Tropentag 2016, Vienna, Austria
September 18-21, 2016

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the University of Natural Resources and Life Sciences (BOKU Vienna), Austria

Harming own interests? Lessons learned from villagers' change of perceptions regarding innovative improved cooking stoves

Götz Uckert[1a], Harry Hoffmann[1a], Johannes Hafner[2], Frieder Graef[1b], Ogossy Gasaya Sererya[3], Anthony A. Kimaro[4], Srijna Jha[1a], Stefan Sieber[1a]

[1]Leibniz Centre for Agricultural Landscape Research (ZALF), [a]Inst. of Socio-Economics, [b]Inst. For Land Use Systems , Germany
[2]Humboldt-Universität zu Berlin, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences (ADTI), Agricultural Economics, Germany
[3]Sokoine University of Agriculture, Dept. of Forest Economics, Tanzania
[4]World Agroforestry Centre (ICRAF), Tanzania Country Programme, Tanzania

Abstract

Cooking energy is scarce in developing countries where a substantial part of the population strongly depend on woodfuel – firewood and charcoal – to meet their daily cooking energy need. A major part of the rural population continues to cook with, three-stone-firewood, cook stoves. For over 30 years, research and development projects have been emphasizing on the reduction of energy input per cooking unit and of emission quantity. Our research aimed at the adaptation, design and testing of improved cooking stoves and at the creation of a mutual process to encourage and facilitate knowledge exchange amongst villagers to understand the up-grading-strategy (UPS) of improved cooking stoves and its importance for their livelihoods. We organized training groups with approximately 100 farmers to implement this technology (the "rocket Lorena mud stove"). This was done through action-research in the Trans-SEC project operating in four villages in Morogoro and Dodoma, Tanzania. We monitored the stove construction activities and the dissemination process, which resulted in 125 additional households with stove implementations. We conducted a) focus group discussions (FGD) to analyze variances between villages and b) in-depth testing of cooking and stove performance between improved vs. the traditional stoves in 80 households. We found that our stove models save about 50 % of firewood energy and 40% of cooking time, leading to 42% reduction in budget for firewood and 98% of the firewood collection time. High efficiency, especially in cooking time, was attributed to the two pot design, energy conservation and high combustion efficiency of our stove. Subsequent up-scaling, further dissemination and increased local ownership of the tested cook stove will carefully include improvements by the villagers diverting from the initial rocket stoves, including better heat insulation and smoke exhaustion. Generally, optimal engineering does not necessarily lead to results that are perceived as optimal by users and hence participatory exchange on user needs are substantial in the improved cooking stove sector.

Keywords

Controlled cooking test, kitchen performance test, improved cooking stoves, efficient cookstoves, energy access, firewood, technology adoption, wood fuel consumption, indoor air pollution, participatory training of trainers, Sub-Sahara Africa, Tanzania,

Introduction

Cooking energy is scarce in developing countries where a substantial part of the population strongly depends on wood-fuels — particularly firewood and charcoal. Moreover in Sub Saharan Africa (SSA), particularly charcoal but also firewood production and consumption has been reported to grow constantly in the last decades and will continue to do so in the decades to come (Arnold et al. 2006, Steierer 2011). Regarding firewood consumption, a major part of the rural population is still utilizing inefficient traditional three-stone firewood stoves (3-SF) for cooking (Kishagar and Kalamkar 2014). While firewood and charcoal “production” is still characterized by unsustainable wood extraction and inefficient fuel conversion, it acts as one of the main driver of deforestation and forest degradation in Tanzania as well as in other developing countries (Mwampamba 2007, Chidumayo and Gumbo 2013). WHO accounted in 2012 that approx. 4.3 million people die annually from the effects of indoor air pollution which is induced by 3 stone fire stoves (WHO 2015).

The paper shows results from the implementation of one of the 13 Up Scaling Strategies (UPS) of Trans-SEC, namely the UPS of “Improved cooking stoves” (ICS) which aims at the reduction of firewood consumption and indoor smoke emissions.

