Title: Estufa Finca—Santos Pilot Project Results Report

Authors: Tom Ternes, Advisor – SeaChar.Org
        Susan Bolton, PhD, P.E., Advisor – University of Washington
        Art Donnelly, President – SeaChar.Org

Date of publication: April 8, 2011
Table of Contents

Acknowledgements .................................................................................................................. 4

Executive Summary .................................................................................................................. 5

1.0 Purpose.................................................................................................................................. 8

2.0 Introduction .......................................................................................................................... 9
  2.1 SeaChar.Org.......................................................................................................................... 9
  2.2 Estufa Finca—Santos Pilot Project ...................................................................................... 9
  2.3 Estufa Finca Stove ............................................................................................................. 9
  2.4 Estufa Finca Stove Setting and Cook Top ......................................................................... 10

3.0 Baseline and Customer Satisfaction Surveys .................................................................... 11
  3.1 Methodology Summary .................................................................................................... 11
  3.2 Estufa Finca Team Roles and Responsibilities ................................................................ 12
  3.3 Population ....................................................................................................................... 13
  3.4 Migrant Homes ................................................................................................................. 14
  3.5 Existing Stoves .................................................................................................................. 14
  3.6 Fuel.................................................................................................................................. 15
  3.7 Transportation ................................................................................................................... 15
  3.8 Customer Satisfaction Survey Protocol Development .................................................... 16
  3.9 Stove Manufacture ........................................................................................................... 17
  3.10 Stove Setting Installations ............................................................................................... 17
  3.11 Customer Satisfaction Surveys – Traditional Stoves ....................................................... 18
  3.12 Stove Installations .......................................................................................................... 18
  3.13 Stove Operators’ Workshops .......................................................................................... 18
  3.14 Customer Estufa Finca Stove Use ................................................................................... 19
  3.15 Customer Satisfaction Surveys – Estufa Finca Stoves ..................................................... 19
  3.16 Customer Satisfaction Survey Results ............................................................................ 20
  3.17 Estufa Finca Stove and Setting Costs ............................................................................ 22

4.0 Controlled Cooking Test ..................................................................................................... 23
  4.1 Methodology ..................................................................................................................... 23
  4.2 Fuel.................................................................................................................................. 23
  4.3 Food .................................................................................................................................. 24
  4.4 Controlled Cooking Test .................................................................................................... 24
    4.4.1 Controlled Cooking Test – Traditional Stove ............................................................... 25
    4.4.2 Controlled Cooking Test – Estufa Finca Stove ........................................................... 25
  4.5 Controlled Cooking Test Results ...................................................................................... 26
    4.5.1 CCT Results - Time .................................................................................................... 26
    4.5.2 CCT Results – Fuel Usage ........................................................................................ 27
    4.5.3 SeaChar.Org Observations During CCT .................................................................. 27
    4.5.4 CCT Results – Biochar Creation .............................................................................. 27

5.0 End of Season Follow-Up Survey ....................................................................................... 29

6.0 Aprovecho Laboratory Test Summary ............................................................................... 30
  6.1 Laboratory Test Methodology ......................................................................................... 30
  6.2 Laboratory Test Results ................................................................................................... 30
7.0 Conclusion .............................................................................................................................................. 32
Appendix A Customer Satisfaction Survey Data Sheet .............................................................................. 33
Appendix B Registration Data Sheet ........................................................................................................ 34
Appendix C Controlled Cooking Test Data Sheet ................................................................................ 35
Appendix D Stove Workshop Instructions .............................................................................................. 36
Appendix E Participating Farmers .......................................................................................................... 37
Estufa Finca—Santos Pilot Project Results
April 8, 2011

Acknowledgements
We wish to thank the following individuals and groups.

University Nacional de Costa Rica: Instituto Regional de Estudios en Sustancias Program Director Rocío Lorío Bolaños, MSC and student interns Diana Viquez and Evelyn Alas. Their knowledge of the region, its farmers and migrant worker conditions were invaluable to the project.

The Coffee Farmers of Los Santos: They embraced this technology and our goal of improving it with careful field-testing. They also gave us full access to their farms, pitched in to mix concrete and haul materials, invited us to lunch and became our friends. The names of participating farmers can be found in Appendix E.

The Migrant Ngöbe Coffee Pickers: They inspired us with their strength, pride and humor, and honored us by allowing us into their homes and lives.

The Cooks, especially the Lopez sisters: They graciously gave their time and attention to provide us valuable feedback and encouragement about our Estufa Finca stove.

Canada Fund for Local Initiatives: The Fund’s generous support made it possible for us to begin our work in time for harvest and allowed us to install and carefully test and monitor 32 stoves.

Seattle International Foundation: The foundation generously supported our pilot project and is also helping us prepare for expansion of the Estufa Finca project.

The Juánico Fallas Mata Family - Juánico, Odillie, Willy and Bernardo: They welcomed us into their home and treated us like family.

Arturo Segura, Carolina Abarca Calderón and Benjamin: They are our closest partners and our friends. The project would never have happened without them.
Executive Summary

The Estufa Finca Stove Project is introducing clean stove technology to the developing world, emphasizing self-sustaining partnerships with local people.

Goals of the project are to:
- Improve air quality to prevent respiratory illness
- Reduce deforestation and resulting soil erosion
- Create biochar for carbon sequestration and soil improvement
- Reduce the time required to collect wood
- Support rural women’s groups to build stoves and develop sustainable businesses

The Estufa Finca—Santos Pilot Project was designed and implemented to evaluate the ability of the Estufa Finca stove to meet these goals through a field-testing and monitoring program. Test and survey protocols were developed and 32 stoves were built, installed, tested and monitored in the homes of migrant coffee pickers in the Los Santos coffee-producing region of Costa Rica.

Five main elements of the Estufa Finca Pilot Project were:
- Population demographic and baseline stove survey
- Customer Satisfaction Survey (CSS)
- Controlled Cooking Test (CCT)
- End of season follow-up survey
- Data analysis

Population demographic and baseline stove surveys were conducted at the beginning of the pilot project in December 2010. The surveys gathered demographic information about the coffee picker population and their existing cooking conditions.

Customer Satisfaction Surveys (CSS) were conducted from December 2010 through January 2011. The surveys measured satisfaction of both the traditional stove and the Estufa Finca stove.

Controlled Cooking Tests (CCT) were conducted over two weeks in January 2011. SeaChar.Org used a modified version of the protocols defined in the standard CCT to monitor three households that had previously participated in the CSS. The CCT protocol compares the time and fuel needed to prepare food on the traditional stove to the Estufa Finca stove.

End of season follow-up surveys were conducted at the end of the coffee picking season.
Estufa Finca—Santos Pilot Project Results
April 8, 2011

Data analyses are summarized below.

Population demographic and baseline stove survey
- 160 residents, 60 cooks, 21 families, 13 farms
- All but one of the stove recipients were indigenous Ngöbe from Panama
- 91% wood burning stoves, 15% located inside the home

Customer Satisfaction Survey
- 41% reduction in time required to cook
- 73% reduction in the number of people who reported being bothered by smoke
- 75% reported it was easy to control cooking temperature on the Estufa Finca stove
- 81% reported it was easy to cook on the Estufa Finca stove
- 100% reported the Estufa Finca stove provided a stable platform for cooking
- 100% reported they like their Estufa Finca stove

Controlled Cooking Test
  - Average cooking time was reduced
  - 47% reduction – medium cooking duration foods (chicken)
  - 39% reduction – long cooking duration foods (beans)
  - Average fuel usage was reduced
  - 72% reduction – medium cooking duration foods (chicken)
  - 32% reduction – long cooking duration food (beans)
  - Average specific fuel usage was reduced
  - 71% fewer gr of fuel/kg of food – medium cooking duration foods (chicken)
  - 40% fewer gr of fuel/kg of food – long cooking time duration foods (beans)
  - Average of 789 gr of biochar per meal was created.

