Performance characterization of improved wood cooking stoves for monitoring household energy interventions in Uganda

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Introduction

Over 90% of the population in Uganda depends on biomass as source of energy (MEMD, 2009). The technologies used to convert biomass to energy are highly traditional. Urban and rural dwellers use predominantly metal charcoal stoves and traditional three-stone stoves, at efficiency less than 10% (Okello et al., 2013). This puts Uganda's forests and its growing population under tremendous pressure. No-wonder, Uganda features a high deforestation rate of about 2.2% (Nampewo, 2013). Adoption of energy conserving technologies such as improved biomass cook stoves could conserve energy and reduce environmental degradation. Thus, there is a need to assess qualitative aspects of stove performance and compare their impact on fuel consumption in households. The aim of the study was to evaluate the performance of improved wood cooking stoves for monitoring household biomass energy interventions in Uganda. Thermal efficiency and fuel consumption of improved cooking stoves (ICS) were determined and compared with traditional three stone stove.

Materials & Methods

The study was conducted in Mbale district located in Eastern Uganda, Nebbi and Adjumani districts in West Nile. Nearly the entire population in the Districts relies on biomass fuels for cooking, which is typical of rural Uganda. Strategic random home visits were made and questionnaires administered to 300 households. For each of the biomass energy technologies (Figure 3 – 7), a Water Boiling Test (WBT) was used to estimate the fuel consumption and thermal efficiency while per capita energy consumption was estimated by Kitchen Performance Test (KPT). The study compared fuel use between households with ICSs and households with traditional three-stone stove. The sample of households that participate in WBT and KPT was selected randomly from among the target population (N = 98) in order to obtain unbiased results. Participants in the study had self-purchased the improved cooking stoves.

Results & Discussion

As shown in Figure 1, 43% of surveyed households in Mbale, Nebbi and Adjumani districts use improved cooking stoves (ICSs).

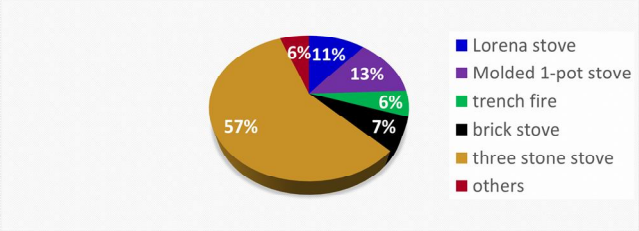

Figure 1: Utilization of fuel wood cooking stoves in Mbale, Nebbi and Adjumani districts

Thermal efficiency and energy consumption of 4 commonly used ICSs (Lorena stove, Molded 1-pot mud stove, trench fire and brick stove, Figure 3 -7) were determined using WBT and KPT and results compared with traditional three stone stove. The average performance (thermal efficiency and energy consumption) of brick stove (17%; 24MJ/cap) was found better than Molded 1-pot mud stove (16%; 28MJ/cap), Lorena stove (14%; 33MJ/cap), trench fire stove (13%; 37MJ/cap) and the traditional three stone stove (9%; 53MJ/cap) in that order (Figure 2). High efficiency of brick stove was due to minimum heat losses as a result of proper insulation vis-à-vis three stone stove.

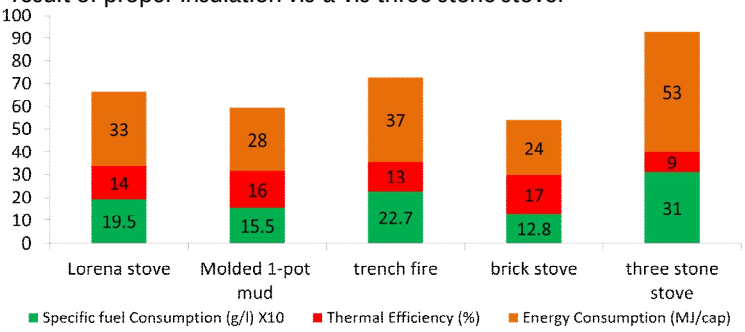

Figure 2: Performance comparison of Improved wood stoves and traditional three stone stoves (n = 3 for each stove)

The level of adoption of improved cooking stoves was 45% in rural households of West Nile and 32% in Eastern Uganda. Their adoption reduces with proximity to protected areas.

Conclusion

Although the adoption of ICSs is below average, they can reduce fuel consumption in actual use by between 30 and 55 %. Their adoption would lessen the pressure put on natural resources use. Further research is needed on other benefits of ICSs in terms of health, environment and climate protection.



Figure 3: Lorena Stove



Figure 4: Molded 1-pot mud



Figure 5: Trench fire



Figure 6: Brick stove



Figure 7: Three stone stove

References

MEMD. (2009). Ministry of Energy and Mineral Development Annual Report 2008.

Nampewo, N. (2013). Saving Mabira Rainforest: Using Public Interest Litigation in Uganda to Save Mabira and Other Rainforests. Boston College Environmental Affairs Law Review , 40 (2), 523-553.

Okello, C., Pindozzi, S., Faugno, S. & Boccia, L. (2013). Development of bioenergy technologies in Uganda: A review of progress. Renewable and Sustainable Energy Reviews, 18, 55 – 63.