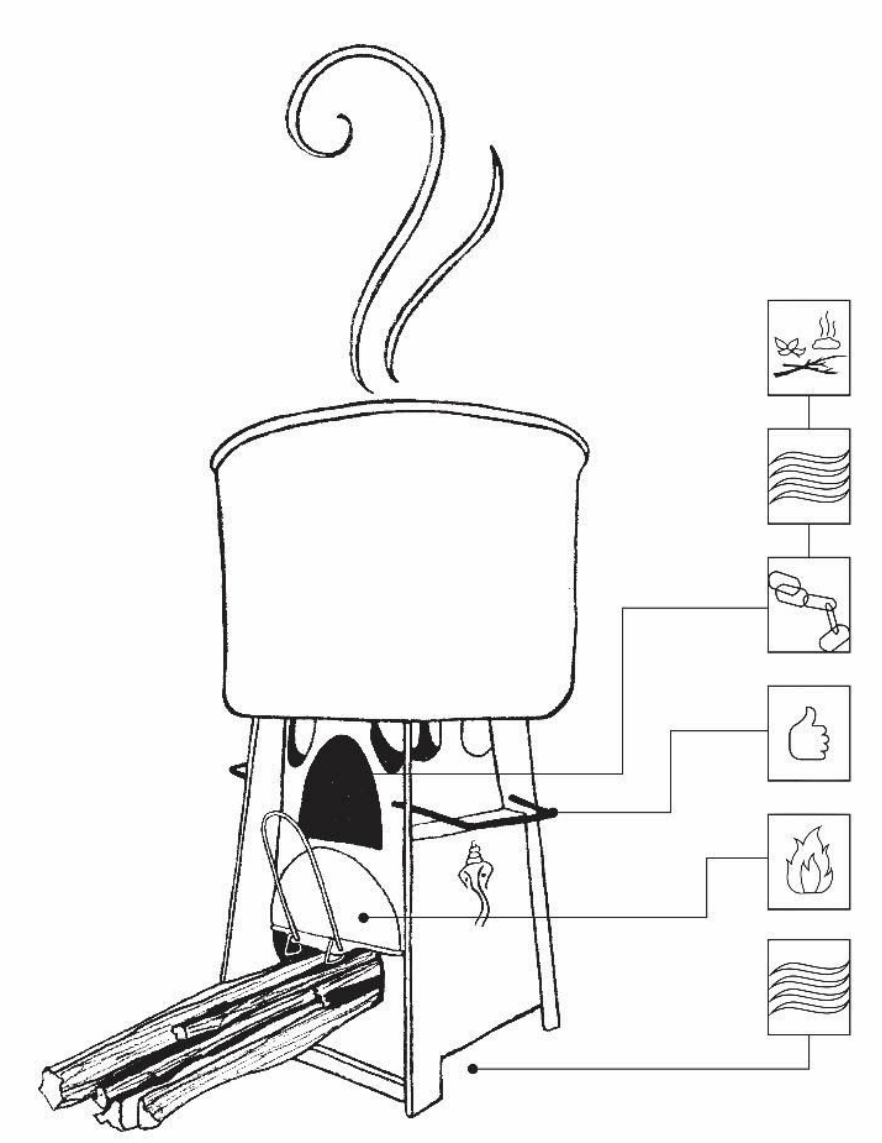

USABILITY SURVEY REPORT OF GANESHA COOKSTOVE PILOT PROJECTS IN NEPAL

SUPPORTED BY THE GANESHA COOKSTOVE PROJECT

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EXECUTIVE SUMMARY

In Nepal, official figures show that 64% of households rely on firewood for cooking, and just 26% have access to clean cooking solutions such as improved biomass cookstoves. The Ganesha Cookstove Project is aimed at creating a low-cost, easy-to-transport stove that not only meets international standards for efficiency and emissions, but also meets the cooking needs of villagers in Nepal.

Usability of the Ganesha biomass cookstove was measured at six different sites in Nepal, and compared to the usability of existing traditional stoves, LPG (gas) stoves, and other stoves in use. A total of 340 Ganesha stoves were distributed, primarily to disadvantaged villagers, and usability surveys were conducted 3 weeks to 6 months after users received the stove. Very little to no training was given in the use of the stove.

A usability survey was developed based upon research by the Centre for Rural Technology Nepal (CRTN), which determined 8 key factors in cookstove usability. Users were asked to rank their stoves, including the Ganesha stove, on those factors. The survey also asked questions to determine hours of use, fuel consumed, and the kinds of food cooked on different stove types. To determine stove acceptance and behavior change, the survey asked if users would buy the Ganesha stove, and if so what they would pay. They were then asked what they would cook on the stove, and how much it would cost to use, and what they liked. Open-ended comments and suggestions were then solicited.

Demographics: 98% of respondents were female, in households that mostly had a family size of 4 to 6 people.

Cooking practices: Respondents cooked 2 to 3 meals for their household each day, and also prepared warm or hot animal fodder in large flat-bottom pots once per day. Foods cooked included *dhindo,* a dish made of corn or millet flour that requires vigorous stirring; rice, legumes, flatbreads, vegetables, potatoes, and dairy products. Alcohol making was also common, and used large stills. Typical cooking pots included a semi-circular bowl called *karaai* for boiling and frying vegetables, and sometimes for making *dhindo;* a heavy round-bottomed pot called *kasaudi*; pressure cookers; and tea kettles. The overwhelming majority (93.5%) used traditional open fires for almost every cooking task prior to these pilot projects. Where respondents had LPG stoves, they used them for making tea and quick-serve meals.

Comparison of usability factors: The 8 key factors identified by CRTN included 1) Fuel Saving, 2) Time Saving, 3) Smoke Reduction, 4) Multi-Purpose, 5) Ease of Use, 6) Safe to Use, 7) Keeps Kitchen Clean, and 8) Looks Nice. The CRTN study and others showed that three attributes – Smoke Reduction, Time Saving, and Fuel Saving – were essential attributes of a clean cookstove. Users ranked the Ganesha stove highest for 2 of these factors: Fuel Saving

and Time Saving. They also ranked the Ganesha stove highest for Multi-Purpose and Safe to Use. They did not rank their traditional stoves highest for any of the 8 factors. LPG stoves were ranked highest for Smoke Reduction, User-Friendliness, Keeps Kitchen Clean, and Looks Nice.

Cost of cooking: Fuel costs varied widely among the 6 pilot project areas. Based on user reporting and subsequent calculations, traditional stoves were the most expensive to use, both overall and per hour of use. Ganesha stoves were found to be significantly cheaper to use, with about half the fuel consumption per hour on average. LPG stoves were well-loved by respondents, and were not reported to be more expensive to use, but were seldom used for big cooking tasks. Users considered them to be “luxury items,” and used LPG only during emergencies, such as hosting unexpected guests, or during the rainy season when fuelwood was wet or unavailable.

Willingness to buy: 93.3% of respondents said they would buy a Ganesha stove if needed and available in the future. When asked what they would pay, most users (69%) said they would pay NPR 500 to 1000 (US$5 to $10). Another 28% would pay more than NPR 1000. This should serve as an indication of the subsidy level needed to meet users’ ability and willingness to pay.

What they cooked on the Ganesha stove: Users said they used the Ganesha stove to cook all of their normal foods, including rice, *dal* (lentils), beans, vegetables, potatoes, *roti* (flatbreads), tea, boiling milk, fish, and *dhindo* (a corn or millet paste that requires vigorous stirring to cook).

User preferences: When asked to provide open-ended comments and suggestions about the Ganesha stove, the most common responses were 1) faster cooking (80%), 2) uses less firewood (72%), 3) fewer emissions (71%), and 4) portability (53%). Users suggested that the stove be made a) to accommodate a bigger pot, b) with a shorter combustion chamber; and c) with a larger opening for wood.

Abbreviations Used in the Text

CBS Central Bureau of Statistics

CCA Clean Cooking Alliance

CCT Controlled Cooking Test

CRTN Centre for Rural Technology Nepal

GCS Ganesha Cookstoves

GCP Ganesha Cookstove Project

HH Households

IAP Indoor Air Pollution

ICS Improved Cookstove

ICS-O Improved Cookstove other than Ganesha Stove

ISO International Standards Organization

KPT Kitchen Performance Test

LPG Liquified Petroleum Gas

NGO Non-Governmental Organization, Nonprofit

NIBC Nepal Interim Benchmark for Cookstoves

RETS Renewable Energy Test Station

RTKC Regional Cookstoves Testing and Knowledge Centre

SDG Sustainable Development Goal

TCS Traditional Cookstove

WHO World Health Organization

1 Introduction

Biomass, primarily in the form of firewood, is the major source of energy for cooking for the majority of people living in low- and middle-income countries in Asia and Africa. About three billion people around the world depend on food cooked over polluting, open fires or inefficient stoves[1] using biomass. Emissions from biomass fuels contribute to 2–8% of anthropogenic climate impacts, and it is estimated that 20–30% of black carbon emissions come from household fuel combustion in inefficient stoves and remain in atmosphere systems. As of 2014, improved cookstoves were used by just 1.3% of the potential market. According to the most recent statistics of the Central Bureau of Statistics in Nepal (CBS), 64% of Nepali households rely on firewood for cooking. In 2014, only 26% of Nepalis had access to clean cooking solutions, including improved biomass cookstoves (World Bank 2017).

A number of efforts have been made by the government of Nepal toward improved cooking, including targets for the use of biomass and LPG in cooking, to meet United Nations Sustainable Development Goals by 2030. The Biomass Energy Strategy (2017)[2] found that nearly 77% of Nepal's energy is supplied by traditional biomass energy. To achieve both national and international goals, the adoption of clean cooking technology in Nepal must be accelerated.

For improved cookstoves to be adopted by a majority of households, they must meet the needs of users, who want to prepare traditional dishes in traditional pots and achieve desired flavors; use locally available fuels; save on the cost of fuel or the time spent obtaining it; and have cooking be easy, efficient, safe and affordable. The most successful stove design efforts are not just created *for* but *with* end users, co-creating the ideal technology.[3]

The clean cooking sector has long sought low-cost, efficient technologies that comply with local or international standards (CCA 2018)[4] and at the same time meet user expectations for performance and usability. What Nepali users of biomass stoves want in a stove was outlined by the Centre for Rural Technology (CRTN 2017).[5] They determined that the key usability factors were 1) Fuel Saving, 2) Time Saving, 3) Smoke Reduction, 4) Multi-Purpose, 5) Ease of Use, 6) Safe to Use, 7) Keeps Kitchen Clean, and 8) Looks Nice.

The Ganesha biomass cookstove (GCS)[6] was developed in accordance with these usability factors and the goal of fulfilling the needs of the lowest-income families in the most remote

[1] WHO, 2018 http://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health
[2] Biomass Energy Strategy document is available at https://www.aepc.gov.np/documents/biomass-energy-strategy
[3] Drawdown, 2017, Paul Hawken (ed.)
[4] Clean Cooking Alliance, Technology and Standards 2018 https://www.cleancookingalliance.org/technology-and-fuels/
[5] The report identified the most essential needs of the biomass stove users all over Nepal through its study entitled Users Need Assessment – This is included as one of the chapters in the Product Development and Labeling of Cookstoves. More information can be found at www.crtnepal.org
[6] More about the Ganesha Cookstove Project is available at www.ganeshastove.com

areas of Nepal, with the most efficient and powerful technology. This report outlines the results of usability surveys of households in six different districts in Nepal that together tested 340 units of the stove.

