Indonesia ICS Program – Feasibility Study

i) Traditional Stove markets in Central Java and Testing of improved appliances

ii) Assessing the current markets for traditional cooking technologies and the actual Efficiency of Traditional and Improved Cookstoves in Close-to-Reality Conditions

Content

Executive Summary 4

Section 1: 10

Stove markets In Central Java Province and Yogyakarta Special Region 10

1. EXECUTIVE SUMMARY 10

2. STOVE PRODUCER 11

3. STOVE DISTRIBUTORS 12

4. STOVE RETAILERS 14

A. SURVEY OF PRODUCERS 15

B. STOVE DISTRIBUTORS 22

C. RETAILERS 26

D. RECOMMENDATIONS FOR FURTHER INVESTIGATION 29

Section 2: 31

Controlled Cooking tests of Improved Devices 31

1. Introduction 31

2. On CCT 32

3. Cooking Preparation 34

Cooking Site 34

Fuel 34

Test performers 34

4. Stove Preparation 35

Menu 35

Practice 35

5. Actual CCT 35

6. Analysis and Conclusion : Wood Stoves 39

7. Analysis and Conclusion : Charcoal Stoves 41

8. Complaints, Comments and Compliments 43

Section 3: Conclusions and discussion: 45

Sources 46

# Executive Summary

This study assessed the markets for traditional cooking devices in Central Java and tests improved devices as compared to the traditional appliances. To do this we conducted a rapid assessment of stove producers and distributors in the region and gathered information of the production and dissemination of traditional cooking devices. Then we tested new devices in a controlled cooking test. Results and findings are then discussed.

1. **Traditional Stove Markets in Central Java**

Most traditional cooking stove production centers are small enterprise which had been inherited from past generation and had been producing stoves for the past 40 years. There are two stove types of cookstove produced - a fuelwood stove, Keren and a charcoal stove, Anglo. In rare instances, some other stove types are also available such as sawdust stove, and improved fuelwood stove (SAE) and improved charcoal stove (Thai Bucket Stove). Most of the producers (69%) produced other types of terracotta products, such as flower pots and water dispensers.

Producers use black clay, red clay, sand and for a few, cement. Mechanical equipment is used by a minority of producers only in raw materials mixing. Most producers rely on manual/human power in stove production.

*Top : GERES Regional Director talking to traditional ceramic stove producer in Central Java*

*Bottom : Traditional ‘anglo’ stoves stacked for sale in Yogyakarta*

Overall, producers are small scale and have low monthly stoves production capacities. Amongst the producers interviewed, the average stove production capacity per month is 200 Keren stoves: most produce less than 100 stoves per month and few more than 300.

*The Typical Javanese Stove Producer:*

*Cook stove producers in Central Java are mostly families running small scale inherited enterprises. Commonly, they have been established for a long time. Most producers lack formal education and produce stoves because of their heritage and skills that have been passed on in the family. The producers are all small scale, employing less than 5 people, and producing between 100 and 300 stoves a month, amongst a range of other products for the local market. Income from stove production is around $0.1-0.3 per stove and $10-60 per month. Most producers use highly no mechanized equipment and inefficient open air kilns or bonfires i.e. pottery is stacked on the ground and covered, for stove firing. Producers usually fire between 50 and 100 stoves per firing. Less than 10% used brick kilns. Most producers use wood, whether exclusively or in mixes with other biomass for stove firing. Producers also tend to distribute their own stoves or to deal with a few local distributors who deliver to end users in small trucks or by bike.*

The survey estimated the production costs per stove. Production costs and selling prices were obtained directly from producers, so the production costs are estimates, as there was no bookkeeping or mechanisms to recorded industrial inputs. These costs include: labor costs, materials and firing costs. They were calculated through the estimations of 36 producers for 2 type of stove with various sizes. The results show that the costs per stove range from RP 1,250 to 2,250 ($0.12-0.22). Selling prices at the producer level, ranged from RP 2,250 to 3,500 ($0.2-0.35 USD).

According to these calculations, producers can make a profit of RP 1000 to Rp2000 ($0.1-0.2 USD) per stove. Monthly income from stove production is then between RP 100,000 to 600,000 ($10-60).

The stove distributors also receive a similar income from buying and selling stoves. We found that income was in the range of RP 150,000 to 750,000 ($15 to $75 USD) per month with distributors making between RP1 000 to 3000 ($0.1 to $0.3 USD) per stove.

The Keren stove (see photo below) is the most prominent stove type in circulation, followed by Anglo. Most producers distributed Keren exclusively; some distributed both Keren and Anglo.

At the distributor level, the average number of stoves sold per month range from less than 100 up to more than 300 stoves. They also stated that there has been a decrease in stove sales over the last few years, although the magnitude and timing of this decrease was beyond the scope of this snap shot study. According to these producers, a factor which significantly influenced the decrease in the number of stoves distributed was the National LPG Program, SKLPG, (see energy policy and household energy studies) and other factors such as, increasing costs of production, lack of skilled employees and increased price of raw materials.

The financial payments for stoves, between producers and distributors, are made along commercial lines; more than half of the distributors acquired stoves from producers in debt based on trust but many producers also paid the stoves on delivery.

**The end users of the stoves are both households and street food hawkers**. This support evidence from the Household User Survey and the Woodfuel flows. In other words, **all three studies indicate that cooking stoves and woodfuel are bought and used by either households or street food vendors.**

In Conclusion, there are many small scale producers, servicing a local demand which is currently decreasing. There are many producers and distributors with collective ability to meet the present demand (as generally it is often observed that stoves are well stocked in many retail shops). Although it seems that many producers are located in areas where there are concentrations of stove/pottery producers, this need to be confirmed further. Working with these traditional producers is a key to success for a stove project, as opposed to training new producers without inherited pottery skills. Further action should be to map the location and short list suitable locations and communities and then to start preliminary work with these local communities.

Stove production uses relatively simple equipment and technology. Firing of stoves is usually done with open pit kilns, less than 10% used brick kilns. Most producers use wood, whether exclusively or in mixes with other biomass for stove firing, and non standardized mechanisms of production. Both these areas have large potential for improvement, for instance in efficient stove firing kilns and in new standardized stove making technologies. Improvements are needed to reach standardized quality, increased production capacities and lower costs.

Overall, Keren, the traditional fuelwood stove in Central Java, is most common. Interventions should therefore consider producers of these traditional stoves as a priority, with the possible aim of converting Keren production to ICS production. The survey’s results showed that the retailers were selling stoves to both households and street food hawkers. These two sectors would then be the target users for ICSP. Prices and performance of traditional technologies should be taken into consideration when designing ICSP as a benchmark to highlight and market improvements or savings stemming from ICS. Other significant challenges of future programs will be related to the methods of dealing with the current stove provision capacities vis-à-vis the reliability of stove supplies and qualities. The current status of many producers means a challenge for the strategy in the introduction of standardized quality stoves, as the supervision of quality control may become complex with the involvement of many actors.

1. **Controlled Cooking Tests of ICS**

A Controlled Cooking Test (CCT) is a detailed laboratory scale test to compare performances of two stoves by using actual food in ‘close to field’ conditions. Here, laboratory scale means that the cook, food, cooking appliances, and location are kept constant and/or controlled over the course of the test. In order to find out potential performances of various stoves and their potentials to be disseminated, CCT is applied on some ICSs and on some traditional stoves as well for comparison. The CCT protocol applied is the CCT Approvecho-University of California Berkeley. In addition, with the cooks cooking actual food, we can get information on complaints, compliments, and comments from him/her to be used later on to estimate public acceptance if the better stove is disseminated to the people.

These tests were carried out in order to assess the potential efficiency savings of each stove and the benefits of an ICS project. In essence they are designed to measure and quantify the efficiency of traditional stoves used versus the proposed improved technology. Another reason for the choice of this test is that calculating thermal efficiency of a stove is recognized as not reliable. Calculating Specific Fuel Consumption (SFC) is generally considered more appropriate in the stove community.

The CCT is a test done in “close to field” conditions i.e. conditions which are as close as possible to real field conditions. This allows us to determine with a higher degree of accuracy how the stoves will perform in real households once they have been disseminated.