End of season follow up surveys by the Universidad Nacional de Costa Rica team found that stove usage dropped off after SeaChar.Org conducted the CSS. The most important factors contributing to this appear to be:
- Insufficient training and follow-up
- Migrant nature of target population
- Unwillingness to spend time preparing small fuel
- Concerns over child safety

The Estufa Finca stove was tested at the Aprovecho Research Center on October 25-29, 2010 using the University of California-Berkeley Water Boiling Test. The standard water boiling test shows an 83% reduction in carbon monoxide output and a 91% decrease in particulate matter emissions from the Estufa Finca stove compared to a typical open cook fire.
Estufa Finca—Santos Pilot Project Results
April 8, 2011

Overall, the Estufa Finca stove was well received by the migrant coffee pickers in whose homes they were installed. Four key lessons were learned during the pilot project:
  • Farmer selection and training is critical
  • On-going cook training is essential
  • Cooks use more than one burner
  • Small pieces of wood required for the Estufa Finca stove were problematic for some users

Pilot project results, both objective and subjective, along with independently verified laboratory test data, indicate the Estufa Finca Farm Stove Program provides a stove that reduces emissions and the time to cook normal foods.
1.0 Purpose

This report summarizes the methodology, implementation and results of the Estufa Finca—Santos Pilot Project. In this project, population demographics and baseline information about existing stoves were collected through interviews with participating cooks in the Los Santos coffee-growing region of Costa Rica from December 2010 through February 2011. In addition, two Estufa Finca stove performance tests were conducted in participating households.

- **Population Demographic and Baseline Stove Survey** – This survey compiled information on the number, age and gender of household members in participating households. This survey also documented existing cooking conditions, common foods, time spent cooking and fuel types used.

- **Customer Satisfaction Survey (CSS)** – This survey measured approval and acceptance of Estufa Finca stoves installed in the homes of migrant coffee picker families.

- **Controlled Cooking Test (CCT)** – This test measured and compared the amount of fuel and time to cook common foods on existing stoves to the Estufa Finca stove.

- **End of season follow-up Surveys** – This follow-up consisted of informal interviews with participating cooks four to six weeks after receiving their Estufa Finca stoves.

To improve the implementation of follow-on projects, this report documents lessons learned during execution of the pilot project. We also include a summary of results from Water Boiling Tests conducted by the Aprovecho Research Center in Cottage Grove, Oregon, US, in October 2010. This test measured the production of carbon monoxide, carbon dioxide and particulate matter emissions for the Estufa Finca stove compared to an open fire.
2.0 Introduction

The mission of SeaChar.Org is to provide positive tools for carbon negative living. The Estufa Finca Farm Stove Project is perfectly suited to promoting the goals of this mission.

2.1 SeaChar.Org

SeaChar.Org is a grassroots, nonprofit organization that promotes the widespread use of biomass waste to create biochar and generate clean energy for the purpose of:

- Mitigating global warming
- Rebuilding healthy soils
- Improving household air quality
- Building green economies in the U.S. and developing countries

SeaChar.Org advances its mission through research, education and the development and distribution of appropriate technologies such as the Estufa Finca stove.

2.2 Estufa Finca—Santos Pilot Project

Every year in the Los Santos region of Costa Rica, approximately 10,000 migrant workers and their families arrive to pick coffee. They live in temporary dwellings and cook on smoky open fires—both inside and outside. Respiratory disease associated with the smoke from these fires is one of the leading causes of illness leading to death in this population.

During December and January of the 2010-2011 harvest season, SeaChar.Org and its local partners introduced 32 of our Estufa Finca stoves, biochar producing, clean cook stove technology to improve the health and well-being of indigenous Ngöbe coffee pickers. Careful monitoring and testing of the study group was performed during the project.

2.3 Estufa Finca Stove

The design of the Estufa Finca “micro-gasifier” stove draws from the work of Dr. Tom Reed, Dr. Paul Anderson and many others who have applied micro-gasification techniques to low cost cook stove technology. Whereas traditional stoves allow smoke to escape as particulate matter, micro-gasifier stoves burn smoke as fuel. Micro-gasification stoves can either burn fuel to ash, or—if oxygen is excluded or combustion is extinguished with water after the gases are burned off—the stove produces biochar as a by-product. Biochar does not differ in composition from charcoal and is produced primarily for soil amendment.

An in-depth analysis of micro-gasification technology can be found at the following website:


The Estufa Finca stove is constructed from common materials easily procured in developing countries: a 20 liter (5 gal) combustion chamber made from a bucket, surrounded by a shroud
formed of galvanized roofing. The stove is big enough to use a wide variety of biomass materials and has good control of both “primary air,” used to control the heating phase, and “secondary air,” used to burn the gas.

2.4 Estufa Finca Stove Setting and Cook Top

During the planning phase of the project, three stove settings were field-tested.

**Cob Setting.** This molded clay enclosure was rejected due to the difficulty in obtaining high quality clay, the labor involved in preparing the clay and the length of time to cure the clay.

**Barrel Setting.** This modified 55 gallon drum enclosure was rejected because it became too hot and was a burn hazard.

**Block Setting.** This concrete block enclosure was selected as the best fit for the Estufa Finca stove because it was inexpensive, easy to fabricate, made of locally available materials and provided a safe cook setting.

![Estufa Finca stove and setting dimensions.]

The Estufa Finca stove setting combined with the cook top provide a stable and protected platform to house the stove and bring the cooking surface to a height desirable for cooking (80 cm). Like the Estufa Finca stove itself, the setting is fabricated from simple materials available in most parts of the world: a 20 liter bucket, cinder blocks, quick-set cement and rebar.

**Lessons Learned.** Stove settings and cook top designs need to take into account differences among cultures, family sizes, foods, meal preparation, pot types and sizes, fuels and stove location. Based on observation and customer feedback, the stove setting and cook top will be a focus for improvement for future stove installations.

**Setting improvements:**
- Make removable child safety guard a standard feature
- Change the base block in the stove setting from two blocks to one, to ensure primary air control

**Cook top Improvements:**
- Allow for multiple pots
- Move rebar supports to provide a more useful side-board surface
- Increase vent hole located on the cook top ring from ½“ diameter to ¾”
- Include a burner accessory for use with smaller diameter pots in cook top kit
3.0 Baseline and Customer Satisfaction Surveys

Population demographic and baseline stove surveys, and the Customer Satisfaction Survey were conducted from December 15, 2010 through January 24, 2011. Thirty-two homes were selected for installation and testing; however, due to issues related to working with a migrant coffee picker population, four of the homes were dropped from the test, leaving 28 homes participating in the full study.

Lesson Learned. Work more closely with farmers in the selection process of potential participants to ensure they are strong candidates for the study. Assume that 20% of participants will not complete the survey, especially in a seasonal, migrant population. Ensure requirements for informed consent of participants are followed.

