

Cleaner cooking while producing biochar: gasifier cookstove adoption in rural Kenya

Gitau K J^{a,b*}, Njenga M^{a,b}, Mendum R^c, Mahmoud, Y^d and Sundberg C^{e,f},

Introduction

A majority of households in developing countries use biomass energy for cooking and heating due to its affordability and accessibility. However, unsustainable biomass use leads to deforestation, environmental degradation and climate change. The pollution from open burning of biomass is a major health concern especially for women and children as they spend a lot of time in the kitchen. Biochar-producing gasifier cookstoves offer an opportunity to address many of these problems, while also producing biochar, which sequesters carbon and can be used as a soil amendment. However, the impacts depend on the cookstove being adopted and integrated into the cooking systems of the rural households. A study was carried out in order to investigate the adoption of these cookstoves in three sites in Kenya (Kwale, Embu and Siaya).

Method - Cookstoves

- Fifty selected households in each of three sites (Embu, Kwale and Siaya) were trained on use of the biochar-producing TLUD gasifier cookstoves with trade name GASTOV.
- Cookstoves were distributed to households for free use.
- Users were asked to save the produced biochar for later use in agriculture.
- Adoption survey was performed at all households after 2-3 months.
- Semi-structured interviews were held with 20% of households after 1-3 years.
- Fuel use, biochar production, cooking time and pollutant concentrations were measured in 25 households in each of the three sites after 6-18 months of stove use

Method - Field

- All households with cookstoves were trained on biochar use in groups of 5-10 persons
- Biochar was applied in furrows 2-3 cm deep in experimental plots of 10-20 m²
- Biochar application rates were determined by amounts produced and saved by households
- Crops were maize and kale
- Crop management was according to local practice

Results - cookstoves

- Uptake rate: 86%, 96% and 100% of households were using the gasifier after 2-3 months in Embu, Kwale and Siaya respectively, with varying frequency, from daily to weekly.
- Households had stored between 1-20 kg of biochar.



Trees on farm are important for fuel supply



Gastov cookstove by Kenya Industrial Research Institute (KIRDI)



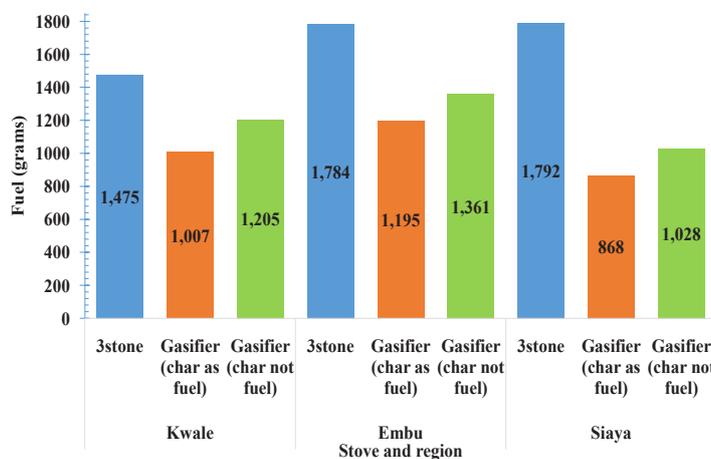
Chopping wood to use with gasifier with a machete



Cookstove canister is filled



Cooking food on Gastov cookstove



Average fuel use while cooking a meal

Stove	PM _{2.5}			CO			CO ₂		
	3 stone	Gastov	% reduction	3 stone	Gastov	% reduction	3 stone	Gastov	% reduction
Embu	4843	150	97	28	5.1	82	665	627	18
Kwale	874	188	79	14	6.1	57	1091	647	41
Siaya	2760	136	95	31	6	81	840	588	30

Reduction in indoor air pollution by use of gasifier stove



Biochar produced in cookstove



Application of biochar produced in cookstoves



Farmer innovation: Leafy green vegetables grown in mix of soil, biochar and chicken manure

Benefits that influence adoption of the gasifier

- Less smoke produced
- Easy to clean
- Easy to handle
- Easy to adjust the heat
- No need to push wood
- Less heat exposure
- Char produced as a byproduct
- Less fuel needed

Challenges identified by users

- Cookstove requires small pieces of wood
- Difficult to light the stove
- Need to reload when fuel has been consumed hence most users prefer to use stove for meals that cook fast

Emissions

Kitchen CO concentrations during cooking were reduced by 57- 95% in the three sites, and PM_{2.5} by 79 - 97%

Crop yields in farmer managed plots

- Vegetables (Kale) increased by 33%
- Maize increased from 0.9 to 4.4 Mg/ha

Discussion

- Clear evidence of “stove stacking” – households using more than one stove for different purposes.
- Households use various fuels from different sources. Firewood was the main fuel used to cook with the gasifier.
- Households see benefits in yields increase from use of biochar but there is competition with other uses of the char, for cooking, heating space and ironing.
- In Siaya fuel saving is crucial for cookstove adoption, but fuel shortage is limiting biochar use in soil.
- Gasifier + use of biochar result into net carbon sequestration and biomass must be produced sustainably.

Recommendations on use of gasifier

- Chop wood when fresh and then dry
- Use well dried wood
- When lighting, place canister on top of pieces of wood or stone
- Second canister encourages cooking of food that take long to get ready and should be prepared in advance to save time
- Cook with doors and windows open for air circulation
- Quench the fuel after cooking to save it for another use

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Publications are available on project website at www.biochar.abe.kth.se

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^aWangari Maathai Institute for Peace and Environmental Studies, University of Nairobi, P.O. Box 2905-0065 Nairobi, Kenya.

^bWorld Agroforestry Centre (ICRAF), P.O. Box 30677-00100, Nairobi, Kenya. M.Njenga@cgiar.org ^cOffice of International Programs, College of Agricultural Sciences, Pennsylvania State University, USA. rmm22@psu.edu, ^dDepartment of Human Geography, Lund University, Sweden, ^e Department of Sustainable Development, Environmental Science and Engineering (SEED), KTH Royal Institute of Technology, Address: Teknikringen 10B, SE-100 44 Stockholm, Sweden. cesu@kth.se ^f Department of Energy and Technology, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden.