Cookstove Usability Testing Protocol

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All files needed to use this testing protocol are also available online at:
https://humanitarian.engineering.oregonstate.edu/usability-testing-protocol-cookstoves

How to Use This Document

1. Read the *Introduction* first for an overview of the protocol.
2. Read the *Usability Testing Protocol* second for a detailed description of the test, guidance for planning tests, as well as alternate testing procedures for specific cooking technologies and to adapt the protocol to laboratory and rapid field testing.
3. Print one copy of the *Data Collection Form* for each individual cookstove that will be tested (multiple forms will be needed for one household if multiple stoves are used at the same time). Make sure that the test administrator has read through the *Usability Testing Protocol* and the *Data Collection Form* before beginning testing.
4. Use the *Data Processing Spreadsheet* to enter and interpret results for individual and multiple tests. Instructions for use are in the spreadsheet.
5. Print final usability scores and results from the *Data Processing Spreadsheet*, or enter them manually from the spreadsheet into the *Usability Results Scorecard*.

Note: Links to different sections of this document are provided in blue throughout.

Scholarly articles regarding the development of this protocol and preliminary trials are submitted for publication in the journals *Energy Research and Social Science* and *Energy for Sustainable Development* in 2018.
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Introduction

Background and Purpose

Usability is a critical factor in a cook's decision to purchase or adopt an improved cookstove, as well as to continue use long-term [1,2]. While the study and incorporation of usability is common in product design for high-income countries, there has historically been little material available to help evaluate the effectiveness and efficiency with which a cookstove meets a user's needs [3] and as a result, usability has often been overlooked [4].

This protocol is intended to give designers and implementers a tool to understand and compare user impressions of traditional and improved cookstoves in low-income countries. This information may be used to better balance user needs with technical performance, emissions, and other objectives to increase the overall uptake and impact of improved cookstoves.

Existing usability standards, models, and protocols have been incorporated as a foundation for this protocol. These include ISO-9241 regarding human-computer interface [5], Quesenberry's "5 E's" of usability [6], and relevant evaluations for the usability of consumer products [7,8]. Works related to cross-cultural evaluations [9,10] and the use of anthropological methods [11,12] have also been referenced to adapt this protocol to the diverse testing situations that may be encountered across different regions and cooking cultures.

Aspects of Usability

This protocol organizes cookstove usability into six major categories:

1. **Fuel cost and convenience:** expense and effort required to obtain and prepare fuel
2. **Cooking performance:** cooking speed, control, and versatility
3. **Operability:** ease of operation and error-tolerance
4. **Maintenance:** expense and effort required for short- and long-term maintenance
5. **Comfort:** perceived comfort and aesthetic considerations
6. **Location-specific needs:** including secondary uses besides cooking

Protocol Design Principles

- This protocol is designed to be a simple and inexpensive field test. Higher quality results and more valid comparisons between stove models can be created with skilled test administrators and larger sample sizes, but valuable information may still be obtained without significant prior experience or investments of time or money.
- Tests are meant to be minimally intrusive to allow for representative cooking practices.
- Criteria and methods are intended to be applicable in as many locations and with as many cooking technologies as possible. Not every test question will be equally applicable to every cooking technology and context, however, portions of the test may be excluded to meet specific testing needs and limitations.
- Provisions to adapt tests for laboratory use to provide limited, preliminary data are provided.
- Criteria are evaluated objectively wherever possible, though many criteria are highly variable and are evaluated subjectively.
- The protocol is designed to maximize value from the effort invested in testing. Open-ended questions and field notes are included to elicit additional details from cooks.
- Reporting of test results is modelled on the ISO-IWA 11:2012 tiers of performance for improved cookstoves to facilitate easier communication.

Introduction (continued)

Test Methods, Data Analysis, and Reporting

This protocol relies on quantitative measurements of stove dimensions, cooking events, and event durations, a quantified survey, and qualitative observations, field notes, and interview-style questions. The various testing methods provide overlapping assessments of usability criteria wherever possible, allowing for the identification of conflicting responses and likely miscommunications or misunderstandings. Each test is given in a home with a cook during preparation and cooking of the main daily meal for the duration of the event (up to several hours). The *Data Collection Form* provides spaces to record testing results, as well as additional guidance for the test administrator.

The *Data Processing Spreadsheet* calculates tiered, numerical scores for each usability criteria (from 0-4), as well as a coefficient of variation for each score to identify statistical significance, and includes additional qualitative data analysis tools designed for those who are not familiar with qualitative methods. Qualitative data from field notes and interview questions does not factor into tiered numerical scores, but can provide additional design and selection guidance and may also help to identify potential biases or errors in test results. In the case of small sample sizes, this data may be more valuable than numerical results.

Most usability criteria are first evaluated (to determine how well a stove meets a certain criterion), then assigned a relative weight (to determine how important a criterion is to the cook) through paired sets of Likert-scale survey questions. A tiered numerical score for each of the six main usability criteria, reflecting likely impact on use and adoption, is calculated from a weighted average of sub-criteria scores. The *Usability Results Scorecard* provides a template for reporting scores for all criteria and sub-criteria. In general, low scores in any one area may be enough to significantly limit purchasing or adoption.

Equipment required:

- Metric ruler or tape measure
- Metric scale (capable of holding the expected fuel(s) and able to measure at least 10 kg)
- Stopwatch or clock

Known Limitations

- Validity may be impacted by the cook's level of familiarity with survey and interview-style questioning, as well as various cultural factors.
- A relatively large number of tests (10+) may be needed to achieve saturation and a statistically valid comparison between stoves, or understanding of a single stove model.
    - It should be noted that smaller sample sizes may still elicit many key aspects of usability for a particular stove and context.
- High variation between tests is likely, compared to technical cookstove evaluations, due to differences in the perspectives and needs of individual cooks.
- Results are specific to the region and culture studied, and may or may not be applicable to other regions and cultures.
- The universality of protocol comes at the expense of some sensitivity to regional cooking needs and cultural factors.