2 Usability Survey Design/Methodology

2.1 The Project Context

The Ganesha Cookstove Project (GCP) is aimed at creating a low-cost, easy-to-transport biomass stove that not only meets international standards for efficiency and emissions, but also meets the cooking needs of users. The design process began with a small metal stove that was originally tested in the small village of Brabal in Rasuwa District, Nepal. With the help of feedback from the villagers and then laboratory testing by the Regional Testing and Knowledge Centre, the design was further modified through an iterative process. This resulted in a model that met the standards of the Nepal Interim Benchmark for Biomass Cookstoves (NIBC 2016) and received positive reviews from a handful of testers. A total of 340 units of the Ganesha stove (shown in Annex I) were then distributed to 6 pilot project areas across central Nepal to evaluate the usability of the design as compared to other stoves in use.

GCP partnered with 6 different organizations with ongoing humanitarian projects. The majority of stoves were distributed to disadvantaged villagers, who had very low incomes and little access to fuel. The partners identified the beneficiaries based on their own criteria, and distributed the stoves between March and May 2018. The villagers were then allowed a varied amount of time (from 3 weeks to 6 months) before surveyors returned to conduct usability surveys.

The Usability Survey Form (Annex II) was developed to determine:

- Stove Usage: Types of stoves used, how often the use occurred, what was cooked, fuel consumed by each stove, and associated expenses
- User preferences: Users were asked to rank the 8 key attributes identified by CRTN: 1) Fuel Saving, 2) Time Saving, 3) Smoke Reduction, 4) Multi-Purpose, 5) Ease of Use, 6) Safe to Use, 7) Keeps Kitchen Clean, and 8) Looks Nice
- Cooking habits and practices: Field observations and photos of households, foods cooked, and cooking methods.
- Ganesha stove-specific questions: Users were asked if they would like to buy the stove and, if so, what they would pay. They were also asked what they would use it for, what they estimated the monthly fuel expense would be, and what they liked most. Users were also given the opportunity to provide open-ended feedback.

Other stoves in use in the pilot project areas included:

TCS – Traditional cookstoves, including three stone fires made with stones, bricks or mud blocks, and open fires with a metal stand known as *odaan*. In all of the pilot project areas, this was the main stove used to cook animal food, distill alcohol, and cook for large groups.

LPG – Gas stoves using propane fuel in canisters. Most stoves have two burners.

ICS-O – Improved cookstoves other than GCS. In several pilot project areas, a small percentage of households had improved versions of traditional cookstoves made of bricks and mud blocks, designed to burn more efficiently than an open fire. Single pothole and double pothole ICS-O, with and without chimneys, were previously promoted by the government of Nepal and NGOs.

Electric Rice Cooker and Induction Stove (IS) – Rice cookers are single-use electric appliances. Induction stoves use electricity and require certain kinds of iron or stainless steel pots that can induct heat from the stove to the pot. Most traditional pots and pans cannot be used on IS.

2.2 Study Area

The project area includes a wide variety of villages in the Central Hills of Nepal. The sites are generally away from the market hubs, located in remote areas where incomes are very low, and villagers are not able to afford modern cooking technology.

Figure 1: Map of Pilot Project Areas in Nepal. Areas include 1) Bethanchowk, Kavrepalanchowk; 2) Majhigaun, Sindhupalchowk; 3) Dhorpatan, Baglung; 4) Muchchok, Gorkha; 5) Bulingtar, Nawalparasi; and 6) Gokulganga, Ramechhap.

The project sites are in 6 districts: east of Kathmandu - Kavrepalanchowk, Sindhupalanchowk and Ramechhap; west of Kathmandu - Nawalparasi, Gorkha and Baglung.

2.3 Usability Survey Sampling

A large percentage of the households who received Ganesha stoves (GCS) were selected randomly from each village[7]. The sample distribution for usability surveys was as follows:

Table 1: Usability Survey Sample Selection

No	Area	GCS Distributed	Percentage of Population Selected for Survey	Sample selected for Usability Survey
1.	Bethanchowk, Kavrepalanchowk	10	100%	10
2.	Majhigaun, Sindhupalchowk	50	40%	20
3.	Dhorpatan, Baglung	100	48%	48
4.	Muchchok, Gorkha	40	25%	10
5.	Bulingtar, Nawalparasi	40	25%	10
6.	Gokulganga, Ramechhap	50	20%	10
7.	Kalinchowk, Sindhupalchowk	50	-	-
	Total	340	32%	108

[7] One village in Kalinchowk, Sindhupalchowk couldn't be surveyed.

A total of 108 households were selected for the usability survey (32% of total HH).

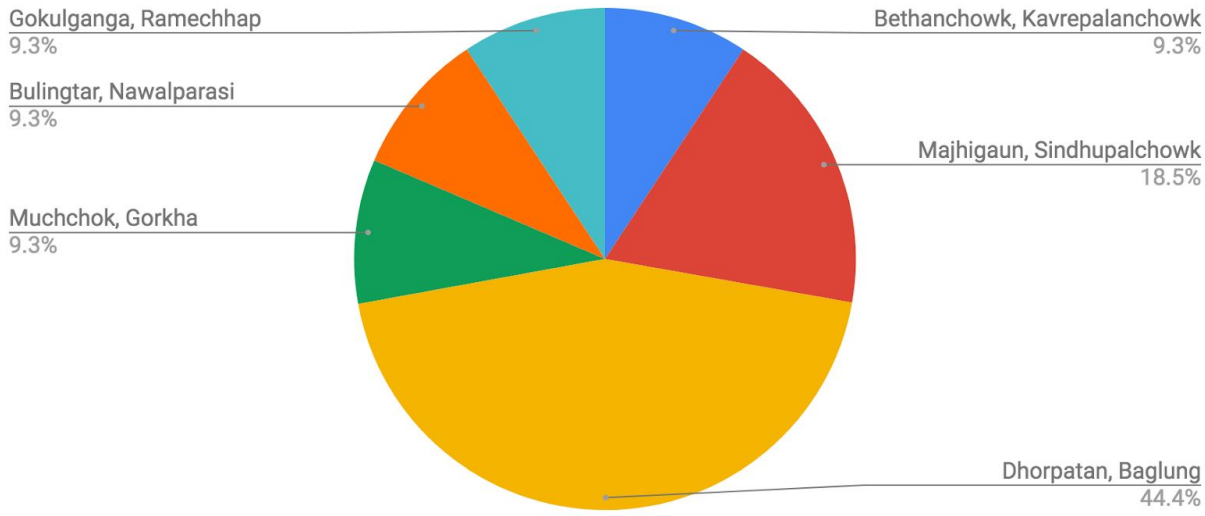


Figure 2: Usability Survey Households Selected in the Pilot Project Areas

2.4 Data Collection and Analysis

In Bethanchowk, Kavrepalanchowk and Majhigaun, Sindhupalchowk, the principal investigator led usability surveys. In the remaining 4 project sites, partner organization representatives were trained by the principal investigator and provided with forms in both English and Nepali. Partner organizations then returned the completed forms, along with photos, videos and observations, for analysis.

Data entry was done using a Google form created for this survey. Additional information was also gathered through telephone interviews with surveyors to understand site-specific information that wasn't included in the forms, or when the information on the form needed clarification.

A scale was assigned from 1 to 5 (worst to best) for attributes. Analysis was then completed using Excel tools.

2.5 Ranking, Weighing and Analyzing Attributes

The mean score per household was calculated for each attribute that made the basis of comparison within the households, within the pilot areas and in analyzing the overall picture of each attribute for each kind of stove.

Illustration:

For example: A household marked its preferences for stove_1 and its features as:

Col_1	Col_2	Col_3	Col_4	Col_5	Col_6	Col_7	Col_8	Col_9
	Smoke Reduction	Time Saving	Fuel Saving	Multi-purpose	User_friendliness	Safety	Clean_kitchen	Good_looks
HH1,stove_1	3	4	3	2	4	2	1	3
HH2,Stove_1	4	3	5	3	4	4	3	3
HH3,stove_1	3	2	1	4	2	1	3	3

Mean Score for Smoke reduction of HH1 $\overline{X} = \frac{\sum Row\ 2\ to\ Row\ Row\ 4\ of\ col\ 2}{No\ of\ HH}$

= (3+4+3)/3

= 10/3

= 3.33

Mean Score for time_saving of HH1 $\overline{X} = \frac{\sum Row\ 2\ to\ Row\ Row\ 4\ of\ col\ 3}{No\ of\ HH}$

= (4+3+2)/3

= 9/3

= 3

Now it can be inferred that the score for smoke reduction of a pilot area is greater than time saving and hence, users perceive that stove 1 is better in terms of reducing smoke than saving time.

Similar calculations were made for all attributes and households, and compared among the stoves and locations.

2.6 Fuel Use and Cost Calculations

Fuel amount in kilograms (Kgs) and the cost in Nepali Rupees (NPR) along with the daily use time in hours was collated from form data.

Illustration:

	Fuel Use (Kgs)	Daily Use Time (Hrs)	Cost (NPR/kg)	Total Cost (NPR)
HH1; Stove_1	2	2	12	24
HH1; Stove_2	4	1.5	12	48
HH1; Stove_3	5	1	12	60

For each household, average fuel use in a month (Kg/M/HH), average cost of fuel per month (NPR/Kg/M) and average cost of cooking event (NPR/Hr) was calculated from this information.

3 Results

3.1 Demographics

All of the survey respondents were the primary cooks in their family. 98% were female, with the largest percentage 41 to 50 years of age (20.5%), followed by 21 to 40 years (19.2%). Family size ranged from 1 to over 10. The most common family size was 4-5 (34%), followed by 5-6 (32%). Another 25% of HH had 7 or more members. Only 10% had 1-2 members.

