ASSESSMENT OF WOODFUEL UTILIZATION AND EFFICIENCY OF COOKING STOVES IN LIKIA, NJORO SUBCOUNTY, KENYA.

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A Thesis submitted to the Graduate School in partial fulfilment of the requirement for the award of a Master of Science Degree in Natural Resource Management of Egerton University.

EGERTON UNIVERSITY

15 March 2017
DECLARATION AND RECOMMENDATION

I declare that this Thesis is my original work and has not been submitted to any other University for an award of a Degree.

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Recommendation

This research Thesis has been submitted with our approval as University Supervisors.

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ACKNOWLEDGEMENT

I would like to acknowledge the grace of the Almighty God who has given me the ability to write this thesis. I wish to appreciate all the support and guidance offered to me in the writing of this thesis and throughout this study period. First my two supervisors Dr. Gilbert Obwoyere and Dr. George Eshiamwata, from whose enormous wealth of experience I have benefitted during the execution of this work. I am also indebted to Rose Nyagwoka, William Karoki, Caroline Chepchirchir and Peterson Mureithi from the Ministry of Agriculture Njoro Sub County, who assisted with fieldwork specifically administration of the questionnaire. Eunice Mideva who played a key role in recording data during the experiments. My appreciation is also extended to other lecturers from the Faculty of Environment and Resource Development and other Faculties of Egerton University for their encouragement and advice that have enabled this thesis be completed. I also wish to acknowledge the invaluable support of my family including my husband Wanjala Nasirembe, my daughters Miranda Mbakhila and Eunice Mideva whose patience and understanding during the difficult times that I went through in pursuit of this work helped me complete the task.
DEDICATION
I wish to dedicate this thesis to the late Prof Moses Karachi whose guidance helped to advance the idea that formed the basis of this study and my father, the late Eric Andwati who always encouraged me to pursue further studies.
ABSTRACT
Over 2.6 billion people of the world’s population prepare their food and heat their homes with biomass fuel mainly woodfuel. Wood fuel is used as a major source of energy without a replacement plan and is partly the cause of deforestation. Among the interventions identified as crucial to slowing down deforestation include promoting alternative sources of energy and using efficient stoves to reduce pressure on forest resources. This study examined wood fuel utilization and efficiency of cooking stoves among the rural population of Likia location, Njoro Sub County. A survey was conducted through a questionnaire administered to respondents from the study area. An experiment using the Water Boiling Test with Split Plot in Randomized Complete Block Experimental Design was used to study the heat gain and efficiencies of the stoves. The heating stoves were the sub plot factor and the sources of energy, the main plot factor. The study variables included temperature changes with time, heat gained during cooking and the efficiencies of the stoves. The mean heat gains and mean efficiencies were treated to ANOVA at 95% confidence level. Correlation analysis was used to study the effect of time on temperature change during cooking. Ninety percent of the respondents used woodfuel for cooking, while the three stone stove was used by 71% of the respondents. There was an acute wood fuel shortage that put pressure on the adjacent Mau forest. The highest mean heat gain was 288.9kJ ± SD 0.00 with the *Olea africana*/ceramic stove while the lowest mean heat gain was 58.6kJ ± SD 0.00 with the waste paper briquettes/wood ceramic stove and the corresponding mean efficiencies were 69% ± SD 0.00 and 14%± SD 0.00 respectively. Not all cooking stoves/woodfuel combinations were able to boil one litre of water within ten minutes. There was significant correlation between the cooking time and temperature changes at 95% confidence level. The LSD, found significant differences in mean heat gained due to the woodfuel used but not due to all the stoves used. There were significant differences in the mean efficiencies of the cooking stoves due to the fuel type, the stoves and interaction between the fuel and the stoves. The study recommends the promotion of on-farm forestry for woodfuel and timber production and creating awareness about the key ecological services provided by forest ecosystems. The promotion of improved energy saving stoves, the improvement of biomass briquette burning properties, the possibility of a subsidy provision for the people to enable their acquisition of alternative sources of energy such as solar energy panels is also recommended. These results are expected to promote sustainability in the wood fuel use and contribute to the slowing down of deforestation of the adjacent Mau Forest.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA  Analysis of Variance
CBO     Community Based Organization
CCT     Controlled Cooking Test
CFA     Community Forest Association
CV      Calorific value
FAO     Food and Agriculture Organization
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>FRA</td>
<td>Forest Resources Assessment</td>
</tr>
<tr>
<td>GCV</td>
<td>Gross calorific value</td>
</tr>
<tr>
<td>GPS</td>
<td>Geographic Positioning System</td>
</tr>
<tr>
<td>GVEP</td>
<td>Global Village Energy Partnership</td>
</tr>
<tr>
<td>ICRAF</td>
<td>International Centre for Agro forestry Research</td>
</tr>
<tr>
<td>IGADD</td>
<td>Intergovernmental Authority on Drought and Development</td>
</tr>
<tr>
<td>KCS</td>
<td>Kenya Ceramic Stove</td>
</tr>
<tr>
<td>KEMA</td>
<td>Kayole Environmental Management Association</td>
</tr>
<tr>
<td>KFS</td>
<td>Kenya Forest Service</td>
</tr>
<tr>
<td>KFWG</td>
<td>Kenya Forestry Working Group</td>
</tr>
<tr>
<td>KPT</td>
<td>Kitchen Performance Test</td>
</tr>
<tr>
<td>KWDP</td>
<td>Kenya Wood fuel Development Programme</td>
</tr>
<tr>
<td>LSD</td>
<td>Least Significant Difference</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
</tr>
<tr>
<td>MDGs</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>NCV</td>
<td>Net calorific value</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>TPES</td>
<td>Total Primary Energy Supply</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environmental Programme</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>VITA</td>
<td>Volunteers in Technical Assistance</td>
</tr>
<tr>
<td>WBT</td>
<td>Water Boiling Test</td>
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