Usability Testing Protocol

General Study Design Considerations

This section provides guidance and references specific to this protocol. Additional detailed study design guidance may be found in the *Cookstove Field Study Resources*[1], published by the Global Alliance for Clean Cookstoves. In any test involving a local cook, be sure to explain the testing procedure and motivation and gain their consent before beginning.

1. **Requirements of the Test Administrator(s)**

   The Cookstove Characteristics Evaluation and User Cooking Event Observation (sections 2 and 3 of the *Data Collection Form*) should be done by a person familiar with common cookstove designs.

   It is critical that the User Survey and Semi-Structured Interview portions of the test (sections 4 and 5 of the *Data Collection Form*) be administered by a person who is:

   - Proficient in a language spoken by cook,
   - Familiar enough with the cook's culture to recognize subtle, culture-specific communication cues,
   - And, whose presence in the kitchen is as unintrusive as possible.

   Past experience with surveys or with related work may also be helpful. Sections 1-3 of the *Data Collection Form* may be done by the same person as the survey and interview, or by a second person. A second test administrator frees the surveyor/interviewer from the distractions of taking measurements, and also allows for the added benefit of a second perspective on cooking behaviors and the cook's responses to the questions.

2. **Additional Test Administrator, Cultural, and Other Related Considerations**

   While no field testing scenario is perfect, factors that should be considered in planning testing and evaluating results include, but are not limited to:

   - **Gender of test administrator:** It is unusual for a man to spend time in the kitchen in many regions, so a male tester may not always be as welcome or receive the same quality of responses. In many cases, a local woman with relevant survey or interview experience may make the ideal test administrator.
   - **Level of trust/familiarity:** The more familiar a cook is with the test administrator, the more likely they are to behave normally and give direct answers in most cases.
   - **Hospitality culture:** A cook may prepare a more complex meal, use different stoves or fuels, etc. if they consider the test administrator(s) to be guests (even if they are asked to prepare a meal normally). A local test administrator can help to advise whether a cook has deviated from a typical meal, and how this might influence test results.
   - **Seasonal and other variations:** Cooking practices may depend on weather, harvest or seasonal employment schedules, etc. Local test administrators can help to advise if and when seasonal patterns may affect test results.

[1] https://cleancookstoves.org/binary-data/DOCUMENT/file/000/000/485-1.pdf

- **Conflicts of interest:** If the test administrator(s) have close connections to a local NGO, government officials, directly to the cook or their extended family, etc., the cook may be inclined alter their responses (likely with a positive bias).

3. **Sample Selection**
   Factors to consider when choosing test participants include:
   - **Familiarity with the cookstove:** Cooks should have used a stove for at least several days, and ideally several weeks, prior to testing to ensure a basic level of familiarity and representative use.
   - **Representation of intended users:** Cooks should be representative of the range of intended users of the stove (by age, income, proximity to urban areas, etc.).
   - **Relevance to testing goals:** Sampling methods and sample size should be adequate for the desired level of detail and significance of the results. Detailed guidance on sampling and statistical significance may be found in the *UNFCCC CDM Guidelines for Sampling and Surveys*[2].

4. **Saturation:**
   - **Minimum sample size:** At least three tests with three different cooks are recommended per stove model to provide a reasonable understanding of usability in terms of qualitative, and anecdotal quantitative, information. This may serve as a valuable and cost-effective starting point for the preliminary design, selection, or assessment of a stove.
   - **Statistical significance:** Approximately 10 tests may be needed to achieve statistical significance for the numerical scores of 75% of usability criteria, based on an acceptable margin of error of ½ point for scores rated from 0 – 4, and with a confidence level of 95%. Higher or lower margins of error may be needed for different testing purposes. Remaining criteria with high variability should be explored with additional interview questions, either in subsequent tests or follow-up visits.
   - **Larger sample sizes:** Samples significantly larger than 10 will increase the statistical significance of numerical scores, however, some scores may not be well-represented by a single value. Within a community, some criteria are likely to have non-normal distributions. Respondents who collect versus purchase firewood, for example, would produce two distinct opinions of the difficulty of obtaining fuel. Care should be taken to make sure even statistically significant criteria are assessed thoroughly with field notes, interview questions, or other methods to provide context.

5. **Supplemental Data Collection**
   Supplemental field notes and photo, video, and audio documentation (with consent) will help to clarify any uncertainties and create the most value from the time spent in the kitchen.

Alternative Testing Procedures

This protocol is designed to measure cookstove usability as thoroughly as possible for common cookstove designs. However, variations may be appropriate for specific testing needs:

1. **Rapid field testing**

[2] https://cdm.unfccc.int/Reference/Guidclarif/meth/meth_guid48.pdfs

When time is limited, or less thorough usability data is required, such as when choosing between a limited number of cookstove models, the User Cooking Event Observation (section 3 of the *Data Collection Form*) may be omitted.

In this case, the remaining physical measurement, survey, and interview portions of the test may be carried out in 20 minutes or less per household (without a cooking event taking place). Note that without observing a cooking event, much contextual information may be lost, and it is more difficult to judge the accuracy of a cook's responses.

2. Laboratory testing

While in-home field testing provides the most complete, valid results, laboratory testing may be used to collect preliminary or basic data before field testing, or if field testing is not feasible. This may be done in one of three ways:

3.1 A Cookstove Characteristics Evaluation (section 2 of the *Data Collection Form*) can be done without lighting a stove. This provides basic information about likely usability performance, and is most valuable with a good prior understanding of local cooking needs and habits.

3.2 In addition to a Cookstove Characteristics Evaluation, a User Cooking Event Observation (section 3 of the *Data Collection Form*) can be simulated by someone besides a local cook. This provides additional information about usability performance and offers valuable first-hand experience to the stove tester, although the results are likely to be less valid than testing by an actual stove user.

3.3 A User Cooking Event Evaluation can also be approximated in a lab with a representative local cook operating the stove. This may offer a higher level of validity than is possible with a foreign or inexperienced stove operator, but asking a user to cook in an unfamiliar laboratory setting instead of their personal kitchen introduces many variables and may limit the validity of the test.