**Method:**

The test was carried out at the house of Head of Karanganom Sub-village, Wonokromo Village, Plered Sub-district, Bantul District, Yogyakarta. The location was selected due to a high number of housewives there who traditionally use wood and charcoal stoves for daily cooking activities. The cooking site was in the backyard of the house. However, for this occasion, the house owner provided roofing and a sort of wall made of metal sheets to protect the test from wind and rain. The site was aimed to resemble common Javanese kitchens as much as possible.

Each team (1 cook and 1 observer) tested every stove three times, and each stove was tested by three cooks. Thus, each stove was tested 9 times. The cooks were used to cooking by using biomass stoves, so it was believed that they would be able to optimize the abilities of the stoves to be tested. Also, since they come from one same neighborhood, they have similar perceptions of cooking (e.g. similar perception in judging whether a food is done or not, same perception on crispiness of fried *tempe*, etc.)

BeforeCCT, the stoves have been used for cooking for several times, so that they were dry enough for CCT. A wet stove may absorb heat produced from wood combustion in such a way that it reduces the stove’s performance. Moreover, cooks were given two days of practice to become accustomed with the new cooking device.

The selected menu was a common menu in Javanese tradition. It was a full course for a small family (5 people), i.e. rice, vegetable soup, fried *tempe*, *sambal*, and drinking water. Before testing, observers weighed raw food (rice, vegetable oil, etc) according to menu, cleaned and weighed cooking ustensils, prepares and weigh fuel just enough for cooking food thoroughly and prepares weighing scale

Once prepared, the cook starts a fire and CCT begins. As soon as a food is done, observer weighs and records the results such as the remaining fuel (including remaining charcoal on wood stove) which are inputted on computerized spreadsheet with pre-set calculations.

**In our case, the main wood burning stove was Keren, and charcoal burning stove Anglo**. **We tested these stoves versus the technology introduced in Cambodia, Nang Kong Ray stove (NKS) for wood and New Lao Stove (NLS) for charcoal**. In addition, we added an improved SAE stove which has already developed and introduced in Indonesia. The SAE stove is a two-pot wood burning stove. New Lao Stove is also designed to allow burning wood and has therefore also been tested with wood.

CCT was carried out from 20 October to 7 November 2009. Based on the cooks’ request, CCT was carried out once a day from 10:00 a.m. to 12:00 p.m.

**Results:**

Specific Fuel Consumption (SFC) is a measure of how many grams of wood is consumed to produce 1 kg cooked food. The greater the SFC, the more fuel consuming is the stove. The respective specific consumptions of the stoves are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wood burning Stove | Keren | SAE | NKS | NLS |
| SFC – g/kg food cooked | 132 | 124 | 127 | 118 |
| Charcoal burning stoves | Anglo | NLS |  |  |
| SFC – g/kg food cooked | 55 | 65 |  |  |

In percentage, that is:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wood burning Stove | Keren | SAE | NKS | NLS |
| SFC comparison | - | - 6.06% | - 3.78% | - 10.6% |
| Charcoal burning stoves | Anglo | NLS |  |  |
| SFC comparison | - | + 18.18% |  |  |

Other useful insights from the CCT were the commentary given by the cooks on the appliances. For example, some stoves such as the NKS and Keren stove were considered by the cooks as easy to use and the cooks also commented that they do not need to kindle wood to cook with these two stoves. SEA stoves were viewed as having a quicker cooking time, but they required constant attention from the cooks, meaning they could not attend to other tasks whilst cooking. Many of the cooks also stated that they prefer stoves that can burn small pieces of wood rather than requiring large pieces of wood.

Comments on the NLS stove and the NKS stove were that they can only use small sized wood, such as branches or chopped wood, and cannot accommodate large pieces of wood during cooking. This means that wood has to be prepared before being utilized as fuel. The cooks also commented that both NLS and the NKS required a prop to support the fuel wood being used, which added an extra hassle to the cooks.

1. **Conclusions**

This study assessed the markets for traditional cooking devices in Central Java and tests improved devices as compared to the traditional appliances.

Cook stove producers in Central Java are mostly families running small scale inherited enterprises. Commonly, they have been established for a long time and often lack formal education and produce stoves because of their heritage and skills that have been passed on in the family. The producers are all small scale, employing less than 5 people, and producing between 100 and 300 stoves a month, amongst a range of other products for the local market. The materials used are black clay, red clay, sand and for a few, cement. Mechanical equipment is used by a minority and only in mixing of raw materials such as sand and clay. Most producers rely on manual/human power in stove production. Overall, producers are small scale and have low monthly stoves production capacities.

Income from stove production is around $0.1-0.3 per stove and $10-60 per month. Most producers use no mechanized equipment and inefficient open air kilns or bonfires i.e. pottery is stacked on the ground and covered, for stove firing. Producers usually fire between 50 and 100 stoves per firing. Less than 10% used brick kilns. Most producers use wood, whether exclusively or in mixes with other biomass for stove firing. Producers also tend to distribute their own stoves or to deal with a few local distributors who deliver to end users in small trucks or by bike. Most of the producers (69%) also produced other types of terracotta products, such as flower pots and water dispensers.

The markets for traditional cooking stoves in Central Java is made up of a numerous small scale producers collectively supply local demand. The demand for traditional stoves has been in decline in recent years as the population of central Java has been given access to electricity and also migrated up the energy ladder toward LPG and away from Kerosene. Even so many people in the region, over 50% of households, rely on direct combustion of biomass for cooking. In these cases the stove are home-made from concrete, brick or scrap material or locally purchased. There are two stove types of traditional cookstove’s produced for the trading market - a fuelwood stove, Keren and a charcoal stove, Anglo.

Improved cooking stove technologies that improve the efficiency of cooking should be considered for these groups. If we consider wood burning stoves, the cooking tests reveal that only the NLS shows significant – even though not spectacular – gain in comparison with the traditional stove (Keren). Its production price would however have to be competitive, below $5 USD, to break into the market.

Regarding charcoal burning stove, indeed, the NLS shows considerably lower performance than the traditional stove (Anglo). The results of this limited test suggest that there are no efficiency gains to be had by disseminating NLS technologies in Indonesia. To be blunt, they are more expensive and, according to these results at least, no more efficient.

They are however more durable and these exercises shed light on more appropriate options for the region. If an appropriate technology can be found the ICS project has good potential in the region. Also, the structure of the traditional stove markets and networks of producers mean that a ‘local production’ approach could be used to train networks of local artisans to produce both of these improved technologies. However, the limited gains in efficiency mean that other appliance designs i.e. not NLS technologies per se, and technologies should be considered for the Indonesian context. These improved stove to be considered will have to display significant efficiency improvement i.e. show ability to substantially reduce energy consumption and emissions of particulates that contribute to indoor air pollution, and also cost competitiveness with traditional technologies i.e. show a realistic pay-back period through fuel savings and be accessible to rural communities in price and physical dissemination. There also remains room for local production of such technologies in Central Java, although other dissemination models, such as import of machined parts of prefabrication, should be considered.

# Section 1:

# Stove markets In Central Java Province and Yogyakarta Special Region

## EXECUTIVE SUMMARY

Stove production and distribution stakeholders were largely those who have been involved in the occupations for a long period of time. Stove production enterprises were also mostly inherited from previous generations in the producers’ families. We can therefore assume that the market is deeply traditionally rooted in the habits of users and working with these actors is a key to success for a stove project.

Current stove production, distribution and retail units have relatively small production (about 70% produce between 76 and 300 stoves per month, average 175 stoves per month) and circulation capacities. However there are apparently many producers, distributors and retailers thus ability to meet the present demand (as generally it is often observed that stoves are well stocked in many retail shops)[[1]](#footnote-2). Although it seems that many producers are located in areas where there are concentrations of stove/pottery producers, this need to be confirmed further.

For significant proportions of producers and possibly distributors, stove based businesses were not the sole source of income. Those producers produced a variety of pottery products. While the survey did not determine whether stove is the only source of income for the distributors, judging by the relatively small incomes derived from stove distribution, it is likely that stove is just one among other commodities they distributed.

