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For cook and climate: Certify cookstoves in their contexts of use

Samer Abdelnour[a,*], Crispin Pemberton-Pigott[b]

[a] Rotterdam School of Management, Erasmus University, Burgemeester Oudlaan 50, 3062 PA Rotterdam, The Netherlands
[b] Key Laboratory of Clean Production and Utilization of Renewable Energy, China Agricultural University, P.O. Box 50, No. 17 Qinghua Donglu, Haidian District, Beijing 100083, China

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ABSTRACT

Improved cookstoves are widely promoted as a health and climate improving technology, yet there remains a wide gap between their reputed benefits and the inconclusive outcomes of most interventions. An increasing number of scientists suggest that the popular lab protocols used to test, rate and model the benefits of improved cookstoves are at least partly to blame. Insights from a recent study of improved cookstove users in Darfur, Sudan, reveal the extent to which the logic and goals of lab-based testing protocols differ from actual cooking practices. We elaborate on the climate and energy policy implications of decontextualized lab tests and conclude with a call to design, test and select for dissemination only those improved cookstoves that are rated on the basis of their intended contexts of use.

In developing countries, poor and rural families face extreme health and safety risks when cooking over traditional open fires or with primitive artisanal metal stoves. These risks include physical injury from collecting and carrying fuelwood, contact and radiative burns, exposure to gaseous pollutants such as carbon monoxide, and risks associated with the inhalation of black carbon and fine particulate matter [1,2]. For these reasons, improved cookstoves are widely promoted as an intervention capable of reducing cooking-related health and safety risks. Additionally, where poor households rely on unsustainably harvested wood for fuel, there is growing interest in carbon financing as a win-win mechanism to greatly expand the distribution of improved cookstoves to those who might not otherwise afford one [3]. Although improved cookstoves have been promoted to address health and environmental concerns for over 50 years, changing the cooking and fuel use behaviour of poor and rural people remains an indeterminate task [4]. Indeed, there continues to be a strong disconnect between policy narratives that champion the benefits of improved cookstoves and the inconclusive outcomes of most interventions.

An increasing number of scientists suggest that the failure of interventions to realize their stated objectives is a problem rooted in how improved cookstoves are designed, tested and rated [5]. Similar to the Volkswagen scandal where vehicles were engineered to perform well during emissions tests [6], stove designers are 'building to the test' because the measurements taken and metrics generated under popular lab test conditions are almost irrelevant to actual cooking practices (e.g. the Water Boiling Test). In turn, when inappropriate metrics reported by unrepresentative lab test sequences inform performance rating systems (e.g. tiers of performance), emission simulations (e.g. *ad hoc* dispersion models) and carbon certification methods, cookstove interventions are, based on experience, unlikely to achieve putative, modelled health and climate outcomes, or worse, cause unintended harm [7,8].

We weigh into this discussion by drawing on a recent study consisting of narrative interviews with improved cookstove users in three camps for displaced people in North Darfur, Sudan. Respondents were asked to share their experiences using improved cookstoves with focus to the perceived benefits they derive from using them. Their responses were coded and analyzed for key themes using an inductive thematic analysis research design [9,10].

Of the 56 respondents, 43 use improved mud stoves of various designs (large/small, one/two-pot); 19 use an all-metal Berkeley Darfur Stove (BDS), and 6 use both. Most mud stoves users were trained to make and repair stoves by aid agencies or learned the skill from a friend or relative. A few women report having purchased their mud stove at a local market where business women make and sell them. The price of a mud stove in Darfur ranges from 10 to 40 Sudanese Pounds (roughly 1.7–5.7 USD official currency exchange, or 0.6–2.35 USD black market). Such stoves save about half the fuel compared with a traditional construction or an open fire. In addition, women who underwent mud stove training also learned to make inexpensive dung and dried okra briquettes. Such briquettes are sold in the camp markets and used to ignite charcoal, displacing plastic bags, straw and paper (Figs. 1).

BDS owners received their stoves from camp leaders who distributed them on behalf of aid agencies through lotteries. Four women

* Corresponding author.
E-mail address: abdelnour@rsm.nl (S. Abdelnour).