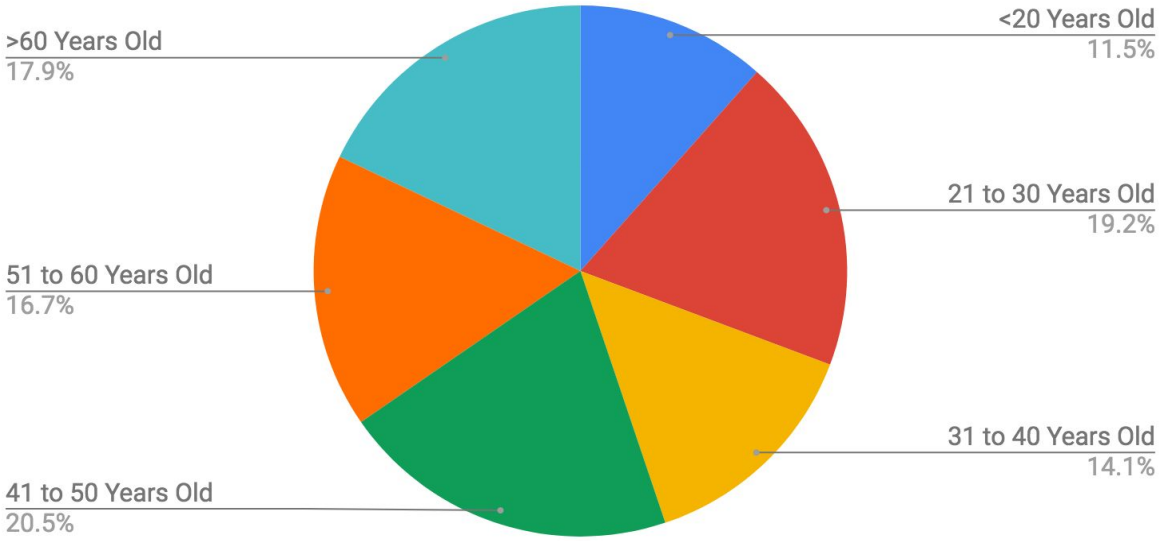


Figure 3: Age of the Main Cook

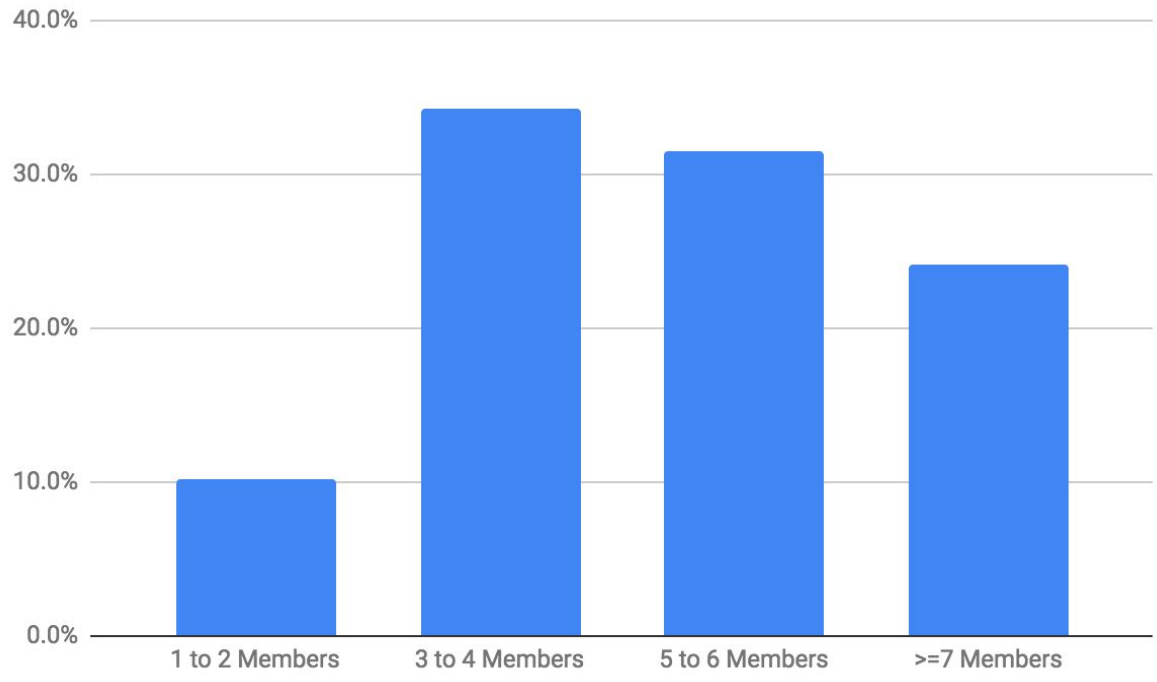


Figure 4: Family Size

3.2 Cooking Practices in Pilot Project Areas

3.2.1 Bethanchowk, Kavrepalanchowk

Villagers in Bethanchowk regularly cook rice, legumes *(dal)*, vegetables, wheat flatbread *(roti)*, animal feed, tea and snacks. They also boil milk and water. The types of cooking devices in use prior to this pilot project included: 1) earthen or metal tripod traditional open fires; 2) improved earthen stoves with two pot holes and a chimney; 3) LPG gas stoves, usually with two burners, that use standard LPG cylinders; and 4) electric rice cookers. A small number of rice husk stoves, which burn wood together with sawdust or rice husk, were also in use. The majority of fuel used is in traditional open fires, primarily for the making of animal feed. LPG stoves are used for small-sized cooking events such as snacks (popcorn, tea), and cooking at rush hours. The remaining stoves are used for major meals such as lunch (rice, *dal*, vegetables) and dinner (*roti*, vegetables). In addition to household cooking, most people in Bethanchowk practice commercial vegetable farming and milk production. *Khuwa,* a dairy product obtained by evaporating milk through continuous boiling and stirring, is made and sold to sweets companies in Kathmandu and nearby towns.

3.2.2 Majhigaun, Sindhupalchowk

In this part of Nepal, corn is the staple crop and many kinds of dishes are cooked out of it. Most common is a boiled corn flour dish known as *dhindo*. Rice, lentils *(dal),* and vegetable soup is the most common food item combination for both lunch and dinner. They usually skip breakfast and compensate with early lunch. They occasionally cook fish and other meat.

Photo 1: Fuelwood in Majhigaun, including construction debris from the 2015 earthquake, and corn cobs.

Cooking stoves were mostly traditional prior to this pilot project, and included three stone fires, metal tripods, and bricks or blocks arranged as tripod. Different-sized flat-bottomed aluminum vessels are the major cooking pots, but pressure cookers are also used by some of the households with smaller family sizes. A few households owned LPG stoves too, but preferred not to use them very often as they reported that the fuel is expensive. Some houses had locally-made charcoal stoves but they were not in use. A few of the households surveyed (2 out of 20) owned biogas digesters with small stoves. These households said they occasionally used them but not frequently, so they preferred not to rank their attributes. The biogas plants were apparently under construction or being transferred to new locations where they are building new

shelters. Firewood and corn cob constitute the major fuels. The wood and furniture of houses destroyed in the 2015 earthquake are the most common fuel sources, since villagers do not have access to the nearby private or community forests.

3.2.3 Dhorpatan, Baglung

In this part of Nepal, there is very little rice production. People fry and bake bread (*roti)* at breakfast and dinner. Along with *roti*, locals eat large quantities of potatoes (steamed or made into *roti*), bean soup, and dairy products. Each of these foods takes a significant amount of time to cook, such as beans that need to be boiled for a long time to soften, and it is time-consuming to fry or bake *roti* for an entire family. In addition to food production, alcohol brewing and distilling is common. Pressure cookers are used to make beans and legumes, and sometimes rice. Semi-spherical open pots (*karaai*) are used for making vegetables and vegetable soup.

Photo 2: A typical kitchen in Dhorpatan with multiple cooking stoves including GCS at left and TCS in back, and a variety of cooking pots. Shown behind the cook is an alcohol still.

Round-bottomed pots with a narrow opening (*kasaudi*) are used to boil rice. They also used a frying pan with handles to fry and cook meat. Closed tea pots (*kitli)* are extensively used for making tea and boiling water. Typical cooking stoves prior to this pilot project were three stone fires and a few LPG stoves.

3.2.4 Muchchok, Gorkha

Daily common food in Muchchok includes morning tea followed by an early lunch of rice, vegetable curry, and lentils *(dal).* In the afternoon, people eat light snacks that include beaten rice *(cheura)*, popcorn *(makai)*, and flatbread *(roti)* with tea. Dinner includes rice or *dhindo* eaten with vegetables and lentil soup or dairy products such as curds, whey or milk. Cooking stoves prior to this pilot project were all traditional: three stone fire, metal tripod, bricks and blocks arranged as tripod.

Photo 3: A user in Muchchok prepares to cook vegetables on GCS.

Different-sized flat-bottomed aluminum vessels are the major cooking pots, but pressure cookers are also used by some of the households with smaller family sizes. Firewood is the main fuel source, obtained from nearby forests. People sometimes also use agricultural bi-products such as lentil stalks, corn cobs and stalks, and twigs and branches of the shrubs and trees from their private fields.

3.2.5 Bulingtar, Nawalparasi

In this area, daily common foods include morning tea followed by an early lunch of rice, vegetable curry, and lentils *(dal).* In the afternoon, people eat light snacks that include beaten rice *(cheura)*, popcorn *(makai)*, and flatbread *(roti)* with tea. Dinner includes rice or *dhindo* eaten with vegetables and lentil soup or dairy products such as curds, whey or milk. Cooking stoves used prior to this pilot project were all traditional: three stone fire, metal tripod, bricks and blocks arranged as tripod. Different-sized flat-bottomed aluminum vessels are the major cooking pots, but pressure cookers are also used by some of the households with smaller family sizes.

Photo 4: Many villagers made use of the portability of the Ganesha stove, like Humisara Khandalu in Bulingtar, Nawalparasi. She prefers to cook in the yard when the weather is good.

Firewood is the main fuel source, obtained from nearby forests. People sometimes also use agricultural bi-products such as lentil stalks, corn cobs and stalks, and twigs and branches of shrubs and trees from their private fields.

3.2.6 Gokulganga, Ramechhap

In Gokulganga, *dhindo*, rice, beans and vegetables are the main food items. Potato is extensively grown and is a staple crop, along with millet, buckwheat and maize. Prior to this pilot project, most of the cooking stoves were traditional. Different sized flat-bottomed aluminum vessels are the major cooking pots but pressure cookers are also used by some of the households with smaller family sizes. Firewood is the main fuel source. Some of the households also use agricultural residues such as corn stalks and corn cobs.

3.3 Stoves in Use

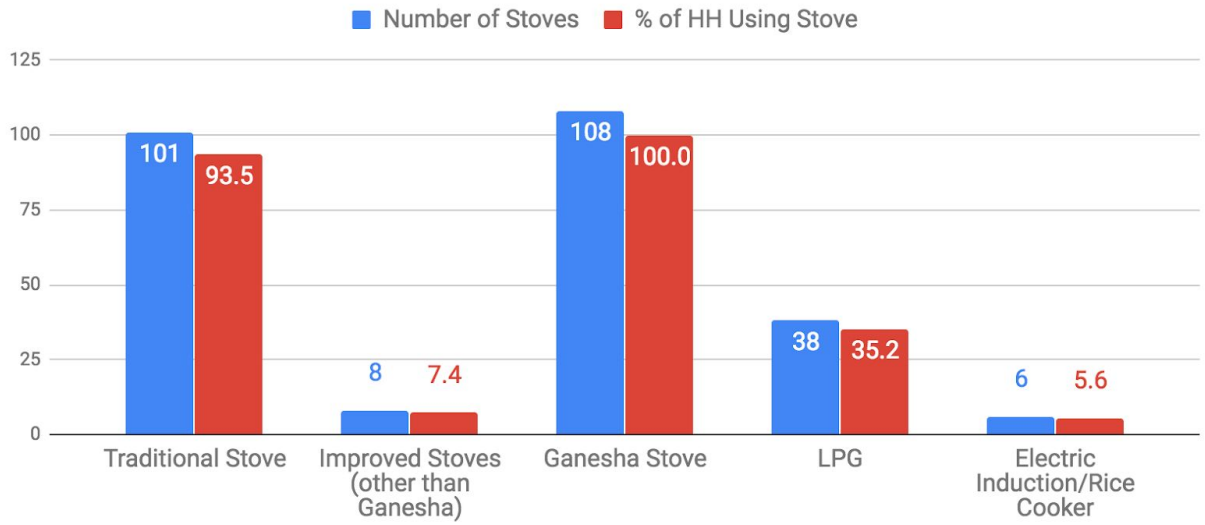


Figure 5: Number and Types of Stoves in Use Among Survey Households

Prior to these pilot projects, 93.5% percent of respondents used traditional cookstoves, 7.4% used improved cookstoves other than Ganesha stoves, 35.2% used LPG, and 5.6% used rice cookers or induction stoves.

