Welcome Everyone!

Summer Stove Camp 2008

Aprovecho Research Center

Introductions…

- Who are you?
- Where are you from?
- What are you most interested in learning and sharing this week?

Defining Our Task

Meeting the needs of Displaced Persons

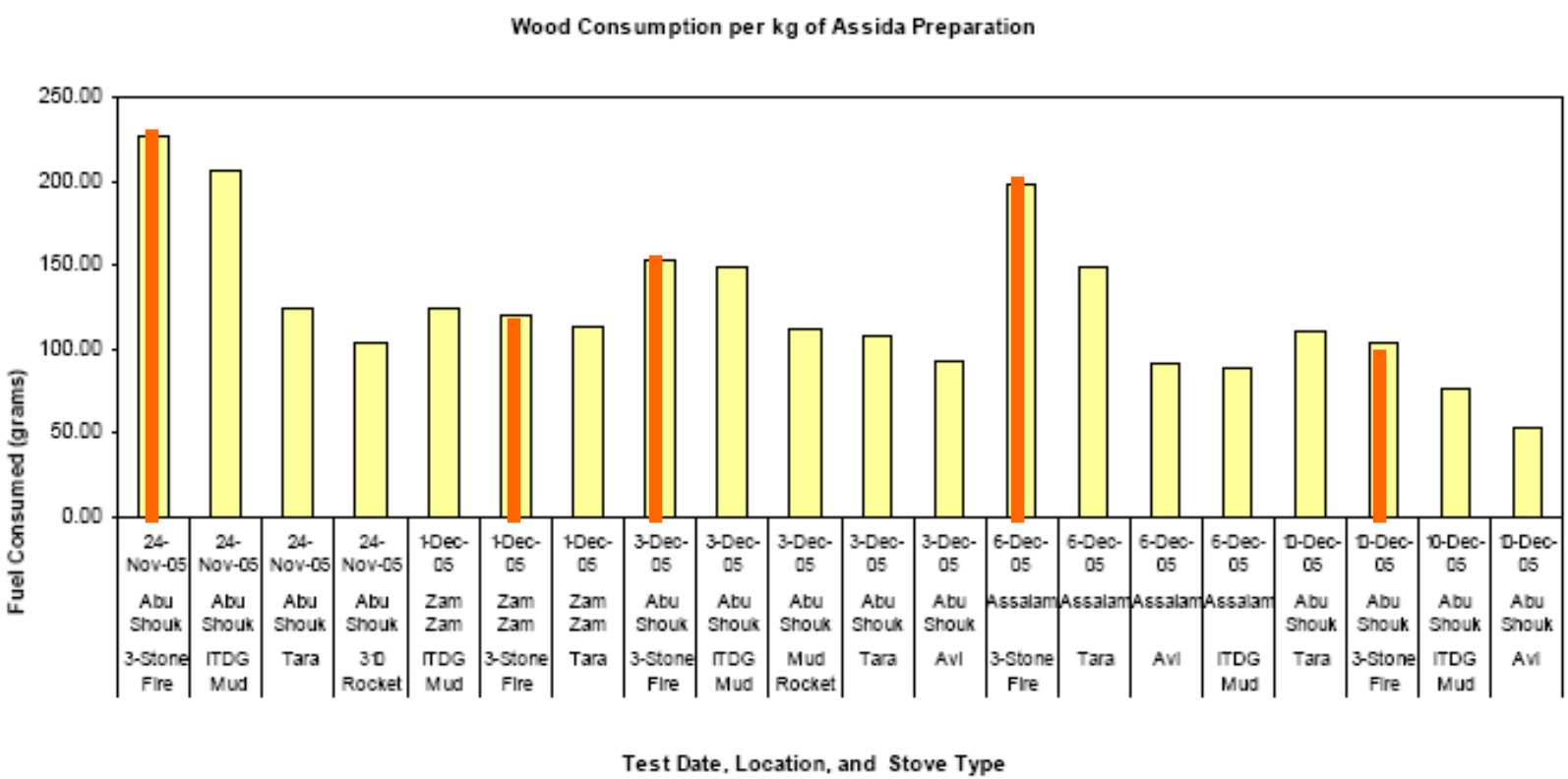
- Mingling Posho video:

  By Ken Goyer on YouTube

Defining Our Task

- Criteria for IDP stoves as listed by Pamela Baldinger of USAID:
  - Why people like stoves (in no particular order):
    - Fuel savings (obviously)
    - Time savings (i.e., cooks faster)
    - Less smoke
    - Less risk of fire and burns (very important--we've tested 2 metal stoves and they've both been problematic on this score)
    - Ease of use (in Darfur, this includes stability during stirring, which is a problem for many stoves)
    - Ease of mobility
    - Ease of maintenance/durability (the less maintenance required, the better)
    - Size/appearance (IDP/refugee homes are small and tightly packed)
    - Cost
    - Taste (there were some complaints about different tast of food when moving from open fire to metal in particular)
    - Ability to accommodate different pot sizes
    - Weather/How long does it take mud to dry
    - How easy/difficult is it to light/control a fire in windy conditions (particularly important in Darfur)

Defining Our Task



Graph Taken from "**COMPETING FOR DEVELOPMENT: FUEL EFFICIENT STOVES FOR DARFUR**"

Thoughts from the Field

- What additional impressions do we have?