Significant challenges of future programs will be on how to deal with the current stove provision capacities vis-à-vis the reliability of stove supplies and qualities. This is reinforced by the fact that the distribution path is not uniform, i.e. most actors carry more than one role in the distribution chain (producer / distributor / wholesaler / retailer).

The current status of many producers means a challenge for the strategy in the introduction of standardized quality stoves, as the supervision of quality control may get complex with the involvement of a lot of actors.

Stove production used relatively simple equipment/technologies. There are definitely scope for intervention, in terms of improvement or introduction stove firing kilns and new stove making technologies, in order to produce standardized quality, increased production capacities and efficiencies of fuels and possibly raw materials usage.

Stove distribution also relies quite significantly on simple vehicle with limited distribution capacities, i.e. bicycles and motor cycles. Although it is not confirmed by the survey, the small distribution capacities of distributors can lead to a reasonable assumption that there are many actors involved in stove distribution. However, about a third of the distributors also use larger capacities distribution vehicles such as pick-ups and trucks.

Overall, Keren, the traditional fuelwood stove, was the stove type produced by most producers, distributed by most distributors and retailed by most retailers. Keren was definitely the fuelwood stove type most circulated in the stove market in the two provinces. This is consistent with the data gathered during the Household User Energy Survey, where woodfuel is the main energy carrier.

## STOVE PRODUCER

**Status of production center as enterprise establishment**

Most stove production centers are enterprise which had been inherited from past generation and had been producing stoves for 16-40 years.

**Stove types produced**

Producers produced mainly two stove types - the traditional fuelwood stove, Keren and the traditional charcoal stove, Anglo. Some other stove types had also been produced by few producers. These include sawdust stove, improved fuelwood stove (SAE) and improved charcoal stove (Thai Bucket Stove).

However, stoves were not surveyed based on their sizes.

Most of the producers (70%) produced other types of terracotta products. The rest of producers, a small proportion, produced stoves exclusively.

**Raw materials**

Producers used black clay, red clay, sand and cement. All of them used black clay and sand, some used also red clay, a few used cement.

The quantities of raw materials, could not be determined in the survey.

All producers purchased raw materials; some purchased as well as obtained raw materials at free cost. Some producers purchased raw materials and get them delivered, others purchased but had to arrange the transportation on their own. In the latter cases, the transportation modes were by bicycles and pick-ups.

Most producers relied on manual/human power in stove production. Mechanical equipment is used by a minority of producers only in raw materials mixing.

**Stove firing**

Most producers used bonfire for stove firing. Less than 10% used brick kilns. Most producers used wood, whether exclusively or in mixes with other biomass for stove firing; about 30% relied exclusively on non wood biomass as fuel for stove firing.

Quantities of fuels used for stove firing could not be determined in the survey.

Most of the producers fired between 50 to 100 stoves per firing. Note also that most producers used bonfires, which in practice has limitless capacities.

Stove production and stove storage sites are commonly between less than 5 to 10 M2. Many producers also had very small production and storage sites which are less than 5 M2.

The production capacities of different producers in different areas varied widely. The average stove production capacity per month found was 200 Keren stoves, the highest was 880 Keren stoves and the lowest was 60.

**Production capacities**

Overall, producers had low monthly production capacities. 50% producers produced less than 100 stoves per month and only 4% produced more than 300 stoves per month.

Factors that influenced the increase/decrease of production quantities were employees, capital. The national LPG policy and rainy season were considered to be factors that decreased the rate of production.

**Producers’ network**

Of the producers, 25 % were also distributors. Producers who were non distributor dealt with between 2 to 7 distributors.

Bicycles were the most common mode of stove transportation vehicle. However on the overall, almost 60% of the producers were distributing or had their stoves distributed by motorized vehicles (car, truck, motor cycle).

**Rule of payment**

Most producers (50%) sold their stoves on upfront payment basis, 15% allowed down payment in their sales and another 15% allowed debt.

**Production costs and selling prices**

Production costs were estimated and ranged from Rp. 1,250 to 2,250 for different stove types and stoves of different sizes. Selling prices at the producer level, ranged from Rp. 2,250 to 3,500.

## STOVE DISTRIBUTORS

**Background of stove distributors**

25 % of distributors were also producers and 75 % were exclusively distributors.

The businesses had been established for a long time; under 20 years for 55 % of respondents, 21-40 years for 30% of respondents and 41-60 years for the rest.

Keren was on the overall the most prominent stove type in circulation. Other stove type distributed was Anglo. Most producers distributed Keren exclusively; some distributed both keren and Anglo.

Most (60%) used two-wheeled vehicle in the distribution of stoves. Four wheeled vehicles used were pick-ups and trucks and were all rented.

Distributors sold most stoves to retailers; also to wholesaler and in the local market. However it was not clear what are actually wholesalers and it is also not clear what does “in the local market” refers to (whether referring to retail sales in the local market or delivery of stoves to retailers in the local market).

For 95 % of the distributors, the distances covered in stove distribution were over 15 Km. For a small number of distributors, their stove delivery coverage was 5 Km or less.

The average number of stoves distributed per month ranged, from less than 100 up to more than 300 stoves. There are almost equal proportions of distributors who distributed less and more than 200 stoves; i.e. almost equal proportions of small and large distributors.

According to the distributors, a factor which significantly influenced the decrease in the number of stoves distributed was the National LPG Program. Other factors – high costs of production, rainy season, employees, increased price of raw materials - were also considered to have contributed to the decrease/increase in the number of stoves distributed (these factors mostly affected the producer-distributors).

The costs of Keren stoves of small, medium and large sizes from the producers were: Rp 1,400, Rp 2,300 and Rp 4,000 respectively; the average prices of stoves sold by the distributors were Rp 2,900, Rp 3,600 and Rp 8,000 respectively.

The costs of Anglo stoves of small, medium and large sizes from producers were Rp 1,000, Rp 2,500 and Rp 5,000 respectively; the average prices of stoves sold by the distributors were Rp 2,000, Rp 3,300 and Rp 8,000 respectively.

Average gross incomes per stove delivered ranged from Rp 1,500 to Rp 4,000. Gross incomes derived from distribution of stoves are estimated to range from Rp 150,000 to Rp 750,000 per month. Distributors might also distribute products other than stoves; therefore their incomes did not depend solely on this commodity.

Other costs associated with stove distribution are car/pick-up renting (Rp 80,000), truck renting (Rp300,000) and truck renting, porter, fuels, food and cigarette (Rp 1,150,000). The cost associated with bicycle delivery was Rp 100 per stove.

More than half of the distributors acquired stoves from producers in debt based on trust. Quite many producers also paid the stoves upfront.

Distributors received upfront payment and down payment for stoves delivered to retailers.

## STOVE RETAILERS

Most retailers received stoves through delivery, whether directly from producers or through the stove distributors. Some retailers in Klaten and Kulonprogo obtained stoves directly from the producers and transport the stoves themselves.

Retailers were selling stoves to both households and street food hawkers.

Most customers were from nearby, within 5 Km or less from the retailers. There were also buyers from further away, within 11 to 15 Km. Only in Klaten district, there were buyers from more than 15 Km away.

Most of the retailers sold between 10-15 Keren (wood-fueled) stoves per week. The highest retail sales rate was more than 20 stoves per week.

The retail prices for Keren stove were mostly between Rp 5,000 to Rp 6,000.

**4. VALUE CHAINS OF STOVE TRADE**

**Stove price mark ups and percentage of mark ups at the level of distributor, retailer and end user**

|  |  |  |
| --- | --- | --- |
|  | Stove trade stakeholders |  |
|  | Producer | Distributor | Retailer | Producer to retail price/end user |
| KEREN (retail price version 1) |  |  |  |  |
| Sales price at different levels (Rp) | 1400 | 2900 | 5000 |  |
| Price mark up at different levels (Rp) | - | 1500 | 2100 | 3600 |
| Percent of price mark up at different levels | - | 110% | 70% | 260% |
| KEREN (retail price version 2) |  |  |  |  |
| Sales price at different levels (Rp) | 2300 | 3600 | 6000 |  |
| Price mark up at different levels (Rp) | - | 1300 | 2400 | 3700 |
| Percent of price mark up at different levels | - | 55% | 65% | 160% |

##  A. SURVEY OF PRODUCERS

**A.1. Background of producers**

Traditional stoves are produced by potters who inherit their skills and businesses from their parents. The family pottery ware business involves the labor of family members, who often have no other job opportunities.

