Project Design Document

Name of project:	Carbon Sequestration and Grassland Restoration In India
Name of C-Sink Manager:	Varaha ClimateAg Pvt Ltd
Project ID:	GCSP1013
Date of issue:	15.10.2025
Methodology:	Global Artisan C-Sink 2.1A
Project location:	India
Project start date:	21.07.2023
Project period:	The project has no end date, but it is verified on an annual basis
Project summary:	Our community-led biochar project is one the world's largest, issuing ~15,000 tCO_2e per month with nearly 100,000 t already delivered. With a best-in-class MRV system and strong community co-benefits including restoration of invasive-infested grasslands and reduction of crop burning this project sets the global benchmark for high-integrity biochar CDR. The project will increase carbon sequestration by working the produced biochar into different matrixes and in this way create a long-term carbon storage with a persistence of up to 1000 years as according to the Global Artisan C-Sink Standard. Without the project, no C-sink would be created since *Prosopis Juliflora and Cotton Stalk* do not constitute a long-term carbon reservoir. In the initial 5 years of the project we expect carbon sequestration of approximately 690,825 CO2eq in total or 138,165 CO2eq / year.

Table of content

1. Purpose and general description of the project

The project *Carbon Sequestration and Grassland Restoration in India* compromises more than 230 Artisan Biochar Producers for biochar production from invasive wood of Prosopis Juliflora and cotton stalks only*.* Biochar is a versatile material with an increasing number of applications in agriculture, environmental engineering, and basic industry. Biochar applied a matrix permitted by the Global Artisan C-Sink Standard poses a stable carbon sink (C-sink). Without the project, no C-sink would be created since invasive wood of Prosopis Juliflora and cotton stalks only does not constitute a long-term carbon reservoir.

Our community-led biochar project is one the world's largest, issuing ~15,000 tCO_2e per month with nearly 100,000 t already delivered. With a best-in-class MRV system and strong community co-benefits including restoration of invasive-infested grasslands and reduction of crop burning this project sets the global benchmark for high-integrity biochar CDR.

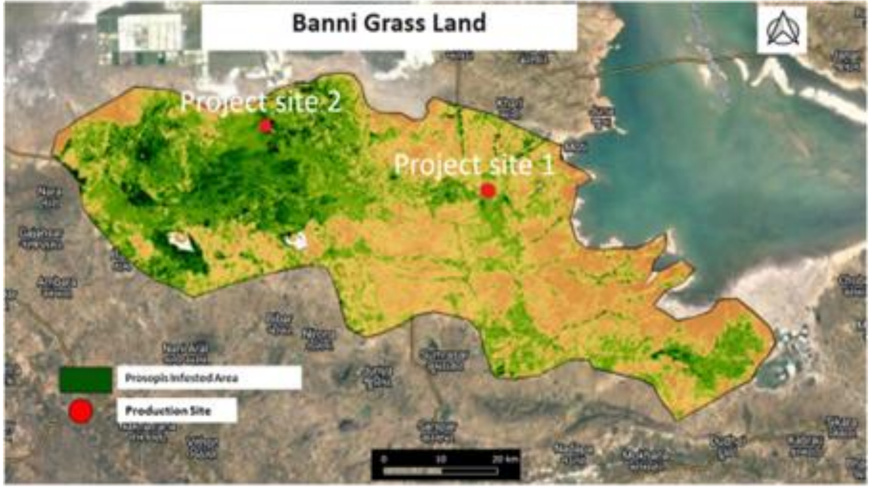
Another objective of the project is to improve the soil quality in India by marketing biochar as soil amendment. Biochar can improve soil quality significantly because of its impact on the soil pH, its water retention capacity, and its ability to store nutrients.

The monitoring and tracking of this project will be carried out by Varaha ClimateAg Pvt. Ltd. In the project the digital MRV technology named KALKI will be used. This will monitor, report and verify biochar production and carbon sequestration.

