PROJECT REIGNITE: TURNING FARM WASTE TO CLIMATE ACTION

Document Prepared by Together for Restoration

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The rising volume of agricultural waste biomass, intensified by growing population, is mounting to a challenging environmental crisis. In India, farmers practice traditional methods of waste disposal: open field burning and decomposition of biomass. Open field burning boosts carbon dioxide (CO_2) emissions and decomposition of waste biomass results in methane (CH_4) production, magnifying environmental impacts locally and globally. These improper agricultural waste management practices exacerbate climate change and pollute air, water, and soil. This underscores the inevitability of robust biomass waste management strategies in the Indian agricultural sector.

However, this disregarded agricultural waste is a promising opportunity. Properly harnessed, it holds the untapped potential of transforming into a powerful carbon sink. Project Reignite provides a pragmatic solution, empowering smallholder farmers to transform their agricultural waste into biochar for soil enrichment – a tangible step towards climate action. First, by stopping open field burning and preventing decomposition of biomass, we significantly reduce GHG emissions. Next, as biomass captures atmospheric carbon, which, when converted to biochar and applied to soil, gets stored underground for centuries, even millennia, providing long-term GHG sequestration. Lastly, applying biochar enhances soil fertility, promoting better crop growth and further boosting carbon capture. In essence, the project delivers more than just effective biomass waste management—it fosters improved agriculture while benefiting the environment and local communities.

In Project Reignite, farmers use the flame curtain pyrolysis method in steel-shield soil pits to process agricultural waste into biochar. The fire on top creates a 'flame curtain' that limits oxygen access to the biomass below. This initiates the pyrolysis process, producing high-quality biochar. Once the pit is full, the fire is extinguished using water, nutrient solutions, or soil. The dried biochar is then mixed with manure and applied deep into the soil (more than 10 cm subsurface).

Project Reignite aims to uplift the lives of small and marginalized communities, particularly women, in India. Open field burning and overreliance on chemical fertilizers has degraded the soil and local water bodies, diminishing agricultural productivity and jeopardizing community health. By introducing biochar to the soil, Project Reignite transforms farms into high-carbon landscapes, increasing agricultural yield, ensuring food security, improving community health, and increasing income for the communities.

This is a grouped project in India. The first instance of the grouped project is being implemented with 5,000 farmers (defined as biochar producers in the project) in the state of Odisha, India.

The project has a crediting period of 7 years, renewable twice. The first instance of this grouped project is expected to remove an estimated 110,760 tCO2e annually, leading to the removal of estimated 775,320 tCO2e over the first crediting period of 7 years.

Audit Type	Period	Program	VVB Name	Number of years
Validation/ Verification	Estimated by 31st March 2024	VCS	RINA Services S.p.A	7 months
Total				7 months

1.2 Sectoral Scope and Project Type

The sectoral scope applicable to the project is Waste Handling and Disposal (Scope number 13) and activity type is production of biochar and utilization in soil (non-AFOLU.)

This is a grouped project in India. The first instance is being implemented in the state of Odisha, India.

1.3 Project Eligibility

The grouped project and its project activities are eligible under the scope of the VCS Program because of the following reasons:

1. The project activity mitigates CO_2 and CH_4 emissions by avoiding open field burning and biomass decomposition. It removes carbon through biochar production and soil application. These actions address CO_2 and CH_4, which come under the seven greenhouse gases outlined in the Kyoto Protocol.
2. Project activity is supported by the VCS methodology VM 0044 V1.1 (Methodology for Biochar Utilization in Soil and Non-Soil Applications)
3. The program activity does not come under the excluded project activities in VCS Program as mentioned in Table 1, page 2,3 of the VCS Standard V4.4.

1.4 Project Design

☒ The project is a grouped project.

New project activity instances will be added in the future.

Eligibility Criteria

Table 1: New Project Activity Instance Eligibility Criteria

S. No.	Criteria provided in Standard	Evaluation Condition for new instances	Applicability to the current instances
1.	Meet the applicability conditions set out in the methodology applied to the project.	Each new project activity instance must meet the applicability conditions set out in the Methodology VM0044 v1.1.	This project activity instance is compliant with the applicability conditions as explained in Section 3.2.
2.	Use the technologies or measures specified in the project description.	Each new project activity instance must involve conversion of waste biomass to biochar and its utilization in soil application. For all new project instances to be added in the future, the same technology would be used, i.e. the process of biochar production by soil pit pyrolysis technique, using steel shield	This project activity instance is compliant with the measures specified as the activity is conversion of waste biomass to biochar for soil application.
3.	Apply the technologies or measures in the same manner as specified in the project description.	Each new project activity instance must use low technology pyrolysis.	This project activity instance uses flame curtain pyrolysis technology in steel-shield soil pit.
4.	Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	The baseline scenario for each new project activity instance must be open field burning or decomposition of waste biomass. The geographical area of the new instance must be within India.	The baseline scenario of this project activity instance is open field burning and decomposition of waste biomass as described in Section 3.14. The geographical area of this instance is within India as

			demonstrated in Section 1.12.
5.	Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area.	Each new project activity is required to demonstrate additionality characteristics that are in line with the first instance of the project activity.	The project activity demonstrates regulatory surplus. The project activity, processing of waste biomass to biochar, is the basis for a positive list in the methodology VM 0044 V1.1 and this project activity instance meets all the applicability conditions as described in Section 3.2 of the methodology. Thus, the project is deemed as additional as further described in Section 3.5.

Table 2: Inclusion of New Project Activity Instance

S. No.	Criteria	Evaluation	Applicability to the current instance
1.	Occur within one of the designated geographic areas specified in the project description.	Each project activity instance must be in the geographic boundary of India.	This project activity instance is in the state of Odisha, which comes under the geographic boundary of India.
2.	Conform with at least one complete set of eligibility criteria for the inclusion of new project activity instances. Partial conformance with multiple sets of eligibility criteria is insufficient.	Each new project activity instance must comply with the complete set of eligibility criteria as established in this document.	This project activity instance complies with the eligibility criteria established for new project activity instances.
3.	Be included in the monitoring report with sufficient technical financial, geographic, and	Each new project activity instance must be included in the	This project activity instance outlines a monitoring plan described

	other relevant information to demonstrate conformance with the applicable set of eligibility criteria and enable evidence gathering by the validation/ verification body.	monitoring report with sufficient technical, geographic, and other relevant information to demonstrate conformance with the eligibility criteria and provide evidence to the VVB.	in Section 5 and will be included in the monitoring report with all relevant information to demonstrate conformance with the eligibility criteria to enable evidence gathering by the VVB.
4.	Be included in the updated project description, with updated project located information (as set out in Section 3.11), which shall be validated at the time of verification against the applicable set of eligibility criteria.	The project description document (including the project location information in Section 3.11) must be updated each time a project activity instance is added.	This project description document includes this project activity instance. The geographic boundary of this instance is included in Section 3.11.
5.	Have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions).	Each new project activity instance must demonstrate ownership by the project proponent from the prospective start date.	This project activity instance is owned and operated by SRCNatura Sure Pvt. Ltd. as mentioned in Section 1.7.
6.	Have a start date that is the same as or later than the grouped project start date.	Each new project activity instance must have a start date that is the same or later than the grouped project start date, which is 16th October 2023.	This project activity instance's start date is 16th October 2023, which is the same as the grouped project's start date because it is the first instance.
7.	Be eligible for crediting from the start date of the project activity instance throughout to	Each new project activity instance must be eligible for crediting from the start date of the project	This project activity instance is eligible for crediting from 16th October 2023 to the end of the

	the end of the project crediting period (only).	activity instance throughout to the end of the project crediting period.	first crediting period, which is 15th October 2030.
8.	Only eligible for crediting from the start of the verification period in which they were added to the grouped project.	Each new project activity instance is only eligible for crediting from the start of the verification period in which they were added to the grouped project.	The crediting period for this project activity instance begins on 16th October 2023.
9.	Not be or have been enrolled in another VCS project.	Each new project activity instance must not be or have been enrolled in another VCS project.	This project activity instance has not been and will not be enrolled in another VCS project.
10.	Adhere to the clustering and capacity limit requirements for multiple project activity instances set out in 3.6.8 – 3.6.9.	Each new project activity instance must adhere to the clustering and capacity limit requirements.	There are no project instances within 10kms of this project activity instance. Project activity does not involve any capacity limits. Therefore, this condition is met.

1.5 Project Proponent

Organization name	SRCNatura Sure Pvt. Ltd.
Contact person	Mr. Rajesh Aggarwal
Title	Director
Address	Plot No. 200, Sector 56, Phase V, Kundli, Sonipat, Haryana, India-131028
Telephone	+91 9582433509
Email	team@togetherforrestoration.org

1.6 Other Entities Involved in the Project

No other entity is involved in the project. Hence, this section is not applicable.

1.7 Ownership

SRCNatura Sure Pvt. Ltd. is the owner of the group project and responsible for management of the project. All VCS credits issued under the group project will be the legal property of SRCNatura Sure Pvt. Ltd. SRCNatura Sure Pvt. Ltd. has agreements with every farmer to demonstrate its legal ownership of the project.

1.8 Project Start Date

The start date of the grouped project is 16th October 2023. The production and soil application of biochar in the first instance of the project activity will commence on 16th October 2023.

1.9 Project Crediting Period

The crediting period of the project is 7 years, twice renewable for a total of up to 21 years. The first crediting period is for 7 years from 16th October 2023 to 15th October 2030.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☐ <20,000 tCO_2e/year

☐ 20,000 – 100,000 tCO_2e/year

☒ 100,001 – 1,000,000 tCO_2e/year

☐ >1,000,000 tCO_2e/year

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
Year 2023 (16th October- 31st December)	23,366
Year 2024	110,760
Year 2025	110,760
Year 2026	110,760
Year 2027	110,760

Year 2028	110,760
Year 2029	110,760
Year 2030 (1st January to 15th October)	87,394
Total estimated ERs	775,320
Total number of crediting years	7
Average annual ERs	110,760

1.11 Description of the Project Activity

Introduction

Project Reignite (grouped project) aims to transition farmers from traditional practices of uncontrolled combustion and biomass decomposition to the production and soil application of biochar in their farms. By introducing farm-level, low-technology pyrolysis method, the project proponent ensures net GHG removals through the following steps:

1. Agricultural waste biomass is sustainably collected and air/sun dried within the farm.
2. The biomass undergoes careful pyrolysis in a steel-shield soil pit located in the farm.
3. The resulting biochar is dried, mixed with manure, and applied to 10cm soil subsurface.

Biochar Producers

A biochar producer in Project Reignite refers to the farmer who works under the project proponent's supervision. They collect feedstock from their own/ family's/ neighbours' farms, manually produce biochar using a steel-shield soil pit located in their farm, and then apply the produced biochar to the farmland where waste biomass originated. The biochar produced is for their own/family's/ neighbours' captive consumption. The initial project instance involves 5000 farmers. Over time, the project will expand with more such instances added.

Pyrolysis Equipment

In project Reignite, the pyrolysis equipment used for biochar production is a steel-shield soil pit. Here, biochar is crafted manually from farm residues in a non-mechanized yet precise manner, ensuring its high quality. Each biochar producer hosts one such facility in their farm, which they maintain. The steel-shield soil pit is expected to last for an average of three years. The only equipment used in the project is "steel shields" as per the design shown in the diagram at section 3.3. The project uses only passive equipment; no active equipment such as with moving parts or mechanisms is used by the project. Therefore, other considerations such as equipment lifetime,

capacity, efficiency that would normally apply in the case of active equipment, are not relevant to the project.

Pyrolysis Technology

The project uses flame curtain pyrolysis technology.

Procedure

Production of Biochar:

"The principle of the flame curtain pyrolysis consists of pyrolyzing biomass layer by layer in the [steel-shield soil pit]. A fire is started in the kiln, and the burning embers spread to form a first layer on the bottom of the kiln. A thin layer of biomass is then added on top of the embers, heats quickly and starts outgassing. The rising pyrolysis gas is caught in the flames and reacts with combustion air entering the kiln from the top. When ash appears on the outside of the carbonizing biomass, the next layer of biomass is homogenously spread on top. Convective and radiant energy from the flames above and from the hot pyrolyzing layers below heat the fresh biomass layer, which starts to pyrolyze. The biochar below the upper pyrolysis layer is shield from oxygen access by the fire curtain itself. The combustion zone thus forms a flame curtain that protects the underlying biochar from oxidizing and cleanly burns all pyrolysis smoke and gases as they pass through this hot fire front. … The manual layering of biomass is repeated until the [steel-shield soil pit] is filled. The pyrolysis process is then actively ended by quenching with water or a nutrient solution (e.g., urine, dissolved fertilizer) or, where water is not easily available, by snuffing with a layer of soil" (Cornelissen et al., 2016).[1]

Application of Biochar:

Once the biochar has sufficiently cooled, it is carefully extracted from the steel shield soil pit. The biochar undergoes a sun/air drying phase, is quantitatively assessed, and then applied to the farmland. Specifically, it's mixed with manure and embedded at depths exceeding 10 cm beneath the soil's surface. This meticulous application enhances the soil fertility and bolsters the farm's adaptive capacity against the unprecedented fluctuations of climate change.

