# Rezatherm

## UNIVERSITY OF COLORADO BOULDER
## ENGINEERING FOR SOCIAL INNOVATION

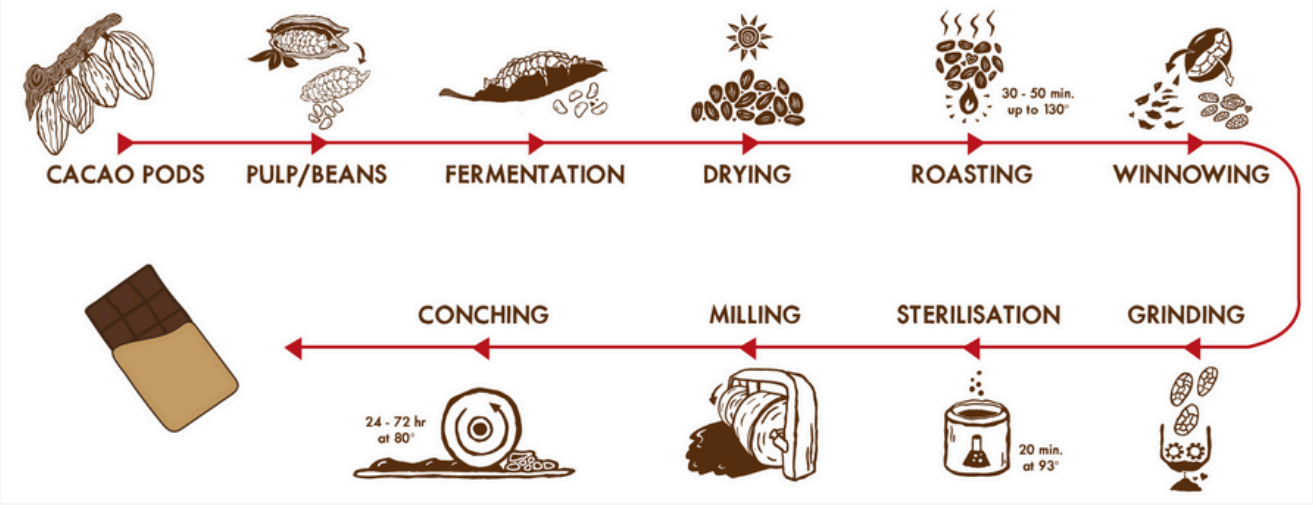
**SMALL SCALE**
**CACAO PROCESSING MACHINE:**
**BEAN- TO - NIBS**

# Background and Motivation

The chocolate industry produces around 4 million tons of cacao annually, generating billions of dollars in revenue, yet only 6% of profits go to cacao farmers. Approximately 6 million people depend on cacao farming for their livelihood, often earning just $2 a day. Currently, there is no small-scale winnowing machine for farmers to assess the quality of their beans. This results in large companies exploiting farmers by underpaying or rejecting large portions of their crops, putting farmers' livelihoods at risk.

## Chocolate Making Process

After beans are grown and harvested, they undergo fermentation and drying before being shipped to the processing plant. There, they are roasted and cracked. The cracked beans are winnowed, separating the husks from the nibs, which are the edible part of the bean in its purest form. The nibs are ground into a paste with cocoa butter, sugar, and flavorings to make chocolate bars. Once mixed, the liquor is poured into molds and shipped worldwide for enjoyment.



# Desgin Overview

Our product is a small-scale winnowing machine that processes roasted cacao beans, separating them into husks and nibs. Our winnower will allow farmers to understand the quality of their product.

The winnower is made of acrylic and designed to be user-friendly and portable. It features a swinging door, similar to a microwave, and removable bins for easy collection and cleaning. The door is transparent, allowing users to see the winnowing process.

To use our machine, plug it into a standard wall outlet and turn it on using the side switch. This is where the electronics are located, featuring a knob to control the fan speed for calibrating. Once turned on, beans in the hopper (not pictured below) will fall into the two motor-powered pinch rollers, which crush them into nibs and husks. The ground beans then fall into the main chamber, where a fan separates the lighter husks from the heavier nibs. Finally, the separator directs the nibs and husks into their respective bins.