CCT

- Q: How can we be sure our stove design meets the needs of the people?
- A: Test!

Standard Testing Protocol

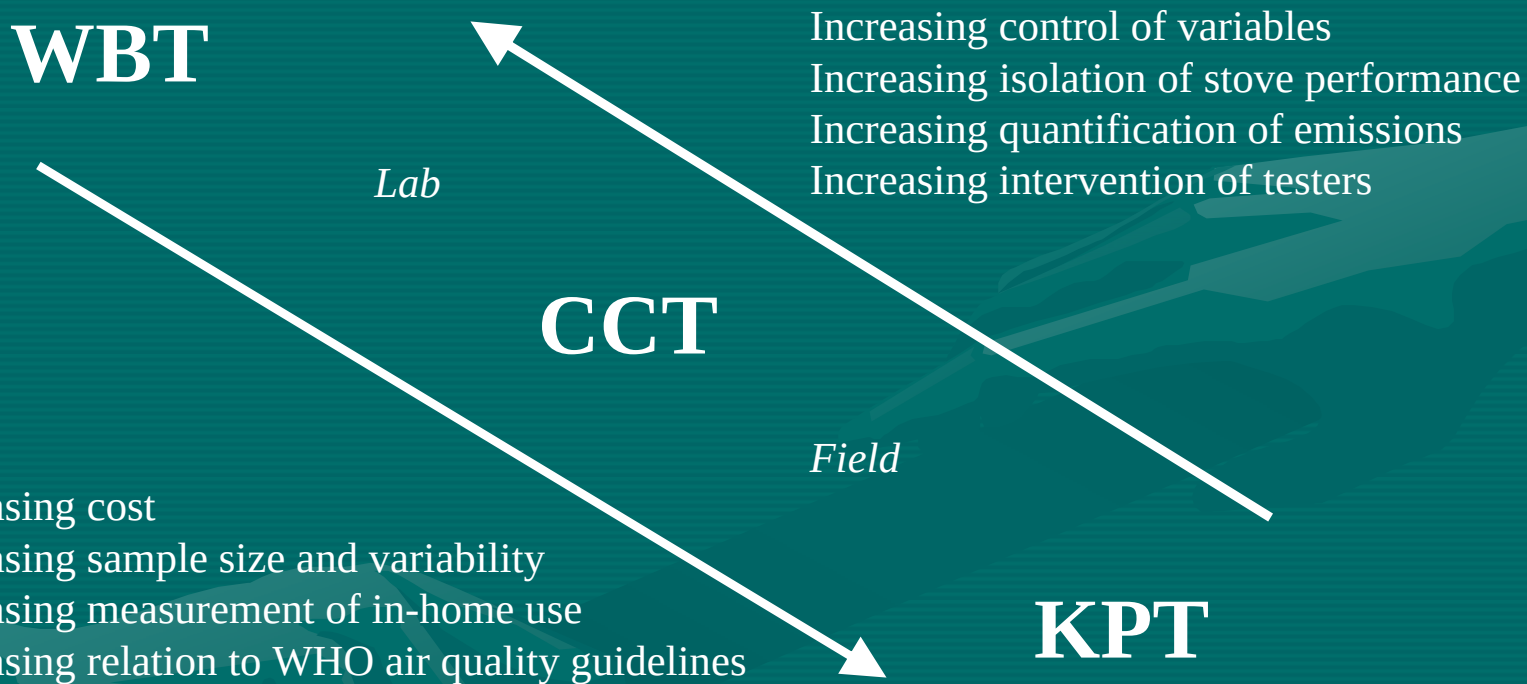
1. ***Laboratory*** **Water Boiling Test (WBT)** –Most variables are controlled to isolate and identify effects of design changes on stove performance. Not meant to predict field performance, but to compare stove designs when performing the same task.

2. ***In-Field*** **Controlled Cooking Test (CCT)** –Comparison of the stove to the traditional cooking method as used by local cooks preparing common meals.

3. ***In-Home*** **IAP and Kitchen Performance Test (KPT)** – The stoves as they are used by many cooks in their homes under normal conditions for days at a time.