3.3.1 Global Comparison of Attributes of All Stoves

CRTN identified the most preferred usability attributes through a user needs assessment. The 8 attributes measured in this study were as follows:

Attribute	Description
*Fuel Saving	Based on the quantity of fuel consumed
*Time Saving	Considering the time taken to cook meals
*Smoke Reduction	Based on the smoke emissions observed
Multi-Purpose	Based on what the stove can be used for
Ease of Use	Based on ability to be operated easily
Safe to Use	User assessment of safety
Keeps Kitchen Clean	Considering the role of the stove in kitchen cleanliness
Looks Nice	Based on stove appearance
*Considered essential attributes of a clean cookstove	

Among the 8 key attributes surveyed, users ranked GCS highest for fuel saving, time saving, multi-purpose, and safe to use. They did not rank TCS highest for any of the 8 factors. LPG stoves were ranked highest for smoke reduction, ease of use, keeps kitchen clean, and looks nice.

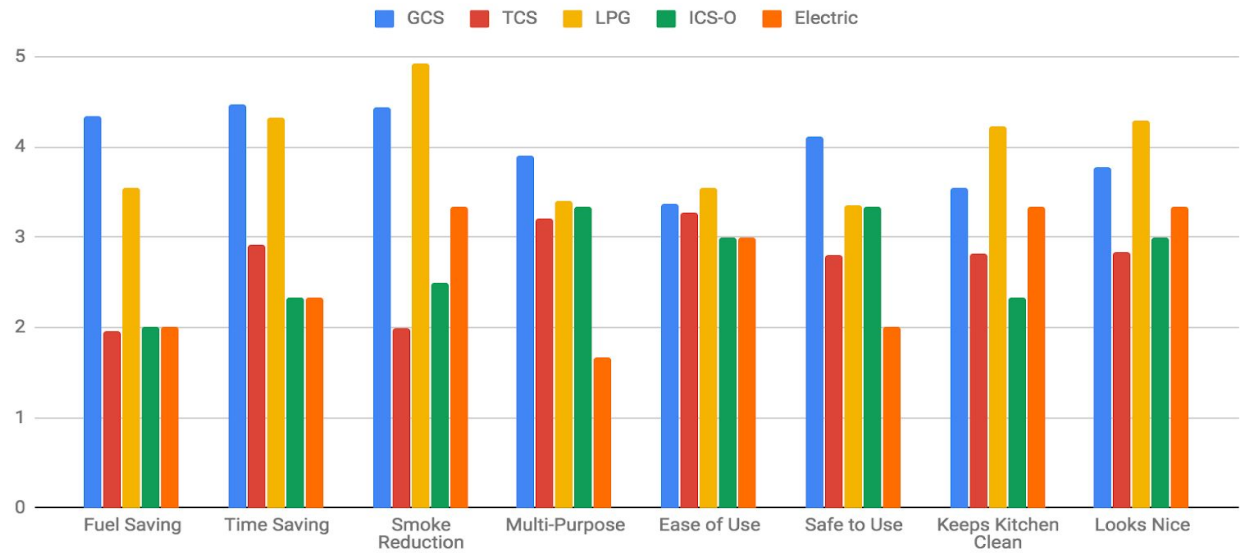


Figure 6: Average Attribute Ranking of All Stoves in All Pilot Project Areas

GCS was found to be the least expensive stove to use, due to its low fuel use. Users also ranked it highest for safety. This stove performed best for saving time, followed by smoke reduction, fuel saving, and safe to use. On average, GCS performed better than TCS and ICS-O.

TCS did not score highest on any of the 8 attributes, but users clearly find TCS to be a useful part of their mix of cooking options. Analyzing attributes of TCS only, the scores for all the attributes ranged from 1.96 (fuel saving) to 3.27 (ease of use). Users ranked TCS worst for smoke reduction and fuel saving, but ranked it highly for cooking multiple dishes and ease of use.

LPG was clearly an aspirational stove, ranked highly by users for many features. Despite their desirability, LPG stoves have a high initial cost and require ongoing expenditures for fuel in cash. Because of the irregular supplies of LPG canisters and a fear that the canisters will leak or explode, most respondents preferred to use TCS or, when available, ICS. Users considered LPG stoves to be “luxury items” and used LPG only during emergencies, such as hosting guests, or during the rainy season when fuelwood was wet or unavailable.

Analyzing attributes of ICS-O, these stoves were ranked high for safety with an average score of 3.3, and low for fuel saving with an average score of 2. On average, these stoves performed better than TCS.

3.3.2 Global Comparison of Important Attributes of Selected Stove Types

To provide a more concise analysis, we compared the 3 main stove types: GCS, TCS, and LPG. This analysis showed that GCS and LPG have the same number of preferences of four each. For GCS, these were: fuel saving, time saving, multipurpose, and safety. For LPG, these were: smoke reduction, ease of use, good looks and keeps kitchen clean.

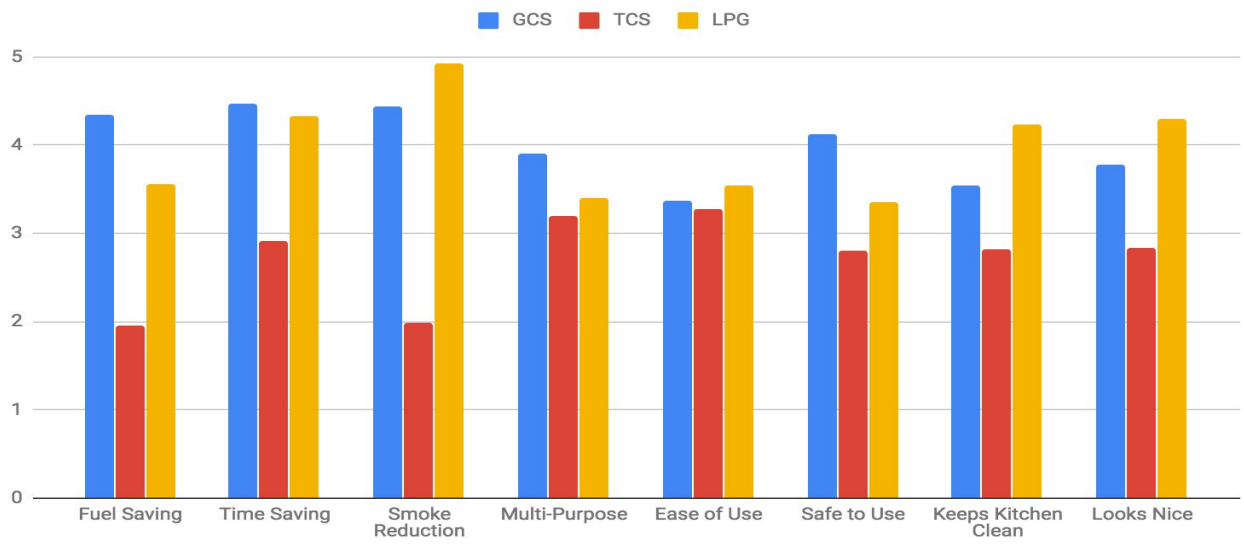


Figure 7: Comparison of Preferred Attributes of the 3 Most Common Stove Types

In this comparison, GCS performed best for fuel saving with 4.34, followed by LPG with 3.55. TCS scored less than 2.

For the time saving attribute, GCS scored highest at 4.47, followed by LPG with 4.32 and TCS with 2.91.

For smoke reduction, LPG scored 4.92 while GCS was ranked 4.44. TCS scored just 1.99.

3.4 Fuel Costs and Cost of Cooking

An analysis of monthly expenses on fuel use in different types of stoves revealed that traditional cooking was the most expensive, both overall and on a per-hour basis. Firewood is usually collected by users, but they do buy firewood when needed. This allowed a determination of the cost of fuel for each area.

Figure 8 shows the overall expense of fuel in the six pilot project sites, and also expense by stove type. Ramechhap had a very high cost of fuel, over NPR 11000 per month per HH. By comparison, Baglung costs were about NPR 6000, Gorkha NPR 5700, Kavrepalanchowk NPR 3200, Nawalparasi NPR 3000 and Sindhupalchowk just NPR 1500.

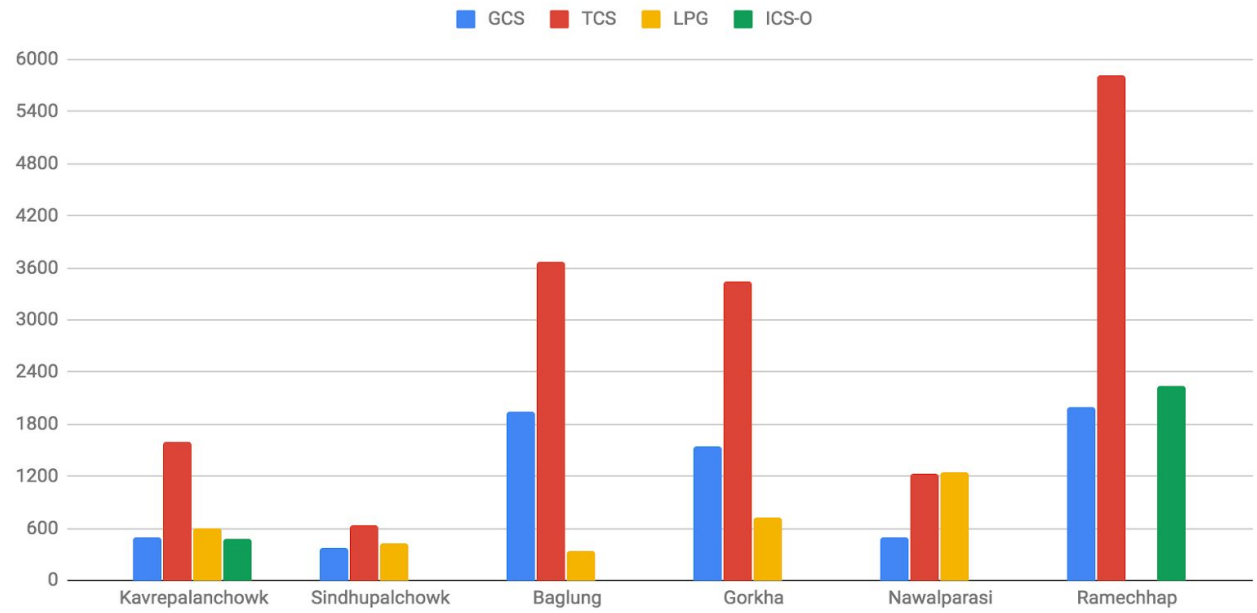


Figure 8: Comparison of All Fuel Expenses (NPR/Month/HH)

The vast majority of fuel used was firewood. This ranged from over 1200 kg per month per HH in Ramechhap and Gorkha, to over 800 kg in Kavrepalanchowk and Nawalparasi, 400 kg in Nawalparasi, and 200 kg in Baglung and Sindhupalchowk.

