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REVIEWER'S REPORT

Manuscript No.: IJAR- 59800

Title: ***Innovative Basutirtha Sal Leaves Biochar (BSLB): Application Potentiality for Soil Amendment, Sustainable Agriculture and Resilience to Environmental Degradation.***

Recommendation:
Accept as it is .....
Accept after Minor revision.....
Accept after Major revision
Do not accept (*Reasons below*)

Rating	Excel.	Good	Fair	Poor
Originality		✓		
Techn. Quality		✓		
Clarity			✓	
Significance			✓	

Reviewer Name: Dr. ANAPANA GOPAL

Reviewer's Comment for Publication.

1. General Comments
The manuscript addresses an interesting and potentially valuable topic: the conversion of dry Sal (*Shorea robusta*) leaves into biochar for soil amendment, sustainable agriculture, waste management, and environmental improvement in the Jhargram region of West Bengal. The proposed use of locally available forest biomass could provide an opportunity to manage leaf litter, improve soil properties, support rural livelihoods, and contribute to carbon management.
The regional focus and the attempt to estimate the availability of Sal leaves and potential biochar production are noteworthy. However, the manuscript, in its present form, is primarily a conceptual proposal supported by several estimated values rather than a systematically conducted experimental or field-based research study. Important information concerning biochar production, laboratory characterization, soil application, crop responses, and environmental benefits is either missing or insufficiently documented.
The manuscript requires substantial revision to establish the scientific validity of its estimates, clarify the proposed production methodology, and distinguish measured findings from assumptions and projected benefits. The authors should considerably strengthen the research methodology, supporting evidence, and scientific presentation before the manuscript can be considered for publication.
2. Content and Originality
1. **Clarification of research novelty:** The manuscript introduces the term "Basutirtha Sal Leaves Biochar (BSLB)" and proposes specific methods for producing biochar from dry Sal leaves. However, the scientific novelty of the proposed approach is not clearly established. The authors should explain how the proposed method

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differs from existing biochar production techniques and what specific innovation it contributes.

2. **Insufficient experimental evidence:** The manuscript reports that Sal leaves biochar contains approximately 57.6–57.7% carbon, 1.06% nitrogen, 3.14% hydrogen, 0.5% sulphur, and has a pH of 8.27. However, the analytical methods, laboratory facilities, sample preparation procedures, number of replicates, and analytical standards used to obtain these values are not provided. The authors must clearly establish whether these are experimentally measured values or values obtained from secondary sources.

3. **Reliability of biomass estimates:** The manuscript estimates approximately 49.6 million Sal trees in the Jhargram forest region, with each tree producing 8 kg of dry leaves annually. These assumptions result in an estimated annual dry leaf biomass of 396,800 tonnes. However, the basis for the assumed number of trees per hectare and the annual leaf production per tree is not explained. These estimates require field measurements, forest inventory data, or reliable published references.

4. **Verification of biochar production estimates:** The manuscript estimates 277,760 tonnes of wet biochar and 138,880 tonnes of dry biochar from the available Sal leaves. The calculation and the distinction between wet and dry biochar are not sufficiently explained. The authors should provide the experimental basis for the assumed conversion yield and clearly define the moisture content of the raw biomass and final biochar.

5. **Comparison with other biochars:** The comparison between Paddy Straw Biochar and Sal Leaves Biochar in the manuscript is potentially useful. However, the values presented in the comparison table require supporting laboratory data and references. The authors should ensure that both biochars were characterized using comparable analytical procedures and under similar experimental conditions.

6. **Insufficient evidence for agricultural benefits:** The manuscript suggests that Sal leaves biochar can improve soil fertility, water retention, nutrient availability, and crop productivity. However, no field experiments, pot experiments, or controlled soil studies are presented. These claims should either be supported by experimental evidence or clearly described as potential applications requiring further investigation.

7. **Environmental benefits need quantitative validation:** The manuscript claims that biochar production could reduce forest fires, air pollution, CO_2 emissions, and CO emissions. However, the reported emission values of approximately 3,667 tonnes of CO_2 and 1,905 tonnes of CO are not supported by a clearly described calculation or emission assessment methodology. These claims require appropriate evidence.

8. **Socio-economic benefits:** The proposed involvement of local forest-dependent communities in leaf collection, biochar production, packaging, and distribution is relevant. However, the expected employment generation, economic feasibility, production costs, market demand, and benefits to farmers have not been evaluated. A preliminary economic assessment would strengthen this section.

3. Technical Quality

1. **Biochar production methodology:** The manuscript discusses pyrolysis, hydrothermal carbonization, and flash carbonization. However, the proposed production process is not described with sufficient technical detail. The authors should provide the actual experimental or proposed operating conditions, including temperature, heating rate, residence time, oxygen availability, and biomass moisture content.