3. Concurrent Controlled/Uncontrolled Cooking Testing

This test may be done concurrently with the Controlled Cooking Test (CCT) or Uncontrolled Cooking Test (UCT). Some fuel and time measurements are shared between this Usability Protocol and the CCT and UCT, and doing multiple tests at once may save time and effort.

4. Technology-Specific Testing Considerations

Not all questions and measurements apply to household cooking technologies other than wood and charcoal stoves. These include solar stoves, gas and liquid fuel stoves, and electric stoves. Aspects of the test that do not apply may be skipped or assigned the highest or lowest rating for a given sub-criteria, as appropriate, to make for a fair comparison with wood, charcoal, or other stove types. Be sure to document any changes or omissions made in the note areas of the *Data Collection Form* to allow for effective communication of results.

5. Institutional Stove Testing Considerations

Questions regarding personal and cultural perceptions towards a stove will have different significance to many institutional cooks. These aspects may be skipped or assigned the highest or lowest rating for a given sub-criteria, as appropriate. Be sure to document any changes or omissions made in the note areas of the *Data Collection Form* to allow for effective communication of results.

Customization and Expansion of Tests

The usability criteria, testing methods, and procedures described in this protocol may be modified and expanded to better fit the evaluation of specific technologies and for certain cooking cultures. The addition of semi-structured interview questions is the simplest way to expand the protocol, as this does not require changes to the *Data Processing Spreadsheet*. Physical measurements and survey questions can and should be added or changed to optimize a test for a given application, however.

Questions that produce high variability in test results may be targeted for expansion, alteration, or division into multiple questions to increase accuracy and validity. This can be done by first exploring the question topic with cooks through supplemental interview questions to clarify the variation in responses. If there are several common, but disparate, opinions among cooks, then the topic should be addressed by that number of questions instead of just one. If likely bias or misunderstanding in cooks' responses is revealed, then the original question may be clarified or reworded in hopes of reducing these effects, or removed altogether, if necessary.

Test Protocol and Administration Guidance

This section explains and gives advice for conducting each portion of the test, which are listed below. Numbers correspond exactly to questions and measurements in the *Data Collection Form*.

Spaces for additional notes provided in all sections are optional, but may help to clarify results and identify additional relevant information.

1. Participant Identification

Equipment required: None

Explanation and testing guidance: This section identifies the participant, stove model(s), and test administrator(s). Complete the entries as indicated in *Data Collection Form*. A set of household and test administrator identification numbers may be prepared in advance to preserve anonymity, if desired.

While completing this section, be sure to confirm with the cook which stove(s) will be used to prepare the meal. If a cook uses multiple different stove models at the same time, use one *Data Collection Form* for each stove and conduct the survey and interview for all stoves together (i.e. ask each question for all stove models before moving to the next question). This reduces the risk of fatiguing the cook compared to repeating the same questions multiple times for multiple stoves.

2. Cookstove Characteristics Evaluation

Equipment required: A metric tape measure or ruler

Explanation and testing guidance: These tests evaluate the physical features of the cookstove and their likely impact on usability. Testing should be done either before cooking begins, or after it is finished, to avoid interfering with cooking activities. Complete each test as indicated in *Data Collection Form*.

For section 2.2: "Fuel feed entry or loading area size," measure the horizontal diameter of vertical fuel feed stoves (like most charcoal and gasifier stoves).

3. User Cooking Event Observation

Equipment required: A metric scale and a stopwatch or clock

Explanation and testing guidance: This section provides an assessment of the quantitative aspects of stove usability and the cook's activities. This section should be started when the cook begins to prepare for the meal and continue until it is finished. Complete each test as indicated in *Data Collection Form*.

For section 3.1: "Fuel preparation," specialized knowledge or tools refers to anything that was not traditionally or previously available to the cook, but is necessary for lighting a given stove model. For example, using an existing knife or machete to make kindling would not count, while a stove that required fuel to be pelletized, or a machine to make fuel briquettes would.

For section 3.5: "Tending and reloading frequency," the administrator may stop recording tending events once the form is full, even if the cooking is ongoing. The purpose of this section is to estimate average times between tending and reloading events, which can be done with information for a portion of cooking, only.

4. User Survey

Equipment required: none

Explanation and testing guidance: This section provides a structured evaluation of the user's impression of the usability of their cookstove(s), as well as the importance of each usability criterion to them. Questions are generally arranged in pairs to address these two aspects of each usability criterion. This survey should be started around the start of cooking. Complete each question as indicated in *Data Collection Form*.

When reading questions with answer choice sets, do not read each option to the cook, but instead ask the question as if it were open ended, and select the option that best fits their response. If no option is clearly the best fit, read aloud the closest options and ask the participant to select one, or ask additional clarifying questions. Reading questions conversationally during natural pauses in cooking activities will reduce distraction for the cook and may result in more valid responses.

Note that question 4.4 regarding fuel cost does not directly address usability, but is an important factor in purchasing and adoption decisions, and may lend insight into a cook's perception of the cost of fuel and likelihood to pay for it long term.

Also Note that question 4.16 regarding maintenance does not include regular cleaning and ash removal of the stove. Only repairs or periodic preventative maintenance should be included

5. Semi-structured Interview

Equipment required: none

Explanation and testing guidance: This section provides an open-ended method for cooks to give additional details about their impression of a stove that were not captured in the survey questions. It is also an opportunity to clarify uncertainty from other portions of this protocol, and may elicit broader information relevant to cookstove or other programs. The interview should be done directly after the User Survey is completed. Complete each question as indicated in *Data Collection Form*.

Scoring

This section explains how test results translate into tiered usability scores. Calculations are done automatically in the *Data Processing Spreadsheet*. All question and test section numbers referenced (i.e. 4.1) correspond exactly with the questions and measurements in the *Data Collection Form*.