All protocol and data analysis spreadsheets can be found on the Aprovecho website: www.aprovecho.org

Stove Testing Continuum



Testing Emissions

1. WBT for stove design in the lab:
   - Collecting all emissions released in order to determine the most fuel efficient and cleanest-burning stove design
2. CCT for assessing performance & acceptability with real cooks in the intended community:
   - Collecting emissions or measuring IAP levels while a local cook prepares the same meal in the same room, on both the traditional and improved stoves
3. KPT to evaluate the fuel savings on a long-term basis:
   - Measuring IAP levels in the room OR monitoring personal exposure of the cook over an extended period of time during normal lifestyle.

CCT Purpose

- THE CCT SHOWS WHAT HAPPENS WHEN A "REAL" COOK USES A STOVE TO COOK LOCAL MEALS
- Stove models will *always* be tested as compared to their common traditional counterparts –

WHAT WE LEARN IS THE % IMPROVEMENT FROM TRADITIONAL STOVE

- A meal representative of the most typical local cuisine will be cooked by a local cook.
- Fuel use and time of cooking will be recorded and compared to the traditional stove.
- Emissions can be measured either using the PEMS or an IAP system in a controlled room.

Advantages to the CCT

- In the CCT, the following variables are controlled:

  1. Food – A single meal in a standard quantity – eliminates variations for family size, visitors, holidays, etc.

  2. Room – Conducting tests with emissions collection or emissions in the same room -- eliminates the variation between kitchens.

- Controlling these variables saves time and expense, while providing strong data with less scatter than a KPT.
- By requesting the same cook prepare the same meal on both the improved and traditional stove, the difference in the **stoves** alone can be better isolated.
- During the CCT, the cooks will be observed. How the cooks use the stove, troubles they have, etc. will be identified.
- This observation of real use of the stove is essential to ensuring the stove is properly designed for cooks.
- At the **end** of the test, the cooks can be asked what they thought of the stove.

Disadvantages to the CCT

- There is still tester intervention – cooks may not use the stove the exact way they would at home
- Only one meal is investigated, while real-world use likely involves variable meals, tea, wash water, etc.

CCT Supplies: Cooks

- In choosing cooks, they should be committed and available to complete the full test series
- It is nice to let the cooks keep the food to share with family/village at the end of tests. This helps to ensure the food is cooked well, and that the cook feels compensated for her time.
- Perhaps the cooks should also be paid a reasonable rate for participating.
- The cooks should be asked to prepare meals, but not necessarily told that the stoves are being studied. The less biased she is, or trying to "do well" to please the tester, the better.

CCT Supplies: Fuel

- Fuel used for the test should be representative of the fuel most commonly used.
  - Cooks can supply their own fuel (be paid for it?) OR
  - Testers can supply the fuel
  - It is important that there be enough of the same fuel to complete the entire CCT series
- An electronic scale is needed for measurement
- An ample supply of fuel is pre-weighed and provided to the cook. The remaining fuel is weighed when she has finished cooking.

CCT Supplies: Food

- A common recipe should be chosen
  - "Doneness" of the meal should be easily identified
  - Should not take too long or too little time to prepare for ease of planning.
  - It helps to choose something that the cooks will appreciate taking home at the end of the day!
- The recipe ingredients, including any needed water, should be provided to the cook in pre-weighed bundles prior to beginning the cooking. She should use all of each ingredient.
- The cook should use the pots (and lids) that she would normally use.

CCT Procedure

- The cooks should have plenty of time (2+ weeks) to learn to use the improved stove, but not be instructed how to run it.
- It is important to clearly explain to the cooks in advance what will happen during the CCT:
  - She will be provided pre-weighed ingredients
  - She should cook the meal the same way every time
  - When the meal is finished cooking, she should tell the tester
  - The cooked food will be weighed (before draining) as soon as the meal is finished
- During the test, the cooks should not be told how to run the stove
- The cooks should not be asked questions about how they like the stove until the test is over. *We do not want to bias the cooks so that they change their behavior during the test.*

CCT Procedure

- During the test, the tester should make notes about the ease of use of the stove.
- The tester should be available nearby to immediately weigh the remaining food and fuel as soon as the meal is finished cooking.
- *****Weighing Charcoal*****
  - If the charcoal is "saved" or used for some other cooking, the charcoal should be weighed and credited back to the stove.
  - If the charcoal is simply let to burn out, it should not be weighed, since the fuel is wasted.