3.1 Methodology Summary

For the Customer Satisfaction Survey, project team members:

- Developed a questionnaire and testing protocols
- Recruited 32 cooks to participate in the study
- Worked with cooks to select the stove location in each home
- Interviewed the cooks about their current cooking methods and level of satisfaction with their current (traditional) stove
- Installed 32 stove settings and cook tops (in most cases, existing stoves were not disabled)
- Delivered 32 stoves
- Conducted workshops to teach users how to use the stoves
- Re-interviewed the cooks about the Estufa Finca stove approximately three weeks later
- Performed an end of season follow-up visit

The following schedule summarizes this process.
3.2 Estufa Finca Team Roles and Responsibilities

An important aspect of the Estufa Finca Pilot Project was the development of partnerships among private, public, educational and governmental organizations. While all organizations supported the project in various ways, following are the primary roles and responsibilities of team members.

Partners
- **SeaChar.Org** – Stove technology development, project management and implementation
- **Universidad Nacional de Costa Rica (UNA) – Instituto Regional de Estudios en Sustancias (IRET) Program** – Project planning, coordination of participating farms, co-design of registration and survey tools and providing follow-up field monitoring
- **Grupo Mujeres de APORTES** – Stove manufacturing, training and marketing
- **Sol Colibrí Organic Coffee and Alliance of Organic Farmers of Costa Rica** – Project management and education outreach
- **Coffee Farmers of Los Santos, Costa Rica** – Stove placement and testing
Estufa Finca—Santos Pilot Project Results
April 8, 2011

Funders
• Canada Fund for Local Initiatives
• Seattle International Foundation
• Groundwork Opportunities
• Rotary International
• Plant-it 2020
• Individual donors

Lessons Learned. Establish and agree to written project roles and responsibilities early in the process and document them clearly. Secure funding a minimum of one month prior to start of project.

3.3 Population

Approximately 150,000 migrants from Panama and Nicaragua travel to Costa Rica yearly for the approximately three month coffee picking season. Anecdotal information indicates that they each earn approximately $25/day, providing the bulk of their yearly income. The pickers live in homes provided by the farmer for whom they work.

Thirteen coffee farmers volunteered to participate in the study. They provided access to 21 sites where migrant pickers lived.

UNA-IRET has been working with coffee farmers in the Los Santos region of Costa Rica for several years to improve the living conditions on coffee farms by providing migrant workers with health and sanitation education, composting toilets, clean water and other improvements. UNA-IRET and APORTES were responsible for contacting candidate farmers, informing them of the Estufa Finca Pilot Project and its possible benefits. SeaChar.Org, with the assistance of UNA-IRET, recruited and enrolled the migrant families who would receive stoves.

The majority of the population for which we provided stoves was indigenous Ngöbe from Panama.

<table>
<thead>
<tr>
<th>Edad/Age</th>
<th>#</th>
<th>Total</th>
<th>Adultos/Adults</th>
<th>Niños/Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mujeres/Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-14</td>
<td>27</td>
<td>63</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>15-59</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60+</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hombres/Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-14</td>
<td>23</td>
<td>99</td>
<td>76</td>
<td>23</td>
</tr>
<tr>
<td>15-59</td>
<td>76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60+</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>162</td>
<td>112</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Promedio/Average</td>
<td>5.8</td>
<td>3.5</td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>

Age and gender profile of the study population.
Estufa Finca—Santos Pilot Project Results
April 8, 2011

divided living quarters. Household composition varied from multi-generational families, to mixed family groups to groups of all men. For the purpose of this study, we defined a household as a group of people sharing meals prepared on one stove. On average, each household had 5.8 members. Only one study participant was over 60 years old.

<table>
<thead>
<tr>
<th>Quien Cocina?</th>
<th>Who Cooks?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mujeres (Women)</td>
<td>Hombres (Men)</td>
</tr>
<tr>
<td>64.3%</td>
<td>28.6%</td>
</tr>
</tbody>
</table>

*Gender profile of cooks in the study population.*

### 3.4 Migrant Homes

Estufa Finca stoves were installed in 32 homes. Homes varied from farm to farm, from stucco homes in good condition to dilapidated wooden structures. Most had electricity, running water in outdoor sinks and outdoor latrines. Homes were located south of the capital city of San Jose, in three districts of the Los Santos Region: Dota, Leon Cortez and Tarrazu. This region is above an elevation of 1600m. Access to homes for stove installation varied from dirt roads to rough trails through coffee fields.

*Lessons Learned.* Work closer and earlier with partners during the farm selection process.

At this location, the 21 residents shared their homes with livestock.

### 3.5 Existing Stoves

Households had four types of existing stoves: fogón (raised open fire), 3-stone fire, leña (wood stove) or propane gas. Approximately one-third of the existing stoves were located inside the home and two-thirds were located outside.

Two households had wood-burning stoves (leñas) with poorly functioning chimneys. Three households had indoor gas stoves but these houses also had an outdoor wood stove.

*Typical traditional fogón.*
Households must pay for their gas usage and thus typically cook beans and other foods that require lengthy cooking times outdoors with wood.

**Lessons learned.** Conduct stove customer interviews at least one week before stove installation. During the interview, evaluate the site for ventilation and stove location.

### 3.6 Fuel

Coffee wood was the primary fuel reported in the Estufa Finca Customer Satisfaction Survey. Firewood from trimmed coffee branches was used in 71% of the households.

In most of the households, adult men gathered wood. Only one household reported that a woman was tasked with providing firewood. In three households, the farmer provided wood. Two households indicated that children helped adults find wood. The wood ranged from 2 cm to 7 cm in diameter and 20 cm to 200 cm in length.

**Lessons Learned.** Additional work associated with fuel preparation for use in the Estufa Finca stove is one of the most frequently cited reasons for not adopting the stove.

<table>
<thead>
<tr>
<th>Tipo de Combustible/Fuel Type</th>
<th>Hombres/Men</th>
<th>Mujeres/Women</th>
<th>Patrones/Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramas de Café/Coffee Branches</td>
<td>85.7%</td>
<td>3.6%</td>
<td>10.7%</td>
</tr>
<tr>
<td>Ramas de Arbol/Tree Branches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The majority of fuel was collected by men.

### 3.7 Transportation

The Estufa Finca team members accumulated approximately 1200 km driving between the team base in Santa Maria de Dota and the stove installation sites in other areas of the Los Santos Region. From December 3, 2010, through January 3, 2011, most team travel occurred in a passenger vehicle supplied by Sol Colibrí. After this, members used a combination of the Sol Colibrí vehicle, taxis, local buses and hitchhiking.
Approximately 4.75 metric tons of stove setting materials, primarily concrete blocks and cement, were delivered from Santa Maria de Dota to the stove installation areas by trucks arranged by Sol Colibrí. Stoves and stove setting tools were transported with team members in the passenger vehicle.

**Lessons Learned.** Transportation of the stove setting materials is a major cost and scheduling component of stove implementation. Ensure transportation is budgeted for, agreed to, and scheduled in advance. Ensure transportation is appropriate for the task, e.g., is four-wheel drive necessary; is vehicle capacity adequate to transport materials and/or personnel. Logistical decisions, such as whether to “drop ship” materials at the installation site versus storing them at APORTES, must be evaluated in advance. To ensure greater buy-in from the farmers on future projects, SeaChar.Org should consider requiring the farmers to supply the setting materials.