Scores for each of the six main usability criteria (listed below) are calculated as a weighted average of sub-criteria scores (listed beneath each main usability criteria), except where noted otherwise. Weights are generally calculated from the Likert-scale questions addressing the importance of each sub-criteria to the user, and are assigned a value from 0-4. Note that some scores are based on more than one question, and other highly subjective measurements do not factor into tiered scores, but serve as additional anecdotal or qualitative indicators of usability.

I. Fuel cost and convenience

A. Fuel availability: Score is based on the results of question 4.5A and judged according to the following rating system:

(4) Best: No time or effort is expended
(3) Good: Less than 15 min/day
(2) Fair: 15-60 min/day
(1) Poor: More than 1 hr/day
(0) Very Poor: Fuel is not available

Weighting is based on the average of the results of question 4.5B and 4.6 (unless the response to 4.6 is N/A, in which case 4.5B is used, only). Weights are valued from 0-4 from the most positive to the most negative option for each question.

B. Fuel preparation: Score is based on the results of question 4.7A and judged according to the following rating system:

(4) Best: No time or effort is expended
(3) Good: Less than 2 min/meal
(2) Fair: 2-5 min/meal
(1) Poor: 5-15 min/meal
(0) Very Poor: More than 15 min/meal

Weighting is based on the results of question 4.7B and is valued from 0-4 from the most positive to the most negative option.

The objective fuel preparation evaluation in section 3.1 is presented alongside the cooking speed score in the *Data Processing Spreadsheet* to help compare between different cooks and stove models, but is not included in the score, since it is likely that some or all fuel preparation activities will be done ahead of time and not be observed during testing.

C. Fuel cost: This is reported as a percentage of household income and does not factor into tiered results. Cost is calculated from questions 4.1 – 4.4 regarding fuel collection, purchasing, and how often the stove is used, as well as fuel consumption measured in section 3.3 and an outside estimate of household income provided by government or other sources. The purpose of this indicator is to serve as a "reality check" to determine if a new stove fuel would place an unrealistic burden on household finances compared to current cooking fuels.

II. Cooking performance

A. Cooking speed: Score is based on the results of question 4.11A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.11B, and is valued from 0-4 from the most negative to the most positive option.

The cooking duration evaluated in section 3.4 is presented alongside the cooking speed score in the *Data Processing Spreadsheet* to help compare between different cooks and stove models, but is not included in the score. Absolute cooking time is highly dependent on cooking culture and type of meals cooked, and not necessarily a good indicator of usability in a given context.

B. Firepower range: Score is based on the results of question 4.8A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.8B, and is valued from 0-4 from the most negative to the most positive option.

C. Firepower control: Score is based on the results of question 4.9A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.9B, and is valued from 0-4 from the most negative to the most positive option.

D. Versatility *(compatibility with common meals and existing pots and pans)***:** Score is based on the results of question 4.12A, which is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.12B, and is valued from 0-4 from the most negative to the most positive option.

The number of dishes cooked per meal (evaluated in question 4.13A) is also compared to the number of burners evaluated in section 2.4. This is used to create assess the likelihood stove-stacking.

III. Operability

A. Fuel feed entry size: Score is based on the results of section 2.2 and judged according to the following rating system:

(4) Best: More than 600 cm^2, or open fire or otherwise unconstructed fuel feed, or modern fuel stove
(3) Good: 300-600 cm^2
(2) Fair: 150-299 cm^2
(1) Poor: 75-149 cm^2
(0) Very Poor: Less than 75 cm^2

Weighting is fixed at 4, since fuel feed entry size impacts many aspects of usability.

B. Tending/refueling frequency: Score is based on the average of the results of question 4.10A, rated from 0-4 from the most negative to the most positive response, and the tending interval calculated in section 3.5, which is judged according to the following rating system:

(4) Best: More than 60 minutes between tending, or no tending needed during cooking
(3) Good: 15-60 minutes between tending
(2) Fair: 5-15 minutes between tending
(1) Poor: 2-5 minutes between tending
(0) Very Poor: Less than 2 minutes between tending

Weighting is based on the results of question 4.10B and is valued from 0-4 from the most negative to the most positive option.

C. Tending/refueling effort: Score is based on the results of question 4.14A. Up to 3 points are assigned, minus 1 for each positive response to question options. Results are scaled by a factor of 1.33 to equate results to other criteria with a 5-point scale, and are judged according to the following rating system:

(4) Best: More than 60 minutes between refueling, or no refueling needed
(3) Good: 15-60 minutes between refueling
(2) Fair: 5-15 minutes between refueling
(1) Poor: 2-5 minutes between refueling
(0) Very Poor: Less than 2 minutes between refueling

Weighting is based on the results of question 4.14B and is valued from 0-4 from the most negative to the most positive option.

The results of Section 3.5, observed tending and reloading frequency, are also reported for comparison with other stove models.

D. Visibility of fire: Score is based on the results of section 3.7 and judged according to the following rating system:

(3) Best: Highly visible (combustion zone can be seen from a distance from anywhere within the cooking area)
(2) Good: Moderately visible (combustion zone can be seen from a distance, but from a limited angle or direction, only)
(1) Fair: Minimally visible (cook must bend down within reach of the stove to see combustion zone)
(0) Poor: Combustion zone is never visible while stove is in operation

Weighting is fixed at 4, since fire visibility is a relatively universal need. Results are scaled by a factor of 1.25 to equate results to other criteria with a 5-point scale.

E. Ease of lighting: Score is based on the average of the results of sections 2.1 (ease of lighting reported by cook) and 3.2 (lighting time required) according to the following rating systems:

Section 2.1:

(4) Best: No kindling/special lighting materials are required AND fire does not need to be lit in an enclosed space within the stove
(2) Fair: Kindling/special lighting materials are required OR fire must be lit in an enclosed space within the stove

(0) Very Poor: Kindling/special lighting materials are required AND fire must be lit in an enclosed space within the stove

Section 3.2:

(4) Best: Lighting requires less than 30 seconds
(2) Fair: Lighting requires between 30 seconds and 3 minutes
(0) Very Poor: Lighting requires more than 3 minutes

Weighting is fixed at 4, since ease of lighting is a relatively universal need.