CCT Sample Size

- One CCT is considered to be:
  - one cook cooking the same meal
    - 3 times on the traditional stove
    - 3 times on the improved stove

    Therefore **1** CCT = **6** meals by one cook
- A CCT series should be done with at least 3 cooks completing a 6-test CCT, for a total of 18 meals.
- More cooks or additional meals can be used if statistical confidence* is not achieved.
  - *Statistical confidence means a COV of the %Improvement between cooks of less than 25%

CCT Data Analysis

- There is a automatic data analysis spreadsheet available for both WBT and CCT.
- During this week, feel free to visit with Nordica to see and use the spreadsheet if you wish.

CCT Emissions

- Emissions during the CCT can be measured in two ways:
  - Perform the test under PEMS which provides total mass emissions
  - Perform all tests in the same room with a stable level of ventilation while measuring IAP. As long as ventilation remains about the same, levels of IAP can be compared between stoves. Each CCT can be done in the cook's home. A cook/home with consistent ventilation should be chosen.

CCT Field Study in India

- Aprovecho worked to develop rocket stoves for Shell Foundation in Southern India. To determine the field performance of the stoves, an extensive series of CCTs was conducted in December 2007.
- Three stoves models: single-pot, double-pot, and double-pot with chimney. Performance was compared to traditional stoves, three-stone fire, and kerosene as used in the region.
- The outcome was extensive data from two emission measurement settings (PEMS and IAP monitor), for a total of 120 meals analyzed.

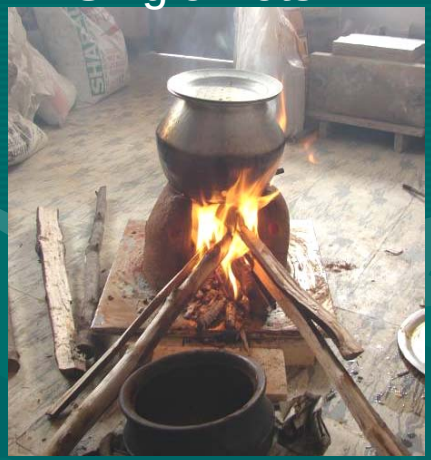
Cooks	**Single Pot**	**Double Pot**	**Chimney**	**Kerosene**	**Three-Stone Fire**
Cook A Cook B Cook C	3 Meals Each Improved, 3 Meals Each Traditional			3 Meals, Various Cooks	3 Meals, Various Cooks
Cook D Cook E Cook F		3 Meals Each Improved, 3 Meals Each Traditional			
Cook G Cook H Cook I			3 Meals Each Improved, 3 Meals Each Traditional		