### 3.8 Customer Satisfaction Survey Protocol Development

Survey development started in August 2010, but was not finalized until a few days before interviews began. SeaChar.Org and UNA team members exchanged e-mails and met in person to finalize the content of the interviews. The interview forms are included in Appendices A and B.

**Lessons Learned.** Reach agreement on questionnaire and protocols at least one month prior to beginning interviews. Translate the questions into both English and Spanish. Ensure that all team members have a common understanding of what the questions mean. If possible, use the same interviewer for both pre- and post-assessments.
3.9 Stove Manufacture

Manufacturing the Estufa Finca stove was the responsibility of the Grupo Mujeres de APORTES (Asociacion de Productores Organicos y Turismo Rural Eco-Educativo de Los Santos) women’s group.

Prior to stove production, APORTES, SeaChar.Org and Sol Colibrí improved the workshop facility, purchased additional tools, supplies and materials and participated in two stove manufacturing and training workshops.

APORTES women, with help from SeaChar.Org members, fabricated and assembled 32 stoves. Stove fabrication consisted of cutting rebar, cans, buckets and shroud materials; drilling holes; snipping tin and de-burring and grinding rough metal edges. Stove assembly consisted of fastening stove components with rivets, bolts and screws.

Lessons learned. To increase production and improve stove quality, future stove manufacturing efforts should be performed with proper drill jigs and tooling fixtures, manufacturing procedures should be documented in a stove builders’ manual and a hardware variability / quality control plan should be developed. Prior to delivery to the field, all stoves should be inspected for workmanship and dimensional tolerances, and lighted to ensure proper combustion and to burn off all residual paints or oils left on the stove materials. Future plans should account for maintenance and replacement of tools, spare parts and consumables such as drill bits.

3.10 Stove Setting Installations

Thirty-two stove settings were installed from December 19 through December 31, 2011 by SeaChar.Org team members and local laborers. Occasional assistance was provided by Sol Colibrí and, at a few locations, the farmers.

When possible, SeaChar.Org team members talked with the cooks in each home to come to agreement on the best place to install the Estufa Finca stove. Because a few of the cooks were in the field picking coffee and not available for consultation, some stoves were installed in a location designated by the coffee farmer without
consultation with the users. Twenty-one stoves were installed inside, 11 were installed outside.

In locations where the stove was not sited on a concrete pad, the ground for the stove was first leveled. The two side columns were then constructed of concrete blocks, rebar, gravel and concrete. Next, the stove cook top assembly was installed on top of the columns using rebar and brackets. Note that the stovetop assembly had been fitted and drilled as a matched set in the APORTES shop prior to installation.

In order to ensure the stove setting concrete was properly cured, the stove settings were constructed a minimum of two days before the stoves were delivered.

**Lessons Learned.** Schedule consultations with the cooks a week before the stove installation to ensure they agree to the stove location. The mortar attaching the top blocks on the support columns should be mechanically reinforced to improve durability.

### 3.11 Customer Satisfaction Surveys – Traditional Stoves

On the day that stove settings were installed, team members from SeaChar.Org and/or UNAIRET interviewed the cooks who would be using the Estufa Finca stove and made site observations. The questionnaires are contained in Appendices A and B.

**Lessons Learned.** Try to separate men from women when asking questions to eliminate “coaching” from men. Translators must be available when stove users do not understand Spanish.

![Dr. Bolton interviewing Ngöbe woman about her existing stove.](image)

### 3.12 Stove Installations


**Lessons Learned.** Ensure stoves and stove settings are constructed with consistent dimensions to avoid rework in the field.

### 3.13 Stove Operators’ Workshops

On the day that stoves were delivered, workshops were conducted in Spanish to teach the cooks how to use the new stove. A SeaChar.Org team member conducted 25 of the workshops and the remaining seven workshops were conducted by an APORTES member.
Workshops consisted of a demonstration by a SeaChar.Org trained instructor who loaded a stove with wood and lit it while giving instructions in Spanish. After the initial demonstration, each cook was asked to demonstrate how to light the stove. The workshops took one to two hours depending on how many household cooks were in attendance. Given the extensive experience the cooks already had in lighting fires, most learned very quickly how to properly light and cook on the Estufa Finca stove. The stove loading and lighting technique is very similar but just different enough from lighting a standard wood fire (lighting on top of the wood instead of on the bottom) that the shift in technique was easily understood.

See Appendix D for stove loading and lighting instructions.

**Lessons Learned.** Stove users may be illiterate so any printed operator’s instructions must be primarily graphic. Graphic instruction sheets, necessary to reinforce the stove demonstrations, should be provided on the day of the initial demonstration and posted near the stove. Demonstrations must include cooking food and how to save the biochar. Follow-up training and observation to ensure the stoves are being properly used should be performed periodically for a few weeks after initial introduction of the stove. Instructions should include cooking methods for common foods.

### 3.14 Customer Estufa Finca Stove Use

Each stove recipient used the Estufa Finca stove for two to three weeks prior to the follow-up customer satisfaction interviews. Due to scheduling constraints, there was no contact with the stove users between the time they received their stove and the time they participated in the stove Customer Satisfaction Survey workshop.

**Lessons Learned.** Ensure all stove users are available to participate in the stove lighting workshops. Make time in the schedule and provide resources in the project budget to allow trainers to follow-up with cooks to ensure they are using the stoves properly.

### 3.15 Customer Satisfaction Surveys – Estufa Finca Stoves

UNA-IRET team members interviewed 28 of the 32 participants with assistance provided by SeaChar.Org from January 7-16, 2011. The cooks had between two and three weeks to use the Estufa Finca stove. The same questions asked during the initial interview about the traditional stove were asked during the follow-up interview about the Estufa Finca stove. Twenty-six of 28 cooks were available for both interviews; SeaChar.Org was able to interview relatives of the two cooks who were not available for the follow-up interviews.
During the follow-up interviews, UNA-IRET discovered that three of the stoves were damaged or unused. They also found that one of the stoves was unused because another family provided cooking services for the man for whom it was installed.

Lessons Learned. Be involved in farmer selection process to ensure farmer and study participants will be likely to complete the study. Design of the survey questions is extremely important. Avoid leading questions and having participants answer in a way that they feel will make you happy.

3.16 Customer Satisfaction Survey Results

Following is a summary of the key findings of the CSS. As noted in Section 3.15, four of the 32 participants did not complete the study; therefore, the following data reflect results from the 28 households that participated in the study from beginning to end.

Health Impact. The use of the Estufa Finca stove resulted in a 73% reduction in the number of cooks who reported being bothered by smoke. With the traditional stove, 68% reported being bothered by smoke, but only 18% reported being bothered by smoke from the Estufa Finca stove.
Cooking Time Reduction. The majority of the study participants cooked twice a day, morning and evening. With their traditional stoves, they reported cooking an average of 2.64 hours per day; with the Estufa Finca stove they reported an average of 1.61 hours a day. This reflects a 39% reduction in cooking time. These data are consistent with the 31% to 47% reduction in cooking time recorded during the Controlled Cooking Test described in Section 4.5.

Ease of Use. When asked if it was easy to cook the foods the participants normally prepare, there was no difference between their traditional stove and the Estufa Finca stove; 89% reported that it was easy to cook the foods they prepare on the Estufa Finca stove.