F. Fire start-up delay *(time between lighting and placing pot on stove)***:** Score is based on the results of question 4.15A, which is judged according to the following rating system:

(4) Best: Less than 1 minute
(3) Good: From 1-3 minutes
(2) Fair: From 4-8 minutes between tending
(1) Poor: 8-15 minutes between tending
(0) Very Poor: More than 15 minutes

Weighting is based on the results of question 4.15B and is valued from 0-4 from the most negative to the most positive option.

G. User error: Score is based on the results of section 3.6, which is judged according to the following rating system:

(4) Best: Zero errors
(3) Good: From 1-3 total errors
(2) Fair: From 3-9 total errors
(1) Poor: 10-20 total errors
(0) Very Poor: More than 20 total errors

Weighting is fixed at 4, since user error can affect usability regardless of context.

H. User instruction: Score is based on the results of question 4.27, which is rated as a 0, 2, or 4, for the most negative to the most positive response.

Weighting is fixed at 4, since the need for adequate instruction is universal.

IV. Maintenance

A. Routine maintenance: Score is based on the results of question 4.16A, which is judged according to the following rating system:

(4) Best: Never
(3) Good: 1 time per year
(2) Fair: 2-3 times per year
(1) Poor: 4-6 times per year
(0) Very Poor: More than 6 times per year

Weighting is based on the results of question 4.16B and is valued from 0-4 from the most negative to the most positive option.

B. Long-term maintenance: Score is based on the results of question 4.17A. Up to 3 points are assigned, minus 1 for each of the following:

- Stove requires purchased replacement parts at least annually
- Necessary replacement parts are not available or hard to find
- Necessary replacement parts are too expensive

Weighting is based on the results of question 4.17B, and is valued from 0-4 from the most negative to the most positive option. Results are scaled by a factor of 1.25 to equate results to other criteria with a 5-point scale. The cost of replacement parts, if reported, is shown alongside this criterion as a percentage of household income in the *Data Processing Spreadsheet.* This serves as a "reality check" to help understand the affordability of replacement parts.

V. Comfort

A. Perceived safety: Score is based on the results of question 4.18A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.18B, and is valued from 0-4 from the most negative to the most positive option.

B. Perceived smoke exposure: Score is based on the results of question 4.19A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.19B, and is valued from 0-4 from the most negative to the most positive option.

C. Cooking area soot deposits: Score is based on the results of section 2.3. If the answer to either question is "yes," the stove is assigned a 4, otherwise, the stove is assigned a 0.

Weighting is fixed at 2, since soot deposits are a relatively universal issue, but often an accepted part of cooking in low-income countries.

D. Pot soot deposits: Score is based on the results of section 3.8, which is judged according to the following rating system:

(3) Best: No soot on pot after cooking
(2) Good: Soot covers bottom of pot, only, after cooking
(1) Fair: Soot covers bottom and less than 1/2 of the sides of the pot after cooking
(0) Poor: Soot covers bottom and more than 1/2 of the sides of the pot after cooking

Weighting is fixed at 2, since soot deposits are a relatively universal issue, but often an accepted part of cooking in low-income countries. Results are scaled by a factor of 1.25 to equate results to other criteria with a 5-point scale.

E. Cooking height: Score is based on the results of question 4.20A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.20B, and is valued from 0-4 from the most negative to the most positive option.

F. Stove aesthetics: Score is based on the results of question 4.21A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.21B, and is valued from 0-4 from the most negative to the most positive option.

G. Perceived durability: Score is based on the results of question 4.22A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.22B, and is valued from 0-4 from the most negative to the most positive option.

H. Perceived value: Score is based on the results of question 4.23A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.23B, and is valued from 0-4 from the most negative to the most positive option.

I. Taste: Score is based on the results of question 4.25A, and is rated from 0-4 from the most negative to the most positive response.

Weighting is based on the results of question 4.25B, and is valued from 0-4 from the most negative to the most positive option.

VI. Location-specific needs

Each location-specific sub-criteria need is assigned either a 1 or 0 for importance to the cook, and 1 or 0 for whether that need is met by a stove. The overall location-specific needs criterion is assigned either a score of 4, if all important needs are met, or 0, if all important needs are not met.

Appendix A: Data Collection Form

A form for recording testing data, along with additional guidance for test administration, is provided in this appendix. The form may be printed from this appendix, or is available separately at:

https://humanitarian.engineering.oregonstate.edu/usability-testing-protocol-cookstoves

Cookstove Usability Testing Protocol:

Data Collection Form

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1. Participant Identification		
1.1	Date [dd / mm / yyyy]	_ _ / _ _ / _ _ _ _
1.2	Time of visit [hr : min]	_ _ : _ _
1.3	Study region	
1.4	Household name or ID number	
1.5	Name of main cook	
1.6	Test Administrator name(s) or ID number(s)	
1.7	Stove model(s) used during cooking evaluation	

Test Overview and Guide:

This test is designed to measure how well a cookstove meets the cooking needs of the user. Detailed instruction, explanation, and information about processing test results can be found in the "Cookstove Usability Protocol" document, which should be reviewed thoroughly before testing.

This page provides an overview of key information needed to give the test. Additional instructions for each section and question are provided throughout the data collection forms in *italics*.

Testing should be done in the kitchen with the cook during the preparation for, and cooking of, the main meal of the day. The cook should be asked to prepare the meal as they normally do. Each test may take up to 3-4 hours.

Test Sections and Requirements:

	Section Name	Tools Required	When This Section of The Test Should Be Done	Who Should Conduct This Section of The Test
1	Participant Identification	(none)	Upon arrival at the household	
2	Cookstove Characteristics Evaluation	A metric tape measure or ruler	Before cooking starts, or after it is finished	Someone familiar with common stove designs
3	User Cooking Event Observation	A metric scale and a stopwatch or clock	During preparation for cooking and throughout the cooking process	Someone familiar with common stove designs
4	User Survey	(none)	During cooking	Someone very familiar with or (ideally) belonging to the same culture as the cook
5	Semi-Structured Interview	(none)	During cooking (immediately after the user survey)	Someone very familiar with or (ideally) belonging to the same culture as the cook

Requirements of the test administrator(s):

It is critical that the user survey and interview portions of the test (sections 4 and 5) be done by a person who is:

- Proficient in a language spoken by cook,
- Familiar enough with the cook's culture to recognize subtle, culture-specific communication cues,
- Whose presence in the kitchen is as unintrusive as possible.