Figure 1: Stove scheme and pictures of ICS implemented, chimney and new ICS design

Material and Methods

Improved stove technology was implemented via action-research by the Trans-SEC project operating in four villages of Morogoro and Dodoma Region in Tanzania to combat resource depletion and health injury. After one year of implementation, parameters of the success of the training of trainer (ToT) concept was monitored via several household surveys. Targeted parameters were smoke reduction, firewood consumption, time of cooking and qualitative assessments of stove users.

a) Total Suspended Particulates (TSP) was determined to assess emission reduction of dust levels from the cooking stoves (Casella Microdust Pro particulate monitor model 176000 A). The gas analyzer assessed indoor air quality through carbon oxides along the stove, cook’s position, at a breathing height (Kane900plus).

b) Combined Controlled Cooking Test (CCT) with Kitchen Performance Test (KPT) was designed to quantitatively access the specific performance of the ICS for a standard cooking task, as well as, qualitative survey of stove performance and acceptability. This was done to render performance test results (De Lepeleire 1981, Bailis et al. 2007, Johnson et al. 2009).

c) Focus Group Discussions (FGD) were held to get insights on change of perceptions, reflect upon scientific results from surveys, and mutually exchange knowledge on new type of stoves.

Results and Discussion

Smoke was measured as PM10 and CarbonMonoxide (CO) – Emissions. Regarding TSP, we observed for instance, that when cooking inside there is a high average particulate matter (PM10) emissions of the 3-SF (0.0060 mg/nm3), compared to ICS (0.0023 mg/nm3). Here the ICS reduced PM10 emissions by 61.2% via a more complete combustion and the use of a chimney to expel the exhaust smoke. The following table shows the reduction of CO-Emissions when cooking with the ICS.

Table 1: CO emission comparison (mg/m3)
(n=24; 6 inside and 6 outside for each 3-SF and ICS)

Inside		Outside	
3-SF	ICS	3-SF	ICS
48.26	18.84	37.62	11.69
Diff. - 60.7%		Diff. - 68.6%	

The *performance* of the different stove types was evaluated among the farmer UPS group of ICS in all four villages. Figure 2, shows monitoring differences of firewood savings in the two regions Morogoro and Dodoma. Although ICS enables savings in both cases we found that cooking practices may reflect firewood scarcity. Due to extensive deforestation and the long distances to remaining resources of collectable firewood in the Dodoma Region, the level of firewood consumption is low – less than 1 kg of firewood per capita per day in the case of cooking with the ICS. In the Morogoro Region we found a higher variation - with some similarities. While it was possible to consume less than 1 kg firewood per capita and day, the existing communal forests and a higher availability lead, especially in case of cooking at 3-SF to doubled consumption rates. Implemented ICS achieved similar performance improvements as tested by MacCarty (2010).

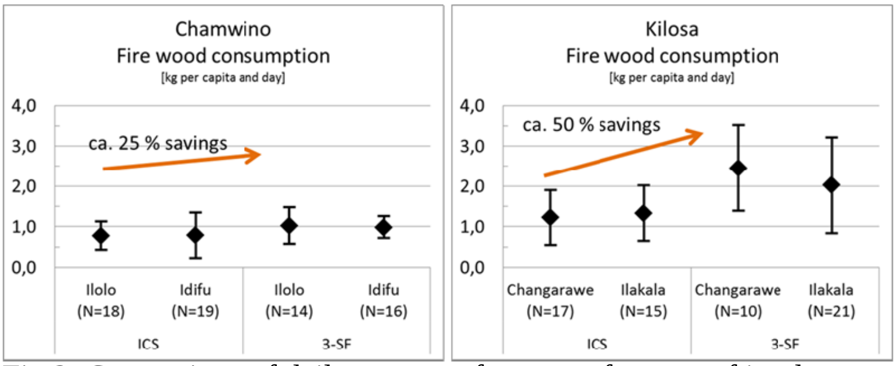

Fig 2: Comparison of daily stove performance for type of implemented ICS and traditional 3-SF in two regions.

To achieve differenciated insights on determinants of firewood consumption standard tests on stove performance were conducted. Figure 3 shows the performance of ICS and 3-SF for different meals cooked. Figure 4 compares the ICS according to the perception of changes between the initially implemented ICS design against the one developed from experienced trainers after one year of implementation.