CCT - Stoves

Improved

Traditional

Single Pots

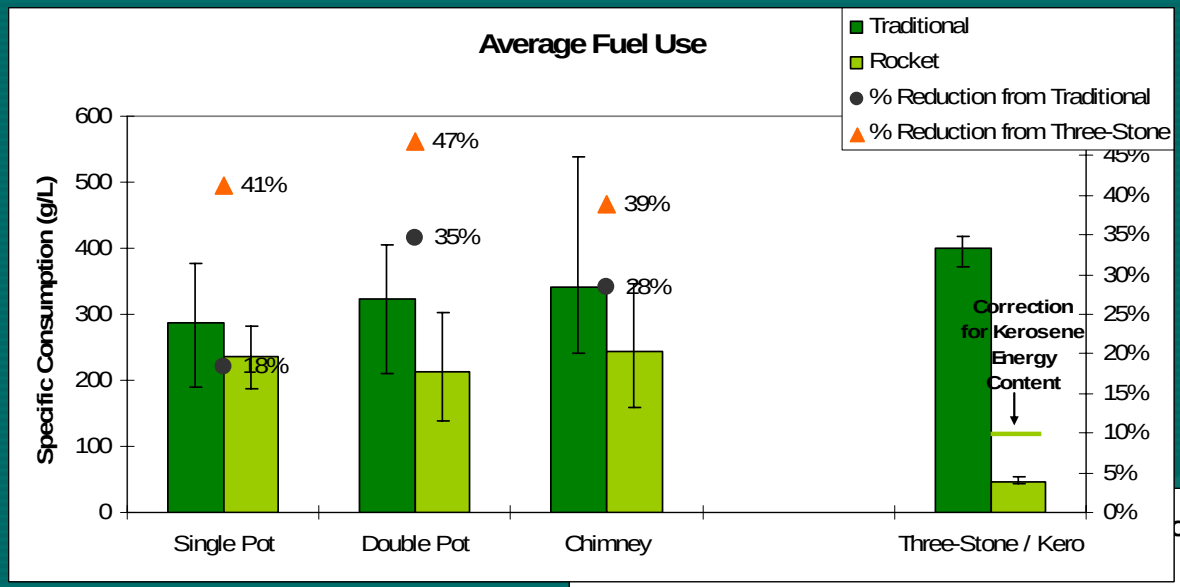


Double Pots

Double Pot with Chimney

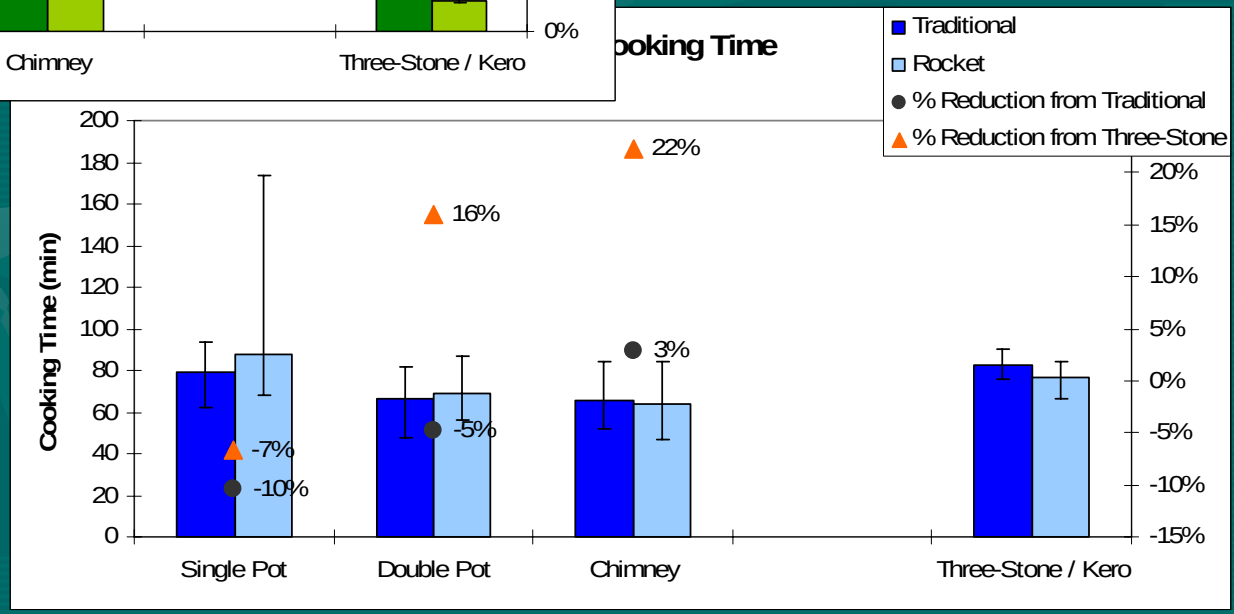
The nine cooks were located in nearby villages and given improved stoves 3 weeks prior to test. No training or instruction was provided before or during the tests. They were paid 50 Rupees per meal and given the large quantities of food to take home to share with their village.

CCT – Fuel and Time

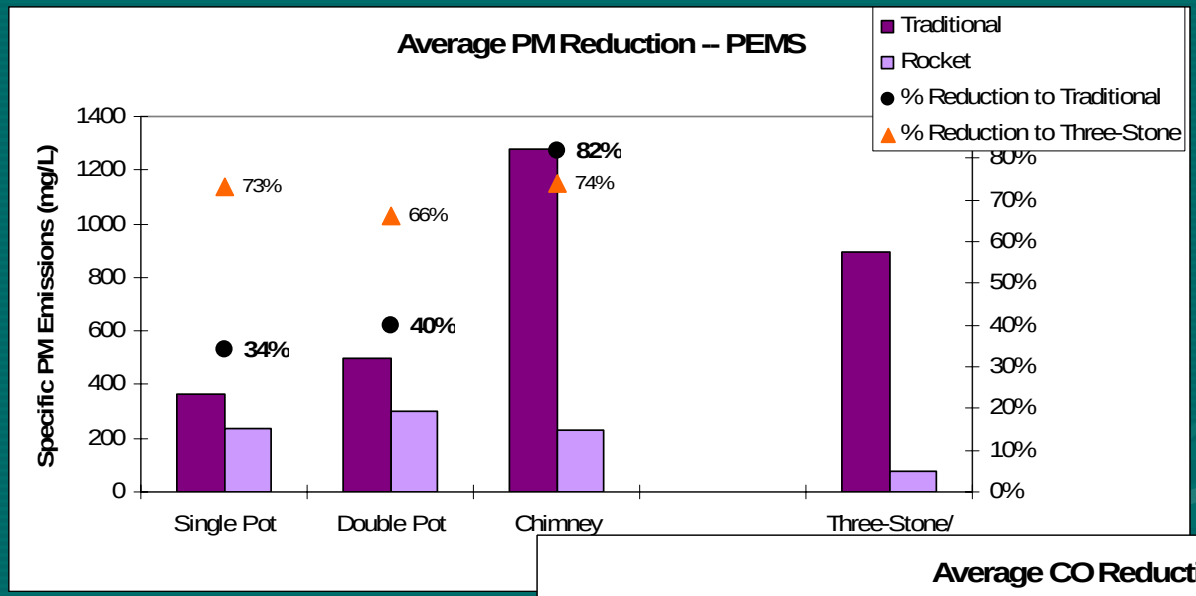


The rocket stoves saved between 18 and 35% of the fuel compared to the traditional stoves. When compared to the three-stone fire, the rockets saved about 40%.