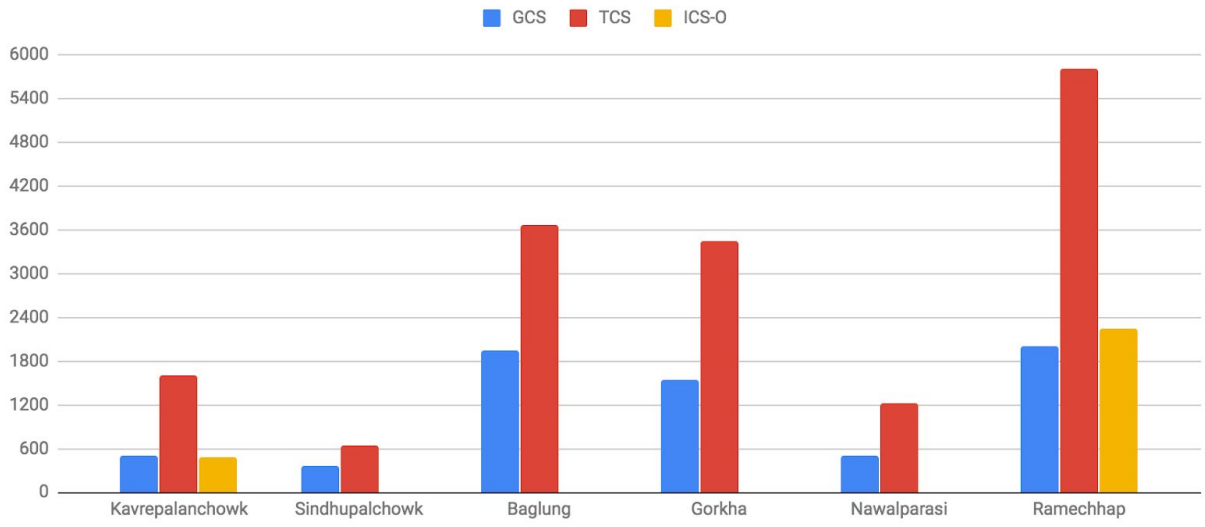


Figure 9: Comparison of Fuel Expenses on Wood Stoves Only (NPR/Month/HH)

The amount of wood fuel used per month varied greatly among project areas. In Ramechhap, total fuel wood used per household per month was over 1,000 Kgs; in Gorkha, the total was 862 Kgs. By comparison, total fuel wood used was lowest in Sindhupalchowk, at 105 Kgs, and in Baglung, at 147 Kgs.

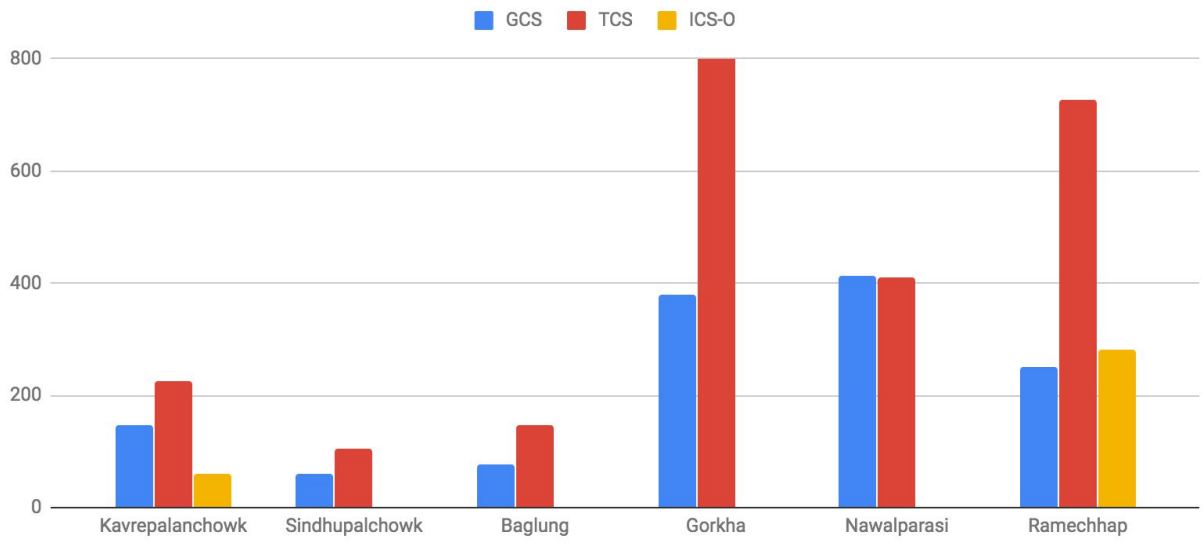


Figure 10: Amount of Fuel Wood Used by Households per Month on Wood Stoves (Kg/HH/M)

Because monthly expenses on fuel are directly related to the frequency and duration of use of each stove, cost per hour of cooking was also calculated (Figure 11).

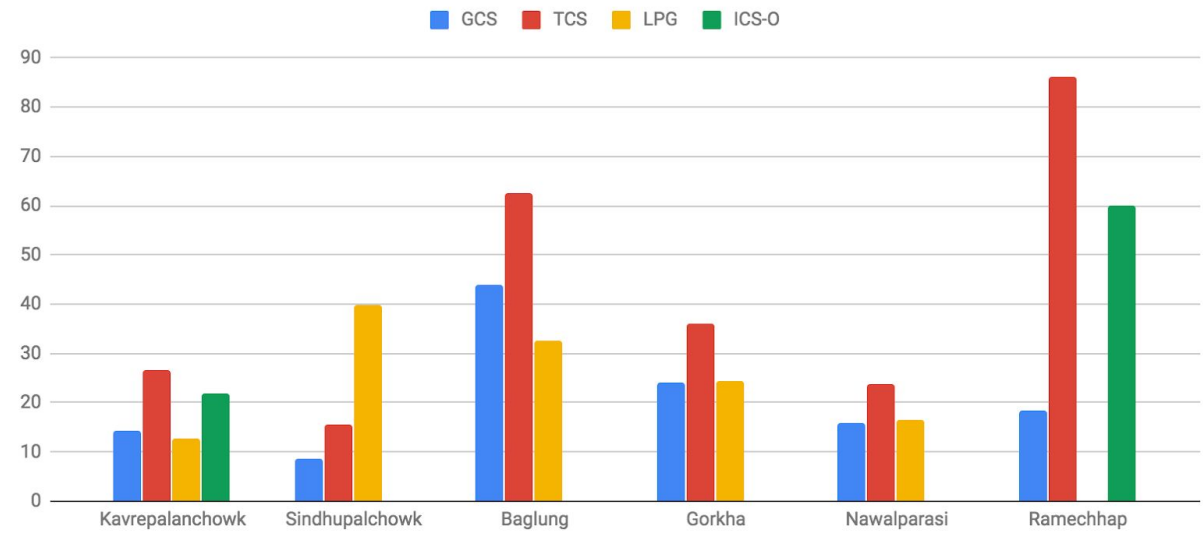


Figure 11: Cost of Cooking Per Hour of Cooking Event (NPR/Hr)

The cost of cooking on GCS varied from NPR 8.6/Hr in Sindhupalchowk to NPR 43.9/Hr in Baglung. In all of the project areas, cooking on GCS was significantly cheaper per hour than cooking on TCS or ICS-O. In general, the cost of cooking on GCS was comparable to cooking on LPG.

The cost of cooking on TCS was calculated to be as high as NPR 86 per hour in Ramechhap, and as low as NRs 15/Hr in Sindhupalchowk. In 5 out of 6 areas, the cost per hour of cooking on TCS was higher than any other option. It should be noted, however, that many villagers use TCS for big tasks that require a lot of firewood, such as heating animal fodder, cooking for big groups, and distilling alcohol. We did not attempt to detail how much of the cost of cooking on TCS is due to inefficiency, and how much may be due to the use of bigger fires in TCS.

Cooking on LPG also had highly varied costs. In Sindhupalchowk, which had the lowest cost of cooking with fuel wood, the cost of cooking on LPG was highest at NPR 40 per hour. The cost of cooking on LPG was much lower in other areas, and lowest in Kavrepalanchowk at NPR 13 per hour.

ICS-O were only reported in the Kavrepalanchowk and Ramechhap project sites. In Ramechhap, the cost of cooking on ICS-O was NPR 60 per hour, while in Kavrepalanchowk it was NPR 22.

3.5 Individual Attributes Rating of Stove Features at Six Different Sites

Bethanchok, Kavrepalanchowk: In this area, GCS scored highest for safety, and also had high rankings for the remaining 7 attributes. TCS did not rank highest for any of the attributes. LPG was clearly the aspirational stove, ranking highest for 6 attributes. Rice husk and electric stoves were rated best for multi-purpose. Because of decreasing availability of firewood in this area, combined with widespread commercial farming, users preferred to use GCS with agricultural waste like corn cobs.

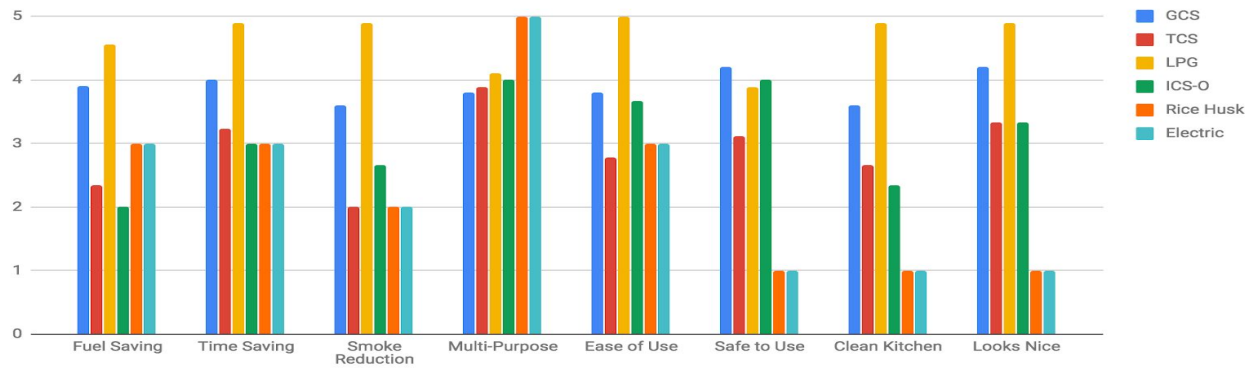


Figure 12: Comparison of Stove Attributes in Bethanchowk, Kavrepalanchowk

Majhigaun, Sindhupalchowk: GCS was ranked highest for multi-purpose and safety. For the remaining 6 attributes, GCS was ranked significantly higher than TCS but lower than LPG. TCS was ranked lower than GCS and LPG on all attributes. LPG scored high on 4 attributes, and was similar to GCS on keeping the kitchen clean and nice looking.