Production centers were managed by young as well as older entrepreneurs; most were managed by young producers (16-30 year old). Most producers also have no or little formal education.

Since these production centers were mostly inherited enterprise, most had been established for a very long time. More than half had been established for more than 16 years and up to 40 years, where the longest establishment period was more than 50 years.

**A.2. Type of stoves and other pottery wares produced**

Several types of stoves were produced by the respondents, with the majority, 70 %, of respondents producing Keren stoves (traditional fuelwood stove); 5 % of respondents produced Anglo stoves (traditional charcoal stove), 16 % of respondents produced both Keren and Anglo stoves, 3 % produced Keren and sawdust stoves, and 6 % produced Keren, Anglo and other stoves (sawdust, improved wood stove - SAE, and improved charcoal stove-The Thai Bucket stove). Improved stoves were produced only when there were orders from buyers. Therefore the stove type that was most commonly produced by producers was Keren (80% of producers).

The major reason why most respondents produced Keren stoves was that producing this stove was easier than producing other stove types. It was also probably due to the fact that there are more fuelwood users, i.e. households.

To increase their incomes, producers usually made other terracotta products in addition to stoves. Of the total respondents, 60 % made both stoves and other terracotta products, and 40 % only produced stoves. Other terracotta products are:

* water jar dispensers
* stove accessories
* flower pots
* bowls
* grinding plates.

**A.3 Motivations of producers to make stoves**

Respondents listed many motivations to make stoves:

* almost 95% mentioned inheritance as a motivation
* 75% mentioned skills
* more than 20% mentioned that they had no other job opportunities
* and almost 20% mentioned other motivations, such as existing customers or profit.

The total is superior to 100%, as respondents were allowed to several answers. The large respective proportions of inherited businesses and lack of other opportunities give the picture of a sector of the economy which is not very dynamic or attractive, as well as seen by its own members as a “last resort” option for working opportunity.

The high proportion of people giving importance to skills however suggests that this is considered as a qualified job, suggesting a recognized profession in the local culture.

**A.4. Raw materials**

**Types of raw materials**

Producers used different types of raw materials to produce the stoves. All of them used black clay and sand, some used also red clay, and few used cement.

**Means of obtaining raw materials**

All the producers had to purchase materials (clay, sand, etc), although few of them sometimes obtained materials without having to pay. Most of the producers obtained materials by purchase, which include delivery. While some other producers also purchased materials, but they had to arrange the transport of materials themselves, sometimes this also include extracting the clay from the sources, i.e. they only purchased clay that was still not extracted/dug, which means they had to arrange the digging, the transport and the pulverizing of the clay. There are also producers who obtained materials through purchase and own extraction. Since it was also found that none of the producers own the land where the clay was deposited, the ownership of the land/clay when producers obtained the clay at a free cost was not entirely clear.

**Distance from production centers to sources of raw materials, and raw material transportation**

The survey investigated the distances from the sources of raw materials to the production centers. The largest portion (45 %) of the production centers surveyed were located within 1-5 Km of the raw materials sites, about 30 % were 6-10 Km, the rest were > 10 Km.

As for the means of raw materials transportation, it was found that most producers used both car and bicycle. There were also quite a number of producers who used only bicycles or bikes for raw materials transportation (15 % of producers); likewise, 10 % of the producers used pick-ups exclusively for raw materials transportation, 10% used cart (man-drawn). In few instances, materials were transported with the sole human power, by basket, suggesting close proximity between extraction and production sites. The remaining used diversified means of transportation, ranging from human power to car (or small trucks).

**A.5. Technology applied in cook stove production**

**Raw materials mixing**

Producers surveyed used both processing equipment and manual processing.

Processing of materials is initiated by soaking the clays so that they reach a certain viscosity/plasticity level before being mixed with sand. For raw materials processing, most producers (85 %) used human power, 10 % used both human power and mixing machines, and 5 % used mixing machines exclusively.

Almost all production centers (97 %) required only one person to mix the raw materials. However, a few production centers required two people to mix the raw materials.

The ratio depends on the quantity and quality both of the clays and sand. The survey was not able to investigate the above issue.

**Stove forming**

Stove forming is done by throwing clay mixture dough on a pottery wheel. After a stove has been formed, it is air dried for a few hours. Then the stove body is beaten from the inside with a flat stone, popularly called a *perbot*, and from the outside with a wooden bat. Final drying usually takes three to five days, depending on the weather and quantity of stoves produced per batch. The number of people needed for assembling the stoves was usually 1-2 persons, but most often only 1 person.

However the above data need to be confirmed further; i.e. most of the assembling was done by 1 or 2 persons **against** production capacities vary widely, from tens of stoves per month, up to more than 800 stoves per month (see later section on “Production Capacity).

**Firing**

Prior to firing, the stoves were dried under direct sunlight for 1-2 hours. Firing of stoves is done in bonfires (open fires) and kilns. In the survey, 90 % of producer respondents used bonfires to fire the stoves, while brick kilns were used by only about 10 % of them.

The main fuel types used to fire the stoves were wood, leaves, straw, twigs, and grass. 40% producers used wood fuels, 30% used biomass without wood fuels, and 30 % used both wood fuels and other biomass.

Most of the producers fired between 50 to 100 stoves per firing. Note also that most producers used bonfires, which in practice has limitless capacities.

**A.5. Production Facilities**

Producers used yards and other outdoor spaces around their houses for the production and storage of stoves. The survey found that stove storage sites were commonly between less than 5 to 10 M2. Most producers had relatively small areas for storage, less than 5 M2.

**A.6. Production capacity**

The production capacities of different producers in different areas varied widely. The average stove production capacity per month found was 200 Keren stoves, the highest was 880 Keren stoves and the lowest was 60.

Overall, production capacity seems to be low. 50% producers produced less than 100 stoves per month and only 5% produced more than 300 stoves per month.

Stove types other than the Keren were generally produced in relatively smaller numbers. The monthly production capacity of traditional charcoal stove (Anglo) stoves is 90, while that of the sawdust stove was 30.



|  |
| --- |
| Comparisons of average monthly production capacities of different stove types  |
| Anglo | 90 stoves |
| Keren | 175 stoves |
| Saw Dust Stove | 30 stoves |

The survey also investigated the factors influencing production capacities, as perceived by producers. The factors that strongly influenced the increase/decrease of production quantities were employees, capital, and the national LPG policy (caused a decrease). However, it must be noted that the survey only assessed the opinions of the respondents.

The rainy season was also considered to be a factor that decreased the rate of production. This was most probably due to the difficulty of air and direct sun drying of the stoves; there were possibly other reasons as well, such as, high moisture levels of fuels and general difficulties in raw material provision due to wet weather (difficult road conditions and difficulties digging clay in the wet season).

**A.7. Trade network of traditional stove**

**Product distribution**

Of the producers, 25 % were also distributors. The 75 % who were not distributors usually had selling relationships with several distributors. As for the producer cum distributors, they would obtain stoves from other producers when demand for stoves increased seasonally. These increases usually occurred during the wedding season (one month, starting at the beginning of Idul Fitri – the end of the Ramadhan fasting month) and during the Islamic sacrifice ritual period (*Hari Kurban*). However the extent of increase/decrease is not investigated by the survey.

Producer cum distributors usually delivered their stoves to shops that would stock the stoves.

The survey found that producers dealt with between 2 to 7 distributors. Many buyers (distributors, wholesalers, retailers, and users) prefer to purchase stoves directly from producers, the main reasons being that it is cheaper and prices can be bargained directly with the producers.

It was most probable that some producers were also dealing directly with retailers as shown in the latter data, however this trade pattern was not captured by the survey.

**Stove transportation**

Bicycles were the most common mode of stove transportation vehicle, therefore number of stoves distributed and distances covered were limited, as compared to stove transportation by motorized vehicle. However on the overall, almost 60% of the producers were distributing or had their stoves distributed by motorized vehicles (car, truck, motor cycle).