Past experience giving surveys or with related research may also be helpful. In many cases, the ideal tester is a local woman with relevant past experience. Similarly, in some locations it is unusual for a man to spend time in the kitchen, so a male tester may not always be as welcome or receive the same quality of responses.

The other parts of the test (sections 1-3) may be done by the same person as the survey and interview (sections 4 and 5), or by a second person. This can free the surveyor/interviewer from the distractions of taking measurements, and also allows for the added benefit of a second perspective on cooking behaviors and the cook's responses to the questions.

Data Collection and Measurement:

Record all times in 24-hour format (i.e. 13:45). Record all other measurements in metric units.

Supplemental field notes and photo, video, and audio documentation (with consent) will help to clarify any uncertainties and create the most value from the time spent in the kitchen.

Other Testing Considerations:

- **Testing multiple stoves simultaneously:** If a cook uses multiple stove models at the same time, use one testing form for each stove and conduct the survey and interview for each stove simultaneously.
- **Testing institutional stoves:** This test is also designed for use with institutional stoves. Note that many of the questions regarding personal and cultural perceptions towards the stove will have different significance (or will not be applicable).
- **Other/uncommon stove designs and cooking scenarios:** There are many different stove designs and cooking scenarios, and not all of them will not align exactly with the questions and measurements in this test. If it is necessary to deviate from the protocol, take detailed notes on what changes were made and why.

Note: If the pages of this document are separated, a "test #" may be written on each sheet to identify them later:

Test # _____

2. Cookstove Characteristics Evaluation

Instructions for tester: *Circle **Y**es or **N**o for each question with a "**Y/N**" option.*
Take additional notes as needed in the spaces provided.

Tools required: *A metric tape measure or ruler.*

Note: *This section is to be done either before or after cooking is completed.*
The tester should be familiar with common cookstove designs.

2.1	Ease of lighting	Kindling or accelerants are required: **Y / N** Fire must be lit in an enclosed space within the stove: **Y / N**
2.2	Fuel feed entry or loading area size	*[Record the most appropriate measurement for the stove's fuel feed entrance. Only measure areas where fuel is normally fed. Do not include air supply or other areas]* Three stone fire/batch fed (TLUD) stove: **Y / N** If No: Width: ____ cm Height: ____ cm **(OR)** Diameter: ____ cm
2.2 Fuel feed entry/measurement notes:		
2.3	Indoor soot evaluation	Gas, alcohol, or electric power: **Y / N** Sealed chimney: **Y / N** (A sealed chimney must vent all visible smoke outdoors)
2.4	Burner count	*[Record the number of individual spaces for separate pots, pans, etc. Write "Plancha" if the stove has a single metal cooking surface.]*
2.4 Burner count notes:		
General notes:		

3. User Cooking Event Observation

Instructions for tester: *This section is to be started when the cook begins to prepare for the meal and continue until it is finished. Record times in 24 hour [hr:min] format. Take additional notes as needed in the spaces provided.*

3.1	Fuel preparation	Start time: ____ : ____ Completion time: ____ : ____ (Includes cutting wood, removing twigs, etc., but not building and lighting the fire.) Specialized knowledge or tools required for fuel preparation: **Y / N**
3.2	Lighting time required	Start time: ____ : ____ Completion time: ____ : ____ (Starts when cook begins placing fuel into the stove. Completed when the stove is lit and remains burning without constant attention.)
3.2 Lighting notes *[describe lighting process, difficulties, and fire starting materials used]*:		
3.3	Fuel consumption	Initial mass: _____ (kg) Final mass: _____ (kg)
3.4	Cooking time	Start time: ____ : ____ Completion time: ____ : ____ (Starts when food, water, etc. is first heated on the fire. Completed when the last dish is removed from the fire.)
3.5	Tending and refueling frequency *[Record the hour and minute of each tending event. Draw a circle around each fuel refueling event, including when the fire is first built.]*	1. ____ : ____ 8. ____ : ____ 15. ____ : ____ 22. ____ : ____ 2. ____ : ____ 9. ____ : ____ 16. ____ : ____ 23. ____ : ____ 3. ____ : ____ 10. ____ : ____ 17. ____ : ____ 24. ____ : ____ 4. ____ : ____ 11. ____ : ____ 18. ____ : ____ 25. ____ : ____ 5. ____ : ____ 12. ____ : ____ 19. ____ : ____ 26. ____ : ____ 6. ____ : ____ 13. ____ : ____ 20. ____ : ____ 27. ____ : ____ 7. ____ : ____ 14. ____ : ____ 21. ____ : ____ 28. ____ : ____
3.6	User error *[Make a tally mark for each occurrence]*	Fire went out: _____ Cook removed functional part(s) of stove: _____ Cook fed too much fuel: _____ Incorrect refueling practices: _____ Incorrect ash cleanout: _____ Other: _____ : _____

3.6 User error notes:		
3.7	Visibility of fire *[Circle the most appropriate option, 0-3]*	**(3)** Best: Highly visible (combustion zone can be seen from a distance from anywhere within the cooking area) **(2)** Good: Moderately visible (combustion zone can be seen from a distance, from a limited angle or direction, only) **(1)** Fair: Minimally visible (cook must bend down within reach of the stove to see combustion zone) **(0)** Poor: Combustion zone is never visible while stove is in operation
3.8	Soot deposited on pot *[Circle the most appropriate option, 0-3]*	**(3)** Best: No soot on pot after cooking **(2)** Good: Soot covers bottom of pot, only, after cooking **(1)** Fair: Soot covers bottom and less than 1/2 of sides of pot after cooking **(0)** Poor: Soot covers bottom and more than 1/2 of sides of pot after cooking
3.9	Other people present during testing	*[List all people present during testing. Note their level of involvement in cooking, responding to survey questions, etc.]*
3.10	Other stove model(s) present in household	*[List and describe all other stoves present in household, but not used during testing.]*
General notes:		

4. User Survey

Instructions for tester: *This section is to be done while the meal is being cooked.*

Ask the participant each of the following questions. If the question includes boxes with answers to the right of the question text, select the option that best fits the participant's response. If no option is clearly the best fit, read aloud the closest options and ask the participant to select one. Circle only one response, unless instructed otherwise.