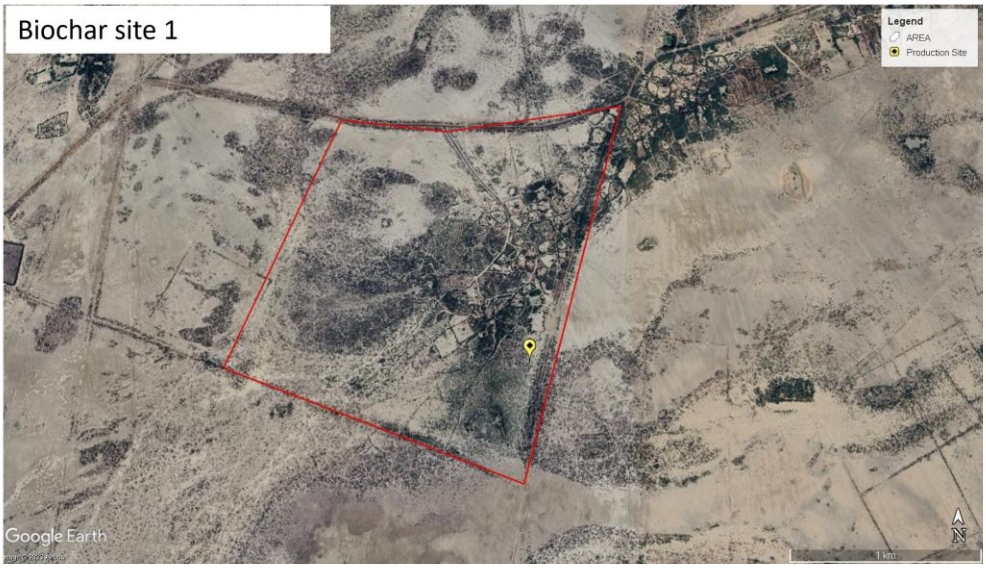
1.1. Project location

The geographical locations of the subsequently installed Biochar Artisan Producers will be documented in the *dMRV tool KALKI*. The GPS location of Artisan Biochar Producers is listed on Annex 7.1.

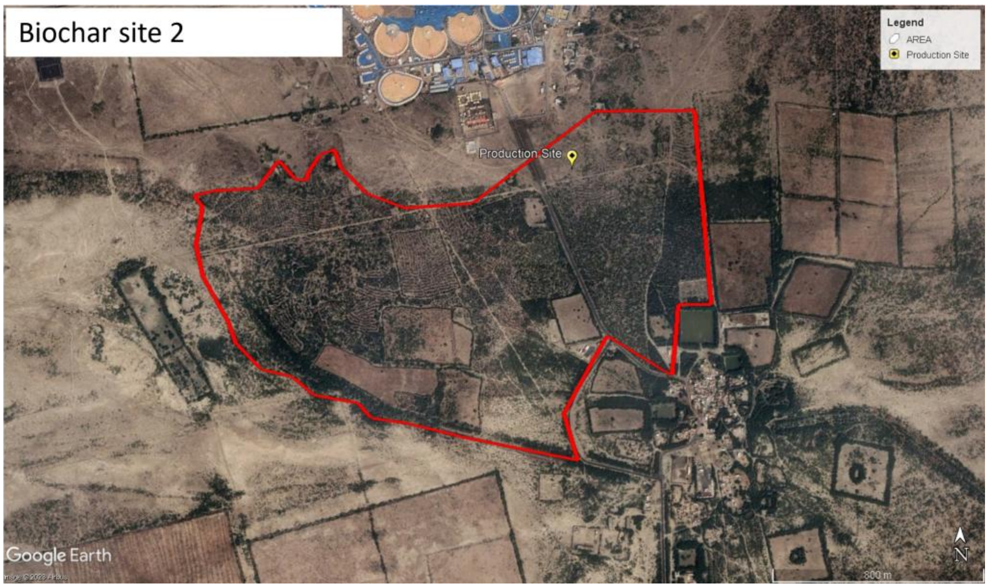
Banni Grasslands, Gujarat



Banni Landscape: The green color in the figure represents the Prosopis-infested area. The project sites are the locations that are heavily infested by Prosopis.