Project Measures Employed

1. Training

   Theoretical Knowledge: The Project Reignite training program has been carefully crafted to offer an in-depth understanding of biochar production technology and the overall process. The biochar producers engage in an extensive theoretical session that covers the principles of flame curtain pyrolysis, procedures for quality control, safety protocols, and maintenance of pyrolysis equipment.

[1] Available at https://doi.org/10.1371/journal.pone.0154617

Practical Demonstrations: Beyond theoretical knowledge, live, hands-on demonstrations are conducted, enabling biochar producers to learn directly from experienced field officers. This practical approach ensures that all biochar producers gain the necessary skills to conduct the project activity.

Exceptional case handling: The third component in training is exceptional case handling. All farmers are shown how to handle cases that do not go as planned for example poor fire, sudden change in weather, emergencies etc.

2. Testing

Following the completion of the training program, biochar producers undergo a rigorous field test. Under the supervision of the field officers, they must successfully produce high-quality biochar that fulfils the project criteria. Only those who demonstrate competence and meet the necessary quality standards are approved and enrolled in the project, ensuring a consistent and high level of expertise across all biochar producers.

3. Monitoring and Auditing

Project Reignite has set up a monitoring team structure which comprises of field officers, managers, and a general manager. Field officers regularly visit farms, collect data, verify production and application, and supervise the work of farmers. Managers conduct regular field audits, oversee the work of field officers, and provide support where needed. The general manager coordinates at various levels to ensure compliance of the project activity and monitoring requirements. Monitoring plan is further described in Section 5.

1.12 Project Location

The location of Project Reignite (grouped project) is India. The geographical boundary for projects located in India is delineated in the form of extreme geographic coordinates of India as:

Latitude - 8°4' to 37°6' N, Longitude - 68°7' to 97°25' E

The first project activity instance is in the state of Odisha, India. The state of Odisha extends from 17.31N latitude to 22.31N latitude and from 81.31E longitude to 87.29E longitude.

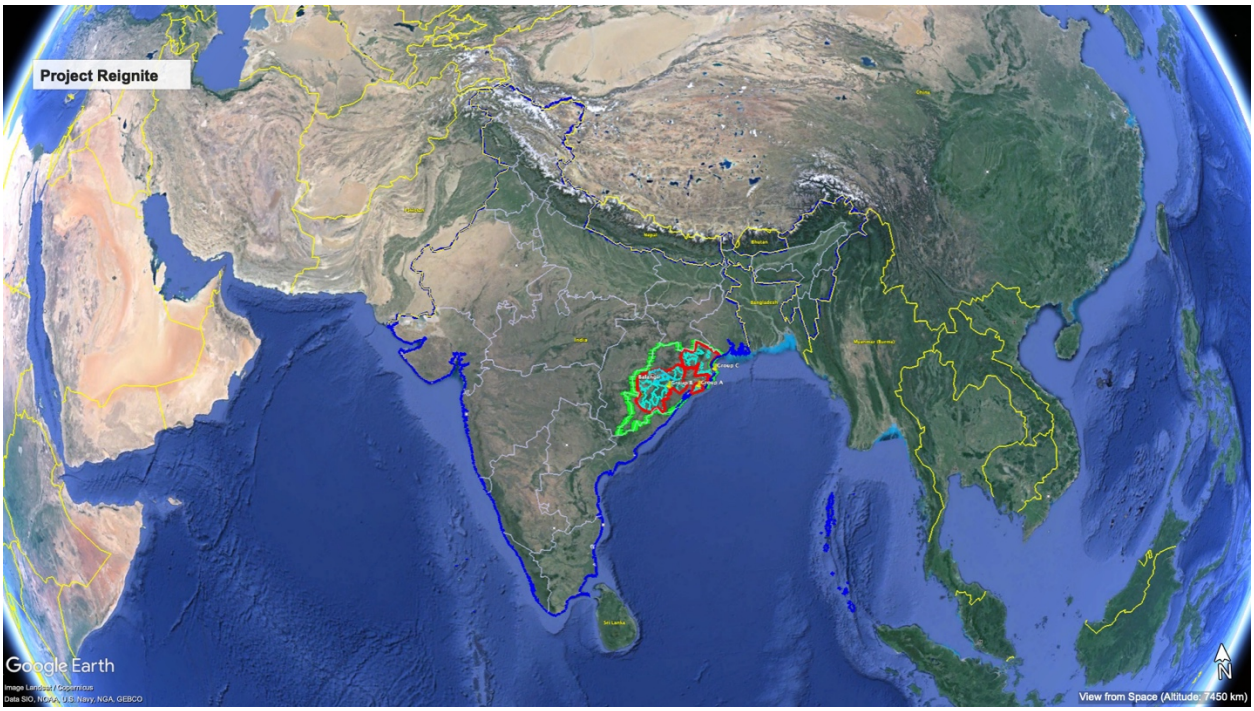
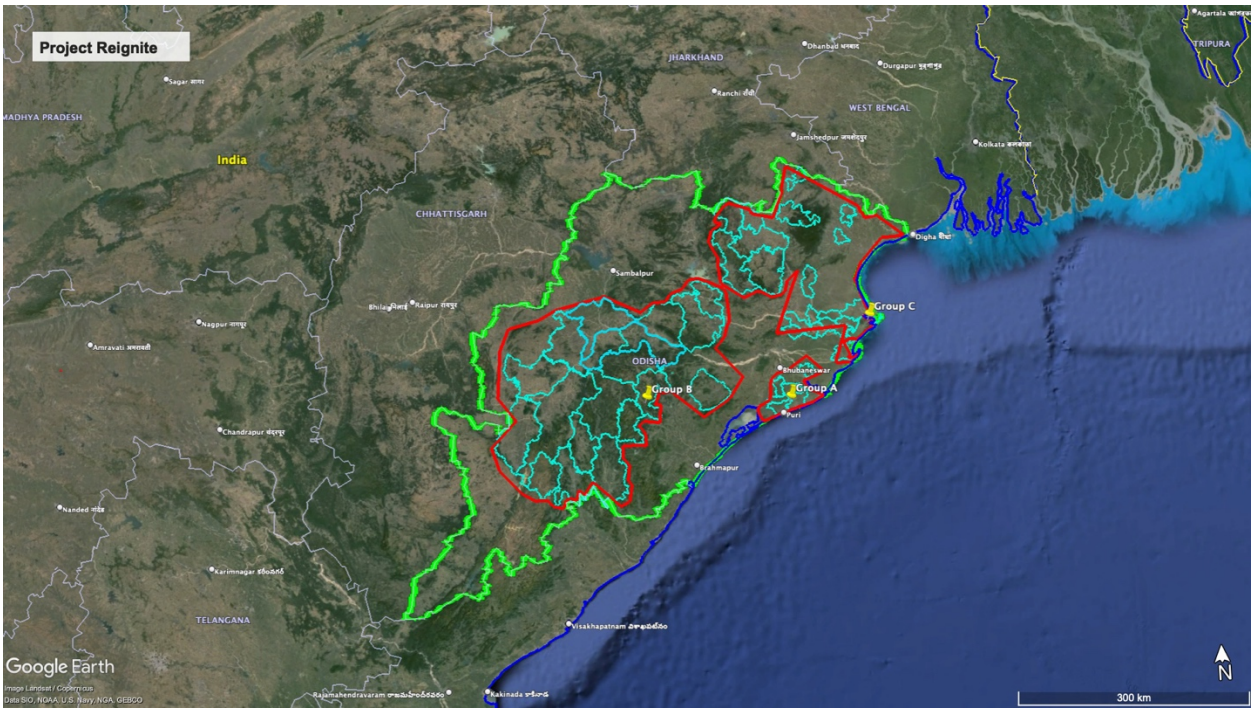
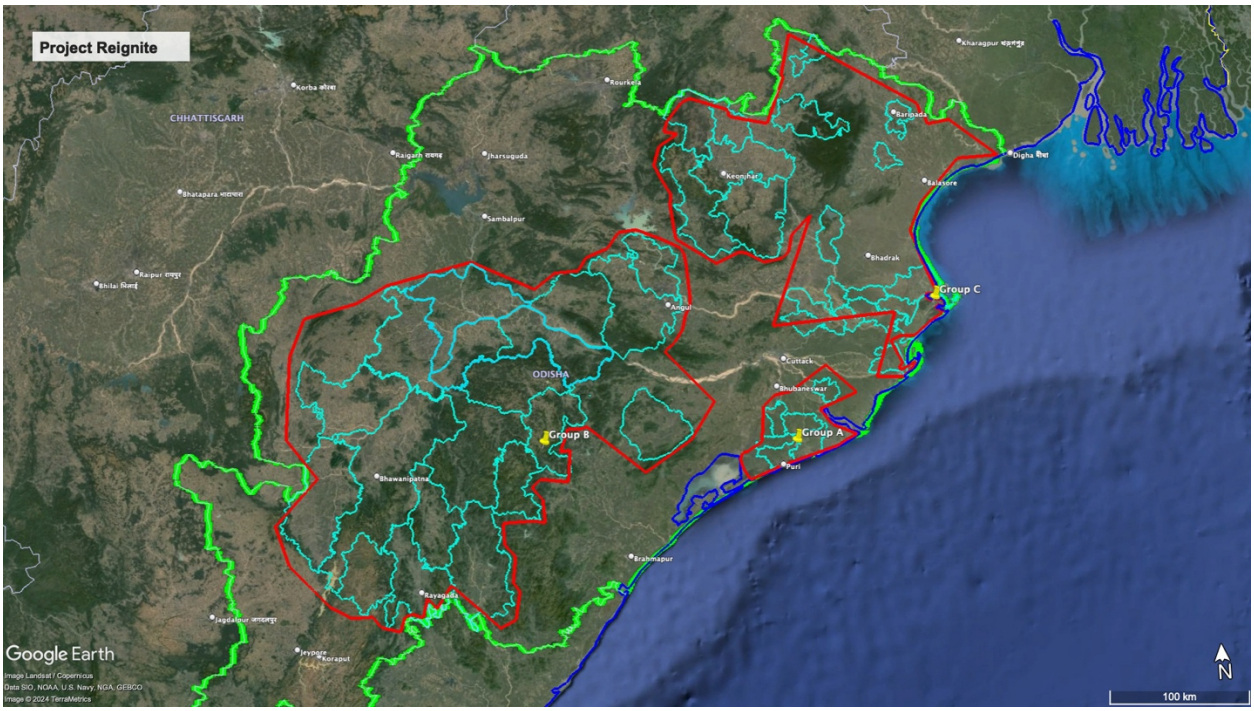


Figure. 2. Map outlining Project Reignite's location.



State of Odisha marked in Green



Groups A, B, and C of farmers in the state of Odisha

Group A

Group B

Group C

1.13 Conditions Prior to Project Initiation

The baseline scenario is the same as the conditions existing prior to the project initiation. Please refer to Section 3.4 for further details.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

There are no laws, statutes, or other regulatory frameworks that prevent the implementation of activities mentioned in the project. Currently, there are no enforced biochar production and soil application laws in place in the state of Odisha in India by the central or state governments. In addition, the Central Pollution Control Board of India (CPCB) and State Pollution Control Board of Odisha (OSCPB) websites[2] suggest that there are currently no regulatory requirements that prevent the project activity. The project does not deal with any type of waste which is regulated in India.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The grouped project has not been registered and is not seeking registration under any other GHG program(s).

1.15.2 Projects Rejected by Other GHG Programs

The project has not been applied to or rejected by any other GHG programs.

1.16 Other Forms of Credit

[2] Available at https://cpcb.nic.in/ and https://ospcboard.org/

1.16.1 Emissions Trading Programs and Other Binding Limits

Does the project reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading?

☐ Yes ☒ No

1.16.2 Other Forms of Environmental Credit

Has the project sought or received another form of GHG-related credit, including renewable energy certificates?