**Hopper**
Whole roasted cacao beans are stored

→

**Grinder**
Cracks the cacao beans

→

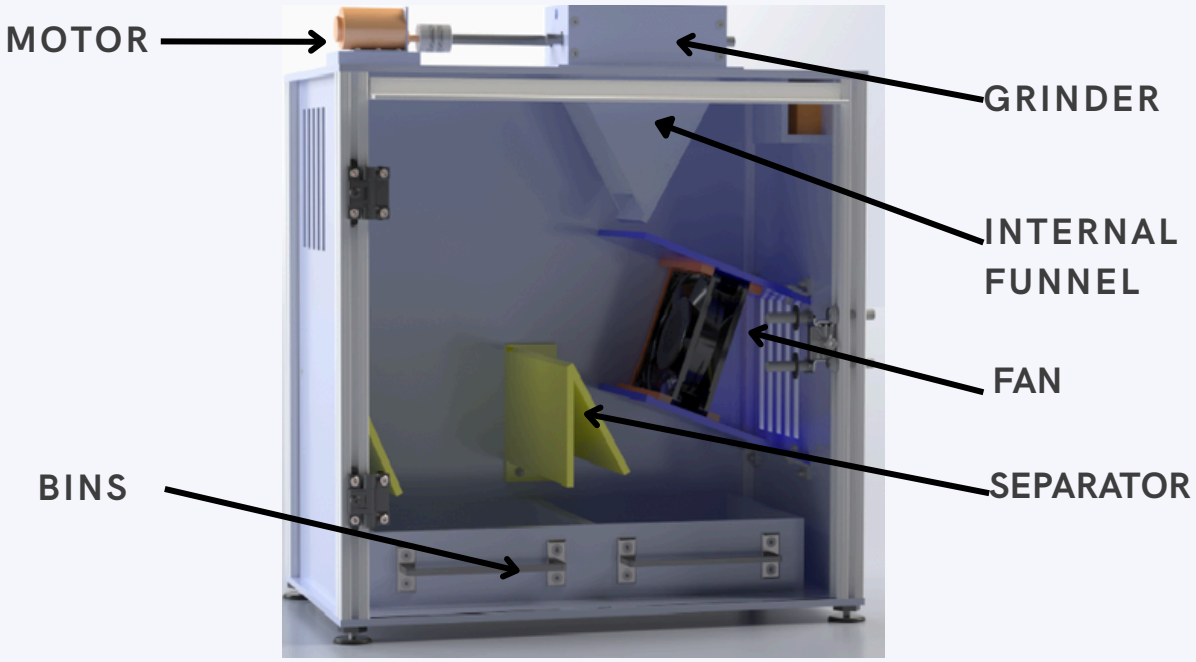
**Internal Funnel**
Guides cacao beans into the main chamber

→

**Fan**
Separates the husks from the nibs

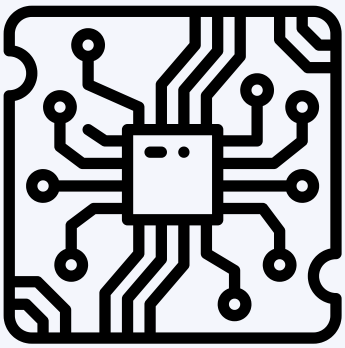
→

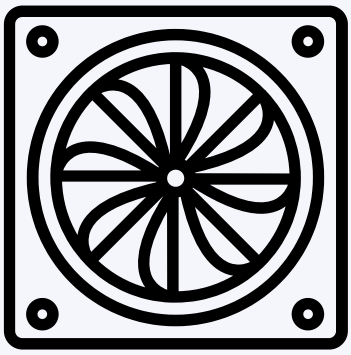
**Bins**
Stores husks and nibs



# Testing

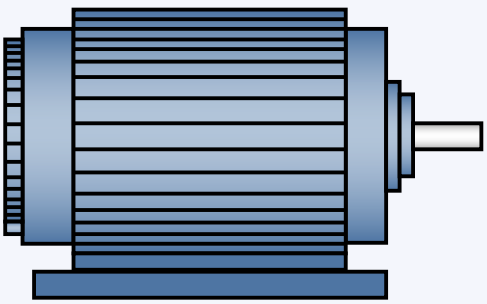
The electronics were tested to verify that the fan and grinder motor operate simultaneously using a switch. Both components operate at 24 volts and are powered from a standard 120-volt wall outlet.





The position of the fan was determined based on the size constraints of our main housing. Then, tests were conducted to find optimal air flow, and the team found that 80 to 120 CFM was ideal.

We found a motor that can operate with high torque and low RPM to power the grinder. Our team ensured the beans were cracked and that the grinder did not jam. The motor was connected to a wall outlet and did not overheat during testing.



# Winnowing Efficiency

Our overall test was the winnowing efficiency of our machine. Winnowing efficiency is the percentage of the husks and nibs separated at the end of the process. The test was done with 60% efficiency with one pass of our machine.

# Competition

Our product's biggest competitor is the Chocolate Alchemy Sylph Winnower. This competitor is the only reasonably priced product that targets amateurs and small-scale chocolate makers. The Sylph Winnower itself costs $375 and does not include a grinder. It is also hard to calibrate and made out of PVC pipes. Other competitors are built for industrial use and cost around $15,000, like the InnoWinnower.

Our product aims to take advantage of this gap in the market by offering a $725 lower-cost, better-quality winnower and grinder for farmers.

| | Affordable | Small Scale | Low Power Requirement | Adjustable | Includes Grinder |
|---|---|---|---|---|---|
| Cocoa Aura  | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sylph Winnower  | ✓ | ✓ | ✗ | ✗ | ✗ |
| InnoWinno  | ✗ | ✗ | ✗ | ✗ | ✓ |

# Business Opportunity

This product would be primarily targeted toward farmers, and as a side market, the bean-to-bar sector. Our team found that our total addressable market for farmers is 1.2 billion USD. The serviceable available market, which makes up more South American countries, that can afford our product, is 260 million USD. From this, our serviceable obtainable market is 25 million USD. Our business model will focus primarily on South America and grow towards African countries.

Our company estimates that it will sell 600 units in the first year and expects to break even in four years. Overall, there is a gap in the market for a small-scale, affordable, and easy-to-use winnowing machine.

# Conclusion and Team

Given more time, our team would consider adding a melange to create a fully integrated chocolate-making machine. We also learned that designing a grinder capable of separating most non-uniform cacao beans is challenging, so we would spend more time optimizing the grinder.

Overall, our team is comprised of six passionate engineers who love chocolate and want to help with the cocoa farming issue!


Special Thanks:
Andrew Morton-Director
Danial Riffell- ESI director
Dario Atallah- Client
Prof. Carmen Pacheco