Fifty-four percent of participants reported no difficulties in lighting the Estufa Finca stove, compared to 32% using their traditional stove: a 40% improvement in ease of stove lighting.

When asked if it was easy to control the stove temperature, participants reported a slight improvement with the Estufa Finca stove over their traditional stoves. During the survey, 75% of the participants reported that it was easy to control the temperature on the Estufa Finca stove.

Thirty-two percent of the traditional stoves were located on or near the ground, requiring cooks to squat or bend over to use them. The Estufa Finca cook top was located at 80 cm above the floor, allowing cooks to stand to use them.

Safety. When participants were asked if they felt safe using their stove, they reported no difference between the traditional stove and the Estufa Finca stove. In both cases, 75% of the participants felt safe using their stoves. To improve the Estufa Finca stove’s safety, SeaChar.Org developed and installed a removable protective shield made from corrugated metal to act as a barrier between the Estufa Finca stove and the stove user. This feature will be standard on future stove installations and should increase the stove’s safety.

A feature of the Estufa Finca stove not available with many of the traditional stoves is its ability to stabilize cooking pots. Observations by the interviewers indicate that only 50% percent of the traditional stoves had stable plot surfaces, compared to 100% of the Estufa Finca stoves.
Estufa Finca—Santos Pilot Project Results
April 8, 2011

**Stove Satisfaction.** There was a 55% increase in satisfaction of the Estufa Finca stove over respondents’ traditional stove. During the survey, 100% reported that they liked the Estufa Finca stove, compared to a 64% favorable response to their traditional stove. Also notable was that several pickers wanted to take their stoves home with them when they returned to Panama and a few asked if they could have the plans to build their own.

![Bar chart showing stove satisfaction](image)

**Lessons Learned.** Ensure the questionnaire data collection sheets are formatted to be conducive to clear recording of data and subsequent metric generation.

### 3.17 Estufa Finca Stove and Setting Costs

Material and labor data recorded during the project show that the costs of the Estufa Finca stove and the setting are approximately $91 per stove and setting. The following table summarizes these costs.

<table>
<thead>
<tr>
<th>Component</th>
<th>Materials</th>
<th>Labor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stove and Cooktop</td>
<td>$24.78</td>
<td>$14.00</td>
<td>$38.78</td>
</tr>
<tr>
<td>Setting</td>
<td>$30.03</td>
<td>$22.00</td>
<td>$52.03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$54.81</strong></td>
<td><strong>$36.00</strong></td>
<td><strong>$90.81</strong></td>
</tr>
</tbody>
</table>

*Estufa Finca stove and setting cost summary.*
4.0 Controlled Cooking Test

The purpose of the Controlled Cooking Test (CCT) was to analyze the performance of the Estufa Finca stove compared to the traditional cooking stoves used by the migrant coffee pickers. SeaChar.Org conducted the test using a modified version of the standard protocol developed by Rob Bailis for the Household Energy and Health Programme, Shell Foundation.

The test was designed to accomplish the following:
- Compare the time needed to cook a common food with the existing traditional stove and the Estufa Finca stove
- Compare the fuel needed to cook that food

4.1 Methodology

Three separate but related families who previously participated in the Customer Satisfaction Survey were chosen to take part in the test. These three households were selected due to their:
- Proximity to each other
- Proximity to the SeaChar.Org home base in Santa Maria de Dota
- Willingness to cooperate and participate
- Use of three types of existing stoves to compare to the Estufa Finca stove

The families resided in adjoining areas in a multi-room, corrugated sheet metal and wood structure provided by farmer Gerbert Chacón Monge. It was located approximately 5 km from Santa Maria de Dota.

Food was weighed and provided to the cooks for the tests. The cooks at these households cooked meals on three nights using their traditional stoves. The same meals were cooked again using the same pots on three nights with their Estufa Finca stove. The amount of fuel used and time to cook each meal was recorded for the traditional stove and the Estufa Finca stove. Resulting biochar was also measured. The data collection sheet is included in Appendix C.

Before starting the test, SeaChar.Org met with Reina, Lilia and Emilia, the three volunteer cooks and their families, to explain the purpose of the test. All participants understood the goals and agreed to participate. During the cooking portion of the test, SeaChar.Org team members did not “coach” or correct the cooks.

4.2 Fuel

Coffee wood was the most common fuel source used by the households and was therefore used for the CCT. The wood was supplied by the coffee farmer and was stored under a roof to remain dry. The wood was relatively dry and when loaded in the stove it ranged from 2 cm to 7 cm in diameter and 20 cm to 40 cm in length.
Stove fires were initiated using melted plastic or floor wax as accelerants, typical fire-starters in this population.

4.3 Food

Rice, beans and chicken were the most common three foods cooked, according to results from the CSS; therefore, these foods were selected for the CCT. SeaChar.Org and APORTES supplied live chickens on the first night. Bags of beans were supplied for the second night and rice was supplied for the third night’s test. This sequence was repeated the following week. Because rice, beans and chicken are usually cooked at night, the dinner meal was chosen for the CCT.

4.4 Controlled Cooking Test

Typical Controlled Cooking Test plan.
4.4.1 Controlled Cooking Test – Traditional Stove

Lilia cooked on a woodstove (leña) located indoors. Although the stove had a chimney, it did not function. Emilia cooked on a firebox (fogón) located indoors. It consisted of a plate of steel with two holes cut in it. This cook top was perched atop several stones placed on a raised, insulated bench. Reina cooked on a fogón located outdoors. It consisted of a 3-stone fire built on top of a 55 gallon drum.

SeaChar.Org was unable to conduct on-site monitoring of emissions during this CCT series; however, the observed level of smoke from the traditional fires was extremely high.

At times it was difficult for the SeaChar.Org team to remain indoors while surrounded by three simultaneous open fires.

About half an hour before meal preparation began, two SeaChar.Org team members delivered food supplies and set up measuring equipment.

Each cook’s husband estimated, prepared and bagged the amount of wood that would be needed for the night’s dish. SeaChar.Org ensured that no wood other than this was used during the tests. SeaChar.Org members, assisted by husbands, measured and weighed wood, pots, water, food, salt and biochar using measuring cups and a calibrated hanging scale. The hanging scale was new and calibrated daily using a liter of water.

Throughout the tests, family members were helpful and patient with the additional time required to weigh the materials, measure foods and calculate cooking times.

Starting approximately 5 - 10 minutes apart, the three cooks each prepared the foods. When the food was completely cooked, the time was recorded and both the finished food and remaining biochar and unburned wood were weighed.

4.4.2 Controlled Cooking Test – Estufa Finca Stove

One week later, the same two SeaChar.Org members returned and observed and measured the cooking of the same meals on the Estufa Finca stove. Because the Estufa Finca stoves had been
installed on December 27, 2010, three weeks prior to beginning the CCT, the cooks were comfortable using their new stoves.

Starting approximately 5 - 10 minutes apart, the three cooks each prepared the foods.