☐ Yes ☒ No

Every project activity instance that will be added to this project will demonstrate that it has neither sought nor received any other form of GHG-related environmental credit, including renewable energy certificates.

Supply Chain (Scope 3) Emissions

This section is not applicable as the project activity does not deal with supply chain of any goods or services. The biomass is sourced from within the biochar producer's or their family's/ neighbors' farms and the biochar produced is applied to the same farm from which biomass originated. Thus, there are no emissions originating from transport of biomass or biochar.

1.17 Sustainable Development Contributions

Project Reignite has many benefits and contributes towards UN's sustainable development goals through environmental, social, economic, and health wellbeing in the following ways:

Table 3: Sustainable Development Goals

SDG Goal Number and Title	Applicability
1. No Poverty	This project involves small stakeholder farmers who are solely dependent on agriculture for income. Project Reignite increases the income stream of famers by increasing the productivity of their lands and thus reducing poverty. In addition, the project creates employment opportunities for field officers and other indirect jobs created by the farmers for production of biochar.
2. Zero Hunger	The use of biochar in soil improves soil fertility, thereby increasing crop yields. With increasing quality of soil, farmers can produce more food, helping combat local and global food insecurity.

3. Good Health and Wellbeing	Open field burning of agricultural waste contributes to air pollution, which has significant implications on respiratory health of local communities and nearby areas. By transitioning farmers to biochar production, Project Reignite will help reduce the incidence of respiratory health issues in communities. Additionally, healthier soils can produce more nutritious crops, contributing to better overall community health.
5. Gender Equality	Women in rural India face the problem of disguised employment. Project Reignite focuses on women empowerment by enabling women of the household to be biochar producers and field officers. By generating work opportunities for women and promoting gender equality, the project will empower women and provide them with financial independence and decision-making power.
6. Clean Water and Sanitation	Community water bodies have been contaminated due to excessive use of chemical fertilizers in the past. Application of biochar to soil reduces the need of chemical fertilizers for agriculture. Biochar's properties of enhancing soil's water-holding capacity reduce the need for irrigation, conserving freshwater resources. In addition, biochar absorbs pollutants, mitigating groundwater contamination and enhancing overall sanitation of the community.
8. Decent Work and Economic Growth	Project Reignite enhances working conditions by shifting farmers from harmful open field burning to safer biochar production. This change increases their income stream. Higher incomes lead to increased purchasing power, stimulating local economic growth. The project also generates new job opportunities, contributing to inclusive long-term economic growth and decent work for all.
10. Reduced Inequalities	Project Reignite addresses this goal by selecting farmers from lowest socio-economic status and highest risk to the effects of climate change for the project activity to increase their income through biochar production and utilization, thereby fostering economic inclusivity. The project does not segregate or discriminate stakeholders on the basis of religion, caste, gender etc.
11. Sustainable Cities and Communities	Project Reignite enables farmers to manage agricultural waste innovatively and sustainably, reducing potential health risks and promoting cleaner, safer rural communities. Additionally, biochar application aids in sustainable land management, supporting the health of

	surrounding ecosystems, thereby contributing to sustainability of local communities.
12. Responsible Consumption and Production	Project Reignite operates under the principles of a circular economy, converting what was traditionally considered a liability - agricultural waste - into a productive asset. By converting residual biomass from one harvest into biochar, we are enhancing both the yield and quality of subsequent crops. This innovative approach not only minimizes waste generation but also actively contributes to environmental preservation. It embodies a sustainable model of production and consumption, ensuring the efficient utilization of resources while minimizing ecological impacts.
13. Climate Action	Project Reignite actively addresses climate change by promoting the transformation of biomass into biochar, a process that sequesters atmospheric carbon and stores it in a stable form. This process not only serves as a significant carbon sink but also mitigates climate change directly. Furthermore, by ensuring the discontinuation of open field burning and biomass decay- practices known to emit substantial amounts of greenhouse gases – Project Reignite's approach offers a dual mechanism for reducing GHG emissions and actively sequestering carbon.
15. Life on Land	Biochar application to soil contributes to sustainable land management by enhancing soil health, reducing soil erosion, improving water retention, and mitigating land degradation. It builds resilience of ecosystems to disturbances, thus aligning with the preservation of terrestrial ecosystems under SDG 15.
17. Partnerships for the Goals	Project Reignite encourages multi-stakeholder engagement and partnerships between farmers and investors/buyers of carbon offsets. This broad cooperation aligns with SDG 17, demonstrating that complex sustainability issues require integrated solutions across different sectors and levels of society. This successfully builds a constructive bridge necessary for the engagement between local communities and investors/ buyers to promote environmental sustainability and socio-economic development.

1.18 Additional Information Relevant to the Project

Leakage Management

There are no leakage emissions applicable to the project as there is no transportation involved in any stage of the biochar lifecycle from sourcing of biomass to application of biochar in the project.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project.

Further Information

There are no further relevant legislative, technical, economic, sectoral, social, environmental, geographic, site-specific and/or temporal information that may have a bearing on the eligibility of the project, the net GHG emission reductions or removals, or the quantification of the project's net GHG emission reductions or removals.

2 SAFEGUARDS

2.1 No Net Harm

There is no net environmental or socio-economic harm associated with the project. The project is meant to stop harmful traditional practices of farmers and create positive environmental and socio-economic impact.

2.2 Local Stakeholder Consultation

Our stakeholder engagement strategy for Project Reignite, focused on smallholder farmers in India, was carefully planned and executed to ensure every voice was acknowledged and all concerns were addressed. This approach, refined with continuous improvement, will serve as the benchmark for future instances of the project. The process was carried out in the following stages:

Information Sessions and Consultations

First, districts for the project were identified. The criteria for identification was based on local community needs and their susceptibility to the effects of climate change. A similar criterion was used to identify the gram panchayats to be included. To involve the communities, we held information sessions and consultations at the gram panchayat level. These meetings took place in local schools or shelters. Every household within gram panchayat was considered a local stakeholder. Personal invitations were handed out to the head woman of each household, supplemented by posters in village communal spots and word-of-mouth. Invitations were sent out 2 weeks in advance to give everyone enough time to prepare. The consultation period lasted from 15th January 2023 to 30th April 2023. The sarpanch and committee members of the gram

panchayats were present in all the meetings to represent the stakeholders. The meetings were conducted in the local language Odia and followed a structured format:

1. Project Introduction: Our representative began the session by warmly welcoming the stakeholders and offering a concise overview of the project. We delved into the methodology of transforming waste biomass into biochar, emphasizing its advantages for farmland rejuvenation and potential economic benefits for the community. Additionally, we highlighted the project's capacity to foster employment opportunities, catering to both skilled and unskilled labor in the area.
2. Technical Briefing: Next, we delved into the technical specifics of the project. We detailed its environmental, social, and economic impacts, and further clarified the carbon mechanism integral to our project and its associated requirements.
3. Discussion and Q&A Session: Upon concluding our presentation, we invited stakeholders to ask questions and voice their concerns. This open forum allowed us to address any uncertainties and foster a sense of ownership among the community members.
4. Documentation: We carefully recorded all queries and feedback during these discussions. By doing so, we ensured that the concerns of stakeholders were not only noted but also aptly addressed, reinforcing their contentment with the project's execution. Below are some of the most recurrent questions posed across the meetings, along with summaries of the responses given by our team. Please note, these questions and answers have been translated from the local language, Odia, to English:

    a. What is the difference between burning the waste directly on the farm or in soil pit?

    Practicing open field burning releases excessive amounts of carbon dioxide (CO2) among other pollutants. Carbon dioxide (CO2) emissions contribute to climate change while the pollutants released worsen air quality, further posing risks to the community's respiratory health. However, biomass is pyrolyzed in the soil pit and converts to biochar.

    b. What is climate change and how is it affecting us?

    Climate change refers to long-term changes and fluctuations in temperature and weather patterns, primarily characterized by a global temperature increase. This phenomenon profoundly affects rural and coastal communities. Direct consequences include altered precipitation patterns, soil quality degradation, and health challenges. Indirect effects encompass economic setbacks like loss of income and forced migrations from areas adversely impacted by climatic shifts.

    c. Will you collect the biochar we produce from us?

    No, the purpose of biochar production is to promote sustainability on your own farmland. You will be producing the biochar from your farm waste and applying it

within the same farm. No one will be collecting the biochar you produce, and you will not be allowed to give the biochar to anyone else for any other use.

d. How will the project solve the problems we are currently facing with farmlands?

There will be a lot of benefits from producing and applying biochar and few of them are as following. First, production of biochar will enable you to sustainably dispose of agricultural waste feedstock instead of burning it, which is harmful for soil and your health. Second, biochar will reduce your reliance on chemical fertilizers, which will further help reduce chemical toxicity of soil and nearby water bodies. Third, the organic soil matter of the soil will increase which will lead to increased yields.

e. What kinds of feedstock can be used to produce biochar?

You are only eligible to use paddy straw, maize cobs, tree pruning, bamboo pruning, ipomoea carnea, and water hyacinth. No other feedstock is allowed for production of biochar.

f. How much biomass will be used to produce 1kg of biochar?

On an average, 4 kg of biomass will be used to produce 1 kg of biochar.

g. How will we know how to produce biochar?

We will be providing you with complete training and demonstrations on how to produce biochar. In addition, you will always have the support of training materials and field officers.

h. Is there any particular time of the day we have to produce biochar?

No, there is no such fixed time when you have to produce biochar. You can produce it as per your convenience.

i. Is there any specific way biochar has to be applied to the farm?

Yes. Biochar must be dried and mixed with manure first and then applied at least 10cms below the surface of the farm.

j. How much time does it take to make biochar?

One run of biochar production takes approximately 3 hours.

k. Do I need to pay any amount to you to join this project?

No, you do not need to pay or invest in anything to join the project. You will be provided with the equipment, training, and support materials to join the project. In fact, the purpose of the project is to enhance your income.

l. What equipment or things I need to join the project?

You only require some space in your farm for the pit.

m. What impact will it have on microbes?

Microbes have a significant role to play in soil productivity. The application of biochar will catalyze microbes to enhance mineralization of soil organic carbon.

Everyone was given an opportunity to ask questions. At the end of the information sessions, all attendees were given a handout which included brief details about the project and the names and contact numbers of local representatives in case anyone had follow-up questions and wanted additional information. Names of all attendees were recorded in an attendance register for each information session.

Sign Up Sessions

After a thorough addressal of all stakeholder queries, each farming family was identified and registered in the project. Registration process was conducted through in-person visits by our local representatives and collection of vital identification details. The sessions were conducted in the month of May 2023.

Training

Training took place in the month of June 2023. Our field officers have been thoroughly trained and tested. The field officers trained all the farmers who were signed up. The farmers were given theoretical training in their local language (Odia) which was then followed by practical demonstrations of production of biochar. After successful completion of theoretical and practical training, farmers were taught how to handle exceptional situations that arise in the field. Training took place in a central place in villages where all signed up farmers were present. In case of absence of any farmer, they were invited to the training that took place in a nearby village in the future.

Testing and Registration

After conducting all training camps, each farmer was tested in their local scenario in July 2023. Our field officers visited each trained farmer and tested them. Farmers were also deliberately put in exceptional situations by the field officer to ensure the farmer knows his/her art and produces high-quality biochar. Once the farmer qualified the training program, they were registered in the project and classified as a biochar producer. They were given a booklet of operating guidelines.

Ongoing Communication

This section includes processes that focus on establishing a robust system for continuous communication with local stakeholders, ensuring their concerns are acknowledged and that our project design remains responsive to their needs.

To initiate an open line of communication, we informed all end users about the establishment of a grievance register. The purpose of this register is to collect and document any concerns or complaints related to the project. There have not been any grievances or complaints till now and will be documented in the project description in case any arise in the future.

Our field officers play a pivotal role in this process. They carry the responsibility of collecting grievances and concerns from stakeholders during the project operation. It is their duty to ensure that these grievances are communicated effectively to the project participants for timely redressal.

This grievance mechanism forms a critical component of our ongoing communication with stakeholders. All concerns received through this channel during the operation of the project are scrutinized for their relevance to the project activities. Once identified as pertinent, these concerns are addressed promptly and effectively.

To supplement this mechanism and ensure comprehensive stakeholder engagement, we have also provided a dedicated helpline number. This helpline connects stakeholders directly to the core team of the project. It serves as an alternative medium for stakeholders to voice their concerns, ask questions, and provide feedback on the project activities.

