NEW TECHNICAL PROGRAMME

Department of Forest Products and Utilization

Experiment No. 21.5.3.13

01.	Experiment No. and Title	:	**Turning lignocellulosic forest/agroforest waste into high-quality charcoal briquettes**
02.	Budget Head	:	352/18248/04 or 352/12036
03.	Collaborative department, if any	:	-
04.	Background information	:	
	Tropical regions are endowed with a rich diversity of tree species; many of which shed significant quantities of branches and leaves annually. These residues, often considered as waste, can be transformed into valuable charcoal briquettes through a process that involves compacting and binding them under high pressure. The resultant briquettes can serve as efficient and eco-friendly alternatives to traditional fuels such as firewood and charcoal. Charcoal briquetting (also called Densification) is the process of compacting the biomass residue into a uniform solid fuel called briquettes. It has higher density and energy content and less moisture compared to its raw materials. This study focuses on evaluating the fuel quality of briquettes produced specifically from woody branches and litter of selected commercial tropical tree species. By analyzing the thermal properties and combustion behavior of prepared briquettes, one can aim to establish their potential as sustainable energy sources. Moreover, this research contributes to the broader objective of waste to wealth creation by promoting the utilization of forestry residues. Hence, an attempt was made to find out the fuel quality evaluation of briquettes made from charcoal powder of woody branches and leaf litter powder which is essential for ensuring they are a viable, sustainable and environmentally friendly alternative to traditional fuels.		
05.	Objectives		1) To assess the qualitative characteristics of charcoal briquettes produced from powder of woody branches and leaf litter 2) To evaluate fuel value index (FVI) of charcoal briquettes based on qualitative characteristics
06.	Principal investigator and associates	:	**Principal Investigator: Dr. M. S. Sankanur** **Co- Investigators :** Dr. R. P. Gunaga Dr. S. K. Sinha **Associate scientist :** Dr. N. S. Thakur
	Null hypothesis		The qualitative characteristics of charcoal briquettes produced from powder of woody branches and leaf litter of different species are not significantly different from each other
07.	Location and Agro-climatic sub-region	:	**Forest Nursery of College of Forestry, NAU, Navsari**
08.	Year and Season	:	2025-26
09.	Crop and Variety	:	Woody branches of Sharu (*Casuarina equisetifolia* L.), Vaans (*Bambusa arundinacea* (Retz.) Willd.), Nilgiri (*Eucalyptus species* Labill.) Limdo *(Azadirachta indica* A. Juss.) and Poplar (*Populus deltoids* W.Bartram ex Marshall) and Leaf litter powder of Keri (*Mangifera indica* (*L.*), Chiku (*Manilkara zapota (L.) P.Royen*), Nilgiri (*Eucalyptus species Labill.*), Saag