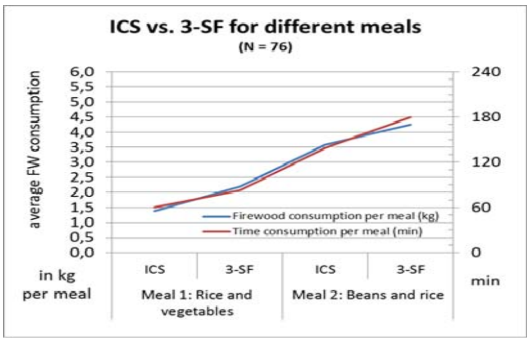

Fig 3: Performance test for types of meals and cooking devices

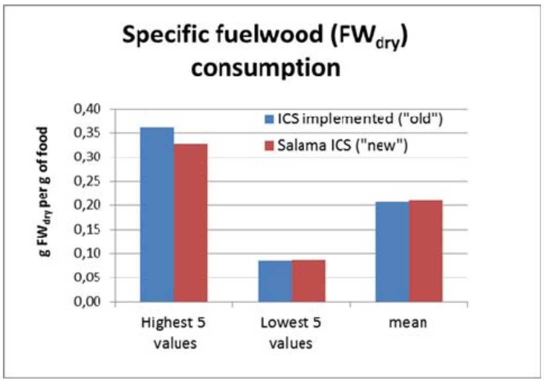

Fig 4: Performance test for ("old") implemented ICS and ("new") SALAMA type of ICS (cooking the maize meal “Ugali” and Vegetables).

Monitoring, CCT and KPT showed significant efficiency gain of up to 50% for ICS against traditional 3-SF. A main result from the ICS user evaluation was that one year of implementation practice led to slight changes in ICS design. Analysis showed that the ICS performance could be enhanced through better heat distribution amongst the two pots.

UPS group members pointed out their experience of the importance of a continuous practice of ICS usage and construction as well as the exchange of knowledge on drying and storing of firewood and the chimney development. As an important result from focus group discussions we found a change of perception. UPS group members were indicating that intended benefits of ICS were derived by higher thermal efficiency. Technologically, ICS usage was leading to lower firewood as well as time consumption. However, the group members also highlighted that the lower indoor smoke burden and an increased safety during cooking was of major importance for acceptance and dissemination.

Conclusions and Outlook

We carefully monitored and analyzed the resulting technologically shift in the design of implemented ICS and how far it might be driven more by aiming for an increase of acceptance and not by focusing only on the knowledge of how to increase efficiency. We found that the design changes did not deter any ICS advantages even in technical performance. We conclude that the risks of moving towards malfunctions of ICS could be balanced by a robust education of trainers and the continuos monitoring of the initial phase of implementation.

Ongoing construction activities should lead to further improvements of improved cooking stoves and in turn lead to higher acceptance of the ICS. This might serve as a successful pilot case for creating a successful up-grading strategy for ICS, where there is a need of a convinced user and a more experienced constructor for further dissemination. Another important step was the creation of a single brand named “SALAMA Jiku Banifu” for advertising.


Figure 5: SALAMA stove to represent ICS technology at the NANE NANE Exhibition 2016.

For ongoing projects in stove implementation we could ask ourselfs:
1. How to successfully establish a perpetual knowledge exchange between farmers/villagers concerning cooking habits, firewood consumption and smoke reduction?
2. How to assist farmer groups in stove construction activities and in self-organizing dissemination processes?
3. What lessons do we get from farmer innovation in the stove design on satisfaction and stove performance?

Acknowledgements
This publication is a product of the projects Trans-SEC (www.trans-sec.org) and Food Security Africa (FSA). The German Federal Ministry of Education and Research (BMBF) has funded and the German Federal Ministry for Economic Cooperation and Development (BMZ) has co-financed the project Trans-SEC. The views expressed are purely those of the authors and may not under any circumstances be regarded as stating an official position of the BMBF or BMZ. The Leibniz-Centre for Agricultural Landscape Research ZALF e.V. financed the project FSA.

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