**Payment mechanism**

Payments to distributors and retailers are a mix of down payment in cash, or by debt, in somewhat equal proportion.

**Production costs and selling prices**

Production costs and selling prices were obtained directly from producers, so the production costs are likely to be estimates made by the producers, as there was no bookkeeping that recorded industrial inputs systematically in those micro pottery industries.

.

|  |  |  |
| --- | --- | --- |
| Stove type | Estimated production cost (Rp) | Average selling price (Rp) |
| Keren (Small) | 1,250 | 2,250 |
| Keren (Medium) | 1,650 | 3,100 |
| Keren (Large) | 2,250 | 3,500 |
| Anglo (Small) | 1,000 | 2,000 |
| Anglo (Medium) | 1,750 | 3,500 |
| Anglo (Large) | 2,250 | 3,500 |

The survey conducted a brief investigation on the strategies used by producers in product promotion. There was no systematic effort used to increase sales. The responses made by the producers should be treated as their opinions on conditions that need to be fulfilled or activities that need to be undertaken to increase sales. However, it also seemed that few producers, perhaps those from Klaten had actually been facilitated to promote terracotta products in exhibition (i.e. the promotion of terracotta products as crafts), as their terracotta crafts are traded internationally.

These activities cited to be conducted to increase sales are as follows:

* quality improvement
* diligence in production and delivery
* activity in exhibitions
* good (fair) price and quality
* discount provision
* good marketing
* promotion and relationship
* hard work

The proportions of each of these suggestions are not relevant here. They are all sensibly equal (between 5 and 15%).

## B. STOVE DISTRIBUTORS

**B.1. Background of stove distributors.**

The survey found that 24 % of distributors were also producers, and 76 % were solely distributors. The years of establishment of respondents’ businesses were under 20 years for 53 % of respondents, 21-40 years for 32% of respondents and 41-60 years for the rest.

**B.2. Sources of stoves, Types of stoves and their circulations, distribution transport types and main targets of distribution**

Based on the survey, 76% of distributors purchased their stoves directly from producers and 24 % sold their own stoves, i.e. they were also producers.

Keren was on the overall the most prominent stove type in circulation. Overall 90% of producers distributed Keren. Anglo was also a stove type which was distributed by 50% of the distributors. A significant proportion of distributors (10%) were also distributing both Keren and Anglo.

Distributors used several types of vehicle to transport stoves: about 40 % used bicycles, 20 % rented mini-trucks/pick-ups or cars, 20 % used motorcycles, and the remaining rented trucks specifically for the occasion. It can be generally seen that most were small or small-medium scale stove distributors, i.e. most (more than 60%) were using two wheeled vehicle, which deliver relatively smaller number of stoves, compared to the minorities who distributed stoves using trucks.

Based on the survey, the main targets of distribution were retailers, comprising about 45 % of distributors’ sales; 30 % of sales were to wholesalers[[2]](#footnote-3), 5 % were distributed in the local market, and 20 % were distributed to retailers and in the local markets[[3]](#footnote-4).

The distance covered by distributors in stove deliveries cannot be determined accurately. While the survey data indicate that for 95 % of the distributors, the distance was over 15 Km. The available survey data leave uncertainties, as it cannot give reasonable distance estimations (i.e. whether a distance is in the proximities of 15 Km, in the hundreds of Km and so on). While, for a small number of distributors, their stove delivery coverage was 5 Km or less.

**B.3. Average number of stoves distributed per month and reasons for decreases in this quantity**

The average number of stoves distributed per month ranged, from less than 100 up to more than 300 stoves. There are almost equal proportions of distributors who distributed less and more than 200 stoves; i.e. almost equal proportions of small and large distributors.

The above survey data may have missed significant data/information on the magnitude of larger scale distributors, i.e. those distributors who distribute more than 300 stoves. The above said classification might have failed to capture data on distributors who distributed far in excess of 300 stoves, e.g. 20%, 40% or more from 300.

According to the distributor respondents, a factor which significantly influenced the decrease in the number of stoves distributed was the National LPG Program (about 70% of respondents). However, the above opinion needs to be treated cautiously, i.e. unless there are further data and information to support it[[4]](#footnote-5). Other factors were also considered to have contributed to the decrease in the number of stoves distributed, as shown in the chart below.

**B.4 Purchase price, sale price, gross income and costs associated with distribution**

Prices of stove purchased by distributors, prices of sales and gross income are as presented in the table. For the gross income, the figures represent only income derived from stove products. Distributors might probably also distributed also goods other than stoves.

**Estimates monthly gross income from stove distribution**

|  |  |
| --- | --- |
| **Scale of distributors** | **Gross income (Rp/month)** |
| Small Scale distributor (100 stoves/month) | 150,000 |
| Medium scale distributor (200 stoves/month) | 300,000 |
| Large scale (300 stoves/month) | 450,000 |
| Large scale (500 stoves/month) | 750,000 |

**Prices of traditinal fuelwood stove, Keren, at the distributor level**

|  |  |  |  |
| --- | --- | --- | --- |
| **Size of Keren** | **Average purchase price (IDR)** | **Average sold price (IDR)** | **Average income per stove (IDR)** |
| Small | 1,400 | 2,900 | 1,500 |
| Medium | 2,300 | 3,600 | 1,300 |
| Large | 4,000 | 8,000 | 4,000 |

**Prices of traditinal charcoal stove, Anglo, at the distributor level**

|  |  |  |  |
| --- | --- | --- | --- |
| **Size of Anglo** | **Average purchase price (IDR)** | **Average sold price (IDR)** | **Average income per stove (IDR)** |
| Small | 1,000 | 2,000 | 1,000 |
| Medium | 2,500 | 3,300 | 800 |
| Large | 5,000 | 8,000 | 3,000 |

|  |
| --- |
| **Cost associated with distribution** |
|   | Min | Max | Average |
| Renting car for transportation | 60,000 | 100,000 | 80,000 |
| Renting truck for transportation | 300,000 | 300,000 | 300,000 |
| renting truck, porter, fuels, food and cigarette  | 1,150,000 | 1,150,000 | 1,150,000 |
| Delivery cost used bicycle / stove  | 100 | 100 | 100 |
| porter | 50,000 | 150,000 | 100,000 |

**B.5. Rule of payment**

Between distributors and producers, trade, specifically referring to financial transaction was found to be based largely on good relationship and trust. As shown in the chart, more than half of the distributors acquired stoves in debt based on trust. Quite many producers also paid the stoves upfront.

While the modes of transaction between distributors and retailers were quite different. All of the transactions were based on upfront payment and down payment.


## C. RETAILERS

**C.1. Supplies of stoves**

Based on the survey, approximately equal numbers of retailers obtained stoves from one source or multiple sources. Most retailers received stoves through delivery, whether directly from producers or through the stove distributors. Some retailers in Klaten and Kulonprogo obtained stoves directly from the producers and transported the stoves themselves.

The survey also found that there were costs associated with retailers’ stove supplies provision. In Klaten regency, most of the costs were associated with transport, while in Magelang, they were associated with the provision of cigarettes and food (in monetary term), which were most probably provided to the people delivering the stoves. Such costs did not occur to retailers in Kulonprogo. The survey was not able to find out the amount of money associated with the above costs, and thus could not determine their significance to the retailers.

**C.2. Stove Buyers**

The survey’s results showed that the retailers were selling stoves to both households and street food hawkers. In Klaten, the customers were both households and food hawkers; in Kulonprogo, all respondents said the customers were households; and in Magelang, all customers were street hawkers. However, the survey did not investigate the proportions of household to food hawker customers.

The approximate distances of stove customers were also investigated. Most buyers were from within 5 Km or less from the sites of sale. There were also customers from farther away, within 11 to 15 Km. In the district of Klaten, most customers were from within 11 to 15 Km of the sites of sale, but, only in this district, there were also customers from more than fifteen Km away from the sites of sales.

**C.3. Stove retail quantities**

Quantities of stoves retailed were different in different regencies. Most of the retailers sold between 10-15 Keren (wood-fueled) stoves per week. No retailer surveyed in districts other than Kulonprogo sold less than 10 stoves per week. Relatively higher retail quantities were found in Klatan and Kulonprogro. Fewer retailers, and these were only in Klaten and Kulonprogo, could sell 20 or more stoves per week. No retailer sold more than twenty-five stoves per week.

Retailers who were found in the survey regencies, except in Magelang, stocked only Keren stoves. Only retailers in Magelang sold charcoal-fueled traditional stoves (Anglo stoves).

**C.4. Price of stoves at the retailer level**

The survey found that the retail price of a Keren stoves were between Rp. 2,500 and 6,000, however retail prices were mostly between Rp. 5,000 and 6,000.

However, the survey did not investigate the prices of different-sized Keren stoves. It is likely that the retail prices recorded in the survey referred to medium-sized Keren stoves, usually the size used by households.

The survey only recorded the price of charcoal (Anglo) stoves in Magelang, where the price was Rp. 8,500 for a large-sized stove.

|  |
| --- |
| **Keren Stove Selling Price (Declarative from respondent)** |
|  | sampling area |  |  | Total |
|  | Klaten | Kulonprogo | Magelang | **All survey regencies** |
| 2500 IDR | .0% | 50.0% | .0% | 14% |
| 3000 IDR | .0% | 50.0% | .0% | 14% |
| 4000 IDR | 50.0% | .0% | .0% | 29% |
| 5000 IDR | 25.0% | .0% | 100.0% | 29% |
| 6000 IDR | 25.0% | .0% | .0% | 14% |

**C.5. Retail strategies**

The survey conducted a brief investigation into the strategies used by retailers in stove sales. There were no systematic efforts used to enhance sales, hence the responses were general opinions of retailers on what they considered good selling techniques. Most respondents cited communicating well with customers, providing good quality products, and giving discounts as strategies used to enhance stove sales.

## D. RECOMMENDATIONS FOR FURTHER INVESTIGATION

The survey has not obtained adequate information on several aspects of stove trade situation:

1. General:

* Lack of details/missing information on stove prices based on different stove sizes, especially at the retailer level.
* Lack of data and information on stove types other than Keren; these include data on prices, quantities produced, quantities distributed and quantities retailed.
* There are quite a lot of queries in the survey which had been answered by respondents. These may perhaps be reduced with different way of asking the questions, which make responding easier.
* Generally, there are needs for consistencies on the various terms and classifications used in the survey, e.g. unclear definition of certain group, especially “stove wholesaler” which are ambiguous, as it seems that distributor can also be considered as wholesaler. The need for terms and classifications to be qualified with defined criteria.

2. Survey of stove producers:

* Needs to confirm the geographical distribution of stove producers:
	+ What is the proportion of stove producers that are located in areas of concentrations of stove/pottery producers?
	+ What is the proportion located in areas which are not areas of concentration of stove/pottery production?
* Obtain quantitative data on raw materials used and fuels used for stove firing and the prices and relevant expenses:

Raw materials used were usually purchased in local quantitative units. It is usually not effective to rely on respondents’ answers for estimations in metric units of raw materials which were purchased. Moreover, the enumerators had not been adequately instructed to obtain quantitative data in metric units.

Data on prices in metric units terms should also be obtained. Expenses related to raw material provision/extraction should also be obtained.

* Obtain data and information on the ratios of raw material mixture

What are the ranges of typical ratios? What factors affect the ratios, i.e. general information of the different mineral and organic composition of the materials in different areas to the knowledge of producers, which can later be followed up in a more comprehensive laboratory studies.

Likewise, the almost absence of quantitative data on fuels used for firing of the stoves, was also due to a more or less similar problems as faced in obtaining quantitative data on raw materials.

* Obtain more accurate data and information on production costs

Production costs and selling prices were queried directly from the producers, therefore it is expected that respondents’ answers for production costs are estimates/assumptions/speculations made by the producers, since they did not have book keeping system.

More accurate data need to be gathered; deriving the data based on the actual costs of raw materials, labour, fuels, other production expenses.

3. Survey of Stove Distributor

* Obtain more detailed/meaningful data on the trade network of stove distributors

The distance covered by distributors in stove deliveries cannot be determined accurately. While the survey data indicate that for 94.7 % of the distributors, the distance was over 15 Km. The available survey data leave uncertainties, as it cannot give reasonable distance estimations (i.e. whether a distance is in the proximities of 15 Km, in the hundreds of Km and so on). While, for a small number of distributors, their stove delivery coverage was 5 Km or less.

* Obtain more detailed data on the quantities of stoves distributed

The above survey data may have missed significant data/information on the magnitude of larger scale distributors, i.e. those distributors who distribute more than 300 stoves. The above said classification might have failed to capture data on distributors who distributed far in excess of 300 stoves, e.g. 20%, 40% or more from 300.

# Section 2:

# Controlled Cooking tests of Improved Devices

In order to assess the potential for an ICS project, one has to measure the efficiency of traditional / main stove in use in the area versus the proposed technology. This will be useful for several steps in the project: calculating the potential savings of the project, calculating CO2 Emissions Reduction. Furthermore, doing this test in “close to field” conditions (controlled cooking test) allows better accuracy of the testing and bring some elements on the cultural acceptance of the device to be introduced. The other reason for the choice of this test is that calculating thermal efficiency of a stove is recognized as not reliable[[5]](#footnote-6). Calculating Specific Fuel Consumption (SFC) is generally considered more appropriate in the stove community.

In our case, the main wood burning stove was Keren, and charcoal burning stove Anglo. We tested them versus the technology introduced in Cambodia, Nang Kong Ray stove (NKS) for wood and New Lao Stove (NLS) for charcoal. In addition, we added an improved stove already introduced years ago and which production, even though marginal, still remains, which tends to demonstrate a certain degree of acceptation and therefore success. It is the SAE stove, a two-pot wood burning stove. New Lao Stove is also designed to allow burning wood and has therefore also been tested with wood.

The respective specific consumptions of the stoves are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wood burning Stove | Keren | SAE | NKS | NLS |
| SFC – g/kg food cooked | 132 | 124 | 127 | 118 |
| Charcoal burning stoves | Anglo | NLS |  |  |
| SFC – g/kg food cooked | 55 | 65 |  |  |

In percentage, that is:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wood burning Stove | Keren | SAE | NKS | NLS |
| SFC comparison | - | - 6.06% | - 3.78% | - 10.6% |
| Charcoal burning stoves | Anglo | NLS |  |  |
| SFC comparison | - | + 18.18% |  |  |

## Introduction

Before disseminating an ICS as an improvement to traditional biomass stoves, we have to know for sure that the ICS is better than a traditional stove to be replaced as well as find out how much improvement the ICS has made. To give an accurate answer to the problems above, a scientific test is a must, and the easiest test to do is Water Boiling Test (WBT).

WBT, in short, is carried out by boiling a certain amount of water. After weighing how much wood a stove consumes during the test and how much charcoal remains at the end of the test, we obtain some technical parameters (*Time to Boil, Thermal Efficiency, Burning Rate, Specific Fuel Consumption*, etc.) as a measurement of the stove performance tested with WBT. Thus, by applying Water Boiling Test on an ICS and on a traditional stove, we can have a performance comparison between the two stoves. If WBT shows that the ICS is not better in performance than the traditional one, we don’t need to step forward to a more complex and expensive test. We can already conclude that the ICS requires some design improvement.

However, merely boiling water and not cooking actual food, WBT cannot measure effectiveness of the stove tested. Cooking actual food may require different fire intensity and cooking duration than that when boiling water. Thus, solely relying on WBT has a risk of a misleading result. For example, a stove may be considered good for it has a good performance on WBT. However, when it comes to cooking actual food, the stove is unable to cook food thoroughly. In other words, the stove is efficient but ineffective. And most importantly, WBT cannot measure how much fuel a stove consumes on daily cooking activities.

Given the limitation of the WBT as mentioned above, we need to perform a CCT (Controlled Cooking Test).

## On CCT

CCT is a laboratory scale test to compare performances of two stoves by using actual food. Here, laboratory scale means that the cook, food, cooking appliances, and location is kept similar over the course of the test. Due to the similarities, then differences resulted can be concluded as performance differences of the two stoves. In addition, with the cook cooking actual food, we can get information on complaints, compliments, and comments from him/her to be used later on to estimate public acceptance if the better stove is disseminated to the people.

In order to find out potential performances of various stoves and their potentials to be disseminated, CCT is applied on some ICSs and on some traditional stoves as well for comparison.

CCT protocol applied here is the CCT Approvecho-University of California Berkeley.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| STOVES TESTED |  |  |  |  |  |  |
|  | **FUEL** | **GRATE** | **HEAT INSULA-TION** | **POT HOLE NUMBER** | **RETAIL PRICE** | **DURA-BILITY** | **AVERAGE WEIGHT** | **MARKET AVAILABILITY** |
| **NLS** | WOOD AND CHARCOAL  | A | A | 1 | - | HIGH | 12.5 | NOT AVAILABLE |
| **ANGLO** | CHARCOAL  | N/A | N/A | 1 | Rp 3.000.,  | LOW | 2.75 | AVAILABLE |
| **KEREN** | WOOD | N/A | N/A | 2 | Rp 5.000,- | LOW | 2.75 | AVAILABLE |
| **SAE** | WOOD | N/A | N/A | 1 | Rp. 17.000,- | MEDIUM | 8.75 | AVAILABLE |
| **NKS** | WOOD | A | N/A | 1 | - | MEDIUM | 8.75 | NOT AVAILABLE |


## Cooking Preparation

### Cooking Site

The test was carried out at the house of Head of Karanganom Sub-village, Wonokromo Village, Plered Sub-district, Bantul District, Yogyakarta. The location was selected due to a high number of housewives there who traditionally use wood and charcoal stoves for daily cooking activities.

Cooking site was on the backyard of the house. However, for this occasion, the house owner provided roofing and a sort of wall made of metal sheets to protect the test from wind and rain. The site, more or less, resembled common Javanese kitchens.

### Fuel

Wood and charcoal had been bought and sundried since 3 months before. Using dry wood and charcoal, it was easy to start the process, and fire was not easily died. Besides, smoke produced was less than that when using wet or green fuel. Wood species used was teakwood (*tectona grandis*).

### Test performers

On this CCT, each stove was tested by two persons, an observer and a cook.

An observer was responsible for preparing CCT, weighing cooked food during CCT, weighing the remaining wood or charcoal at the end of the CCT, and recording the testing process.

Cooks were local housewives who were used to cooking by using the stoves tested. Each cook was asked to cook and prepare food according to cooking procedures previously agreed collectively with other cooks.

|  |  |  |
| --- | --- | --- |
| Test performers | **OBSERVERS** | **COOKS** |
| Charcoal Stoves | Indar Priyaji | Amronah |
| Yuni Supriyati | Sarmini |
| Ferdinandus | Ani Rahman |
| Wood Stoves | Hartini | Asmudah |
| Edelbertus Jara | Zumi Musri |
| M.Zakky F.R | Wahyuni |

Each team (1 cook and 1 observer) tested every stove three times, and each stove was tested by three cooks. Thus, each stove was tested 9 times.

The cooks were used to cooking by using biomass stoves, so it was believed that they would be able to optimize the abilities of the stoves to be tested.

Since they come from one same neighborhood, supposedly they have same perceptions in cooking (e.g. same perception in judging whether a food is done or not, same perception on crispiness of fried *tempe*, etc.)

## Stove Preparation

BeforeCCT, the stoves have been used for cooking for several times, so that they were dry enough for CCT. A wet stove may absorb heat produced from wood combustion such a way that it reduces the stove’s performance.

### Menu

Selected menu was a common menu in Javanese tradition. It was a full course for a small family (5 people), i.e. rice, vegetable soup, fried *tempe*, *sambal*, and drinking water. For details of the menu, see appendix.

### Practice

Their traditional stove are Keren and Anglo, so ICS’ like NKS and NLS is new to them yet the cooks should be familiar with the NKS and NLS that they are able to use the stove correctly. Thus, they have to learn to cook with NKS and NLS for particular time to be familiar with the stove. Because of limited of time (10 days) and amount of newly arrived NLS and NKS for the CCT from Cambodia (1 stove for each type), we decided to ask cooks to use JKTI’s collection of NKS and NLS. JKTI have 2 NKS and 1 NLS from Philippines and many Thai Buckets (TB). Total NKS for familiarity practice are 3 stoves, fit with the total cook for wood stove. For charcoal stove, they practice with 1 NLS from Cambodia, 1 NLS from Philippines and 1 Thai bucket.

BeforeCCT, cook and observer practice pre-test: conducting CCT so that cook and observer know how to conduct CCT, what step do they take before CCT and during CCT.

On 19 - 20 August 09, observer and cook did try out on how to conduct CCT. On the two days, each cook was practicing or doing CCT only 2 times because few days later time was going into Ramadan. They didn’t want to do CCT during Ramadan and Idul Fitri. Due to limited time (each stove is tested 2 times), the results can not be used to describe performance of the stove.

CCT Practice:

* Ani Rahman – NLS Cambodia – Charcoal
* Amronah – NLS Phillipina - Charcoal
* Sarmini – TB Kragilan - Charcoal
* Asmudah – NKS Cambodia – Fuel Wood
* Wahyuni – NKS YDD lama – Fuel wood
* Yumimusri – NLS – Fuel wood

## Actual CCT

CCT was carried out from 20 October to 7 November 2009. Based on the cooks’ request, CCT was carried out once a day from 10:00 a.m. to 12:00 p.m.

Before testing, observers:

* Weighing raw food (rice, vegetable oil, etc) according to menu. See appendix for detail of raw food.
* Cleaning and weighing cooking utensil. Every cooking utensil is on dry and clean condition.
* Prepares and weigh fuel just enough for cooking food thoroughly. Then the fuel is placed within cooks’ reach.
* Prepare weighing scale in a place so that it’s not disturbing cooks and observers activity.

Having all prepared, cook starts a fire and CCT begins. Cook kindles fire while cooks, including wash and chopping vegetable according to collectively agreed size. Cooks chop vegetable while cooking and kindling fire is similar with their cooking habit. Observer observes and record testing process. As soon as a food is done, observer weigh and record the weighing result. After all food is done, cook weighs remaining fuel (including remaining charcoal on wood stove).

Weighing result is input on computerized spreadsheet that the calculation is performed automatically.

CCT RESULTS OF WOOD STOVES

**(Average of 3 Tests)**

CCT RESULTS OF CHARCOAL STOVES

**(Average of 3 Tests)**


## Analysis and Conclusion : Wood Stoves

On this CCT, amount of Total Weight of Food Cooked result is different in between stoves. Compared to Keren Stove, SAE is 0.4% higher, NKS is 1.7% less and NLS is 0.2% less. Evaporating rate correlates with Cooking Time and heat produced by the stoves. Having compared with Cooking Time (see graphics below), NKS is concluded as hotter stove.

*Equivalent dry wood consumed* is net wood consumed during test and converted to 0% moisture content. This parameter can serve as direct measurement on wood consumption of stoves. In comparison with Keren, SAE needs 5.6% less wood to cook, NKS 5.8% and NLS 10.8%.

*Weight of wood remaining* is incompletely burned wood collected at the end of the test. The parameter directly indicates combustion quality on wood stove combustion chamber. The more is wood, the worse is combustion quality. A lot of factors affect combustion quality, few to mention are primary air supply and size or shape of pot rest.

Compared to Keren*,* SAE uses almost the same amount of wood (3.4% less than Keren) while NKS uses the most wood (64.7% less remaining than Keren). NLS, though is not as dramatic as NKS, and also shows better performance than traditional Keren (22.6% less than keren). This fact proves that stove with grate has better combustion quality than stove without grate.

SFC is how many grams of wood consumed to produce 1 kg cooked food. The more SFC, the more fuel consuming is the stove. According to Picture above, SAE’s SFC is 5.9%, NKS 4.1% and NLS 10.7% less than Keren. Therefore, NLS uses less fuel than the three other stoves.

Among 4 tested stoves, SAE is the fastest stove. Compared to Keren, SAE is 22.8% faster than Keren and NKS 12.2% faster than Keren whereas NLS is the slowest stove, at 2.3% slower than Keren.

