processes. In addition, the price difference between unfermented and fermented beans may not be sufficiently significant to incentivize farmers to ferment their beans. The prices published for June 2017 were IDR37,150/kilogram for unfermented beans and

¹ Selbar Officer (Aug1, 2015) *Selemadeg West District, Tabanan Regency website*, Retrieved from <http://selbar.tabanankab.go.id/profil-desadesa-angkah/>

² (2013), Badan Pusat Statistik, Provinsi Bali. *Plantation Production (tons) According to the Commodities and Regency / City in Bali in 2013*, Retrieved from <https://bali.bps.go.id/linkTabelStatis/view/id/88>

³ Selbar Officer (Aug1, 2015) *Selemadeg West District, Tabanan Regency website*, Retrieved from <http://selbar.tabanankab.go.id/profil-desadesa-angkah/>

⁴ BPTP (2008) *Teknologi Budidaya Kakao, Seri Buku Inovasi: BUN/13/2008*, Retrieved from http://kalbar.litbang.pertanian.go.id/ind/index.php?option=com_content&view=article&id=266:gernas-kakao&catid=66:program-utama&Itemid=209

IDR43,150/per kilogram for fermented beans⁵.

The farmers currently dry their beans directly under the sun, placing the beans on the ground. As well as being weather dependent and vulnerable to attack from animals, the current outdoor floor drying process is viewed by local farmers as inefficient and time-consuming.

LOCATION

PROJECT LOCATION: ANGKAH VILLAGE, TABANAN, BALI



HYPOTHESIS

Our hypothesis was that a Hybrid Solar Dryer (HSD) will reduce the drying time for cacao as compared to the traditional floor drying method.

METHODOLOGY

The fresh cacao beans were provided by UPH Subak Abian Buana Mekar, Kopernik's local partner for this project. While individual farmers do not usually ferment the cacao beans, the UPH does, and for that reason we tested beans that had been fermented using a three-tier fermentation box (Image 1) that Kopernik built. This box was larger than the usual fermentation box and its three-tier design was intended to assist farmers to more easily move the beans through the fermentation process, but it was not expected to have any further effect on the quality of the beans.

⁵ (July 5, 2017) *Cacao Price June 2017*, Retrieved from <http://perkebunannews.com/2017/07/05/harga-kakao-juni-2017/>



Image 1. Three-tier Fermentation Box in UPH Subak Abian Buana

The beans were first weighed and then stored inside the fermentation box for five days. The cacao temperature and outdoor temperature were measured daily using a thermometer. After five days, the fermented cacao underwent a cut test to check the bean's quality.

The beans were then dried for five days, their quality was tested again by cracking them open and evaluating their color and crack shape (Image 2). The cacao beans tend to darken in color during drying as the majority of the browning reactions will occur during this process⁶.

The total yields were calculated at the end of the experiment.

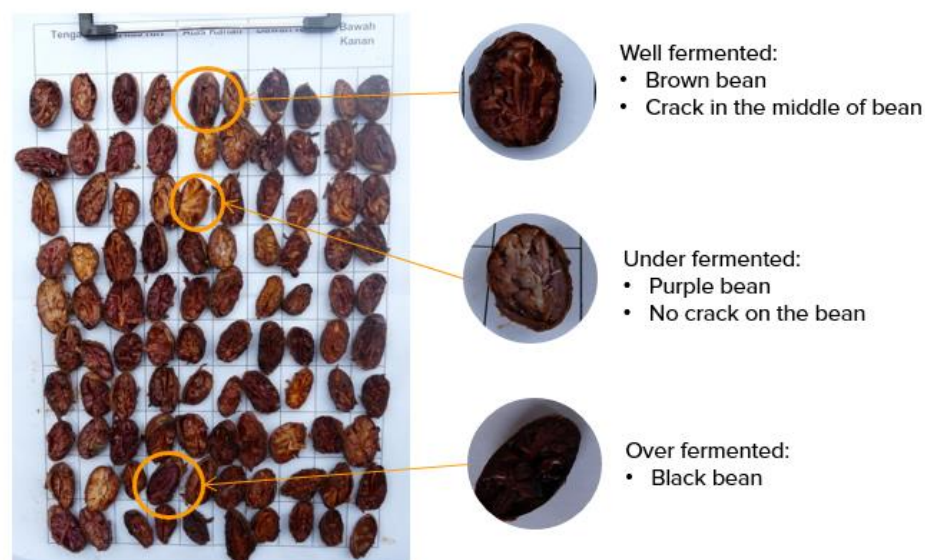


Image 2. The cut test shows the quality of the fermented bean, Photo: Kopernik⁷.

⁶ AusAID (2010) Cocoa processing method for the production of high quality in Vietnam.