Our approach to ongoing communication is rooted in transparency, accessibility, and responsiveness. We believe in maintaining a two-way dialogue with our stakeholders, which informs and enhances our project design while ensuring that the community remains actively involved and invested in the project's success.

Conclusion of the stakeholder consultation process

As described above, the stakeholder consultation was concluded in a manner that provided the local stakeholders every opportunity to voice any concerns, grievances, or reservations the project. During the stakeholder consultation period from 15/01/2023 to 30/04/2023, a series of meetings were held with the local stakeholders belonging to the area of operations of the project. Local stakeholders were encouraged to ask questions to the representatives holding the meetings. The queries and feedback from the locals have been documented thoroughly and serve as evidence of what transpired at the stakeholder consultation process. Though there were a number of queries from the meetings, each of those queries was satisfactorily replied to by the ground team and the attendees were satisfied with the replies provided to their queries. There were no outstanding concerns at the end of the stakeholder consultation process that were not satisfactory. There were no requests from the local stakeholders during the consultation process to alter or modify the project design, procedures, methodology of producing biochar, or the monitoring. Therefore, the project design was informed by the local stakeholder consultations and consequently there was no need to update the VCS-PD as a consequence of the stakeholder consultation process.

2.3 Environmental Impact

No negative environmental impacts have been identified from the project and an environmental impact assessment is not required for the project. In fact, the project supports positive environmental impact.

2.4 Public Comments

Below are the public comments that were received during the public commenting period from 19/09/2023 to 19/10/2023.

Table 4: Responses to public comments

S. No.	Comment	Response
1.	How are you manage the data on such a large scale? The tech for data collection must be explained in details in the description. Otherwise its a pointless thing.	We are managing the data on such a large scale using the Reignite mobile app. The mobile app has been developed and is maintained by the Together for Restoration Software Engineering team consisting of software engineers dedicated for the project. The app is private and only available to the Reignite monitoring team to monitor and report biochar production and application. The procedure for data collection is explained in the monitoring plan in the PDD. The data is stored in a Google Cloud database with a backup facility.
2.	Why is this project being done in Odisha and why not any other state. How was this selection made?	We have been working with farmers in Odisha for years and we are introducing the project for the betterment of local communities in Odisha. It is also noted that in the state of Orissa, paddy is the principal crop. The biochar from cultivation of the paddy crop is estimated by us to be 9.5 tonnes per production facility (such as envisaged in the project) per year, on a dry weight basis. Among other crop residues, paddy has one of the highest residue yields and therefore the potential of emission removals to be claimed is high wherever paddy is the main crop. This was one of the main considerations behind the selection of the state of Orissa for planning the biochar project.
3.	Has the project proponent taken permission from government bodies to burn stubble? Stubble burning is not a big issue in Odisha.	The project does not involve burning of stubble. In fact, the project is meant to stop stubble burning which is currently happening across India. Farmers will be producing biochar using a special technique called flame curtain pyrolysis. Biochar production does not require any government permissions as of now. We would like to point out

		that the widespread practice of “open burning” or “left to decay” of crop residues results in the loss of carbon absorbed during the life of the crop. By converting the biomass residue into biochar and its further soil application, the project prevents this loss from taking place.
4.	Biomass claimed is very large. What is source of tracking for this biomass.	The source of tracking for biomass is the Reignite mobile app. Our field officers interview farmers at the beginning of each agricultural season for the estimated amounts of biomass available and expert judgment is used further to validate the estimates. Regarding the quantities of biomass residues that our project would utilize, we would like to state that the estimations of biochar yield per production facility per year have been derived on the basis of our longstanding experience in agricultural biomass waste projects as well as empirical knowledge in the field. The estimations made in Table 1.1 of the VCS PD are also supported by expert technical opinion.

2.5 AFOLU-Specific Safeguards

This section is not required as the project is non-AFOLU.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Methodology for Biochar Utilization in Soil and Non-Soil Applications

VM0044, Sectoral Scope 13

Version 1.1 Published on 5 July 2023

3.2 Applicability of Methodology

The project proponent is in the process of installing new (greenfield) biochar production facilities (steel-shield soil pit) at the farm level where waste agricultural biomass will originate and biochar will be produced and applied.

The project proponent will (1) source waste biomass, (2) produce biochar and (3) ensure the biochar is utilized in soil application. The project activities meet the following conditions:

Table 5: Technological scope

S. No.	Condition	Applicability
1)	The methodology is applicable when biochar is produced from eligible waste biomass through a thermochemical process such as pyrolysis, gasification, and biomass boilers and the biochar is subsequently applied to an end-use (soil or non-soil applications). Torrefaction and hydrothermal carbonization as processes of biochar production are excluded from the methodology.	The methodology is applicable as the biochar will be produced from eligible waste biomass (described in Table 6 below) using flame curtain pyrolysis technology and the biochar will be subsequently applied to soil as an end use. No other process of biochar production is a part of the project activity.
2)	The methodology is applicable to projects using either low or high technology production facilities to produce biochar, as per the definitions of each provided in Section 3 of this methodology.	The project activity uses low technology production facilities to produce biochar. Steel-shield soil pit complies with the definition of low-tech production facility as provided in Section 3 of the methodology.
3)	The biochar producers must have a health and safety program to protect workers from airborne pollutants and other hazards.	Biochar producers will be following a health and safety program to protect their health. The summary of the health and safety program is following: 1. The production facility (steel-shield soil pit) will be located at a safe distance from physical structures to prevent fires.

		2. The biochar producer will wear a face mask and hand gloves during production for protection. 3. The biochar producer will maintain a safe distance from the fire and should use a long stick to control the fire. 4. The biochar producer will wear non-inflammable clothing during production and will have access to safety kits in close vicinity.

Table 6: Eligible feedstocks and production

S. No.	Condition	Applicability
4 a)	Feedstock must be purely biogenic waste biomass and not purpose-grown.	Biochar producers will only be using biogenic waste biomass originating from their own/family's/neighbours' farms to produce biochar. As waste biomass is the by-product of cultivation of crops (primary activity of farmers), it will not be purpose-grown.

4 b)	Feedstock must have been otherwise left to decay or combusted for the purposes other than energy production.	In the absence of the project activity, feedstock will be combusted in the open field for purposes other than energy production. Following information source has been used to demonstrate the same: The source of biomass is identified as the biochar producer's or their family's/neighbours' fields, and the biomass is not being used in the baseline scenario as farmers are practicing open field burning and decay of biomass. Signed attestations in line with Appendix 2 of the methodology confirm that the biomass was not used for alternative purposes but was getting burnt in open field fires and left to decay in the five years preceding the project start date. During the survey, it was found that waste agricultural biomass is left to decay in the field and burnt. As part of the survey, the farmers provided signed statements conforming that prior to the project, they were resorting to open field burning of biomass residue, or in some cases, it was left to decay. No farmer reported the use of biomass as combustion fuel for energy purpose.
4 c)	Feedstock must not have been imported from other countries.	The biochar producers will only be using waste biomass from their own/family's/neighbours' farms to produce biochar. No transportation of biomass, except walking distance, will take place. Thus, feedstock will not be imported from other countries.
4 d)	Feedstock must meet the sustainability conditions provided in Table 1. This table	Feedstocks that will be used for biochar production in the project activity meet the sustainability conditions provided in

	is not an exhaustive list of waste biomass examples.	Table 1 of the methodology and the applicability is described in Table 7 below.

Table 7: Sustainability Criteria for Feedstock

Feedstock Sourcing Category	Sustainability Criteria	Waste Biomass	Applicability
Agricultural Waste Biomass	A. Where project proponents are using agricultural waste biomass directly from fields and not from a centralized biomass-processing operation (e.g., food processing facilities), project propends must provide documentation that the project activity is not leading to a decline in soil carbon stocks or a reduction in crop productivity, or that in the baseline agriculture waste biomass was burned without energy production (e.g., open burning or stubble) B. In the absence of documentation, feedstock removal is limited to no more than 50 percent of total residues to protect against soil degradation	Rice Straw Maize Cobs Tree Pruning Bamboo Pruning Ipomoea Carnea (Shrub)	In the baseline scenario, agricultural waste is being burnt without energy production. Currently, majority of the waste biomass is put on fire to clear the field and some of the biomass that comes out during harvesting is left to decay on corners of the farm. The baseline scenario is described in Section 3.5. Documentation as described in Table 6 Point 4b (in line with Appendix 2 of the methodology) proves that in the baseline, agriculture waste biomass was burned without energy production. Furthermore, in the project activity, biochar will be mixed with manure and applied to the same farms from which waste biomass originates, and the project activity will increase soil carbon stocks over time. "… studies have indicated that the simultaneous application of biochar and compost resulted in enhanced soil fertility, water holding capacity, crop yield and C sequestration benefit" (Agegnehu et al., 2017).[3] Blanco-

[3] Available at https://doi.org/10.1016/j.apsoil.2017.06.008

	(Andrew 2006; Battaglia et al., 2020).		Canqui et al.[4] demonstrated significant increases in soil carbon concentrations 6 years after biochar application in his study, which supports using biochar applications to store carbon in soils.
Aquaculture Plants	A. Waste must be by-products of aquaculture. B. Project proponents must be demonstrated that waste invasive species such as water hyacinth (Eichhornia crassipes) were not purposely introduced in order to qualify as feedstock for biochar production.	Water Hyacinth (Eichhornia crassipes)	Water Hyacinth (Eichhornia crassipes), a pervasive invasive species, has plagued Odisha's water ecosystems for nearly a century. Historical records show that its problematic spread was already recognized in 1930, with efforts to combat its growth recorded by the Legislative Council of Bihar and Odisha (Sinha et al. 1930).[5] Narayanan et al. (2007)[6] further emphasize its widespread presence in India. This species, with its well-documented invasive history, was not deliberately introduced and its utilization adheres with the sustainability conditions.

Table 8: Continued Eligible Feedstocks and Production Conditions

S. No.	Condition	Applicability
5)	Biochar made from a single or mixed eligible feedstock must comply with the latest version of the IBI Biochar Testing Guidelines or the EBC Production Guidelines.	Biochar will be made from a single feedstock per batch and will comply with the conditions applicable to low-technology production facilities (steel-shield

[4] Available at https://doi.org/10.1111/gcbb.12665

[5] Available at http://archives.biharvidhanmandal.in/jspui/handle/123456789/121330

[6] Available at https://www.researchgate.net/publication/315917487_Water_hyacinth_Eichhornia_crassipes_-_management_of_an_invasive_weed_the_Indian_scenario

		soil pit using flame curtain pyrolysis in our case) in the latest version of the EBC Production Guidelines.[7]
6)	The waste biomass used as feedstock to produce biochar and the resulting biochar to be utilized in soil or non-soil application may be transported via ships, boats, and vehicles other than road transportation up to a distance of 200km. However, it must only be transported by vehicles (i.e., road transportation) for distances more than 200km as defined under CDM Tool 12: Project and leakage emissions from transportation and freight.	There will not be any transportation involved as the biochar will be produced and applied in the same/nearby farm from where waste biomass originated. Hence, this condition is not applicable.
7)	Mineral additives such as lime, rock minerals, and ash may comprise up to 10 percent of the mass when added. If the addition exceeds 10 percent on a dry weight basis, the biochar producer must present laboratory tests indicating that the final product meets IBI Biochar Testing Guidelines or EBC Production Guidelines thresholds for organic and inorganic contaminants.	This condition is not applicable as mineral additives will not be added in production.
8)	Other evidence that may be used to demonstrate compliance with waste biomass sustainability criterion are biomass certification schemes such as the Roundtable on Sustainable Biomaterials (RSB), International Sustainability and Carbon Certification (ISCC) or any other certification scheme approved and/or endorsed by a relevant legislative body or international body such as the European Union, CORSIA, and national/state governments.	No other evidence is required or used.