<table>
<tr><td></td><td colspan="2"></td><td></td><td>(Tectona grandis) and Sharu (Casuarina equisetifolia)</td></tr>
<tr><td>10.</td><td colspan="2">Experimental details</td><td>:</td><td>-</td></tr>
<tr><td></td><td>(a)</td><td>Treatments</td><td>:</td><td>Total 25 treatments
<table>
<tr><th>Treatments</th><th>Woody branch powder</th><th>Leaf litter powder</th></tr>
<tr><td>T1</td><td>Sharu +</td><td>Keri</td></tr>
<tr><td>T2</td><td>Sharu +</td><td>Chiku</td></tr>
<tr><td>T3</td><td>Sharu+</td><td>Nilgiri</td></tr>
<tr><td>T4</td><td>Sharu+</td><td>Saag</td></tr>
<tr><td>T5</td><td>Sharu+</td><td>Sharu</td></tr>
<tr><td>T6</td><td>Vaans+</td><td>Keri</td></tr>
<tr><td>T7</td><td>Vaans+</td><td>Chiku</td></tr>
<tr><td>T8</td><td>Vaans+</td><td>Nilgiri</td></tr>
<tr><td>T9</td><td>Vaans+</td><td>Saag</td></tr>
<tr><td>T10</td><td>Vaans+</td><td>Sharu</td></tr>
<tr><td>T11</td><td>Nilgiri+</td><td>Keri</td></tr>
<tr><td>T12</td><td>Nilgiri+</td><td>Chiku</td></tr>
<tr><td>T13</td><td>Nilgiri+</td><td>Nilgiri</td></tr>
<tr><td>T14</td><td>Nilgiri+</td><td>Saag</td></tr>
<tr><td>T15</td><td>Nilgiri+</td><td>Sharu</td></tr>
<tr><td>T16</td><td>Limdo+</td><td>Keri</td></tr>
<tr><td>T17</td><td>Limdo+</td><td>Chiku</td></tr>
<tr><td>T18</td><td>Limdo+</td><td>Nilgiri</td></tr>
<tr><td>T19</td><td>Limdo+</td><td>Saag</td></tr>
<tr><td>T20</td><td>Limdo+</td><td>Sharu</td></tr>
<tr><td>T21</td><td>Poplar+</td><td>Jaambu</td></tr>
<tr><td>T22</td><td>Poplar+</td><td>Keri</td></tr>
<tr><td>T23</td><td>Poplar+</td><td>Chiku</td></tr>
<tr><td>T24</td><td>Poplar+</td><td>Saag</td></tr>
<tr><td>T25</td><td>Poplar+</td><td>Sharu</td></tr>
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<tr><td></td><td>(b)</td><td>Experimental Design</td><td>:</td><td>For analysis, CRD design will be used for estimation of qualitative characteristics of charcoal briquettes viz., moisture content, basic density, ash content, calorific value and fuel value index.</td></tr>
<tr><td></td><td>(c)</td><td>Replications</td><td>:</td><td>Three samples will be drawn randomly and used for assessment of variation in qualitative characteristics of charcoal briquettes.</td></tr>
<tr><td></td><td>(d)</td><td>Plot size (if applicable)</td><td>:</td><td>Gross - ____ m x ____ m</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Net - ____ m x ____ m</td></tr>
<tr><td></td><td>(e)</td><td>Spacing</td><td>:</td><td>NA</td></tr>
<tr><td></td><td>(f)</td><td>Seed rate (kg/ha)</td><td>:</td><td>NA</td></tr>
<tr><td></td><td>(g)</td><td>Manures and fertilizer</td><td>:</td><td>NA</td></tr>
<tr><td></td><td>(h)</td><td>Any other detail, if required</td><td>:</td><td>-</td></tr>
<tr><td>11.</td><td colspan="2">Observations to be recorded</td><td>:</td><td>Observations to be recorded:
The following observations will be recorded from charcoal briquettes produced from lignocellulosic waste material</td></tr>
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			1. Moisture content (in %) 2. Basic density (in g/cc) 3. Ash content (in %) 4. Calorific value (in MJ/kg) and 5. Fuel value index (in Kcal/kg) 6. Burning time 7. Amber quality 8. Smoke quality
12.	Methodology	**:**	
	The charcoal briquettes produced in this study will be 8 cm × 3 cm (length ×width) with the help of the briquette-making machine using charcoal powder of woody branches *viz*., Sharu (*Casuarina equisetifolia* L.), Vaans (*Bambusa arundinacea* (Retz.) Willd.), Nilgiri (*Eucalyptus species* Labill.) Limdo *(Azadirachta indica* A. Juss.)] and Poplar (*Populus deltoids* W.Bartram ex Marshall) including leaf litter powder of Keri (*Mangifera indica* (*L.*), Chiku (*Manilkara zapota (L.) P.Royen*), Nilgiri (*Eucalyptus species Labill.*), Saag (*Tectona grandis L.f.*) and Sharu (*Casuarina equisetifolia L.*)] among five commercial tropical tree species along with the waste flour as a starch adhesive with three replications. Mixing of charcoal powder of woody branches in combination with leaf litter powder among different commercial tropical tree species along with waste flour as a starch adhesive will be performed manually in a bucket until evenly distributed. The adhesive content 10% will be used based on oven-dry charcoal stem power and leaf litter powder among different commercial tropical tree species. The charcoal powder of woody branches in combination with leaf litter powder and adhesive will be mixed evenly then transferred into briquette-making equipment and the material will be subjected to compression through a hydraulic press machine at a pressure of 30 kgf/cm^2. The charcoal briquettes obtained will be then dried by exposing to sunlight for 3 days. **Outcome of the study:** Data base on transforming lignocellulosic waste material into quality charcoal briquettes will be generated for the first time in South Gujarat. The study outlines best combinations of lignocellulosic waste material *i.e.* charcoal wood powder and litter among commercial tropical tree species to develop the a viable, sustainable and environmentally friendly alternative to traditional fuels. It supports energy security, environmental stewardship and economic development in regions where these resources are abundant.		