Project Site 1: Vagura Village - Excavation of Prosopis & Production of Biochar has already started. The red color boundary is the identified excavation area. The yellow color location pin in the image represents the biochar production site. The production happens in the vicinity of the excavation site only eliminating the need for transportation of feedstock.



Project Site 2: Gorewali Village - Identified site for excavation of Prosopis & Production of Biochar. The red color boundary is the identified excavation area. The yellow color location pin in the image represents the biochar production site. The production happens in the vicinity of the excavation site only eliminating the need for transportation of feedstock.

The geographical locations of the subsequently installed Biochar Artisan Producers will be documented in the spreadsheet (Annex 7.1)

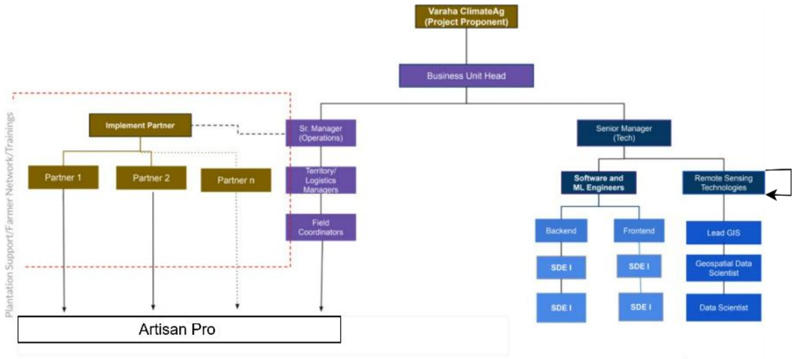
1.2. Stakeholders and partners involved

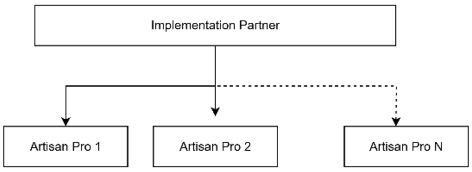
Varaha is the sole project proponent responsible for developing the project, designing the MRV solution, and coordinating with the registry for credit issuance and sales. Varaha also leads training and capacity-building initiatives for all operational stakeholders.

To enable effective on-ground implementation, Varaha partners with multiple Implementation Partners (IPs) such as established Farmer Producer Organizations (FPOs) and NGOs. These IPs manage local-level operations, including farmer engagement, residue and invasive biomass collection, and facilitation of biochar production. Importantly, within this structure, **Artisan Producers (Artisan Pros)** carry out the biochar production itself using the equipment, training, and protocols provided by Varaha. Artisan Pros are directly linked to the designated IPs, ensuring accountability and quality control and each artisan pro is managed by a supervisor designated by the corresponding IP.

Varaha retains complete control over how Artisan Pros operate by providing standardized training, operating guidelines, monitoring tools, and continuous oversight. IPs act as supervisory entities to coordinate and operated Artisan Pros at the field level, while Varaha remains the ultimate authority on technical processes, MRV compliance, and credit generation.

It is critical to note that Varaha is the exclusive project proponent and the sole holder of all carbon rights generated from biochar production under this project. This is explicitly defined in binding contractual agreements with every IP. IPs function only as operational partners and have no ownership, rights, or authority to run independent or parallel carbon projects. Similarly, Artisan Pros work under the strict control of IPs and Varaha, and they do not hold or claim any carbon rights.