<table>
<thead>
<tr>
<th>Test Date</th>
<th>Test Time</th>
<th>Food Cooked</th>
<th>Food Amount (kg)</th>
<th>Biochar Produced (kg)</th>
<th>Ambient Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 17</td>
<td>6:15 - 6:40 PM</td>
<td>Rice</td>
<td>0.4 - 0.9</td>
<td>0.5 - 1.75</td>
<td>21</td>
</tr>
<tr>
<td>Jan 18</td>
<td>6:10 - 6:50 PM</td>
<td>Chicken</td>
<td>1.75 - 2.0</td>
<td>0.5 - 1.75</td>
<td>24</td>
</tr>
<tr>
<td>Jan 19</td>
<td>6:20 - 7:35 PM</td>
<td>Beans</td>
<td>0.45</td>
<td>0.5 - 1.0</td>
<td>24</td>
</tr>
</tbody>
</table>

*Controlled Cooking Test data, with Estufa Finca stove.*

*Lila cooking on her Estufa Finca stove.*

### 4.5 Controlled Cooking Test Results

Following is a summary of the key findings of the CCT.

As stated in Section 4.0, the CCT was designed to accomplish the following:
- Compare the time needed to cook a common food with the Estufa Finca stove and the existing traditional stove
- Compare the fuel needed to cook that food

In addition, SeaChar.Org provides cooks’ observations obtained during the CCT.

Because the Estufa Finca stove produces biochar, data on the production of biochar was also recorded.

#### 4.5.1 CCT Results - Time

The average cooking time was reduced in all three tests: short cooking duration foods (rice) – 31%, medium cooking duration foods (chicken) – 47% and long cooking duration meals (beans) – 39%.

These data are consistent with the 41% reduction in cooking time reported in the Customer Satisfaction Survey in Section 3.16.
4.5.2 CCT Results – Fuel Usage

Note that the data do not account for moisture content of the wood, so actual results are better than shown because we are overestimating the weight of the wood. Due to recording errors in two of the three rice CCTs, we cannot include results for rice in our fuel usage graph; however, average dry fuel usage was down 32% for beans and 72% for chicken.

The Estufa Finca stove took 40% fewer grams of fuel per kilogram for beans and 71% fewer for chicken.

4.5.3 SeaChar.Org Observations During CCT

The CCT conducted for the Santos Pilot Project did not include an interview or survey component. All information about the “cook’s impression” is from observations by SeaChar.Org president Art Donnelly:

All three of the cooks were extremely quick at lighting the Estufa Finca stove. They all had success at cooking a wide range of foods. All of them employed a combination of air and fuel regulation to achieve better turn down ratios and cooking times. They did not treat the Estufa Finca stove as a batch loaded stove; they added time and increased heat by adding fuel. If only a small amount of fuel was added at a time, the stove continued gasifying cleanly. However, even though the Estufa Finca stove was fast, easy to light and did not smoke, the traditional stoves were more convenient. They handled multiple pots better and could keep foods warm all day. Additionally, most cooks perceived the new stove as “dangerous” because they had small children. All stove settings need to include child safety guards. Lastly, any additional effort required for fuel preparation is a perceived as an inconvenience.

4.5.4 CCT Results – Biochar Creation

Because this study involved a migrant population, biochar was not the focus of this pilot project. However, the amount of biochar produced was measured as part of the cooking test. As a result of the nine meals cooked, 7.1 kg of biochar, or an average of 789 gr (1.75 lb) per
meal, was created. The biochar from these CCTs was collected by the coffee farmer and mixed in his family garden plot.

**Lessons Learned.** A CCT should consist of more trials using the same food, which would provide a larger and thus more reliable data set. Also, because data entry errors on two tests in our rice cooking series invalidated the results for rice, we must develop a redundant data recording system for this test. We also learned that:

- The baseline traditional stoves must all be similar (Each traditional stove in this CCT group was unique: fogón, leña, 3-stone fire)
- Battery powered digital scales would increase accuracy
- There must be a minimum of two people per team for all tests
- Pre-filling, weighing and labeling sacks with wood for the cooks is the best strategy for monitoring fuel usage
- The team must supply the food for the tests and it must be the same food the cooks are used to cooking
- All aspects of testing should be documented with photos
5.0 End of Season Follow-Up Survey

After completion of the second Customer Satisfaction Survey and the departure of the SeaChar.Org team members in January 2011, the UNA-IRET team continued to monitor the use of the Estufa Finca stoves by the migrant coffee pickers. Recent reports from both the UNA-IRET team and one of our coffee farmer partners have given us a window into usage patterns through the end of the recently concluded coffee harvest season. The following is a summary these observations:

- Five of the 28 households had discontinued use of the Estufa Finca stoves due lack of availability of smaller sized coffee wood trimmings and the additional time required to trim larger wood to allow it to be used in the Estufa Finca stove.
- In several cases households were still using the stoves; however, they were using them improperly. They were allowing larger pieces of firewood to simply burn or smolder with no attempt to regulate the airflow. Evidence of this was soot on the walls above the stoves and the accumulation of ash in the combustion chambers.
- In some cases people were not using the stoves in the morning because we had emphasized lighting them outside and people did not want to go out in the cold and wind to do so.
- It was observed in several households that (unspecified) parts were missing.
- In at least one household, the family who had been trained in stove use had left. The new family had no knowledge of how to use the Estufa Finca stove. Additionally, the farmers at this location did not know how to use the stove.
- In households that had successfully adopted the stoves, the stoves were in good condition. However these stoves were being used to supplement the traditional cook-stove and had not replaced the existing stove.
- Some cooks reported feeling unsafe using the stoves because the surface became very hot.
6.0  Aprovecho Laboratory Test Summary

While not part of our Estufa Finca Pilot Project, SeaChar.Org believes that the Aprovecho Estufa Finca stove laboratory test results are relevant to this report.

The Estufa Finca stove was laboratory tested at the Aprovecho Research Center in Cottage Grove, Oregon, US on October 25-29, 2010. Results from the study were released in the report, *Testing Results of Estufa Finca*, by Mike Hatfield, Ryan Thompson, Sam Bentson, on November 24, 2010. Study highlights are summarized below.

6.1  Laboratory Test Methodology

The stove was tested under the Aprovecho portable emissions collection hood, in which real-time emissions of CO₂, CO and PM_{TSP} were recorded.

The Estufa Finca stove was tested using the Water Boiling Test developed by the University of California-Berkeley. The first phase of the test consisted of a high-power analysis in which 5 liters of water were brought to a boil in an uncovered 7 liter pot. In the low power phase of the test, 5 liters of water were simmered at about 3°C below full boiling temperature for 45 minutes.

6.2  Laboratory Test Results

**Fuel Use.** The Estufa Finca stove is a very powerful stove. The average power output during the high power phase of the WBT was recorded as high as 14,000 W, which is equivalent to the power output of a 60 liter institutional stove. A regular household rocket stove is more on the order of 4,000 W. The power output of the Estufa Finca stove is a little excessive for the 5 liter WBT. As a result, the stove had relatively high fuel consumption for this particular cooking task, and it did not meet the benchmark for fuel use.

**Emissions.** The emissions of the Estufa Finca stove are extremely low. Aprovecho has set clean cook stove benchmarks for emissions at 20 grams of CO and 1500 mg of PM to complete the simulated cooking task of the WBT. While it produced an average of 26 grams of CO in our tests, we found that the Estufa Finca stove is capable of meeting the CO benchmark (having produced 14.1 and 17.2 g CO in two of the tests). The stove easily exceeded the Particulate Matter benchmark, producing an average of 573 mg of PM, or almost two-thirds less PM than the PM benchmark. It is remarkable that such a high power stove is capable of outperforming the benchmark for PM emissions in a test intended for lower power stoves.