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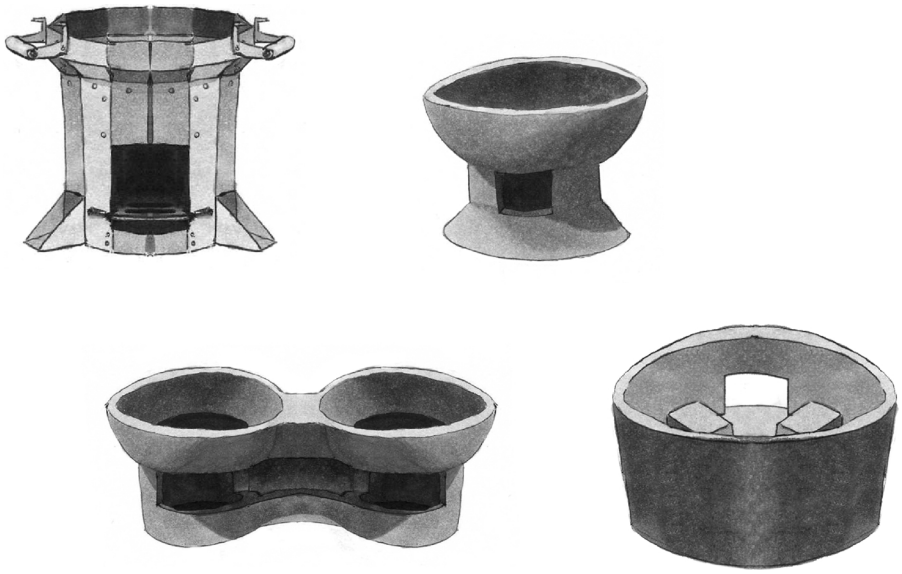

Fig. 1. A selection of improved cookstoves found in Darfur's camps. They include variants of locally made improved mud stoves and the metal Berkeley-Darfur Stove.

report using liquid petroleum gas stoves, also received as aid, primarily to boil water quickly or for space heating. Many women aspire to own gas stoves but the relatively high cost and inconsistent supply of fuel in camps hinders uptake. It is worth noting that many women regularly use more than one stove: large cooking pot-sized stoves to cook meals and small kettle-sized stoves to make tea or coffee. Interviewees report having between 6 months and 13 years of experience cooking with improved stoves, the median being 5 years.

What we find most interesting is that the women interviewed overwhelmingly describe the main economic benefit of improved cookstoves as enabling them to transition away from "expensive" wood to charcoal. A small sack of charcoal purchased with 5 Sudanese Pounds (> 1 USD) is enough to prepare two meals plus tea; to prepare the same meals with wood is double the cost in most places. Women also note that when needed, both wood and charcoal are readily available for purchase at local markets. Charcoal is perceived to be cleaner than wood as it produces far less smoke when burning. Hence, regardless of stove type, women report charcoal as their primary and preferred cooking fuel. Wood fuels are regularly used to prepare *kisra*, a sorghum crepe cooked on a flat metal tray at high temperatures over a *ladaya*, a traditional three-stone fire, or on the legs of an inverted BDS, a finding corroborated by a recent study in Darfur where at least 17% of cooks were found to use their BDS in this manner [11] Fig. 2.

Regardless of stove type, all respondents perceived the health benefits of improved cookstoves as reduced smoke inhalation, reduced eye infections and fewer burns. Mud stoves were acclaimed safer for children because unlike metal stoves they are cool to the touch. Eye infections are framed as an economic issue because treatment is relatively expensive. Additional benefits include general safety and cleanliness as both fire and ash are contained within the stove, there is less smoke in the household and fewer stove-induced fires in camps.

To summarize, the women interviewed report the key drivers for improved cookstove adoption are the immediate economic and health benefits realized, namely the transition to a cheaper fuel, reduced smoke inhalation and fewer burns. They report that fuel is readily available at the camp markets, and materials to make improved mud stoves and briquettes are also broadly accessible. These findings suggest that the generic baseline narrative that all women travel long distances at personal risk to collect wood to cook over open fires does not universally hold. As such, our study provides further evidence discrediting the idea that improved cookstoves are an effective intervention to reduce gender violence [12,13]. Moreover, where there is a functioning market economy, women who do scavenge for fuel view spare fuel as potential income and donated stoves as a saleable asset.