1.3. Description of baseline scenario

Baseline Scenario for Prosopis Juliflora: -

Before the project’s inception, the invasive shrub Prosopis juliflora (Annex 7.11) had spread unchecked across the Banni grasslands, steadily encroaching on native habitats. Its rapid expansion posed a serious threat to indigenous grass species and local biodiversity, as it displaced native vegetation and disrupted the ecological balance of the grassland ecosystem. Recognizing this threat, the government integrated the removal of Prosopis juliflora into the forest management plan in 2004, laying the groundwork for grassland and biodiversity restoration. There are no financial incentives that our project receives from the government. The primary incentive for the communities and the government is ecological restoration and carbon removal along with other co-benefits such as employment opportunities.

The growth of Prosopis Julifora has caused a severe dearth of natural fodder within the grassland ecosystem making it difficult to feed the cattle. This has resulted in change in livelihood practices in the local community. In parallel, the Maldhari community engaged in widespread illegal logging of the shrub, selling the harvested wood in open markets as an energy source. The combustion of this biomass contributed to greenhouse gas emissions, while also fueling a local economy centered on unsustainable extraction.

Beyond its ecological and social impacts, Prosopis juliflora has detrimental effects on soil health. The roots of prosopis julifora extend up to 50 metres in the search for water, for an appetite of 30 litres of water a day per shrub. Instead of greening, this plant has destroyed the grasses by utilizing the ground water, and killed Kankrej cattle, which graze on its toxic pods, Prosopis has taken over vast sections in the region, radically unbalancing the grassland ecosystem, and creating ecological and social ramifications. Its deep roots extract excessive groundwater and nutrients, leading to soil nutrient depletion. The species also releases allelopathic compounds that suppress the germination and growth of other plants, reducing soil biodiversity and organic matter cycling. Over time, its litter and root exudates can acidify the soil, while dense root networks alter soil structure and reduce moisture retention. Collectively, these processes degrade soil fertility and further hinder the recovery of native vegetation.

Prosopis would remain a net emitter, either through natural decay, which releases CO_2 and methane, or through its traditional use as fuelwood, where it is burned, emitting all its stored carbon immediately.

The baseline situation, therefore, was characterized by the unchecked proliferation of an invasive species, its exploitation for illegal logging, and the resulting ecological and soil degradation. This highlights the urgent need for sustainable management strategies to control Prosopis juliflora, restore soil health, and protect the biodiversity of the Banni grasslands.

Baseline Scenario for Cotton Stalk: -

Among the crop residues, cotton stalks are the dominant and the easiest way to clear the field is burning these in the field itself. For example, nearly 25–30% of cotton stalk residue produced is surplus and is either left in the field as uncollected or to a large extent open-field burnt. In India alone, ~4 to 6 million tons of cotton stalks are burned annually, releasing approximately 7 to 12 million tons of CO_2 to the atmosphere, in addition to methane, nitrous oxide and air pollutants. About three-fourths of greenhouse gas (GHG) emissions from agro-residue burning were CH_4 and the remaining one-fourth was N_2O. Burning of cotton stalks alone contributes to about 8–10% of GHGs from agricultural residue burning in India.

The baseline scenario for carbon removal accounting is the "business as usual", in which no permanent biochar-based carbon sink is generated and is considered as zero. The fact that biomass could have been used differently in the baseline scenario, has no impact on the consideration of the baseline as zero.

$$C - sink\ (Baseline)\ =\ 0\ tCO2e$$

1.4. Biochar carbon sinks

When plant biomass is burnt or decomposed, the assimilated carbon is released again in the form of CO_2. However, if the plant biomass is pyrolyzed, about half of the plant carbon is transformed into a mixture of predominantly very persistent carbon compounds that form a solid material known as biochar. While in the environment, any carbon compound is subject to degradation; for most components of biochar, this process is extremely slow, and mostly even so slow, that it is hard to measure for thousands of years. Provided that the biochar is not burned, the biochar carbon remains as a C-sink in the terrestrial system.