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2. **Inconsistency in process conditions:** Table 1 presents different temperature and residence-time ranges for slow pyrolysis, fast pyrolysis, and hydrothermal carbonization. Some of these conditions require technical clarification, particularly the reported residence time of less than 3 seconds for slow pyrolysis and the description of fast pyrolysis with a residence time of hours to days. The authors should verify these values and distinguish between biomass residence time, vapour residence time, and total processing time.
3. **Clarification of hydrothermal carbonization:** The manuscript describes hydrothermal carbonization using dry Sal leaves and reports a moisture content of 6–12%. The authors should clarify the process conditions and explain whether water is added during treatment, since hydrothermal carbonization generally involves processing biomass in hot compressed water.
4. **Proposed production chamber:** The manuscript mentions an earthen pit or concrete chamber measuring 3 m × 2 m × 1.5 m. However, the chamber design, construction materials, temperature-control mechanism, air supply, gas release system, and safety measures are not described. A detailed schematic diagram of the production unit would improve reproducibility and technical understanding.
5. **Incomplete characterization section:** Section 6, titled "Characteristics of Sal Leaves Biochar," appears incomplete, while Section 7 presents some physicochemical properties. The authors should reorganize these sections and provide a complete characterization of the biochar, including ash content, volatile matter, fixed carbon, bulk density, electrical conductivity, surface area, and relevant elemental composition, wherever available.
6. **Analytical methods:** The authors should specify the methods and instruments used to determine carbon, hydrogen, nitrogen, sulphur, pH, and moisture content. Standardized analytical procedures should be identified, and the results should be supported by appropriate laboratory data.
7. **Calculation and unit inconsistencies:** The biomass and biochar production equations require careful checking. For example, the conversion from 396,800 tonnes of dry leaves to 277,760 tonnes of wet biochar assumes a yield of 700 kg per tonne, while the manuscript also reports 138,880 tonnes of dry biochar. The relationship between these quantities and the moisture content should be explicitly demonstrated.
8. **Land requirement and biochar demand:** The manuscript estimates the biochar demand for 60% of the agricultural land in Jhargram District as 201,187 tonnes. However, the application rate per hectare is not provided. The authors should show the formula, recommended application rate, and assumptions used to estimate the total demand.
9. **Environmental impact assessment:** The claims concerning carbon sequestration, greenhouse gas mitigation, and reduced pollution should be supported by a suitable carbon balance or life-cycle assessment. The authors should consider emissions from collection, transportation, processing, and biochar application rather than considering only the carbon retained in the final product.
10. **Water and heavy metal remediation:** The manuscript proposes the use of Sal leaves biochar for removing arsenic, manganese, lead, and zinc from water and soil. However, no adsorption experiments, removal efficiencies, or supporting Sal-biochar-specific data are provided. These applications should be supported by experimental results or presented as possible future research directions.

4. Language and Presentation

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The manuscript requires substantial language editing to improve clarity, grammar, scientific terminology, and readability.

1. Several sentences contain grammatical errors, inappropriate word choices, and unclear expressions. For example, phrases such as "resilience the environmental degradation," "high crops production," and "the burning issues" should be rewritten using appropriate scientific English.
2. Scientific names should be presented consistently. The correct botanical formatting should be *Shorea robusta*, with the genus capitalized, the species name lowercase, and both italicized.
3. The manuscript uses inconsistent terminology, including "Sal Biochar," "SL-Biochar," "BSLB," "wet Biochar," and "dry Biochar." The authors should define the abbreviations and use consistent terminology throughout.
4. Units and numerical expressions should be standardized. For example, "hectors" should be corrected to "hectares," and temperature, biomass, and percentage values should be presented using consistent scientific notation.
5. The manuscript contains several typographical and formatting errors, including missing spaces, duplicated words, inconsistent capitalization, and incomplete sentences.
6. The term "Basutirtha Methods" requires a clear scientific definition. The authors should explain whether it represents a newly developed production technique, a proposed conceptual framework, or a locally designed process.
7. The title should be revised for grammatical accuracy and scientific clarity. The phrase "resilience the environmental degradation" is inappropriate and should be replaced with a scientifically meaningful expression.

A thorough language and technical editing process is strongly recommended.