⁷ AusAID. 2010. Cocoa processing method for the production of high quality in Vietnam. Australia.

Three methods were tested to dry the fermented cacao beans.

1. The Hybrid Solar Dryer (HSD) – which was designed by our local partner.
2. The Floor Solar Dryer (FSD) – which is the current traditional practice in Angkah village.
3. The Mixed Solar Dryer (MSD) – which combined the HSD and FSD processes.

Equal amounts of 88 kilograms of fermented cacao beans were used for each drying method. Monitoring was performed daily to measure cacao temperature and moisture level, as well as indoor and outdoor temperature.

The following table summarizes the experimentation methodology of the drying process (Figure 2):

DRYING PROCESS	HSD*	FSD**	MSD*** FSD** → HSD*		Quality Testing
DURATION	5 days	5 days	3 days	2 days	1 day
TOOLS	• Thermometer and Hygrometer				• Cutter • Weight scale
MEASUREMENTS	• Sample temperature and moisture • Outdoor and indoor temperature/humidity				• Bean Quality • Flavor • Yield

Figure 2. Summary of experiment methodology

FINDINGS

The findings were that:

- The moisture level of the beans in the HSD was two times higher than the beans dried using the FSD method after five days of drying.

This was an unexpected result, disproving our hypothesis of better drying results from the HSD when compared to the FSD. The reason for this disappointing result was found to be the higher humidity level inside the HSD as compared to the outdoor humidity level. This was due to the faulty design of the HSD, which had poor air circulation inside the dryer.

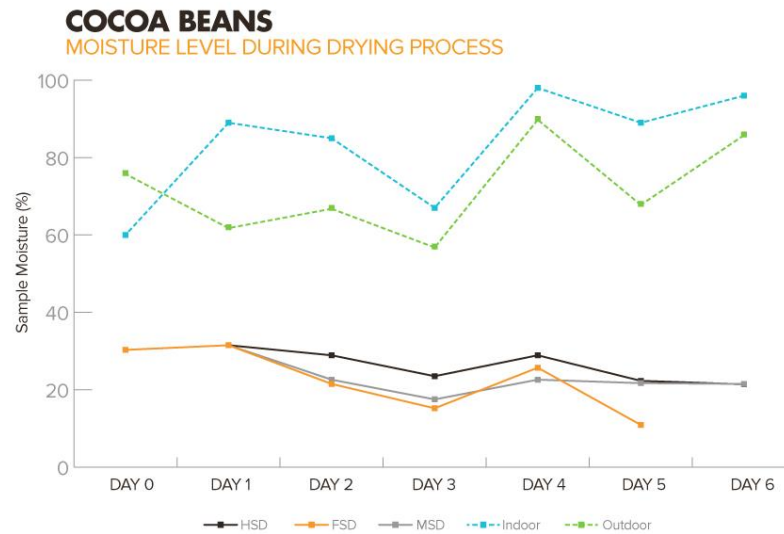


Figure 6. Beans moisture level during drying process

The fermentation results using the three-tier fermentation boxes were as expected. This was confirmed through a cut test on the fermented beans resulting in a yield of 95%, meaning that 95 out of 100 beans were considered good quality, evident by the brown color and crack in the middle of the bean⁸.

CONCLUSION

This project tried to improve the drying process for cacao beans, however the HSD that was built did not perform well. The moisture level of the HSD-dried beans was two times higher than the beans dried in the open space on the cement floor. Based upon further investigation, poor air circulation inside the HSD had increased the indoor humidity to levels higher than the outdoor humidity levels. This issue first needs to be addressed to compare the HSD and FSD drying methods more successfully.

TESTIMONIAL :

"I appreciate the fact that Kopernik is willing to work in improving the Hybrid Solar Dryer after finding out that the result of dried cacao beans was not too satisfying at the end of this phase. I hope in the next phase the dried beans' quality can be better"

- Pak Adi, Chief of UPH Subak Buana

RECOMMENDATION

Based on the data collected, Kopernik's recommendation is:

1. The current HSD design needs to be improved to provide better air circulation, particularly in humid conditions. This could involve adding an exhaust fan and changing the plastic material of the roof to polycarbonate sheeting.

⁸ AusAID (2010) *Cocoa processing method for the production of high quality in Vietnam*.

A second phase of this experiment will be implemented by Kopernik. In this experiment, the HSD design will include these modifications. The same data as phase one with fermented beans will be collected and compared.

LEARN MORE

Kopernik's [Increasing Farmer Incomes: Solar Drying Solutions Phase One](#) project experiments with a different model of solar dryer to dry cashews and copra.

Kopernik's Senior Analyst, Nadya Pryana from our Last Mile Consulting Team recently published a [Kopernik Insight](#), concluding that ineffective drying causes a US\$3 billion loss across ten agricultural commodities in Indonesia.