If biochar with an H to Corg ratio < 0.40 is applied to soil, a major part of its carbon is considered Persistent Aromatic Carbon (PAC, the portion of biochar carbon bound in clusters of more than seven aromatic rings as analyzed by the hydro pyrolysis method) and will constitute a carbon sink for several millennia. A minor though relevant part of the biochar-carbon is less persistent (semi persistent carbon, SPC) and likely to be microbially degraded within decades to centuries, presenting a mean residence time of 50 years. The biochar carbon that may be decomposed within the first 1000 years after the application to soil is called Semi-Persistent Carbon (SPC) and constitutes a temporary C-sink. For biochars presenting an H to Corg ratio < 0.4, the PAC fraction is conservatively fixed by the standard at 75% and the SPC fraction at 25%.

1.5. Project Boundary

All emissions occurring due to biomass sourcing, biochar production and application are accounted for and will be adequately offset by registered carbon sinks.

The project boundary covers all emissions associated with biomass sourcing, biochar production, processing, and application, and ensures that they are adequately offset by registered carbon sinks. The boundary accounts for Scope 1 and Scope 2 emissions, as well as relevant Scope 3 transport emissions, arising throughout the lifecycle of biochar used for the creation of a carbon sink (C-sink).

Security Margin for GHG Emissions

In artisan biochar production, a standardized security margin is applied to cover potential greenhouse gas (GHG) emissions from auxiliary or indirect activities. These include:

1. Biomass Sourcing – Transportation of biomass to the location where pyrolysis takes place
2. Emissions during Pyrolysis – Methane emissions that may occur during pyrolysis
3. Biochar processing and soil application – The distribution of biochar to farmers in the nearby areas for soil addition.

To maintain a lean certification process while ensuring environmental integrity, a margin of 20 kg CO_2e per ton of biochar (dry matter) is levied. This represents approximately 0.7% of the carbon contained in biochar and is widely accepted as an industry-standard buffer to account for uncertainties in the overall process.

$$Security\ Margin = Biochar\ produced\ (m^3) \times Bulk\ density\ (t/m^3) \times 0.02(t\ CO_2e\ per\ t\ biochar)$$

For example, if 1,000 m^3 of biochar is produced with a bulk density of 0.26 t/m^3, the security margin equals 5.2 t CO_2e. This margin must be deducted from the Permanent Atmospheric Carbon (PAC) fraction of the carbon sink before it can be registered and marketed, thereby ensuring that all possible minor emissions are conservatively accounted for.

1.6. Eligibility

- ☒ Production of biochar according to Global Artisan C-Sink conditions.
- ☒ Farmers and Artisan Biochar Producer are not certified under any other methodology for nature-based climate service (i.e. biomass production and soil organic carbon).
- ☒ Social Impact: Involved parties have to be compensated fairly and transparent.
- ☒ Project location: Project is located in low- or middle-income country according to the World Bank classification.
- ☒ Biochar production does not exceed 100m3/year for a single C-Sink Farmer or 1500m3/year for a single Artisan Pro and is done with a low-tech production unit.
- ☒ The C-sinks issued in this project are not claimed in any other Carbon Crediting Scheme.

S. No.	Eligibility	Rationale
1	Production of biochar according to Global Artisan C-Sink conditions.	Our artisanal biochar project adheres to the Global Artisan C-Sink (GACS) conditions for several compelling reasons: ● Sustainability: The GACS framework prioritizes the use of biomass feedstocks that wouldn't otherwise be utilized. This prevents competition with food production and discourages unsustainable land-use changes. ● Community Benefits: By focusing on small-scale production and local feedstocks, our project empowers local communities. GACS principles encourage the creation of new income streams for farmers and rural populations. ● Carbon Sequestration: The GACS methodology emphasizes practices that maximize carbon capture and storage in the produced biochar. This ensures the long-term effectiveness of our project in mitigating climate change. ● Transparency: GACS promotes robust monitoring, reporting, and verification (MRV) procedures. This transparency fosters trust with stakeholders and allows for an accurate assessment of the project's carbon removal potential. ● Scalability: The artisanal approach championed by GACS allows for a distributed production model. This enables us to replicate the project across various regions with minimal infrastructure requirements. ● Alignment with Carbon Standard International (CSI): Following GACS guidelines ensures our project aligns with the high standards set by CSI. This facilitates verification and allows us to generate tradable carbon credits, further incentivizing project sustainability. In conclusion, adhering to GACS conditions positions our artisanal biochar project for long-term success. It fosters environmental and social responsibility while contributing significantly to carbon sequestration efforts, all within the framework of a recognized and respected carbon standard.