Generally the rocket stoves took about the same time to cook the meal as their traditional counterparts. However, the double-pots saved about 20% of the time as compared to the three-stone fire.

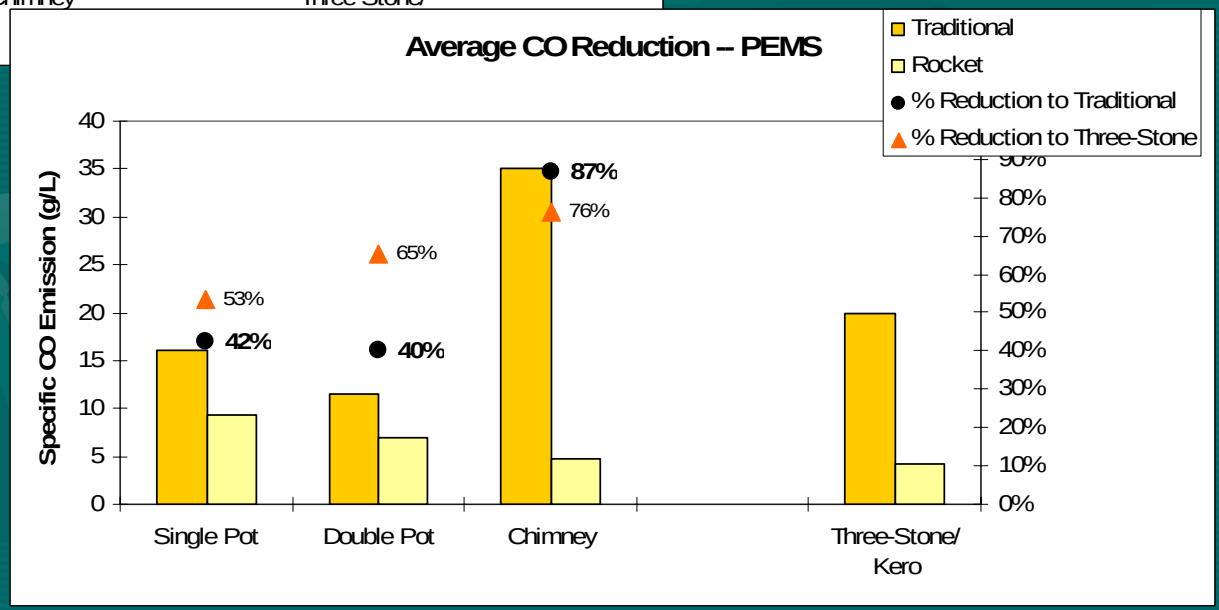


CCT – Total Emissions

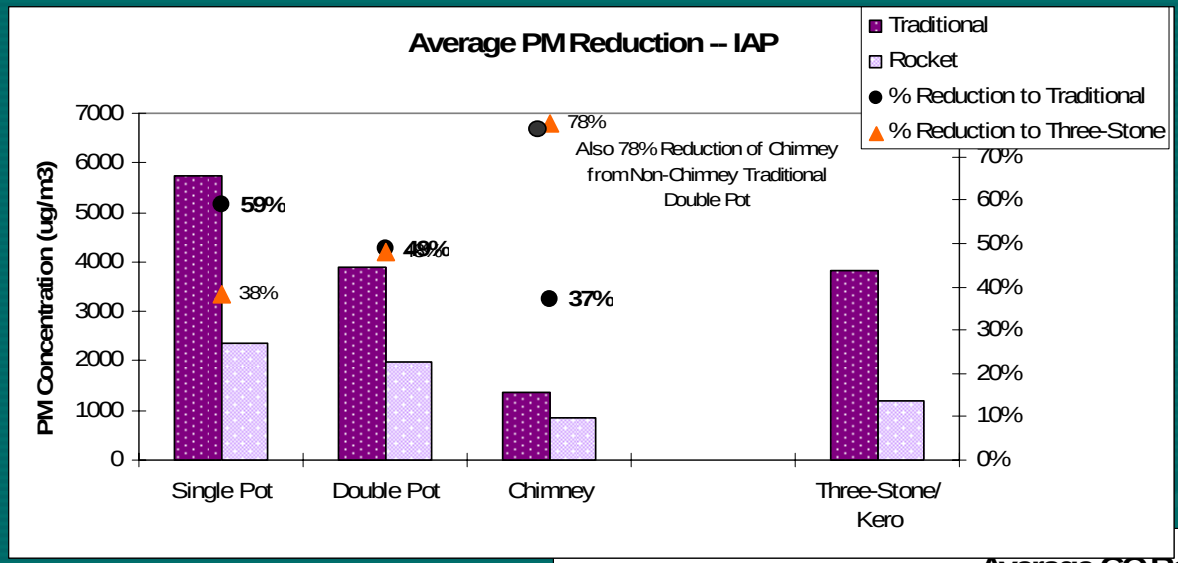


The non-chimney stoves reduced total PM by 34%-40% compared to traditional, and about 70% compared to the three-stone. The rocket chimney stove released 82% less PM out the chimney than cement chimney stove with poor draft.

The rockets reduced CO by about 40% vs. traditional and 53-60% compared to the three-stone. Similar to the PM results, insufficient draft resulted in high levels of CO from the traditional chimney stove.