5. Structure and Organization

1. The manuscript contains repeated descriptions of biochar properties, Sal forest resources, biomass estimates, and environmental benefits in the Abstract, Introduction, and subsequent sections. These repetitions should be reduced.
2. The Introduction should provide a clearer scientific background on biochar production from forest leaf litter, the importance of Sal forests, the characteristics of lateritic soils, and the specific research gap addressed by the study.
3. A separate **Materials and Methods** section should be included. It should describe the source and collection of Sal leaves, sampling procedures, biomass estimation, biochar production, laboratory characterization, and calculation methods.
4. The sections on the study area and location should be consolidated. The geographical and socio-economic descriptions are extensive but are not consistently connected to the central research objectives.
5. The section titled "Research and Innovation on Sal Forest, Dry Sal Leaves and Yield Biochar" should be reorganized to distinguish forest resource estimates from experimentally determined biomass and biochar yields.
6. The proposed equations under the "Basutirtha Methods" section are not presented in a sufficiently clear mathematical format. Each equation should include properly defined variables, units, and calculation procedures. The authors should also explain the scientific contribution of these equations.
7. The sections on characteristics, benefits, applications, and key points should be reorganized to avoid overlapping information. The comparison between Sal leaves

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biochar and Paddy Straw Biochar should be presented with a clear table title, units, and supporting data.
8. The manuscript includes incomplete or apparently missing sections, particularly "Environmental Set Up and LULC of Jhargram" and "Flowchart of Implementation Methods." These sections should either be completed with relevant figures, maps, and explanations or removed if they do not contribute directly to the study.
9. The proposed symbolic design and patent symbol should be reconsidered. If the authors intend to present an original technical design or patented process, the associated technical description and novelty should be clearly established. Otherwise, these elements may be more appropriate for a project proposal than a scientific research article.
10. A separate Discussion section should be included to compare the findings with existing biochar research, interpret the results, discuss limitations, and explain the practical implications of the proposed approach.

6. References and Citations

1. The manuscript contains a substantial reference list, including publications related to biochar, soil improvement, carbon sequestration, and environmental management. However, several statements in the main text are not supported by appropriate in-text citations.
2. The authors should provide references for the major quantitative estimates, particularly the total forest area, percentage of Sal trees, number of trees, annual dry leaf production, forest fire incidence, agricultural land area, and lateritic soil distribution in Jhargram District.
3. The reported carbon content and other physicochemical properties of Sal leaves biochar should be supported by original experimental data or relevant published studies. References related to other biomass-derived biochars cannot independently establish the properties of Sal leaves biochar.
4. The authors should cite appropriate scientific sources for the different pyrolysis techniques, hydrothermal carbonization, flash carbonization, temperature ranges, residence times, and biochar yield percentages.
5. The reference list contains inconsistent formatting. Some references follow a journal-style format, while others use an author-date format. A single referencing style consistent with the journal's guidelines should be followed.
6. Reference number 15 appears to combine two separate references, and reference number 22 also appears to contain multiple sources in a single entry. These should be separated and formatted individually.
7. Some references contain incomplete bibliographic details, inconsistent journal abbreviations, and punctuation errors. The authors should verify the complete titles, author names, volume numbers, page ranges, and DOI information.
8. The relevance of certain references to the central subject should be reconsidered. References concerning bamboo, sugarcane, elephant reserves, and unrelated agricultural topics should be retained only where they directly support the discussion.
9. The authors should verify the accuracy and accessibility of all government reports, institutional documents, and online sources, particularly those used to support district-level statistics.
10. Recent research on biochar derived from forest litter and other leaf-based biomass, including studies on physicochemical properties, soil application, crop responses, and life-cycle environmental impacts, should be incorporated.

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7. Overall Recommendation

The manuscript addresses a relevant and potentially useful research topic with regional importance. The utilization of dry Sal leaves for biochar production could offer opportunities for forest waste management, soil improvement, sustainable agriculture, and rural livelihood development in the Jhargram region.

However, the current manuscript has substantial scientific and technical limitations. The biomass availability estimates, biochar yield calculations, physicochemical characteristics, production conditions, agricultural application rates, and environmental benefits require stronger evidence and clearer explanations. Most importantly, the manuscript does not provide sufficient experimental details to establish whether the reported biochar properties and production yields are based on actual laboratory investigations or theoretical estimations.

The authors should strengthen the methodology, verify all quantitative calculations, provide supporting analytical data, improve the discussion, and substantially revise the language and organization. If the work is intended as a conceptual or project proposal rather than an experimental research article, its scope and presentation should be revised accordingly.

8. Final Decision

Minor Revision

The manuscript requires minor revision before it can be considered for publication. The authors should address the methodological deficiencies, verify the reported numerical estimates, provide reliable evidence for the biochar characteristics and production potential, and improve the scientific presentation. In particular, the distinction between experimentally established findings and projected applications must be made clear. A revised manuscript should be reassessed after these substantial concerns have been addressed.