2	Farmers and Artisan Biochar Producers are not certified under any other methodology for nature-based climate service (i.e. biomass production and soil organic carbon)	Artisan biochar producers under our project are not certified under any other methodology for nature-based climate services. This ensures, ● Preventing Double Counting ● Maintaining Additionality ● Streamlining Verification ● Focus on Biochar Expertise
3	Social Impact: Involved parties have to be compensated fairly and transparent	Our artisanal biochar project is committed to promoting social equity and poverty reduction through fair and transparent compensation practices. This extends to all involved parties, including our valued implementation partners, who play a critical role in feedstock collection. We have meticulously ensured that all personnel engaged in on-ground operations receive fair compensation, adhering strictly to the established regional and national labor laws. This commitment to transparency fosters trust with our partners and local communities, while also guaranteeing compliance with ethical sourcing standards. By prioritizing fair treatment and economic opportunity, we empower those involved and contribute to the long-term sustainability of the project. We pay for all the costs associated with biomass excavation, biochar production, and biochar application. This includes the cost of the Kon Tikki fabrication, biomass excavation and collection, salaries of all the ground personnel involved in the project, and transportation costs for biochar application. We conduct regular audits to ensure that all the local labor laws related to the work environment and compensation are followed at each production site. Moreover, we are also providing the majority of the biochar produced in the project for free to the farmers.
4	Project location: Project is located in a low- or middle-income country according to the World Bank classification.	Our project is located in India. As per World Bank classification, India is a low-income country.

5	Biochar production does not exceed 100m3/year for a single C-Sink Farmer or 1500m3/year for a single Artisan Pro and is done with a Low Tech Production Unit	We ensure our biochar production using low-tech production unit don’t exceed 1500m3/year for a single Artisan Pro.
6	The C-sinks issued in this project are not claimed in any other Carbon Crediting Scheme.	The C-sinks generated in this project are exclusively issued and are not claimed under any other Carbon Crediting Scheme.

1.7. Additionality

Without this project, Prosopis would remain a net emitter, either through natural decay, which releases CO_2 and methane, or through its traditional use as fuelwood, where it is burned, emitting all its stored carbon immediately. While government-led eradication programs, such as those by the Gujarat Ecology Commission (1995–2008) and the state forest department (2017), have attempted removal, they have not integrated carbon sequestration, nor have they effectively slowed Prosopis expansion. This project changes the carbon outcome by not only removing Prosopis but also permanently sequestering its carbon as biochar.

In the absence of the project, Prosopis is either left to spread or is harvested for fuel, regrowing within four years without leading to permanent carbon storage. In contrast, the project’s intervention results in an additional 4-6 tC/ha of permanent carbon removal, further reinforcing its additionality. Beyond removal, the project integrates technological innovation, financial sustainability, knowledge transfer, and community engagement to establish a permanent carbon sink. The introduction of Kon-Tiki technology in rural India enables efficient, low-emission biochar production, while comprehensive training programs equip local producers with the necessary skills. As biochar markets remain nascent, carbon finance is critical, as revenues from biochar sales alone cannot sustain the project (more details in section-financial additionality) . Additionally, by providing biochar-based fertilizers to farmers at no cost, the initiative eliminates financial barriers to its adoption.