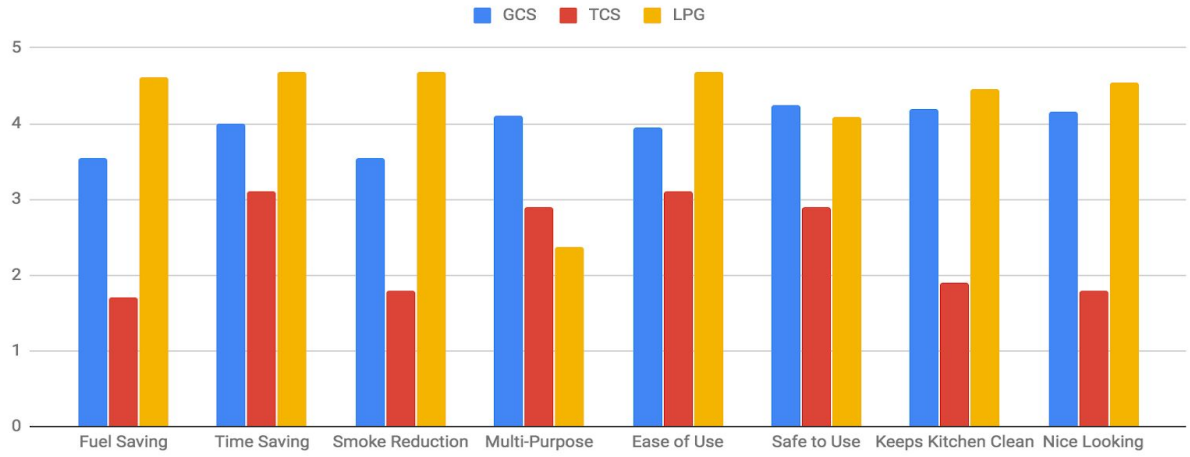


Figure 13: Comparison of Stove Attributes in Majhigaun, Sindhupalchowk

Dhorpatan, Baglung: GCS was ranked highest for fuel saving, and was also ranked highly for time saving, smoke reduction, safety, clean kitchen and looks nice. TCS scored best for multi-purpose and ease of use. LPG was given the highest ranking for time saving, smoke reduction, clean kitchen, and looks nice.

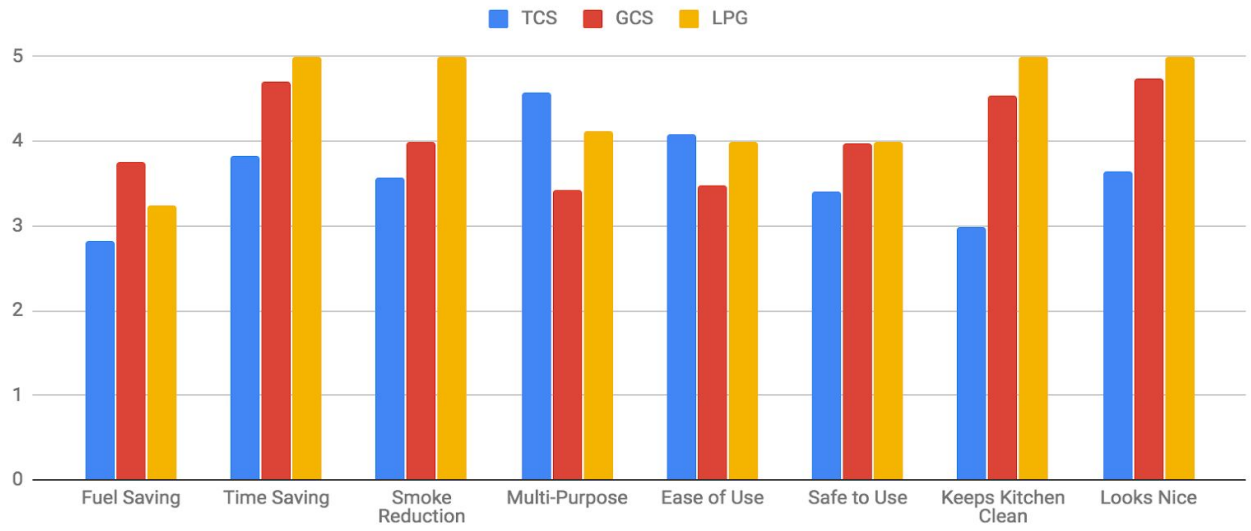


Figure 14: Comparison of Stove Attributes in Dhorpatan, Baglung

Muchchok, Gorkha: GCS was ranked highest for fuel saving, time saving, and safety. TCS was rated best for keeping the kitchen clean, ease of use and looks nice. LPG was preferred over the other stove types only for multi-purpose and smoke reduction features.

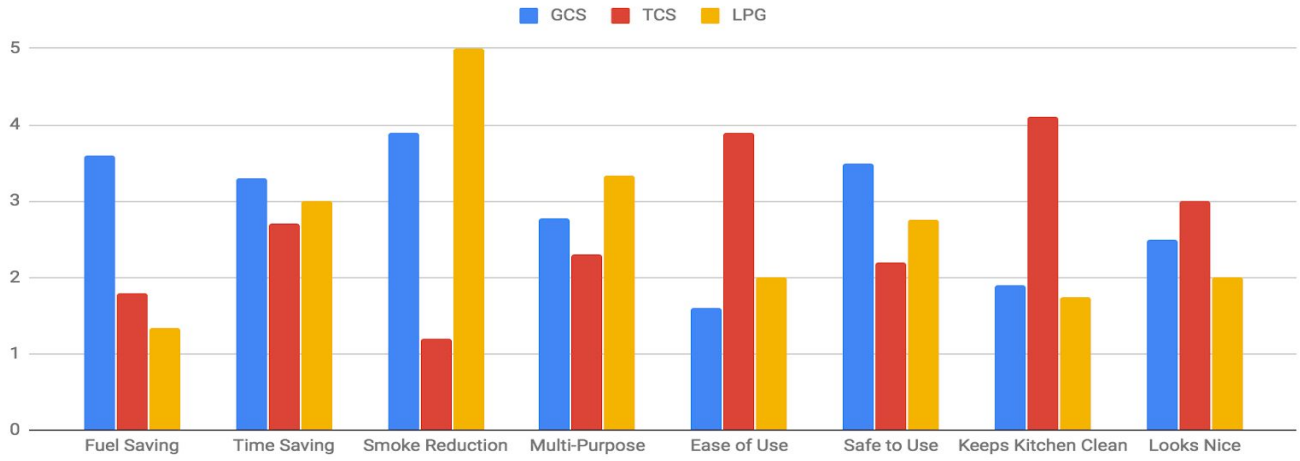


Figure 15: Comparison of Stove Attributes in Muchchok, Gorkha

Bulingtar, Nawalparasi: GCS was ranked higher than TCS on 4 attributes, but ranked lower than LPG on all features. TCS was ranked highest for ease of use and safety. LPG was clearly the aspirational stove type in this area, ranking highest on 6 of 8 attributes.

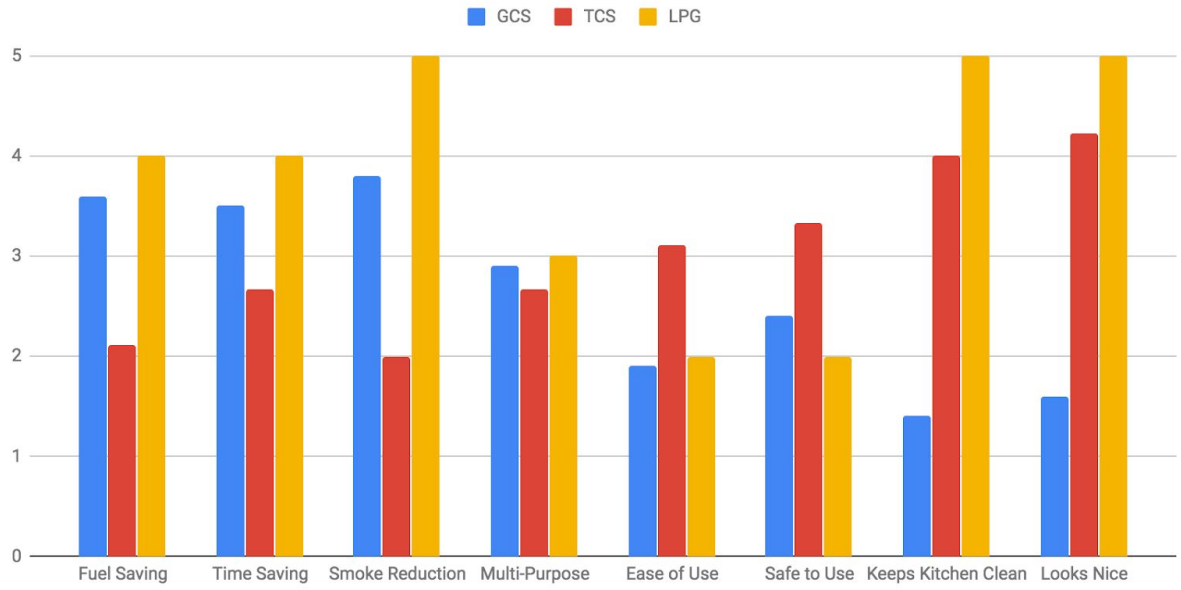


Figure 16: Comparing Stove Attributes in Bulingtar, Nawalparasi

Gokulganga, Ramechhap: Users ranked GCS highest on 6 of the 8 attributes. TCS was ranked significantly below GCS and ICS-O. ICS-O ranked highest for cooking different dishes (multi-purpose), looks nice, and safety. No LPG stoves were reported in this area.