[7] Available at https://www.european-biochar.org/media/doc/2/version_en_10_3.pdf

Table 9: Eligible biochar end-use application criteria

S. No.	Condition	Applicability
9)	Biochar is eligible to be utilized and accounted for under the methodology if it is being utilized within one year of its production. Biochar is subject to natural decay and the permanence of biochar is calculated for a period of 100 years. To adhere to the decay factor established for 100 years and prevent any decay before application, biochar must be utilized in soil or non-soil applications within the first year of its production.	Biochar will be produced from the waste biomass after the agricultural season ends and crops are harvested. Biochar producers will apply biochar as production takes place. Thus, biochar will be utilized within a few weeks of its production. The monitoring plan described in Section 5.3 includes tracking of the biochar applied.
10)	Biochar is eligible to be used as a soil amendment on land other than wetlands. Eligible land types include cropland, grassland, vegetated urban soils, and forest. Biochar is eligible to be applied either to the soil surface or subsurface. For surface application, the biochar must be mixed with other substrates such as compost, manure or digestate from anaerobic digestion. For subsurface application, the biochar may be applied either as a unique soil amendment or mixed with other substrates. For any soil application, the biochar must: a) comply with biochar material standards to avoid the risk of transferring unwanted heavy metals and organic contaminants to soil. Project proponents must meet the IBI Biochar Testing Guidelines or EBC Production Guidelines, or relevant national regulations for avoiding soil contamination. b) have a hydrogen to organic carbon molar ratio ($H:C_{org}$) of less than or equal to 0.7	Biochar will be applied to the soil subsurface as a mixed soil amendment with manure (cow dung). a) There is no risk of transferring unwanted heavy metals and organic contaminants to soil. Farmers will be applying biochar made from biomass that originated from the same farm. Thus, there is no risk of cross contamination as the biochar will not be transported to a centralised facility. The laboratory analysis report of representative biochar samples confirms that the heavy metals and contaminants content in biochar meets the EBC Production Guidelines.

		b) $H:C_{org}$ will be monitored annually as described in Section 5.2 using nationally accredited laboratory results following EBC production guidelines to ensure hydrogen to organic carbon molar ratio of less than or equal to 0.7.
11)	Biochar is eligible to be used in non-soil applications including but not limited to cement, asphalt, and any other applications where long-term storage of the biochar is possible. Only biochar produced in high technology production facilities, as defined under the methodology, is eligible to be used in non-soil applications.	Biochar will not be used in non-soil applications in the project. Thus, the condition is not applicable.
12)	Project proponents must demonstrate that biochar and/or final products are long-lived via credible evidence such as laboratory results, peer reviewed research papers or any other third party-evaluated product assessment, such as decay rate analysis, as applicable. The information provided must include the lifetime of the product in which biochar is stored long term. The resultant product must be compliant with national/international product quality standards/specifications as applicable (e.g., the American Concrete Institute Standards in the US).	Biochar production in Project Reignite employs flame curtain pyrolysis, which is high temperature ranging between 650°C and 750°C (Cornelissen et al. 2016). Such temperatures yield robust biochar with significant resistance to decay. The Intergovernmental Panel on Climate Change (IPCC) has reported that biochar produced under these conditions retain 89% of their mass after a century (IPCC, 2019).[8] "Pyrolysis temperature influences biochar stability, with temperatures > 500°C generally leading to longer-term half-lives (> 1000 years)" (Ippolito et al., 2020).[9] Another notable study by

[8] Available at https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch02_Ap4_Biochar.pdf

[9] Available at https://doi.org/10.1007/s42773-020-00067-x

		Spokas (2010)[10] supports the long-term stability of high-temperature biochar.
13)	The methodology must not be applied if biochar is used for energy purposes, burned as a fuel (e.g., as a substitute for charcoal or coke) or used in other soil or non-soil applications where biochar cannot be demonstrated to be a long-lived and persistent carbon sink.	Biochar will only be used for soil application and will not be used for any other purposes.
14)	Biochar must not be used in applications in which substantial amounts of the biochar are oxidized (e.g., burned or used as a reduction agent in steel production, processed into activated carbon, or other uses that are fossil fuel-intensive).	Biochar will only be used for soil application. Thus, it will not be used in application in which substantial amounts of the biochar are oxidised.

[10] Available at https://doi.org/10.4155/cmt.10.32

15)	Non-soil applications are ineligible under the methodology if there is a loss of more than 50 percent of the carbon measured by dry weight basis (e.g., some activated carbon, due to excessive fossil fuel input, results in a loss of more than 50 percent of the original biochar carbon material and therefore would not be eligible).	Biochar will not be used in non-soil application.

3.3 Project Boundary

The project boundary for the grouped project is India. The project boundary for the first instance of the grouped project is Odisha. It encompasses farms that are part of the project where project activity will be taking place.

Map of the physical locations of the various installations:

5000 production sites are in Odisha. Please refer to the Project Location Section 1.12 in the document for the map. The production facilities are situated on the farms of each registered biochar producer, where all project activities are conducted.

Production Facility Diagram:

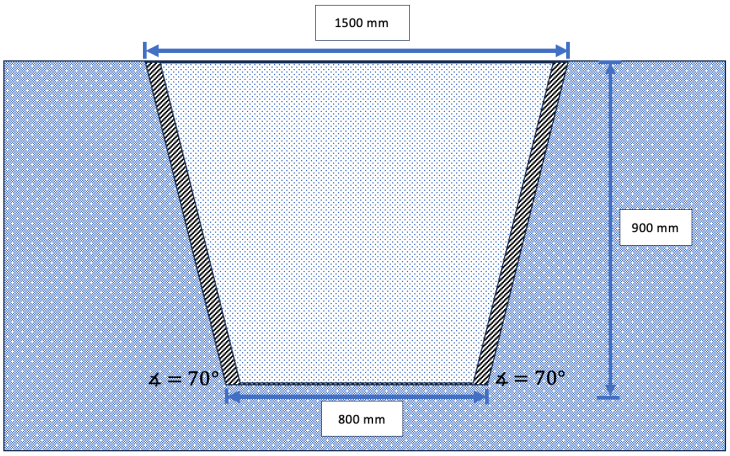


Figure 3. Diagram of Steel-shield Soil pit

Project Activity Lifecycle:

In the project activity, all three stages take place at the farm level itself. The following mass and energy flow diagram demonstrates the lifecycle of the project activity which takes place in each registered production facility site in the project.

1. Waste biomass is sustainably sourced from the biochar producer's or their family's/neighbors' farms and is sun/air dried.

2. Waste biomass is treated through the flame curtain pyrolysis process in the steel-shield soil pit located in the biochar producer's farm, biochar is produced, and sun/air dried.

3. The final application of biochar mixed with manure in soil occurs more than 10 cm subsurface in the farms from where waste biomass originated.

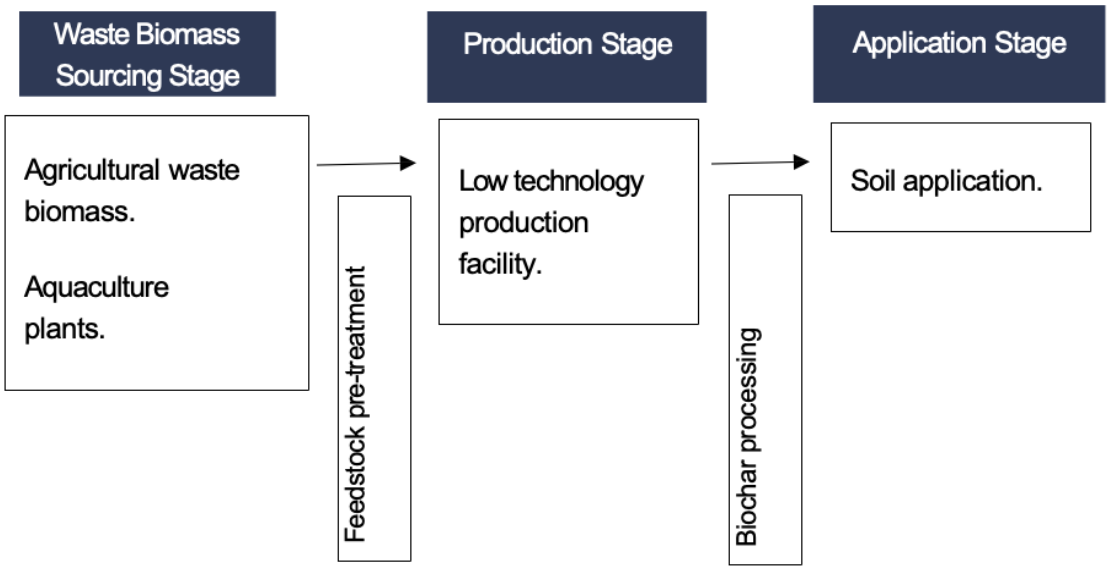


Figure 4 Project Boundary adapted from VM0044 Methodology Figure 1

The greenhouse gases included in or excluded from the project boundary are shown in the table below.

Table 10: Greenhouse gases accounted.

Source		Gas	Included?	Justification/Explanation
Baseline	Feedstock Production	CO_2	No	As per the methodology, all are excluded because waste biomass is considered renewable per eligibility conditions.
		CH_4	No	
		N_2O	No	
	Feedstock Transportation	CO_2	No	Feedstock will not be transported as production will take place at the farm level.
		CH_4	No	
		N_2O	No	
	Combustion, aerobic, and anaerobic decomposition of feedstocks	CO_2	No	There are CO_2 and CH_4 emissions from combustion of biomass or its decay in the absence of project activity. However, the methodology assumes baseline emissions to be zero (conservative assumption).
		CH_4	No	
		N_2O	No	

Source		Gas	Included?	Justification/Explanation
Project	Feedstock production	CO_2	No	As the project does not use purpose grown crops, there are no emissions from feedstock production. Waste biomass is considered renewable as per the methodology referring to CDM renewable biomass definition and applicability conditions.
		CH_4	No	
		N_2O	No	
	Pyrolysis or thermochemical conversion (low technology systems)	CO_2	No	As per the methodology, default methane emission value for steel-shield soil pit (low-technology production facility) are taken from published literature (Cornelissen et al. 2016).
		CH_4	Yes	
		N_2O	No	
	Electricity and/or fossil fuels consumed during eligible thermochemical process	CO2	No	No electricity or fossil fuels are consumed during the pyrolysis process.
		CH4	No	
		N2O	No	
	Biochar Transportation	CO2	No	No emissions are involved as there is no transportation of biochar in the project activity.
		CH4	No	
		N2O	No	
	Pre-treatment of feedstocks (e.g., grinding, grinding)	CO2	No	No emissions are involved as no pre-treatment of feedstocks takes place.
		CH4	No	
		N2O	No	
	Biochar application (e.g., preparation of biochar for final use)	CO2	No	No emissions take place during biochar application as it is applied manually by farmers.
		CH4	No	
		N2O	No	

3.4 Baseline Scenario

Introduction

India's agricultural landscape, abundant with crop yields, faces the prevalent challenges of open field burning and biomass decay. As a major agricultural contributor, the state of Odisha in India, where the first instance of the grouped project is being implemented, is no exception to this issue. To record this challenge, the project proponent conducted its own survey.

Empirical Investigation Summary:

Survey Design: To understand the current practices of farmers regarding agricultural waste biomass disposal, the survey consisted of closed-ended questions. The questions were clear, in local-language Odia, and unbiased.

Initial Test: To refine the questions and ensure clarity, the questionnaire was initially tested with a small group of 20 farmers. These 20 farmers were later part of the baseline survey also.

Survey: All 5000 farmers (100% of the farmers in the first project instance) were sent the survey questionnaire to which their responses were solicited.

Training of Surveyors: To ensure consistency in data collection, all surveyors were provided rigorous uniform training.

Data Collection: To collect qualitative information, informed consent was taken from participants and face-to-face data collection took place.

Data Analysis: An overwhelming majority (94%) of the farmers responded that they have been practicing open field burning with the biomass residue in their fields.

Interpretation of Results: The survey results indicate that in the baseline scenario, open field burning is the overruling practice among farmers.

3.5 Additionality

Additionality for the project is determined as follows:

1. **Step 1: Regulatory Surplus**

    a. Absence of Government Mandate: Currently, project proponent has not identified any laws, regulations, policies, or mandates instituted by the Government of India or Government of Odisha that necessitate the project activity (conversion of waste agricultural biomass into biochar and its subsequent application to agricultural soils.) While there exists recommendations and initiatives by government bodies, no mandatory regulation for biochar production and application is in place in the host state and country.

    b. Project Voluntariness: This biochar project operates entirely on a voluntary basis and participation is based on the will of the farmers. It is not compelled or prescribed by any legal instrument, statute, regulation, or decree within the host state and country.

    c. Exclusion from International Frameworks: Furthermore, the project is not dictated or mandated by international conventions or frameworks, including but not limited to the United Nations Framework Convention on Climate Change (UNFCCC).

d. Conclusion: Given the aforementioned points, the project operates beyond existing regulatory requirements, fulfilling the criteria of regulatory surplus as formed by the standard. In addition, the project proponent will regularly assess new laws and guidelines in the future.