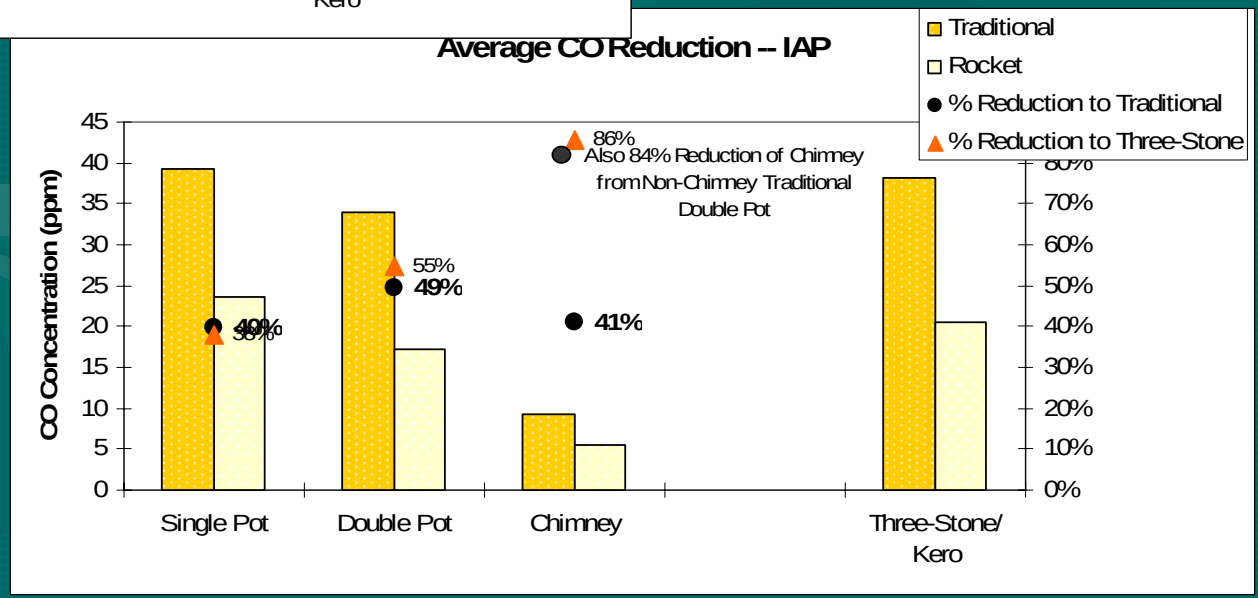


CCT- IAP Levels

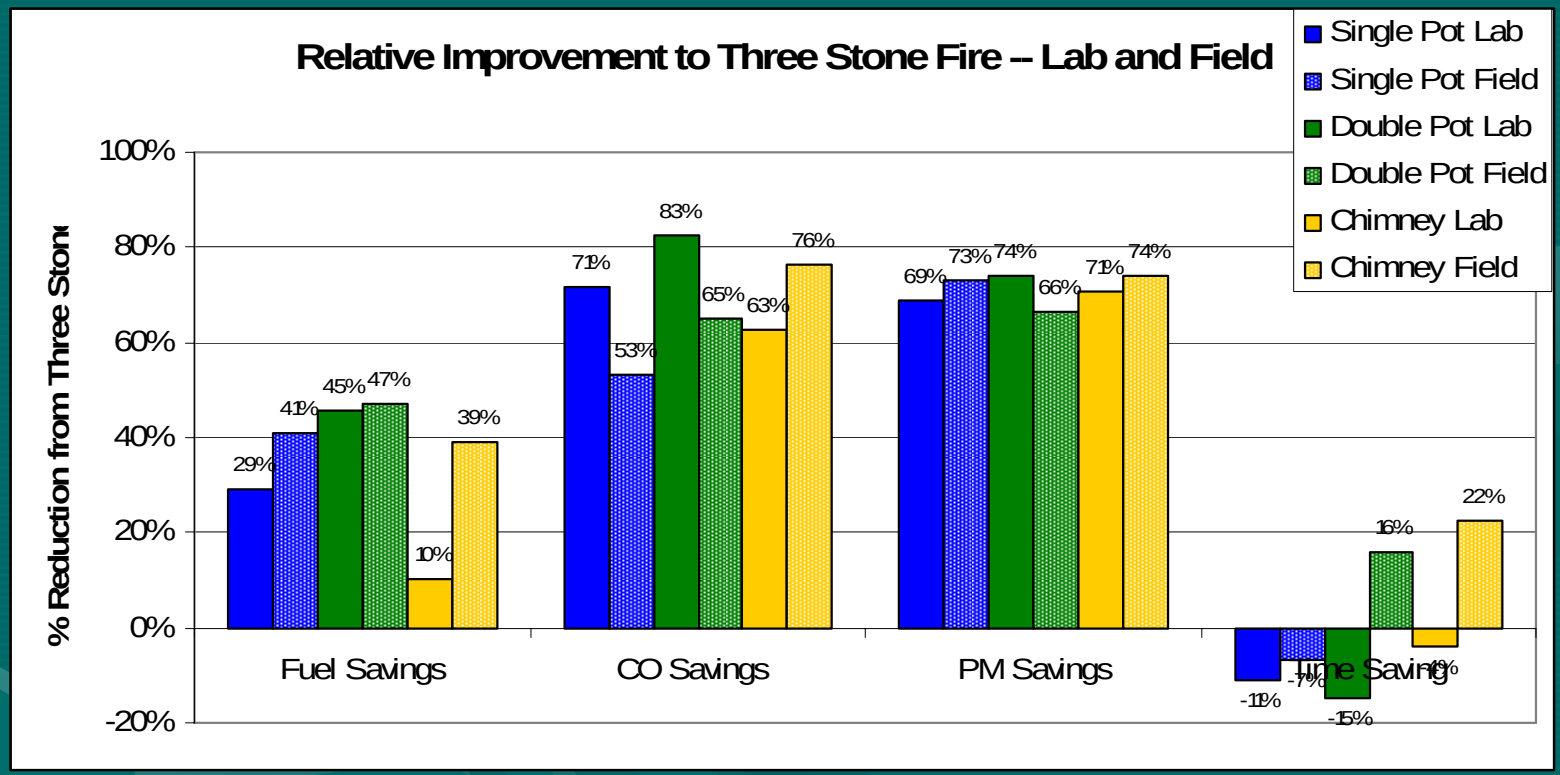


IAP results were similar to the total emissions. However, the rocket with chimney caused 78% less IAP in the room as the three-stone fire or non-chimney traditional counterpart.

Levels of CO in the testing room were about 85% less using the chimneyed rocket as compared to the three-stone and traditional stoves. The remaining emissions are due to starting the stove with pot off, and changing pots during cooking.



CCT – Lab vs. Field Results



Fuel Savings were better than expected in the field, chimney stove was 29% better.
CO savings not quite as good, but reasonably in line with lab (within 18%)
PM savings almost exactly as predicted by lab (all within 8% or less!).
Time savings better in field, especially for double pots, since women make best use of both pots.

India CCT – Overall Results

- Traditional stoves in India are already an improvement to the three-stone fire, roughly 20% reduction on all measures.
- There was a high variation between cooks. Those with limited fuel made careful fires, those with abundant fuel made large and smoky fires.
- The CCT was a great way to investigate field performance and receive feedback on how the cooks liked the stoves.

	One-Pot (total emissions and IAP)	Two-Pot (total emissions and IAP)	Chimney (IAP Only)
To Traditional			
Fuel Reduction	18%	35%	28%
CO Reduction	41%	45%	41%
PM Reduction	46%	44%	37%
To Three-Stone Fire			
Fuel Reduction	41%	47%	39%
CO Reduction	46%	60%	86%
PM Reduction	56%	57%	78%

What's Next…

- Lab Tour
- Lunch
- Form Teams for Stove Testing and Design
- Three-Stone Fire CCTs

Current Status of Refugee Stoves

- Show Darfur report…
  - Photos
  - Graph