## Analysis and Conclusion : Charcoal Stoves

Entire test is conducted with identical amount of foods. However, in the end of test, total weight of food cooked of the two stoves comes out differently. On picture above, *Total weight of cooked food* of NLS is less than Anglo. The difference happens because of the difference in evaporating rate between stoves. Evaporating rate correlates with Cooking Time and heat produced by the stoves. Since Cooking Time of Anglo turns out to be longer than NLS (see Cooking Time picture below) we can conclude that NLS is hotter stove than Anglo. In comparison, average of Total Weight of Food Cooked NLS 1.34% less than Anglo. However, distinction between the different cooking tasks and respective consumption has not been done, or testing with different sequence of tasks.

Equivalent dry charcoal consumed is the weight of charcoal consumed during test (converted to 0% humidity). This is a direct measurement of charcoal consumption. To cook food on identical amount of food, Anglo only consumed 440 grams while NLS 514 grams or NLS consume charcoal 16.76% more than Anglo.

SFC is how much grams of wood consumed to produce 1 kilograms of cooked food. The higher SFC is, the worse is stove performance. To produce 1 kilogram of cooked food, Anglo consumes 54 grams while NLS consume 65 gram of dry equivalent charcoal. NLS has 19.9% higher SFC than Anglo.

*Total Cooking Time* is time gap between starting fire and last food is done. It turns out that Anglo cooks longer than NLS. With exactly same amount and kind of food, Anglo takes longer to cook than NLS. NLS cook 33.6% faster than Anglo.

## Complaints, Comments and Compliments

Selected cooks are housewives using biomass stove at daily life. As experienced users, their judgments on applicative aspect of a stove on daily use are immeasurable in assessing and evaluating the stove.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Wood Stoves |  |  |  |  |  |
|  | **DESCRIPTION** | **NKS** | **SAE** | **NLS** | **KEREN** | **NOTE** |
| **Plus** | User friendly | Y |   |   | Y | NKS and KEREN is considered easy to start a fire on and cook don’t need to kindle wood very often |
| Fast Cooking | Y | Y | Y |   | SAE cooks fast because it has two pot holes.  |
| Able to produce blazing fire | Y |   | Y |   |   |
| Fuel Saving | Y | Y |   |   |   |
| Fuel versatility  |   | Y |   | Y | Cooks prefer stove that can burn small rather than big size fuelwood.  |
| Inexpensive Price |   |   |   | Y |   |
| Availability  |   |   |   | Y |   |
| **Minus** | Troublesome on operating stove  |   | Y |   |   | Cooking with SAE, cook cannot do other task simultaneously. Cook must sit the stove most of the time. Food must be prepared before cooking.  |
| Require Special Fuel  | Y |   | Y |   | NLS and NKS can only be fueled with twig or chopped wood.  |
| Requires additional equipment  | Y |   | Y |   | Using NLS and NKS, cook needs a prop to support fuelwood. |
| Slow Cooking |   |   |   | Y |   |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Charcoal Stoves |  |  |  |
|  | **DESCRIPTION** | **NLS** | **ANGLO** | **NOTE** |
| **Plus** | Fast Cooking | **X** |  |   |
| User friendly | **X** |  | Easy on adding charcoal  |
| Availability |  | **X** | Available everywhere in local stores |
| Inexpensive Price |  | **X** |   |
| **Minus** | Fuel consuming | **X** |  |   |
| Difficulty on starting a fire  | **X** | **X** | Often cook should fan the stove for quite a long time before it gets ready to cook  |
| Slow Cooking |  | **X** |   |

# Section 3: Conclusions and discussion:

This study assessed the markets for traditional cooking devices in Central Java and tests improved devices as compared to the traditional appliances.

Cook stove producers in Central Java are mostly families running small scale inherited enterprises. Commonly, they have been established for a long time. Most producers lack formal education and produce stoves because of their heritage and skills that have been passed on in the family. The producers are all small scale, employing less than 5 people, and producing between 100 and 300 stoves a month, amongst a range of other products for the local market. Producers use black clay, red clay, sand and for a few, cement. Mechanical equipment is used by a minority of producers only in raw materials mixing. Most producers rely on manual/human power in stove production. Overall, producers are small scale and have low monthly stoves production capacities. Income from stove production is around $0.1-0.3 per stove and $10-60 per month. Most producers use highly no mechanized equipment and inefficient open air kilns or bonfires i.e. pottery is stacked on the ground and covered, for stove firing. Producers usually fire between 50 and 100 stoves per firing. Less than 10% used brick kilns. Most producers use wood, whether exclusively or in mixes with other biomass for stove firing. Producers also tend to distribute their own stoves or to deal with a few local distributors who deliver to end users in small trucks or by bike. Most of the producers (69%) also produced other types of terracotta products, such as flower pots and water dispensers. In other words, they are not dedicated stove producers.

The demand for traditional stoves has been in decline in recent years as the population of central Java has been given access to electricity and also migrated up the energy ladder toward LPG and away from Kerosene. Even so many people in the region, over 50% of households, rely on direct combustion of biomass for cooking. In these cases the stove are home-made from concrete, brick or scrap material or locally purchased. There are two stove types of traditional cookstove’s produced for the trading market - a fuelwood stove, Keren and a charcoal stove, Anglo.

Improved cooking stove technologies that improve the efficiency of cooking should be considered for these groups. If we consider wood burning stoves, the cooking tests reveal that only the NLS shows significant – even though not spectacular – gain in comparison with the traditional stove (Keren). Its production price would however have to be competitive, below $5 USD, to break into the market. Regarding charcoal burning stove, indeed, the NLS shows considerably lower performance than the traditional stove (Anglo). The results of this limited test suggest that there are no efficiency gains to be had by disseminating NLS technologies in Indonesia. To be blunt, they are more expensive and, according to these results at least, no more efficient.

They are however more durable and these exercises shed light on more appropriate options for the region. If an appropriate technology can be found the ICS project has good potential in the region. Also, the structure of the traditional stove markets and networks of producers mean that a ‘local production’ approach could be used to train networks of local artisans to produce both of these improved technologies. However, the limited gains in efficiency mean that other appliance designs i.e. not NLS technologies per se, and technologies should be considered for the Indonesian context. These improved stove to be considered will have to display significant efficiency improvement i.e. show ability to substantially reduce energy consumption and emissions of particulates that contribute to indoor air pollution, and also cost competitiveness with traditional technologies i.e. show a realistic pay-back period through fuel savings and be accessible to rural communities in price and physical dissemination. There also remains room for local production of such technologies in Central Java, although other dissemination models, such as import of machined parts of prefabrication, should be considered.

## Sources

Ogle, D. (2005) - Why you shouldn’t use “efficiency” numbers to choose a stove - Aprovecho Research Center

<http://www.bioenergylists.org/stovesdoc/Ogle/efficiency/thermal%20efficiency%20damon-dean.pdf>

GERES 2009 – Woodfuel flows in Central Java

GERES 2009 – Household Energy survey

1. Compared to the magnitude of future potential intervention. Roughly 2,500,000 improved stoves per year will eventually need to be supplied if an improved stove program were to outreach 100% households in Central Java and Yogyakarta - taking into account that there are about 5,000,000 fuelwood using households in the provinces and a stove lifetime of about 2 years. [↑](#footnote-ref-2)
2. The term “wholesaler” used in the survey is unclear, as the survey did not define specifically its criteria. There can be an overlap with “distributor” who are also selling stoves to retailers. [↑](#footnote-ref-3)
3. This is ambiguous, i.e. whether this meant that retailers retailed stoves in the local market or just delivered stoves to retailers in the local market or any other sales/delivery mechanism. [↑](#footnote-ref-4)
4. The situation on cooking energy mix in Indonesia/Java has been very dynamic since the introduction of the LPG Program. However recent survey demonstrate that the introduction of the Program has not caused significant decrease in the use of biomass, i.e.fuelwood use for cooking in Central Java has continued to be significant. [↑](#footnote-ref-5)
5. Ogle, D. (2005) - Why you shouldn’t use “efficiency” numbers to choose a stove - Aprovecho Research Center

<http://www.bioenergylists.org/stovesdoc/Ogle/efficiency/thermal%20efficiency%20damon-dean.pdf> [↑](#footnote-ref-6)