2. Step 2: Positive List

a. Activity Penetration Method

The positive list determination pivots on the concept of activity penetration, emphasizing that if biochar production doesn't exceed 5% of its potential, it's considered to be additional.

b. Establishing the Basis for Positive List

The premise for biochar additionality is rooted in its nascent stage of development. As the global biochar production from waste biomass remains underexplored, projects that contribute to this can be classified as additional if they do not push global production beyond 5% of the available waste biomass.

c. Calculation of Activity Penetration in the project

i. Expected Observed Adoption (OA_y) Post Incorporation of Project Reignite's first instance

With the estimated 2021 global biochar production standing at 773,787 metric tonnes (excluding our project), the inclusion of our annual expected production of 75,000 metric tonnes elevates it to:

$$\text{New } OA_y = 773{,}787 + 75{,}000 = 848{,}787$$

ii. Expected Activity Penetration of the first instance of Project Reignite

Using the globally recognized formula (as used in the methodology)

$$AP_y = \left(\frac{OA_y}{MAP_y}\right) \times 100$$

Where MAP_y (Maximum Adoption Potential) for the given year remains constant at 1,369,486,910 tonnes, we derive:

$$AP_y = \left(\frac{848{,}787}{1{,}369{,}486{,}910}\right) \times 100 = 0.062\%$$

$$AP_y << 5\%$$

This activity penetration, inclusive of our project's contribution, remains significantly below the critical 5% threshold.

d. Conclusion

Project Reignite, will contribute estimated 75,000 tons of biochar production annually, which seamlessly fits within the parameters set by the VCS Methodology Requirements. The derived activity penetration, even with the project's contribution, is 0.062%, which is well beneath the 5% benchmark.

Project Reignite not only aligns with the guidelines but also contributes meaningfully to the global push for biochar production, without tipping the balance of the positive list criteria. Thus, the project is additional in accordance with the principles established by the VCS methodology.

3.6 Methodology Deviations

Project Reignite takes a deviation from the methodology in the following ways:

The deviation is related to the frequency of monitoring of the two parameters below, as the values of these parameters do not vary much from month to month and are nearly the same, except for the monsoon months. However, there is no biochar production expected during the monsoon, due to the wet conditions during the monsoon.

Table 11: Proposed Deviations

S. No.	Parameter	Requirement of the methodology	Proposed Deviation
1)	Moisture content for calculation of biochar on dry weight basis	Frequency of recording: Moisture content should be monitored for each batch of biochar type *t*.	Frequency of monitoring will be on a monthly basis for random samples of biochar produced of type *t*. The field sample size will be determined using the Standard for Sampling and Surveys for CDM project activities and programme of activities as a guideline. The laboratory will be testing a representative sample from the field samples.
2)	H:C_{org} (Ratio of hydrogen to organic carbon) of biochar produced	Frequency of recording: Each batch of biochar produced at the production facility *p*.	Frequency of monitoring will be on an annual basis for random samples of biochar produced of type *t*. The field collection sample size will be determined using the Standard for Sampling and Surveys for CDM project activities and programme of

			activities as a guideline. The laboratory will be testing a representative sample from the field samples.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

4.1.1 Sourcing Stage

As explained in Section 3.4, in the absence of the project activity, waste biomass would have been left to decay or would have been combusted for purposes other than energy production in the year biochar will be made within the project boundary. According to the methodology, the default net baseline emission avoidance is defined as zero following a conservative scenario ($BE_{SS,y}$).

4.1.2 Production Stage

In the baseline scenario at production stage, no biochar is produced for the purposes of the project activity and therefore no GHG removals or related emissions are considered.

4.1.3 Application Stage

In the baseline scenario at application stage, since no biochar was produced, no GHG removals or related emissions are considered.

4.2 Project Emissions

4.2.1 Sourcing Stage

At the sourcing stage, waste agricultural biomass will be collected from the same or nearby farm (within walking distance) where the production facility (steel-shield soil pit) is located. Therefore, the emissions at the sourcing stage ($PE_{SS,y}$) are set to zero.

4.2.2 Production Stage

$$ER_{PS,y} = \sum_{t}\left(\left(\sum_{k} CC_{t,k,y} \times \frac{44}{12}\right) - \left(\sum_{p} PE_{PS,t,p,y}\right)\right)$$

Where:

$ER_{PS,y}$ = GHG emissions removals at production stage in year *y* (tCO_2e)

$CC_{t,k,y}$ = Organic carbon content on a dry weight basis for biochar type *t* used for application type *k* in year *y* (tonnes)

$PE_{PS,t,p,y}$ = Project emissions at production stage for production of biochar type *t* at production facility *p* in year *y* (tCO_2e)

$\frac{44}{12}$ = Coefficient to convert organic carbon to tCO_2e

4.2.2.1 Low Tech Production Facilities

Step 1: Estimate organic carbon content ($CC_{t,k,y}$) of biochar

$$CC_{t,k,y} = \sum_{p} (M_{t,k,p,y} \times F_{Cp,t,p} \times PR_{de,k})$$

$CC_{t,k,y}$ = Organic carbon content on a dry weight basis for biochar type *t* used for application type *k* in year *y* (tonnes). Biochar type is based on the feedstock used to produce the biochar

$M_{t,k,p,y}$ = Mass on a dry weight basis of biochar type *t* for application type *k* produced at production facility *p* in year *y* (tonnes)

Table 12: Estimated Biochar Production per facility *p*

Feedstock	Estimated Mass of biochar on a dry weight basis for 1 production facility (tonnes) per year[11]
Paddy Straw	9.5
Tree Pruning	1
Bamboo Pruning	2
Maize Cobs	1
Ipomoea Carnea	1
Water Hyacinth	0.5

$F_{Cp,t,p}$ = Organic carbon content of biochar type *t* produced in production facility per tonne of biochar, taken on a dry weight basis (percent). Project Reignite will be determining these values through laboratory material analysis of biochar annually which will be provided to the VVB during verification. At the validation stage, values provided in Table 4AP.1 taken from IPCC (2019)

[11] Estimates are based on expert judgement.

Appendix 4: Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments: Basis for Future Methodological Development have been used.

Table 13: Organic carbon content for different types of feedstocks

Feedstock Type	Feedstock	Organic Carbon Content
Rice husks and rice straw	Paddy Straw	0.49
Wood	Tree Pruning	0.77
	Bamboo Pruning (Only taken from mature bamboo with woody stems)	
Herbaceous	Maize Cobs	0.65
	Ipomoea Carnea	
	Water Hyacinth	

$PR_{de,k}$ = Permanence adjustment factor due to decay of biochar to be defined for application type k (dimensionless). Biochar is subject to natural decay rate when used in soil applications such as in agriculture, forests, croplands, or grasslands.

"The temperature in the main pyrolysis zone just below the flame curtain is 680°C to 750°C and cools down slowly below the main pyrolysis zone when new feedstock layers are added to 150–450°C depending on the duration of batch before final quenching" (Cornelissen et al. 2016). It matches with average values collected from a sample of production facilities during process testing as described in Section 5. Due to high temperature pyrolysis, the fraction of biochar remaining after hundred years is 0.89 (Table 4AP.2 of IPCC (2019)).

It was determined through tests conducted by an external laboratory that the temperature achieved during the flame curtain pyrolysis process is in excess of 600 degrees C. The laboratory was commissioned to conduct a series of temperature measurements while the pits were charged with the biomass and the pyrolysis process was being carried out. The laboratory results showed that the temperature during the pyrolysis was always more than 600 degrees C. This supports the value of $PR_{de,k}$ taken as 0.89 corresponding to temperatures above 600 degrees C. In addition, T_{prod} is a monitored parameter in the project where temperature is measured on a continuous basis for each batch of biochar produced.

Calculation of carbon content for each biochar type t, application type k (soil application), year y

1) Paddy Straw

$$CC_{paddystraw,k,y} = \sum_{p=1}^{5000} (9.5 \times 0.49 \times 0.89)$$

$$CC_{paddystraw,k,y} = 20{,}714.75$$

2) Tree Pruning

$$CC_{treeprunings,k,y} = \sum_{p=1}^{5000}(1 \times 0.77 \times 0.89)$$

$$CC_{treeprunings,k,y} = 3{,}426.5$$

3) Bamboo Pruning

$$CC_{bambooprunings,k,y} = \sum_{p=1}^{5000}(2 \times 0.77 \times 0.89)$$

$$CC_{bambooprunings,k,y} = 6{,}853$$

4) Maize Cobs

$$CC_{maizecobs,k,y} = \sum_{p=1}^{5000}(1 \times 0.65 \times 0.89)$$

$$CC_{maizecobs,k,y} = 2{,}892.5$$

5) Ipomoea Carnea

$$CC_{ipomoeacarnea,k,y} = \sum_{p=1}^{5000}(1 \times 0.65 \times 0.89)$$

$$CC_{ipomoeacarnea,k,y} = 2{,}892.5$$

6) Water Hyacinth

$$CC_{waterhyacinth,k,y} = \sum_{p=1}^{5000}(0.5 \times 0.65 \times 0.89)$$

$$CC_{waterhyacinth,k,y} = 1446.25$$

Step 2: Estimate project emissions $PE_{PS,p,y}$ for low technology production facilities

$$PE_{PS,p,y} = \left(P_{ED,p,y} + P_{EP,p,y} + P_{EC,p,y}\right) \times \frac{\sum_t \sum_k M_{t,k,p,y}}{M_{p,y}}$$

Where:

$PE_{PS,p,y}$ = Project emissions at the production stage at production facility p in year y (tCO_2e)

$P_{ED,p,y}$ = Emissions associated with the pre-treatment of waste biomass at production facility p in year y (tCO_2e)

$P_{EP,p,y}$ = Emissions associated with the conversion of waste biomass into biochar at production facility p in year y (tCO_2e)

$P_{EC,p,y}$ = Emissions due to the utilization of auxiliary energy for the purpose of pyrolysis at production facility p in year y (tCO_2e)

i) **Determining $P_{EP,p,y}$: Emissions associated with the pre-treatment of feedstock at production facility p in year y for low technology facilities**

$P_{ED,p,y} = P_{EDE,p,y} + P_{EDF,p,y}$

$P_{ED,p,y}$ = 0 as there is no pre-treatment of feedstock involved. Feedstock is air/sun dried.

ii) **Determining $P_{ED,p,y}$: Emissions associated with the thermochemical process at production facility p in year y for low technology facilities**

$$P_{EP,p,y} = \sum_{k}\sum_{t}(F_e \times GWP_{CH4} \times M_{t,k,p,y})$$

Where:

$P_{EP,p,y}$ = Emissions associated with the conversion of waste biomass into biochar at production facility p in year y (tCO2e)

F_e = Average methane emissions from producing one tonne of biochar in year y (tCH_4/tonne). Values from Table 3 in Cornelissen et al. (2016) may be used based on the corresponding type (i.e., low technology production facility type). The first instance of project Reignite uses Steel-shield soil pit (low technology production facility type t). Thus, F_e = 0.014 for steel-shield soil pit.

GWP_{CH4} = Global warming potential of methane. Use value referenced in the latest version of the VCS standard

As per VCS standard V4.4, GWP_{CH4} = 28

$M_{t,k,p,y}$ = Mass on a dry weight basis of biochar type t and application type k produced at production facility p in year y (tonnes).

Calculation of emissions during production for each production facility p in year y:

$$P_{EP,p,y} = (0.014 \times 28 \times 9.5) + (0.014 \times 28 \times 1) + (0.014 \times 28 \times 2) + (0.014 \times 28 \times 1) + (0.014 \times 28 \times 1) + (0.014 \times 28 \times 0.5)$$

$$P_{EP,p,y} = (0.014 \times 28) \times (9.5 + 1 + 2 + 1 + 1 + 0.5)$$

$$P_{EP,p,y} = (0.392) \times (15)$$

$$P_{EP,p,y} = 5.88$$

iii) **Determining $P_{EC,p,y}$: Emissions due to the utilization of auxiliary energy for the purpose of pyrolysis**

$P_{EC,p,y}$ = 0

As no external energy is required to initiate and maintain the pyrolysis, the emissions are 0.

$$PE_{PS,p,y} = (0 + 5.88 + 0) \times \frac{75{,}000}{75{,}000}$$

Thus, following is calculation for $ER_{PS,y}$:

$$ER_{PS,y} = \sum_{t}\left(\left(\sum_{k} CC_{t,k,y} \times \frac{44}{12}\right) - \left(\sum_{p} PE_{PS,t,p,y}\right)\right)$$

$$CC_{t,k,y} = (20{,}714.75) + (3{,}426.5) + (6{,}853) + (2{,}892.5) + (2{,}892.5) + (1{,}446.25)$$

$$\sum_{k} CC_{t,k,y} = 38{,}225.5$$

$$\sum_{p} PE_{PS,t,p,y} = \sum_{p=1}^{5000} 5.88 = 29{,}400$$

$$ER_{PS,y} = \left(38{,}225.5 \times \frac{44}{12}\right) - (29{,}400)$$

$$ER_{PS,y} = 110{,}760$$

4.2.3 Application Stage

$PE_{AS,y}$ = 0 as project Reignite does not involve any processing. Biochar is manually applied to the same farm from where the biomass originates from. The biochar is air/ sun dried. Hence, there is no combustion of fossil fuels or consumption of electricity in the application stage.