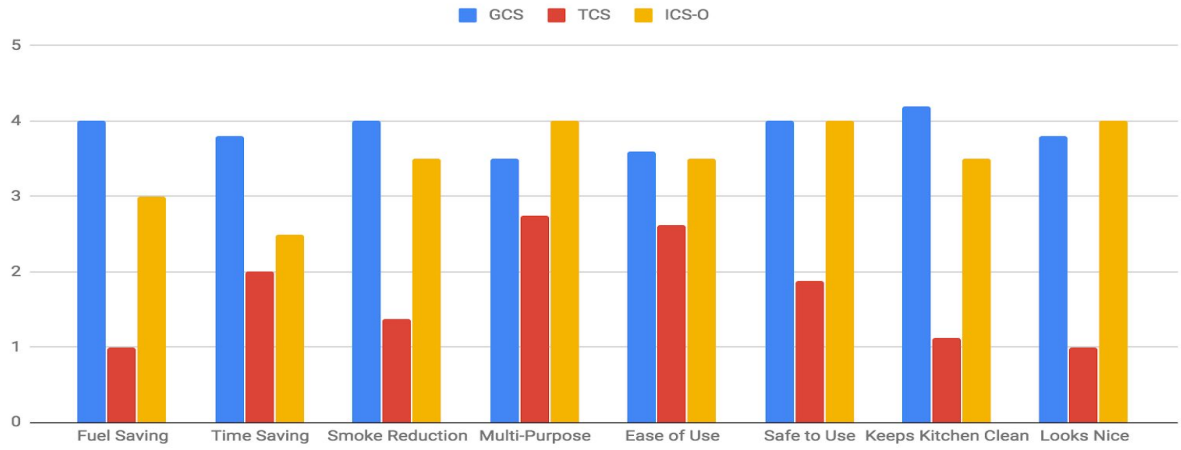


Figure 17: Comparison of Stoves Attribute Scores in Ramechhap

3.6 Ganesha Specific Questions

3.6.1 Willingness to Buy

In response to the Usability Survey question about whether the users were willing to buy GCS in the future, 93.3% said they would buy if needed and available within their budget. It is also to be noted that the responses were solicited after people used GCS for three weeks to six months' time.

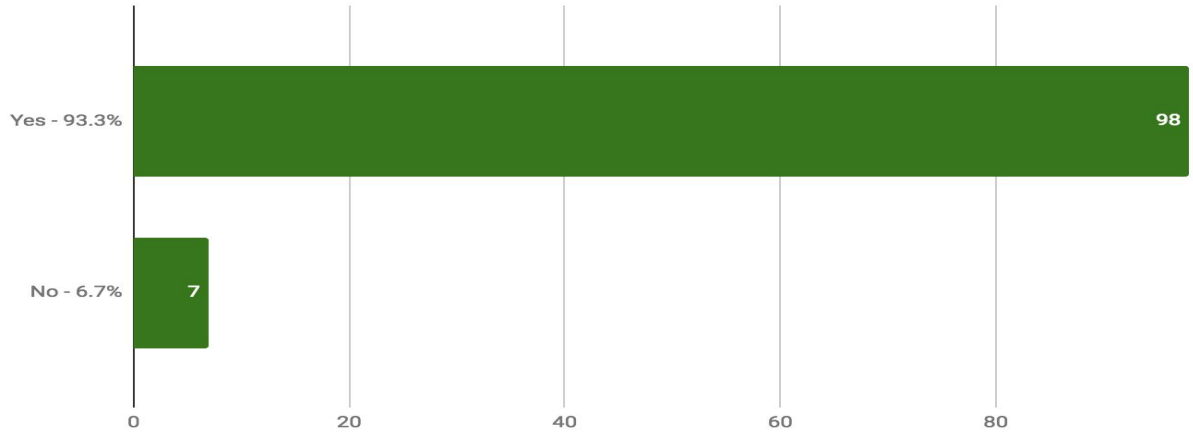


Figure 18: Willingness to Buy

For those who were willing to buy the stove, the following question asked how much they would pay. Figure 19 summarizes responses.

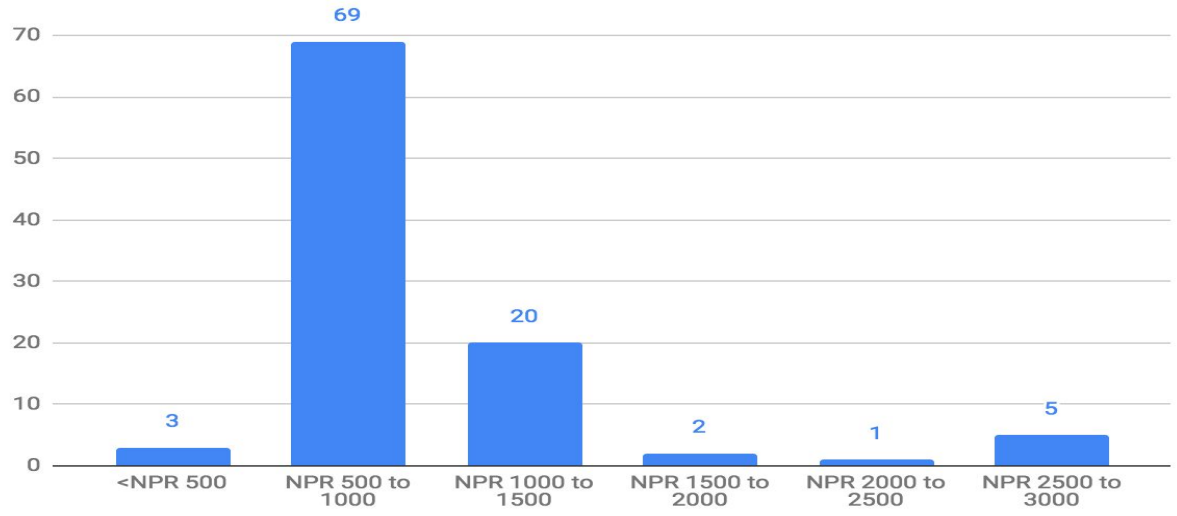


Figure 19: Willingness to Pay for GCS

The most common affordability price for the stove was NPR 500 to NPR 1000, expressed by 69% of respondents. Another 20% said they would pay NPR 1000-1500.

3.6.2 User Preferences

The figure below is the result of compilation of the open-ended response to the question: What do you like most about the GCS Stove?

There were 211 responses to the question, which were further categorized into twelve groups of responses (from most to least frequent):

1. **Faster Cooking:** Food is cooked faster, saves time, multi-tasking while cooking is possible
2. **Uses Less Firewood:** Less firewood needed, saves firewood, less firewood consumed, reduced use of firewood, small amount of firewood is sufficient, more economical to use
3. **Fewer Emissions:** Reduced emission, no smoke, clean burning, less smoky, leaves cooking utensils clean, clean flame, good fire, clean fire, saved from smoke
4. **Portability:** Can be taken anywhere, food can be cooked anywhere, easy to transport, can cook at desired places, can be moved from one place to another, easy to store
5. **Clean Kitchen:** Looks clean, looks good, kitchen remains clean, easy to clean, house clean
6. **Safe to Use:** Safe, does not burn clothes or hands
7. **Easy Operation:** Easy to cook, easy to use
8. **Space Heating**: Useful for body warming, heating air
9. **Tastier Food**: Food tastes good, good for drying fish, good for boiling milk, delicious food
10. **Like Everything**: Good for everything
11. **No Wind Impact:** Fire not impacted by wind, fly ash not seen
12. **Good Design:** Like the design of the stove

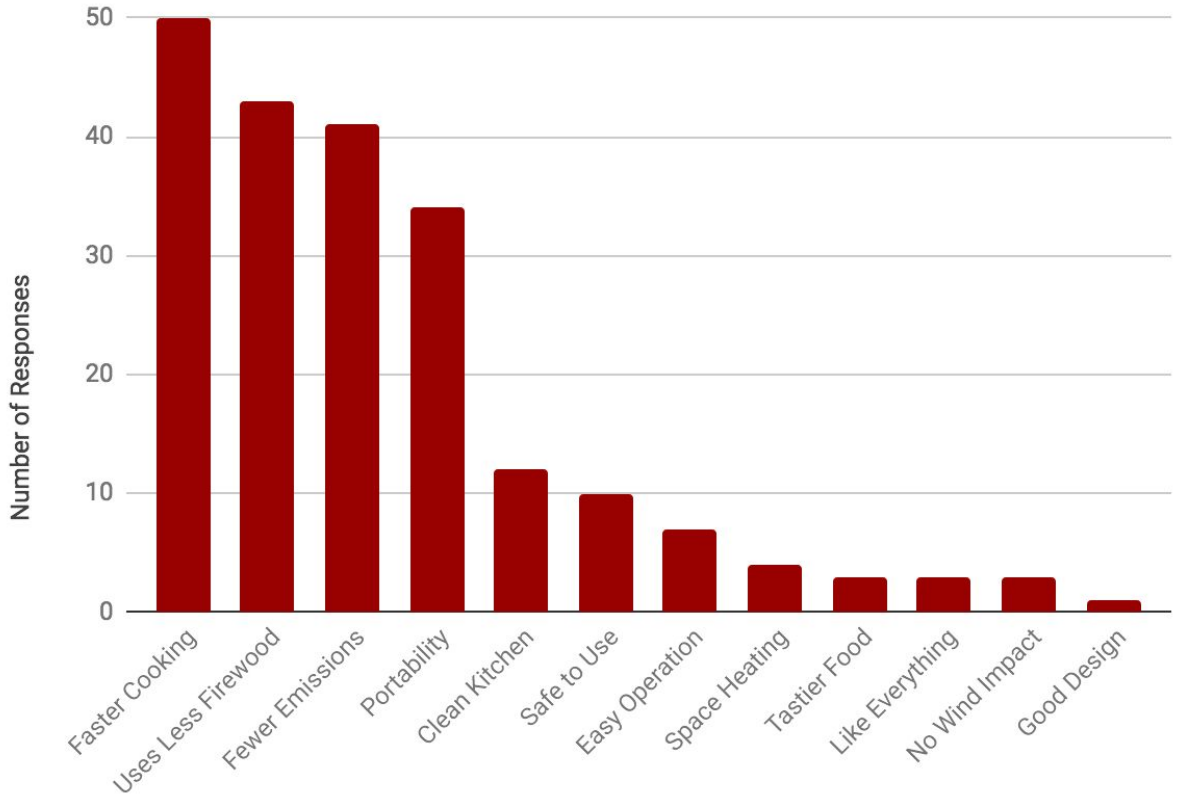


Figure 20: What Users Liked About GCS

Figure 20 shows the perception rankings of 12 stove features as indicated by the users. Faster cooking, reduced firewood consumption, lower emissions, portability and cleanliness were the top five stove features liked by users.

Analyzing the results from the open-ended question for GCS (Figure 20) provided several attributes that were important to users, but not included on the survey form. Specifically, users identified portability as an important feature. Likewise, tastiness of the food cooked on a stove, and the design of the stove itself were also identified as important attributes.

Photo 5: Usually men do not cook. But if there is a better way of cooking, he does. Making good use of corn cobs in Majhigaun.

Photo 6: Multiple stoves in use. The bigger pot at left is animal fodder being cooked on TCS. This cook prefers cooking for people on GCS at right.