**Specific Emissions per Fuel Use.** The benchmark standards do not always give the best indication of what is going to happen in the field once the stove is used for a particular cooking process. It is useful to evaluate the emissions of the Estufa Finca stove by considering the specific emissions per fuel use. These data can be combined with an evaluation of fuel use in
Estufa Finca—Santos Pilot Project Results
April 8, 2011

the field to project potential emissions reductions of the stove compared to a 3-stone fire. Note that the 3-stone fire used as a baseline may or may not equate to a standard 3-stone fire used by the Costa Rican population.

The PEMS hood gives us the following results for specific emissions per fuel use:

It should be noted that the scatter around the data points of the tests was large. The coefficients of variation are 49% and 44% for CO and PM, respectively. To gain a reliable coefficient of variation, more tests should be performed.

With results for emissions per consumption of fuel wood, we can evaluate the possible emissions of this stove versus an open fire. If, in the field, the Estufa Finca stove uses the same amount of fuel as the 3-stone fire, we can project an 83% reduction in CO emissions and a 91% reduction PM emissions. Because the Estufa Finca stove uses less fuel than the 3-stone fire in the field, reductions in emissions will be even greater.
7.0 Conclusion

In general the Estufa Finca stove was well received by the migrant coffee pickers in whose homes they were installed. Although this was a very new technology, people were willing to try it. Given the minimal training and follow-up, a high percentage of the cooks successfully and regularly incorporated the stoves into their kitchens. The need for a cooking technology, such as the Estufa Finca stove, that improves indoor air quality for this population is obvious and well documented. Logistically, however, this population is difficult to serve effectively. These key lessons were learned during the pilot project:

- Farmer training is critical to the success of the program. This must take place well in advance of the beginning of the harvest season.
- Farmers must have a stake in the ongoing success of the program. Establishing value for the biochar that the stoves create is one idea. At least two of the farmers in the study are currently purchasing biochar.
- Training in use of small diameter, short fuel, which is different from most traditional fuels, is important. Consistent availability of appropriate fuel is critical.
- On-going operator training is essential; it must include cooking demonstrations as well as demonstrations on how to save the biochar.
- Graphic operator instruction guides must be posted near the stoves to supplement trainings.
- Cooks use more than one burner at a time (even if two side-by-side traditional 3-stone fires on the ground). The improved stove installation must be configured to allow cooking of more than one dish at a time or the Estufa Finca stove will not replace the traditional stove.
- Many of the cooks instinctively and without prompting used control of the air and fuel to control cooking heat and time. We routinely saw cooks add wood as they cooked without disrupting gasification. This was a major advance in our understanding of how these stoves work in real world conditions.
- All of the techniques used to prolong cooking time resulted in the production of less biochar.

The pilot project results should be understood as only indicative of the potential performance of the Estufa Finca technology in other physical or cultural settings. The data sets and time frames used to derive the results presented in this report are extremely limited. They also consist of a mix of objective and subjective data along with independently verified test data. However, these results indicate that this technology is worth continuing to develop and has the potential to support the Estufa Finca stove program in achieving its goals to:

- Improve air quality to prevent respiratory illness
- Reduce deforestation and resulting soil erosion
- Create biochar for carbon sequestration and soil improvement
- Reduce the time required to collect wood
- Support rural women’s groups to build stoves and develop sustainable businesses
## Appendix A  Customer Satisfaction Survey Data Sheet

<table>
<thead>
<tr>
<th>PREGUNTAS</th>
<th>Primer mes</th>
<th>Segunda mes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm owner</td>
<td>Propietario de finca</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Código</td>
<td></td>
</tr>
<tr>
<td>Date of questionnaire</td>
<td>Fecha aplicación cuestionario</td>
<td></td>
</tr>
<tr>
<td>Name of interviewer</td>
<td>Nombre del entrevistador</td>
<td></td>
</tr>
<tr>
<td>Name of interviewer</td>
<td>Nombre del entrevistador</td>
<td></td>
</tr>
<tr>
<td>Location - Canton</td>
<td>Localización del cienm (Cantón)</td>
<td></td>
</tr>
<tr>
<td>Location - District</td>
<td>Localización del cienm (Distrito)</td>
<td></td>
</tr>
<tr>
<td>GPS coordinates</td>
<td>Coordenadas GPS</td>
<td></td>
</tr>
<tr>
<td>Location of stove</td>
<td>Ubicación de la cocina con respecto al albergue</td>
<td></td>
</tr>
<tr>
<td>Inside/Outside</td>
<td>Dentro</td>
<td></td>
</tr>
<tr>
<td>Date of interview workshop</td>
<td>Fecha de instrucción en user</td>
<td></td>
</tr>
<tr>
<td>Number of cooks</td>
<td>Número de usos de la cocina</td>
<td></td>
</tr>
<tr>
<td>System maintenance resp.</td>
<td>Responsable del mantenimiento del sistema</td>
<td></td>
</tr>
<tr>
<td>Who cooks (note sex)</td>
<td>¿Quién cocina? (anote sexo de entrevistado)</td>
<td></td>
</tr>
<tr>
<td>Age of interviewee</td>
<td>Edad de entrevistado</td>
<td></td>
</tr>
<tr>
<td>How many do you cook for?</td>
<td>¿Cuántas personas cocina? (Una familia o grupo de cuántas personas)</td>
<td></td>
</tr>
<tr>
<td>Women - Age</td>
<td>Edad - Mujeres</td>
<td>0-14, 15-59, 60+</td>
</tr>
<tr>
<td>Men - Age</td>
<td>Edad - Hombres</td>
<td>0-14, 15-59, 60+</td>
</tr>
<tr>
<td>Number of slots available for cooking (see note)</td>
<td>Número de placas disponibles para cocinar (ver nota)</td>
<td></td>
</tr>
<tr>
<td>If you use more than one, when do you use the others?</td>
<td>Si muestran varias, cuándo usan una y otra</td>
<td></td>
</tr>
<tr>
<td>Campfire/Stove - Sex/Age</td>
<td>Leña/fuego</td>
<td>Sexo, Edad</td>
</tr>
<tr>
<td>Gas - Sex/Age</td>
<td>Gas</td>
<td>Sexo, Edad</td>
</tr>
<tr>
<td>What food do you cook daily?</td>
<td>¿Qué tipo de alimentos preparan a diario</td>
<td></td>
</tr>
<tr>
<td>How many times a day do you cook?</td>
<td>¿Cuántas veces al día cocina?</td>
<td></td>
</tr>
<tr>
<td>In hours, how much total time is spent cooking?</td>
<td>¿Cuánto tiempo en total dedica a cocinar? (por la mañana, tarde, y noche) en horas</td>
<td></td>
</tr>
<tr>
<td>Do you have sufficient wood/gas?</td>
<td>0. Cuentan con suficiente madera (o gas)</td>
<td></td>
</tr>
<tr>
<td>Is it difficult to light?</td>
<td>1. Prepara dificultad para encender</td>
<td></td>
</tr>
<tr>
<td>Is it easy to control the temperature</td>
<td>2. El fácil controlar la temperatura</td>
<td></td>
</tr>
<tr>
<td>Does the smoke bother you?</td>
<td>3. La molesta el humo cuando cocina</td>
<td></td>
</tr>
<tr>
<td>Is it easy to cook the foods you prepare?</td>
<td>4. Las comidas que suelen preparar, las cocinan fácilmente</td>
<td></td>
</tr>
<tr>
<td>Do you usually put lids on pots when you're cooking?</td>
<td>Normalmente utilizas las tapas cuando cocina</td>
<td></td>
</tr>
<tr>
<td>Do you feel safe using this stove?</td>
<td>5. Te siente segura utilizando esta cocina</td>
<td></td>
</tr>
<tr>
<td>Do you like the stove you're using?</td>
<td>6. Te gusta la cocina que utiliza</td>
<td></td>
</tr>
<tr>
<td>When it's cold, do you warm yourself with your stove?</td>
<td>7. Cuando hace frío, el fuego de la cocina serve para calentar</td>
<td></td>
</tr>
<tr>
<td>Have you had an accident with the stove?</td>
<td>8. Ha tenido algún accidente con esta cocina</td>
<td></td>
</tr>
<tr>
<td>Do you save the charcoal?</td>
<td>9. Entrega el carbón producto de la cocina (si usa leña)</td>
<td></td>
</tr>
<tr>
<td>What do you do with the charcoal?</td>
<td>10. Utiliza el carbón para (si usa leña)</td>
<td>Residuos, Compost, Otros uso</td>
</tr>
<tr>
<td>Put on ground b burn (other uses)</td>
<td>11. Otros uso</td>
<td></td>
</tr>
</tbody>
</table>