4.3 Leakage

LE_y = 0 as there are no transmissions at any stage of the biochar life cycle. Biochar is produced and applied within the same farm from where the biomass originates from. All transportation is done manually as everything is located within walking distance.

4.4 Net GHG Emission Reductions and Removals

Emission reductions at the sourcing stage ($ER_{SS,y}$) are 0 as the methodology conservatively assumes default value of zero (tCO_2e)

Net GHG emission reductions and removals are calculated as follows:

$ER_y = ER_{SS,y} + ER_{PS,y} - PE_{AS,y} - LE_y$

Where:

ER_y = Net GHG emissions reductions and removals in year y (tCO_2e)

$ER_{SS,y}$ = GHG emission reductions at sourcing stage in year y (tCO_2e)

$ER_{PS,y}$ = GHG emission removals at production stage in year y (tCO_2e)

$PE_{AS,y}$ = GHG emissions at application stage in year y (tCO_2e)

LE_y = Total leakage emissions in year y (tCO_2e)

$ER_y = 0 + 110{,}760 - 0 - 0$

Thus, estimated annual emission reductions are 110,760 (tCO_2e)

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
Year 2023 (16-10-2023-- 31-12-2023)	0	23,366	0	23,366
Year 2024	0	110,760	0	110,760
Year 2025	0	110,760	0	110,760
Year 2026	0	110,760	0	110,760
Year 2027	0	110,760	0	110,760
Year 2028	0	110,760	0	110,760
Year 2029	0	110,760	0	110,760
Year 2030 (01-01-2030-- 15-10-2030)	0	87,394	0	87,394
Total	0	775,320	0	775,320

5 MONITORING

5.1 Data and Parameters Available at Validation

<table>
<tr><td>Data / Parameter</td><td>$F_{Cp,t,p}$</td></tr>
<tr><td>Data unit</td><td>Percent (%)</td></tr>
<tr><td>Description</td><td>Organic carbon content of biochar for each biochar type t produced in production facility p per tonne of biochar, on a dry weight basis (%)</td></tr>
<tr><td>Source of data</td><td>At validation stage, default values provided in Table 4AP.1 are used, which are taken from IPCC (2019) Appendix 4: Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments: Basis for Future Methodological Development</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th>Feedstock Type</th><th>Feedstock</th><th>Organic Carbon Content</th></tr>
<tr><td>Rice husks and rice straw</td><td>Paddy Straw</td><td>0.49</td></tr>
<tr><td rowspan="2">Wood</td><td>Tree Pruning</td><td rowspan="2">0.77</td></tr>
<tr><td>Bamboo Pruning (Only taken from mature bamboo with woody stems)</td></tr>
<tr><td rowspan="3">Herbaceous</td><td>Maize Cobs</td><td rowspan="3">0.65</td></tr>
<tr><td>Ipomoea Carnea</td></tr>
<tr><td>Water Hyacinth</td></tr>
</table>
</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>At validation, IPCC (2019) stated global estimates of organic carbon content of biochar as a function of feedstock and heating temperature are used. During the project implementation (crediting period,) the values will be monitored using biochar material analysis at an accredited laboratory for calculation.</td></tr>
<tr><td>Purpose of Data</td><td>Calculation of project emissions</td></tr>
</table>

Comments	Below are the reasonings for classification of each feedstock type: 1. Paddy Straw: Category: Rice husks and rice straw Reasoning: Paddy straw is the residue left after the rice grain is harvested. Given its direct relation to rice production, it is most appropriately classified with rice husks and straw. 2. Tree Pruning: Category: Wood Reasoning: Tree pruning are derived from trees, which are inherently woody plants. The pruned branches and twigs have the same woody characteristics as the main tree and are therefore classified under wood. 3. Bamboo Pruning: Category: Wood Reasoning: While bamboo is technically a grass, mature bamboo develops a woody stem known as a culm. These woody culms give bamboo its rigidity and strength, making it akin to wood in many applications. Thus, for purposes of biomass classification, mature bamboo pruning will be categorized as wood. 4. Maize Cobs: Category: Herbaceous Reasoning: Maize (or corn) is a type of grass, and while the cob is harder and more rigid than the rest of the plant, it does not have the woody properties found in trees or mature bamboo. Therefore, it fits best under the herbaceous category. 5. Ipomoea Carnea: Category: Herbaceous Reasoning: Ipomoea Carnea is a type of forb. Forbs are broad-leaved herbaceous plants, and thus, they fit squarely within the herbaceous category. 6. Water Hyacinth: Category: Herbaceous Reasoning: Water hyacinth is a free-floating perennial aquatic plant. Its rapid growth and herbaceous nature make it best suited for the herbaceous category.

Data / Parameter	$PR_{de,k}$
Data unit	Dimensionless
Description	Permanence adjustment factor due to decay of biochar (dimensionless) defined for application type k
Source of data	IPCC (2019) Appendix 4: Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments: Basis for Future Methodological Development
Value applied	"The temperature in the main pyrolysis zone just below the flame curtain is 680°C to 750°C and cools down slowly below the main pyrolysis zone when new feedstock layers are added to 150–450°C depending on the duration of batch before final quenching" (Cornelissen et al. 2016). As pyrolysis temperature for flame curtain pyrolysis method is known to be >600°C and as observed in practice, permanence adjustment factor is 0.89 from IPCC (2019) Appendix 4 AP.2.
Justification of choice of data or description of measurement methods and procedures applied	Biochar is a stable material that may be used for soil and non-soil applications. As a material, it has a decay rate that must be accounted for. This parameter considers how much of the original carbon will remain in the biochar and may be accounted as a carbon sink after its final application. IPCC and EBC are internationally recognized, and the data provided in the guidelines are peer reviewed.
Purpose of Data	Calculation of project emissions
Comments	The methodology suggests that for low technology production facilities, project proponents must use a conservative default value of 0.56. The conservative default value is suggested only in case the pyrolysis temperature is unknown (Figure 4Ap.1 in IPCC, 2019). However, in the case of Project Reignite, pyrolysis temperature is known to be higher than 600°C as flame curtain pyrolysis method is used in steel-shield soil pit. The project activity has been process tested for the average production temperature by a laboratory and the report will be available at the time of validation. The project activity has been process tested for the average production temperature by a laboratory and it was found that the temperature was higher than 600 degrees Celsius. In addition, Tprod is measured on a continuous basis for each batch of biochar and is a monitoring parameter.

Data / Parameter	GWP_{CH4}
Data unit	Tonnes CO2e per tonne CH4 (tCO2e/ tCH4)

Description	Global warming potential of methane
Source of data	IPCC Fifth Assessment Report
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	The VCS Standard V4.4 requires that CH4 is converted to CO2e using the 100-year global warming potential derived from IPCC Fifth Assessment Report.
Purpose of Data	Calculation of project emissions
Comments	The latest standard version at the time of listing suggested GWP_{CH4} to be 28. The latest IPCC Assessment Report (Sixth) suggested GWP_{CH4} to be 21. However, a conservative value of 28 is applied.

Data / Parameter	Fe
Data unit	tonnes CH4 per tonne biochar (t CH4/t)
Description	Average methane emissions from producing one tonne of biochar in year y in a low technology production facility
Source of data	Table 3 in Cornelissen et al. (2016)
Value applied	14kg CH4/ tonne of biochar for steel-shield soil pit
Justification of choice of data or description of measurement methods and procedures applied	Methane emissions must be accounted for as methane is the main gas released from low technology production facilities. The value of methane emissions per tonne of biochar produced in a steel-shield soil pit (low-technology production facility) has been taken from Table 3 in Cornelissen et al. (2016).
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	Biomass categories and quantities used for selection of the baseline scenario and production of biochar utilized in the project activity
Data unit	tonnes (t) on dry basis

Description

Biomass Categories and Quantities at each production facility[12]:

Feedstock Type	Feedstock	Estimated Amount available at baseline (in tonnes) each year
Agricultural Waste Biomass	Rice Straw	57
	Tree Pruning	6
	Bamboo Pruning	12
	Maize Cobs	6
	Ipomoea Carnea (Shrub)	6
Aquaculture Plants	Water Hyacinth (Eichhornia crassipes)	3

Biomass Quantities available at all production facilities (derived from the above values):

Feedstock Category	Feedstock	Estimated Amount available at baseline (in tonnes) each year
Agricultural Waste Biomass	Rice Straw	285,000
	Tree Pruning	30,000
	Bamboo Pruning	60,000
	Maize Cobs	30,000
	Ipomoea Carnea (Shrub)	30,000
Aquaculture Plants	Water Hyacinth (Eichhornia crassipes)	15,000

- Biomass is sourced from the same/neighboring farm where the production facility is located.
- Biomass would have been burnt in the open field or left to decay in the absence of the project activity. Details are provided in Section 3.4.
- Sustainability criteria for all biomass is met. It is described in Section 3.2.

[12] Estimates are based on expert judgement.

Source of data	Expert judgement based on on-site assessment of biomass categories and quantities
Description of measurement methods and procedures applied	Using weight meters and moisture meters. Adjusted by moisture content in order to determine the quantity of dry biomass.
Frequency of Monitoring/ recording	Data monitored once before validation
QA/QC procedures to be applied	Cross-check the measurements with an annual mass balance.
Purpose of Data	Monitoring of eligible biomass categories and quantities used as feedstock for production of biochar
Comments	For each biochar type *t* to be produced, a laboratory has performed field testing for yield rates. Results will be available at the time of validation.

5.2 Data and Parameters Monitored

Data / Parameter	$M_{p,y}$
Data unit	tonnes (t)
Description	Total mass on a dry weight basis of biochar produced in production facility p in year y
Source of data	On-site measurements
Description of measurement methods and procedures to be applied	Total weight of biochar produced at production facility p in year y will be measured using a weighing scale. Moisture content will be monitored for the project using laboratory analysis of representative sampling of biochar produced every month from the beginning of the crediting period.
Frequency of monitoring/recording	Monitored continuously, recorded for each batch produced and summed as a total
Monitoring equipment	Weighing scale as per details provided for $M_{t,k,p,y}$ below.
QA/QC procedures to be applied	Calibration of weighing scales on-site by the Reignite monitoring team (defined in Section 5.3) using a known weight to be done annually.
Purpose of data	Calculation of project emissions
Calculation method	N/A

Comments	Biochar quantity will be weighed separately using a weighing scale for each biochar type t at each biochar production facility p. The sum is recorded as $M_{p,y}$

Data / Parameter	$M_{t,k,p,y}$
Data unit	tonnes (t)
Description	Mass on dry weight basis of biochar type t and application type k produced at production facility p in year y
Source of data	On-site measurements
Description of measurement methods and procedures to be applied	Total weight of biochar type t, used for application type k, produced at production facility p in year y will be measured using a weighing scale. Moisture content will be monitored for the project using laboratory analysis of representative sampling of biochar produced every month from the beginning of the crediting period.
Frequency of monitoring/recording	Monitored continuously, recorded for each batch applied
Monitoring equipment	Weighing scale Specification: Aliston Electronic Portable Fishing Hook Type Digital LED Screen Weighing Scale
QA/QC procedures to be applied	Calibration of weighing scales on-site by the Reignite monitoring team (defined in Section 5.3) using a known weight, to be done annually.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	Biochar quantity will be weighed separately using a weighing scale for each biochar type t at each biochar production facility p. Moisture content will be measured using testing done by a laboratory every month from the start date of the project. Field sampling will be done using the Sampling and Surveys Standard for CDM Project Activities and Program of Activities, as a guideline. The laboratory will be using a representative sample from the field samples for testing. The laboratory will follow ASTM D1762-84 Standard Test Method for Chemical Analysis of Wood Charcoal or a similar testing method. The dry weight of biochar will be measured using the results.