3.6.3 Suggestions and Comments about GCS

The most common suggestions and advice from the users of GCS were:

- Modify to accommodate bigger pots by adding a pot rest that would make the pot more stable while frying and stirring
- Shorter combustion chamber with increased chamber width could help burn cleaner and longer and could also reduce smoke
- Changing the design to accommodate longer and bigger wood pieces

4 Conclusion

Usability of the Ganesha biomass cookstove was measured at six different sites in Nepal, and compared to the usability of existing traditional stoves, LPG (gas) stoves, and other stoves in use. A total of 340 Ganesha stoves were distributed, primarily to disadvantaged villagers, and usability surveys were conducted 3 weeks to 6 months after users received the stove. Very little to no training was given in the use of the stove.

A usability survey was developed based upon research by the Centre for Rural Technology Nepal (CRTN), which determined 8 key factors in cookstove usability. Users were asked to rank their stoves, including the Ganesha stove, on those factors. The survey also asked questions to determine hours of use, fuel consumed, and the kinds of food cooked on different stove types. To determine stove acceptance and behavior change, the survey asked if users would buy the Ganesha stove, and if so what they would pay. They were then asked what they would cook on the stove, and how much it would cost to use, and what they liked. Open-ended comments and suggestions were then solicited.

Demographics: 98% of respondents were female, in households that mostly had a family size of 4 to 6 people.

Cooking practices: Respondents cooked 2 to 3 meals for their household each day, and also prepared warm or hot animal fodder in large flat-bottom pots once per day. Foods cooked included *dhindo,* a dish made of corn or millet flour that requires vigorous stirring; rice, legumes, flatbreads, vegetables, potatoes, and dairy products. Alcohol making is also common, and uses large stills. Typical cooking pots include a semi-circular bowl called *karaai* for boiling and frying vegetables, and sometimes for making *dhindo;* a heavy round-bottomed pot called *kasaudi*, pressure cookers, and tea kettles. The overwhelming majority (93.5%) used traditional open fires for almost every cooking task prior to these pilot projects. Where respondents had LPG stoves, they used them for making tea and quick-serve meals.

Comparison of usability factors: The 8 key factors identified by CRTN included 1) Fuel Saving, 2) Time Saving, 3) Smoke Reduction, 4) Multi-Purpose, 5) Ease of Use, 6) Safe to Use, 7)

Keeps Kitchen Clean, and 8) Looks Nice. The CRTN study and others showed that three attributes – Smoke Reduction, Time Saving, and Fuel Saving – were essential attributes of a clean cookstove. Users ranked the Ganesha stove highest for 2 of these factors: Fuel Saving and Time Saving. They also ranked the Ganesha stove highest for Multi-Purpose and Safe to Use. They did not rank their traditional stoves highest for any of the 8 factors. LPG stoves were ranked highest for Smoke Reduction, User-Friendliness, Keeps Kitchen Clean, and Looks Nice.

Cost of cooking: Fuel costs varied widely among the 6 pilot project areas. Based on user reporting and subsequent calculations, traditional stoves were the most expensive to use, both overall and per hour of use. Ganesha stoves were found to be significantly cheaper to use, with about half the fuel consumption per hour on average. LPG stoves were well-loved by respondents, and were not reported to be more expensive to use, but were seldom used for big cooking tasks. Users considered them to be “luxury items,” and used LPG only during emergencies, such as hosting unexpected guests, or during the rainy season when fuelwood was wet or unavailable.

Willingness to buy: 93.3% of respondents said they would buy a Ganesha stove if needed and available in the future. When asked what they would pay, most users (69%) said they would pay NPR 500 to 1000 (US$5 to $10). Another 28% would pay more than NPR 1000. This should serve as an indication of the subsidy level needed to meet users’ ability and willingness to pay.

What they cooked on the Ganesha stove: Users said they used the Ganesha stove to cook all of their normal foods, including rice, *dal* (lentils), beans, vegetables, potatoes, *roti* (flatbreads), tea, boiling milk, fish, and *dhindo* (a corn or millet paste that requires vigorous stirring to cook).

User preferences: When asked to provide open-ended comments and suggestions about the Ganesha stove, the most common responses were 1) faster cooking (80%), 2) uses less firewood (72%), 3) fewer emissions (71%), and 4) portability (53%). Users suggested that the stove be made a) to accommodate a bigger pot, b) with a shorter combustion chamber; and c) with a larger opening for wood.

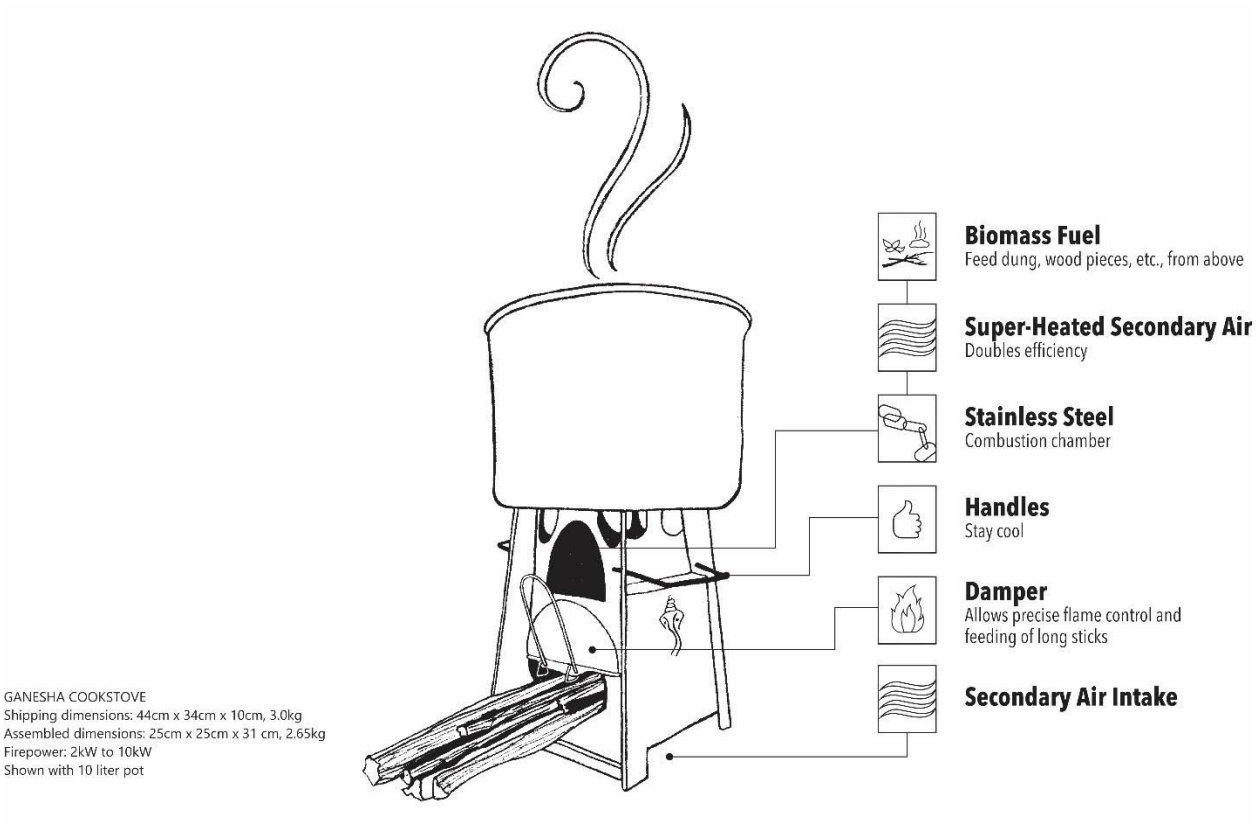
Users in pilot project villages did not intend to stop using TCS, as they have many attributes that villagers need. TCS can take fuel wood of many sizes; very large pots and alcohol stills can be used with them; and when it is cold, people like to sit around the open fire while the food is cooking. On the negative side, TCS consumes a huge amount of fuel and burns dirty, leaving soot on cooking pots, walls and roofs. Breathing is often difficult in such environments.

When people are used to it, LPG burns clean and is easy to operate once installed. The bigger issue is about the upfront cost and refill problems since canisters must be carried to and from nearby towns. A regular supply of LPG isn’t assured. Users also reported that they had issues with the safety of LPG, as they feared leakages and the explosive potential of cylinders.

ICS-O burned cleaner than TCS, but were not portable in any way. All of the ICS-O were fixed types and looked very old. The chimneys were often clogged, making them burn with more smoke than any other stove. The few non-chimney ICS-O seen were already deformed, due to lack of maintenance.

Some other stoves like charcoal stoves were also observed but were not in use at the time of our survey. Modern forms of cooking using electric induction stoves and rice cookers were generally not perceived well in terms of multi-purpose cooking and ease of use. Where available, the electricity was reported to be expensive.

Annex I Ganesha Cookstove Model 3.0 Layout



Layout by the Manufacturer

Annex II Ganesha Cookstove Usability Form

A. Participant Identification and Demographics			
1.	**Visit Date and Time**		
2.	**Name of the Organization and Surveyor**		
3.	**Name and Age of current main cook**		
4.	**Sex of current main cook**	(M) Male (F) Female	
5.	**District**		
6.	**Municipality/Rural Municipality**		
7.	**Village Name and Ward No**		
8.	**No of Family Members**		

B. Stove Usage					
	1. How many stoves do you have? ***Please Mark X or list them below***	**2. How often do you use them?** ***Hours per day***	**3. What do you cook on these stoves?** ***Describe the usage such as Food items cooked / Water boiling / Space Heating / Animal food / Other***	**4. What is the monthly expense on these stoves?** ***Estimate fuel amt * the unit cost in NRs (or time spent)***	**5. Maintenance required?** ***Times per month***
Traditional stove *3-stone; Metal tripod; Cement blocks; Earthen traditional*					
Improved stoves (other than Ganesha)					
Ganesha Stove					
LPG					
Electric (induction/RC)					
Other:					

C. Stove Comparative Ratings Scale from 1 to 5 (Lowest 1 to Highest 5)								
Stove Types Used	Fuel Usage	Cooking Time	Smoke	Multi-purpose	User friendly *Ease to install and use*	Safe to use	Keeps kitchen clean	Looks nice
Traditional stove*(3-stone; Metal tripod; Cement blocks; Earthen traditional)*								
Improved stoves (other than Ganesha)								
Ganesha Stove								
LPG								
Electric (induction/RC)								
Other:								

D. Ganesha Stove Specific Questions	
1. Would you like to buy this stove? (If yes, go to next question. If no, mention the reasons here and stop here).	
2. How much would you buy the stove for? ***Please mention amount in NRs***	

3. If you buy it, what would you use it for? *Please describe options: breakfast/lunch/dinner/all day meals: also list the items*	
4. What is the estimated monthly expense for energy use (cooking/heating/boiling)?	
5. Do you use both the upper and lower openings of the stove to add wood? (upper only, lower only, both?)	
6. What do you like the most about the stove?	

E. Photos (Please check boxes at the right for pictures taken)	
1. User cooking on the stove *(user and stove)*	
2. The stove while in use showing the placement and type of fuel *(cooking area and fuel)*	
3. Picture showing the pot and dish cooking on a stove *(stove in use)*	
4. The Completed Form *(both pages 1 and 2)*	
5. Any other:	

NOTES:

List of Figures

List of Photos