Si o No  | Comentarios  | Si o no
## Appendix B. Registration Data Sheet

<table>
<thead>
<tr>
<th>English</th>
<th>Español</th>
<th>Primer Entrevista</th>
<th>Segundo Entrevista</th>
<th>Cantidad/Quantity</th>
<th>Comentarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood type and wood storage location</td>
<td>Madera expuesta (astillas, regada por el suelo)</td>
<td>Yes or No</td>
<td>Comentarios</td>
<td>Yes or No</td>
<td>Comentarios</td>
</tr>
<tr>
<td>Is much ash observed in the stove</td>
<td>Se visualiza mucha ceniza dentro de la cocina</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are the pots black</td>
<td>Ollas con hollín/tiznadas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stove on the ground</td>
<td>Cocina en suelo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the stove damaged (No air control door, holes in the top...)</td>
<td>Veo daños a la cocina(falta puero de control el aire, huecos en la tapa...)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other damage</td>
<td>Presenta algún otra daño</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there something to stabilize the pots</td>
<td>Premitea estabilizada de las ollas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilation of smoke: chimney connected to the stove</td>
<td>Canalización de humo: chimenea-conectado a la cocina</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the cooking space prevent flames from coming out the front</td>
<td>La cámara esta protegida para evitar quemaduras</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is another type of stove used</td>
<td>Se utilizara otro tipo de cocina</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the charcoal stored</td>
<td>El carbón está siendo almacenado</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are walls and rooms sooty</td>
<td>Paredes y techos añahumados</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pans/utensils</td>
<td>Ollas/Utensilios</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>Pequeños (&lt;20 cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Medianos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>Grandes (&gt;30 cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stove height</td>
<td>Altura aproximada cocina cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas stoves</td>
<td>Concinas de gas</td>
<td>Bueno o malo</td>
<td>Observaciones</td>
<td>Bueno o malo</td>
<td>Observaciones</td>
</tr>
<tr>
<td>What is condition of valves and hoses</td>
<td>Estado de válvula y mangueras</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is it in a safe place</td>
<td>Ubicación, lugar seguro</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are burners and pots stable</td>
<td>Rejillas y estabilidad de las ollas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C. Controlled Cooking Test Data Sheet

### Controlled Cook Test Data Sheet Old Stov Traditional Stove

<table>
<thead>
<tr>
<th>Data (all weights in grams)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of wood at start</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wood size in cm: average length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of charcoal container</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt. of food to be cooked</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Wt. of empty pot (no lid)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of start of cooking test</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations:
- include note on wind conditions and temperature

### Controlled Cook Test Data Sheet New Stove - Estufa Finca Stove

<table>
<thead>
<tr>
<th>Data (all weights in grams)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of wood at start</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wood size in cm: average length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of charcoal container</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt. of food to be cooked</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Wt. of empty pot (no lid)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of start of cooking test</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations:
- include note on wind conditions and temperature

Indoors/Outdoors
- Temp (C)
- Top used?
Appendix D. Stove Workshop Instructions

Buenos días, como están todos
Hoy, queremos compartir con ustedes como usar la cacerola nueva. El fuego que produce es fuerte y no hay humo.

Hay reglas simples para usar la cocina:

* Inicie con una cocina limpia sin ceniza ni carbon.
* Encienda afuera de la casa sobre una base que permita la circulación del aire desde abajo hacia arriba.
* No cubra los huecos de la base de la cocina con lena. Si los huecos están cubiertos, no puede pasar el aire que necesita.
* Para encenderla utilice ramas secas, los pedazos más pequeños de madera se pueden utilizar para iniciar el fuego colocándolos sobre las ramas más grandes.
  - El tiempo para cocinar se controla según la cantidad de lena, es decir, si ponen poca lena el fuego durara menos tiempo.
  - Espere que el fuego tenga fuerza antes de poner la tapa, posteriormente puede poner la cacerola en su casa entre las columnas de bloques.
* Si necesita mas tiempo para cocinar puede alimentar la cacerola con un pedazo de lena de vez en cuando. Cuando quiera más flama levantela y cuando quiera menos bajela, con esto puede controlar el humo y tiempo de cocción, además de variar temperatura.
* Para guardar el carbon es importante tomar en cuenta que una vez que disminuya la flama apague el fuego de la siguiente manera: Vierta el contenido de la cacerola en el suelo fuera de la casa, enfrielo con agua para evitar quemaduras y obtener el carbon, el cual puede ser aprovechado para mejorar los suelos y para evitar malos olores que provengan de la latrina.
* Si no quiere guardar el carbon, puede continuar cocinando, es importante que levante la cacerola para permitir el ingreso de mas aire, al terminar de cocinar se debe sacar la ceniza y limpiar para que la cacerola pueda ser utilizada nuevamente.

Si tienen algunos problemas o preguntas sobre como usarla digale a su patron. El puede llamarnos y alguien puede ir a ayudarlos.

Sabemos que encender esta cacerola es u poco diferente, pero ustedes tienen tanta experiencia con fuego que probablemente van a aprender como usarlas muy rápido, ustedes son parte de un estudio.
La única cosa que queremos es que por favor la use por una semana para acostumbrarse en lo que es como funciona esta cacerola. Entonces si no le gusta, esta bien.

Vamos a regresar en 3 semanas mas o menos para hacer preguntas otra vez. "Queremos la verdad".Les gusta ese pero este no! Diganos la por favor la verdad o si tiene ideas de como mejorarlas diganos también.

Gracias.
Appendix E. Participating Farmers

Milciades Alvarado
Vernon Romero Madrigal
Gerbert Chacón Monge
Minor Montero
Christian Mora
Juan Mora
Dagoberto Mora Mora
Miguel Navarro
Gerardo Picado
Jorge Prado
Miguel Prado
Rafael Prado
Aníbal Romero
Arturo Segura
David Ribera Ureña
Elvira Vega