The relevance of these findings for climate and household energy policy come into focus when considered against the typical protocols used to model the climate benefits of improved cookstoves and certify them for carbon financing. Currently, performance ratings rely on controlled lab tests that specify a standard fuel (almost always wood), a fixed burn cycle (high and low power), a standard pot size, a limited number of replications, and the assumption that all biomass fuel is harvested unsustainably [14,15]. This lab logic fails to appreciate that stoves burn whatever users put in them, an example being the testing of the BDS as 'wood-burning' while in practice Darfuris might use it to burn charcoal of questionable origin [16].

Indeed, the cooking and fuel choices of women in Darfur vitiate the relevance of wood-centric protocols to test and carbon-certify improved cookstove performance. Where charcoal is the primary cooking fuel, charcoal should be used to test and rate the performance of a given stove. There is no functional reason not to replicate patterns of use even when multiple fuels and stoves are involved. This is extremely relevant for testing and certifying carbon-offsetting technologies; for instance, the Clean Development Mechanism of the Kyoto Protocol requires carbon certification methods to account for net carbon dioxide emissions from combustion, deforestation, unsustainable wood harvesting and charcoal production. If actual cooking and fuel practices are not taken into consideration, performance modelling may overestimate the potential climate benefits of improved cookstoves and there may be positive cash exchange for net-negative results [17]. A first step is to better understand how, with what and why people cook, and to incorporate these into cookstove design and testing methods.

To conclude, the widespread use of mud stoves and charcoal as the primary fuel in Darfur suggests that the oft-repeated baseline narrative that 'all poor and rural women cook with wood over open fires' does not universally hold. This reinforces our point that improved cookstoves should be tested and rated in their contexts of use with actual cooking practices. Though this may seem intuitive, there is an almost complete absence of peer-reviewed scientific articles on field-based protocols for testing improved cookstoves. Similarly, the ongoing ISO process to develop a standard for improved cookstoves, with which we are both involved, is overwhelmingly preoccupied with lab-based protocols employing an arbitrary test sequence. The scientific community working on cookstoves requires a fundamental redirection away from the logic of arbitrary lab tests to contextual design, testing and

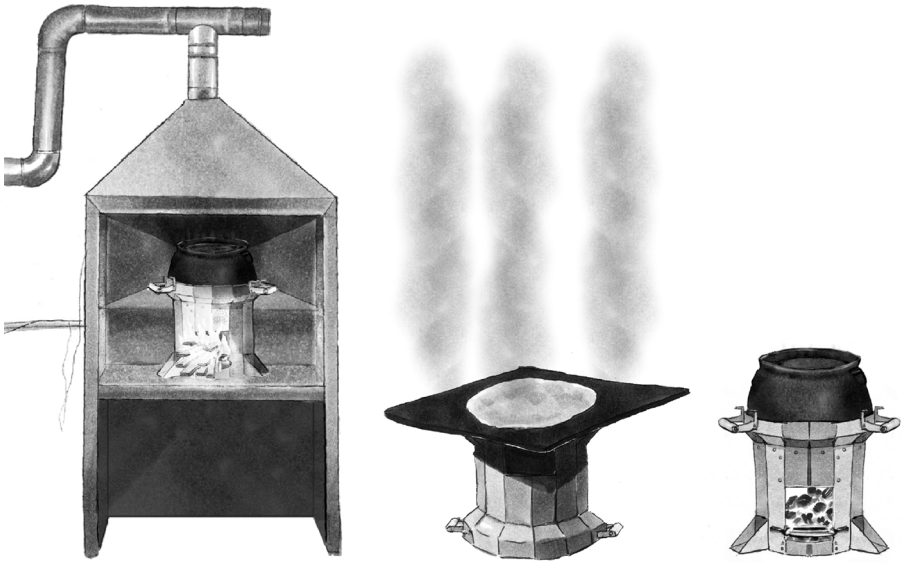

Fig. 2. The Berkeley-Darfur Stove under conditions of lab testing and actual use.

certification. Doing so also requires taking appropriate technologies such as improved mud stoves and a broader array of biomass fuel into serious consideration [18,19]. A context-centric logic requires a better understanding of how the availability and market price of fuel influences cooking preferences and practices in specific settings, and in turn, how they relate to the wider economic, environmental and societal policy implications of fuel use in developing countries [20,21]. In places like Darfur, energy policies that promote sustainably harvested and produced charcoal at local markets is likely to realize greater climate benefits than giving away free cookstoves designed to burn wood. To reiterate, improved cookstoves should be designed, tested and rated in their contexts of use, lest interventions will continue to fail policy makers, users and the climate.

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