If no pre-determined answer options are provided, follow the instructions included with each question. Please use additional space to make comments about unclear or unexpected responses.

Note: *The tester should be very familiar with or (ideally) belong to the same culture as the cook.*

4.1	"How many times do you cook on your stove each day?"	*[Record response as a number. Include other relevant notes.]*
4.2	"How often do you buy cooking fuel?"	*[Enter period as a number of days, weeks, months, or "never". Be sure to include units. Include other relevant notes.]*
4.3	"How much cooking fuel do you buy at once? Do you know about how many kilograms it weighs?"	*[Record response as described. Indicate if the participant is uncertain about the weight of the fuel they purchase.]*
4.4	"How much do you pay each time you buy cooking fuel?"	*[Record currency value. Include other relevant notes.]*
4.5 A	"How much time do you or someone who lives in your home spend collecting or buying fuel on average, per day or per week?"	*[Record number of minutes or hours per day or per week. Be sure to include units. Include other relevant notes.]*

4.5 B	"How do you feel about time spent collecting or buying stove fuel?"	"It is a serious burden"	"It is a nuisance"	"I am neutral"	"I enjoy it a little"	"I enjoy it a lot"

4.6	"How enjoyable is spending time cooking, collecting, or buying fuel with other people?"	"Not at all"	"Not very"	"I am neutral"	"Somewhat"	"Very"	"I don't do these things with other people" *(N/A)*

4.6 Notes:

4.7 A	"About how much time do you or someone who lives in your home spend cutting, drying, or otherwise preparing fuel each day for your stove?"	*[Record number of minutes or hours. Be sure to include units. Include other relevant notes.]*

4.7 B	"How do you feel about time spent preparing stove fuel?"	"It is a serious burden"	"It is a nuisance"	"I am neutral"	"I enjoy it a little"	"I enjoy it a lot"

4.8 A	"Is it hard or easy to keep the fire small and cook at a low heat on your stove?"	"Very hard"	"Hard"	"Neither easy nor hard"	"Easy"	"Very easy"
4.8 B	"How important is it that a stove can easily cook with a small fire or at a low heat?"	"Very unimportant"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.8 Notes:						
4.9 A	"Is it hard or easy to control the size of the fire in your stove?"	"Very hard"	"Hard"	"Neither easy nor hard"	"Easy"	"Very easy"
4.9 B	"How important is it that the size of the fire can be adjusted easily?"	"Very unimportant"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.9 Notes:						

4.10 A	"How do you feel about the frequency with which your stove needs to be tended?"	"I dislike it so much that I don't like to cook with it."	"I don't like how much tending it needs"	"I am neutral"	"I like how little tending it needs, but wish it needed less"	"I really like how little tending it needs. I wouldn't change it."
4.10 B	"How important is it that your stove can be left without being tended for a long time?	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.10 Notes:						
4.11 A	"Does your stove cook quickly or slowly?"	"Very slowly"	"Slowly"	"Neither quickly nor slowly"	"Quickly"	"Very quickly"
4.11 B	"How important is it that a stove cook quickly?"	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.11 Notes:						

4.12 A	"How many of the different sizes of pots and pans you cook with fit on your stove?"	"None"	"Less than half"	"About half"	"More than half"	"All"
4.12 B	"How important is it that a stove can cook with all of the sizes of pots and pans you normally use?"	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"

4.12 Notes:						
4.13	"How many different dishes do you usually cook at the same time during the main meal of the day?"	*[Record response as a number]*				
4.13 Notes:						
4.14 A	"Are any of the following true for you when you reload fuel or tend the fire in your stove?"	*[Circle all that apply]*				
		"I have to remove the pot"	"I am exposed to a lot of heat or sometimes burn myself"		"I am exposed to a lot of smoke"	
4.14 B	"How important is it that it is easy to reload and tend a stove?"	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.14 Notes:						
4.15 A	"About how many minutes does it take for the fire to get hot enough to start cooking after you light it?	*[Record response as a number of minutes]*				
4.15 B	"How important is it that a stove gets hot enough to cook on quickly?"	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.15 Notes:						
4.16 A	"Do you routinely fix or maintain your stove? If so, how often?"	*[Enter interval as a number of days, weeks, months, or "never"]*				
4.16 B	"Do you agree or disagree that the routine maintenance of a stove is an important concern?"	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.16 Notes:						
4.17 A	"Are any of the following true about the maintenance requirements of your stove?"	"It requires purchased replacement parts once a year or more"	"Necessary replacement parts are not available or hard to find"	"Necessary replacement parts are too expensive" *[If yes, ask and record how much money per year is needed for parts]:* _____		
4.17 B	"Do you agree or disagree that the long-term maintenance of a stove is a significant concern?"	"I strongly disagree"	"I disagree"	"I neither agree nor disagree"	"I agree"	"I strongly agree"