Data / Parameter	T_{prod}
Data unit	Degrees Celsius (C)
Description	Average annual production temperature during pyrolysis
Source of data	Data records of biochar production
Description of measurement methods and procedures to be applied	Use instruments with recordable electronic signal (digital).
Frequency of monitoring/recording	Continuous, monitored for each batch produced, aggregated to annual averages
Monitoring equipment	Handheld high temperature industrial infrared thermometer
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent NABL accredited laboratory.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	It was determined through tests conducted by an external laboratory that the temperature achieved during the steel shield soil pit pyrolysis process is in excess of 600 degrees C. The laboratory was commissioned to conduct a series of temperature measurements, while the pits were charged with the biomass and the pyrolysis process was being carried out. The laboratory results showed that the temperature during the pyrolysis was always more than 600 degrees C. This supports the value of PRde,k taken as 0.89 corresponding to temperatures above 600 degrees C.

Data / Parameter	$F_{Cp,t,p}$
Data unit	Percent (%)
Description	Organic carbon content of biochar for each biochar type t produced in production facility p per tonne of biochar, taken on a dry weight basis
Source of data	Laboratory material analysis
Description of measurement methods	Laboratory material analysis following EBC Production Guidelines on the production of biochar will determine F_{Cp} values on a regular basis.

and procedures to be applied	
Frequency of monitoring/recording	Testing will be performed annually as there will not be a material change in feedstock or thermochemical production parameters more frequent than annually.
QA/QC procedures to be applied	Laboratory accredited by India's national agency NABL (National Accreditation Board for Testing and Calibration Laboratories).
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	Field sampling will be done using the Sampling and Surveys for CDM Project Activities and Program of Activities Standard as a guideline. The lab will be using a representative sample from the field samples for the testing.

Data / Parameter	$H:C_{org}$
Data unit	Dimensionless
Description	Ratio of hydrogen to organic carbon
Source of data	Laboratory analysis
Description of measurement methods and procedures to be applied	Nationally Accredited Laboratory analysis following EBC Production Guidelines.
Frequency of monitoring/recording	Annually field samples will be collected using the Sampling and Surveys Standard for CDM Project Activities and Program of Activities as a guideline. Laboratory will be using a representative sample out of the field samples collected using Sampling.
QA/QC procedures to be applied	Laboratory accredited by India's national agency NABL (National Accreditation Board for Testing and Calibration Laboratories).
Purpose of data	Used to demonstrate eligibility for use in soil applications. As per applicability condition 10, biochar used in soils must have an $H:C_{org}$ of less than 0.7.
Calculation method	N/A
Comments	As all production facilities will be utilizing the same technology and same feedstocks, a representative sample will be tested annually. Field sampling will be done using the Sampling and Surveys Standard for CDM Project Activities and Program of Activities as a guideline. Laboratory will be taking a representative sample from the field samples.

5.3 Monitoring Plan

1. Main Objective

   The main objective of the monitoring plan is to prove the carbon sink from the final application of biochar and to quantify the emissions resulting from the project activity during the project crediting period, prior to each verification.

2. Sampling approach

   For the periodic monitoring of parameters $M_{p,y}$ and $M_{t,k,p,y}$ described in the monitoring plan in section 5.2 above, the values of weight of the biochar produced and applied will be measured and recorded for every batch of biochar produced. These values being weights of dry biochar produced, will be derived by subtracting the moisture content of the biochar from the total weight measured by means of weighing scales. While the weight of each batch produced will be taken and recorded, the value of moisture content will be monitored using a sampling approach. Values of the parameters $F_{cp,t,p}$ (organic carbon content of biochar) and $H:C_{org}$ (ratio of hydrogen to carbon in the biochar) will also be determined using a sampling approach.

   The sampling approach that will be followed is based on the CDM Standard for Sampling & Surveys for CDM project activities and programme of activities (Version 9.0 of the standard from EB 110 Annex 1) and the CDM Guideline on Sampling & Surveys for CDM project activities and programme of activities (version 4.0 of the guideline from EB 67 Annex 6). The sampling approach is described as below.

   Step 1: Choose the parameter of interest for sampling

   For all of the 3 parameters, viz., "moisture content", "$F_{cp,t,p}$" and "$H:C_{org}$", the parameter of interest is a mean value of the respective parameters.

Moisture content	The mean value of moisture content of the wet biochar is the desired parameter of interest
$F_{cp,t,p}$	The mean value of organic carbon content of the dry biochar is the desired parameter of interest
$H:C_{org}$	The mean value of ratio of hydrogen to carbon in the dry biochar is the desired parameter of interest

   Step 2: Select the sampling scheme

   As the biochar producing farms in the project are located within a single region (i.e. the state of Odisha in India), as similar in area and crop, there is homogeneity between the facilities and hence, a "Simple Random Sampling (SRS)" is appropriate for the sampling scheme.

   Step 3: Determine the expected value of the parameter of interest

   Pilot studies conducted through external laboratories will provide data on the range of value each parameter is expected to take. The range of value is characterized as both "mean value (μ_e)" of the parameter and "standard deviation (σ_e)".

   Step 4: Select the confidence interval for the sampling

   For the purpose of the sampling exercise, a confidence interval of 90/10 has been applied. The values determined by the sampling would have a level of precision of +/-10% relative to the parameter's true value, with a 90% level of confidence in the result

Step 5: Calculate the sample size for the monitoring

The sample size will be calculated as

$$n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$$

where,

n= sample size
N= total number of biochar batches produced in the project
$V= (\sigma_e/\mu_e)^2$
1.645 represents the 90% confidence required
0.1 represents the 10% relative precision

Step 6: Results of sampling

The samples, calculated as per Step 5 above will then be sent to an external laboratory for testing of 'Moisture content', '$F_{cp,t,p}$' and '$H:C_{org=}$'. The laboratory will independently carry out its tests and provide results of the test to the PP. The test results will be provided by the laboratory and will be arrived at by considering the mean values for each parameter.

Step 7: Check for the reliability of the estimate from the sampling
This step involves three further steps:

Step 7a: Find the 't-value' corresponding to the sample size (n) and confidence level (90%) from statistical tables or by using the MS Excel function TINV(0.1,(n-1)).

Step 7b: Find the standard error (ε) of the mean value estimate as

$$\varepsilon = \sqrt{\left(1 - \frac{n}{N}\right)\sigma^2/n}$$

Step 7c: Calculate the precision of the estimate as the product of 't-value' and ε

The relative precision (R.L.) is (t-value x ε)/σ_{sample}

Step 7d: Reliability test:

If R.L. < 0.1 or =0.1, the estimate is reliable; the value of σ_{sample} is accepted as a reliable monitored value for the parameter (i.e. Moisture content/$F_{cp,t,p}$/$H:C_{org}$)

If R.L. > 0.1, the estimate cannot be considered as reliable; the sampling must be repeated with a higher sample size

3. Organizational Structure (Roles, responsibilities, and capacity of monitoring team)

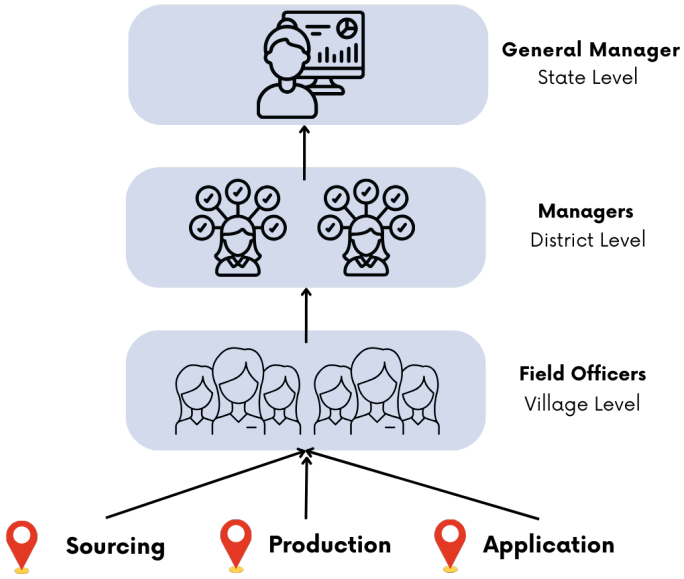


Figure 5: Structure of monitoring team

Institutionally, permanent Reignite Monitoring Team 1 has been established for the first instance of the grouped project. A dedicated monitoring team will be established for every instance of the grouped project. The team consists of a General Manager, Managers, and Field Officers.

The General Manager is responsible for leading the team and is appointed at the state level.

Managers are specialists in agriculture and oversee the work of field officers. They are appointed at a district level. Their duties include on-site inspections, reviewing records, comparing new data with past figures for accuracy, and ensuring quality controls are in place. They also coordinate field officers to maintain consistent implementation and measurements.

Field officers are responsible for field inspections of biochar production, and application. Further, they perform the data collection and use Project Reignite internal mobile app to monitor and report ground data. The main tasks of the field officers are as follows:

a. Regular inspections of farms under their supervision

b. Weight measurements of the biochar produced at the farms (this includes the first and second weighing if the seals are broken to ensure that there is no loss or diversion of biochar for other uses and to record only the lower of the weight measurements which will enable the emission removals to be conservatively calculated

c. Ensuring that every batch of biochar produced at each participating farm will use the same type of biomass feedstock and that there would be no mixing of biomass types while charging the soil pits

All members of the team have expertise in agriculture and have experience ranging from 10 (field officers) - 35 years (general manager). They have been trained and tested by our scientific experts on biochar production and monitoring.

4. Training, Testing, and Registration of Personnel

First, entire monitoring team (including the general manager, managers, and field officers) has been trained and tested by our scientific experts on biochar production and monitoring. Second, each biochar producer, who will be a part of the project and shifting from traditional practices to biochar production to manage their farm waste, has been trained, tested, and registered in the project by the field officers. The training covered instructions on performance of activities related to sourcing, production, storage, and biochar application. Biochar producers have been assigned an ID that represents their production facility.

5. Type of technology used to produce biochar

Flame curtain pyrolysis technology in steel-shield soil pit is used to produce biochar. It is further described in Section 1.11.

6. Description of Monitoring Tasks

As majority of farmers are located in remote areas, they do not have access to smartphones or internet, or have the ability to use a mobile app. Thus, the field officers will regularly inspect and report data using the Project Reignite mobile app. Following are the monitoring tasks that are carried out:

- Sourcing
    - Biochar producers (farmers) will be sourcing waste biomass from their own/ family's/ neighbors' farms. Field officers will interview the biochar producers at the beginning of each sourcing cycle (end of agricultural season) to identify the types and estimated amounts of waste biomass available at the production site.
- Production
    - The field officers visit the biochar producer (farmer) for each batch produced and conclude their inspections weekly to inspect the biochar production during the week. During the visit, the field officer measures and verifies the biochar production physically and seals the bags filled with the biochar produced. They enter the below information on the app:
        - Inspection ID (generated automatically, linked with the field officer's and biochar producer's ID)
        - Weight of biochar produced
        - Date range of biochar production
- Application
    - Once the biochar producer (farmer) is ready to apply the inspected biochar to the soil, the field officer visits the farm and opens the sealed bags. The sealed bags are opened only in the presence of the field officer inspecting the farm. For any bag whose seal is found broken, the field officer will order a second weighing to be done. The lower of the two weight readings would be applied to determine the values of the mass parameter $M_{t,k,p,y}$ for the further calculations of carbon content $CC_{t,k,y}$ and project emissions $PE_{PS,p,y}$. They supervise the biochar producer during application to ensure all biochar produced has been applied to the soil. They collect the following data points after supervision of application:
        - Date of Application
        - GPS Coordinates of Application
        - Signature of the Biochar Producer

- Signature of the Field Officer

7. Internal Auditing to Check Data Integrity and Monitoring (QA/QC Procedure):

   Managers will regularly conduct internal audits of biochar producers to validate the data submitted by field officers through the app. This multi-layered verification approach not only reviews digital records but also corroborates them with physical evidence, producer statements, and other forms of verification. Managers are responsible for confirming the proper implementation of all quality control and quality assurance measures, which includes inspecting the calibration of weighing equipment, providing ongoing training for field officers, and ensuring the uniform application of best practices in data collection and reporting. Additionally, managers play a crucial role in keeping both field officers and biochar producers updated on the latest biochar production standards and best practices for monitoring.

8. Maintenance and Data Storage of the Project System

   Because of the long-term nature of the project, data collection and archiving are crucial components. All field data, data analyses, models, calculations of carbon stocks, and copies of the monitoring reports will be stored in a dedicated cloud database with a backup facility. The data will be stored and maintained in the database for 9 years from the start date of the project (project crediting period (7 years) + 2 years).

APPENDIX

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