4.17 Notes:						
4.18 A	"Which of the following best describes how you feel about the safety of your stove?"	"It is so unsafe that I do not want to use it"	"It is not very safe to use"	"It is neither safe nor unsafe"	"It generally feels safe to use, but sometimes feels unsafe"	"It stove feels very safe to use"
4.18 B	"How important is the safety of a stove?"	"Very un-important"	"Un-important"	"Somewhat important"	"Im-portant"	"Very important"
4.18 Notes:						
4.19 A	"Which of the following best describes the amount of smoke your stove creates in the area where you cook?"	"There is so much smoke that I don't like to use this stove"	"I don't like the amount of smoke "	"I am neutral"	"I like how little smoke there is"	"The stove produces no smoke"
4.19 B	"Is smoke in the cooking area an important concern to you?"	"Very un-important"	"Un-important"	"Somewhat important"	"Important"	"Very important"
4.19 Notes:						
4.20 A	"Which of the following best describes how you feel about the height of this stove above the ground?"	"The height makes it is so uncomfortable that I don't like using it"	"The height makes it somewhat uncomfortable to use"	"I am neutral"	"The height is comfortable, but not perfect"	"The height is perfect. I wouldn't change it"
4.20 B	"How important is the height of a stove?"	"Very unimportant"	"Unimportant"	"Somewhat important"	"Important"	"Very important"
4.20 Notes:						
4.21 A	"Which of the following best describes how you feel about the appearance of this stove?"	"It is so ugly that I do not like having it in my house"	"It does not look very attractive. I wish it was different"	"I am neutral"	"It looks good, but could look better"	"I really like the way it looks. I would not change it"
4.21 B	"How important is the appearance of a stove?"	"Very unimportant"	"Un-important"	"Somewhat important"	"Important"	"Very important"

Test # _____

4.21 Notes:						
4.22 A	"Which of the following best describes how you feel about the durability of this stove?"	"The durability is so poor that it is not worth using"	"It is not very durable"	"I am neutral"	"It is somewhat durable"	"It is very durable"
4.22 B	"How important is the durability of a stove?"	"Very unimportant"	"Un-important"	"Somewhat important"	"Important"	"Very important"
4.22 Notes:						
4.23 A	"Which of the following best describes how you feel about the value of this stove?"	"It is a bad value for the cost"	"It is not a very good value for the cost"	"I am neutral"	"It is a good value for the cost"	"It is a very good value for the cost"
4.23 B	"How important is the value of a stove in your decision to use it?"	"Very unimportant"	"Un-important"	"Neither important nor unimportant"	"Important"	"Very important"
4.23 Notes:						

4.24

Ask the following question for each of the needs listed below. Circle "yes" or "no" for each.

Add additional needs in the "other" categories if you know or suspect that there are other local needs not included in these questions.

"Is (this need) an important feature of a cookstove to you?"

"If so, does this stove meet that need?"

		Important feature?		Need met by stove?	
1	Space heating	Yes	No	Yes	No
2	Insect repellent	Yes	No	Yes	No
3	Lighting	Yes	No	Yes	No
4	Portability	Yes	No	Yes	No
5	Water heating	Yes	No	Yes	No
6	Food drying or smoking	Yes	No	Yes	No
7	Other: _____	Yes	No	Yes	No
8	Other: _____	Yes	No	Yes	No

4.25 A	"Does this stove make the flavor or taste of your food better or worse than other stoves?"	"Much worse"	"A little worse"	"Neither better nor worse"	"A little better"	"Much better"
4.25 B	"How important is the flavor or taste added by a stove?"	"Very unimportant"	"Un-important"	"Somewhat important"	"Important"	"Very important"
4.25 Notes:						
4.26	"How long have you been using this particular kind of stove"	*[Enter response as a number of days, weeks, months, or years. Be sure to include units.]*				
4.26 Notes:						
4.27	"Did your stove come with a paper instruction manual, or were you trained how to use your cookstove?"	No	Yes, but it was not good enough	Yes, and it was good enough		
4.27 Notes:						

5. Semi-structured Interview

Instructions for the tester: *This section is to be done immediately after the completion of the survey.*

Ask each of the following questions to the participant. Summarize their responses in the space provided below each question. Please ask additional clarifying questions, at your discretion, to encourage more complete responses.

Other questions may also be added to clarify the results of the survey or other issues that arose during the testing process in section 5.5 at the bottom of this page.

5.1	"Can you list a few of your favorite things about your stove? Why do you like them?"
5.2	"Can you list a few of your least favorite things about your stove? Why do you dislike them?"
5.3	“Is there anything you would like to change about your stove?”
5.4	"Is there anything else you would like to tell me about your stove or cooking in general?"
5.5	Additional question(s) and response(s).

Appendix B: Data Processing Spreadsheet

Double click on the embedded file, below, to open.

The spreadsheet is also available at:
https://humanitarian.engineering.oregonstate.edu/usability-testing-protocol-cookstoves

Appendix C: Results Scorecard

This template for reporting results is shown in this appendix is also output automatically by the *Data Processing Spreadsheet* referenced in Appendix B.

II. Cooking performance

	Result	Relative Weight	Highest sub-criteria ME (95% CI)
A. Cooking speed (percieved)			
Cooking duration (measured)			
B. Firepower control			
C. Firepower range			
D. Use of all pots and pans			

Overall performance score:

Highest subcategory ME:

III. Operability

	Result	Relative Weight	Highest sub-criteria ME (95% CI)
A. Fuel feed entry size			
B. Tending frequency (perceived)			
Tending frequency (measured)			
Fuel reloading frequency (measured)			
C. Tending/refueling effort (perceived)			
D. Visibility of fire			
E. Ease of lighting			
F. Fire start-up delay			
G. User error			
H. User instruction			

Overall operability score:

Highest subcategory ME:

IV. Maintenance

	Result	Relative Weight	Highest sub-criteria ME (95% CI)
A. Routine maintenance			
B. Long-term maintenance			
Annual maintenance cost (% of income)			

Overall maintenance score:

Highest subcategory ME:

V. Comfort

	Result	Relative Weight	Highest sub-criteria ME (95% CI)
A. Perceived safety			
B. Perceived smoke exposure			
C. Cooking area soot deposits			
D. Pot soot deposits			
E. Cooking height			
F. Stove aesthetics			
G. Perceived durability			
H. Perceived value			
I. Taste			

Overall comfort score:

Highest subcategory ME:

VI. Location-specific needs

	Need met by stove?
A. Space heating	
B. Insect repellant	
C. Lighting	
D. Portability	
E. Water heating	
F. Food drying or smoking	
G. Other 1:	
H. Other 2:	

Overall location-specific needs score:

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