The Government of India has exempted Prosopis from felling and transit restrictions, making its removal legally unrestricted. However, no subsidies, tax benefits, or policy incentives exist to support biochar production or carbon sequestration at this scale. Without carbon finance, Prosopis removal would continue without durable carbon storage, leading to either continued emissions from decay and burning or the unchecked spread of the species.

The Global Artisan C-Sink Standard provides both the monetary incentive and the technical knowledge transfer required to enable climate-positive biochar production. Varaha ClimateAg Pvt. Ltd ensures this by offering training not only in biochar production but also in the preparation and application of biochar-based fertilizers. In addition, Varaha helps cover biochar production costs upfront using revenue generated through carbon credit sales. This dual approach equips farmers to adopt the practice sustainably and prevents harmful, polluting methods of production that could otherwise result in greenhouse gas emissions. Furthermore, the methane compensation mechanism embedded in the Global Artisan C-Sink is a critical innovation for achieving net negative emissions with Kon-Tiki based biochar sinks.

How the Project Demonstrates Additionality: -

Technological Innovation

Historically, artisanal biochar production was constrained by the absence of accessible, low-emission technologies. By introducing Kon-Tiki kilns - efficient, user-friendly, and low-cost - the project overcomes this barrier, enabling smallholders to produce biochar sustainably without prior technical expertise. In addition, Varaha brings in its proven expertise in digital Monitoring, Reporting, and Verification (dMRV) systems. These systems use field-level digital tools to accurately track each aspect of production from biomass sourcing, production volumes, and carbon removal. This technological backbone ensures credibility, transparency, and verifiability of each and every carbon sink created under the project, addressing one of the most critical gaps in artisanal biochar initiatives globally.

Financial Additionality

Financial barriers have been the single greatest impediment to scaling artisanal biochar. The project addresses this through carbon finance rather than relying on biochar markets. Based on actuals, revenues from biochar sales amount to only about USD 85,000 against over 100,000 credits generated, which translates to less than USD 1 per credit. These figures clearly show that biochar sales are economically insignificant, and the project is almost entirely dependent on carbon credit revenues and climate financing to remain financially viable. This reliance firmly establishes the project’s financial additionality, as it could not exist without carbon market revenues.

Knowledge Transfer

The project seeks to close the longstanding skill gap by delivering tailored training programs through the Global Artisan C-Sink Manager. Rather than relying on fragmented knowledge transfer, the initiative builds a structured pathway for individuals to develop mastery over sustainable biochar production. Training begins with practical instruction on assessing feedstock conditions, including moisture readings. The program further introduces Monitoring, Reporting, and Verification (MRV) use cases, ensuring that artisans not only understand production but also how to capture, and communicate its impact for both community resilience and global carbon markets. To guarantee long-term continuity, every process is carefully documented through Standard Operating Procedures, which serve as both training material and practical reference. These procedures are disseminated through structured training sessions designed to balance hands-on practice with theoretical understanding, encouraging knowledge sharing at the community level.

Community Engagement

Community adoption is fostered through awareness-building and education campaigns that clearly communicate the agronomic, environmental, and financial benefits of biochar. By engaging farmers directly, the project cultivates buy-in and a sense of ownership, securing the long-term sustainability of the initiative. Importantly, the project also benefits surrounding communities by distributing biochar to nearby farmers for direct application to their soils. This not only improves soil fertility and water retention but also demonstrates tangible agronomic benefits, further strengthening local acceptance and support for the project.

Conclusion

By systematically dismantling the technological, financial, and social barriers that have historically hindered artisanal biochar production, the Carbon Sequestration and Grassland Restoration in India Project demonstrates clear additionality. The project generates a permanent and verifiable carbon sink through sustainable biochar production, while improving croplands, restoring grasslands, and enhancing rural livelihoods. Without carbon credit revenues, this model would be financially non-viable, making carbon financing the decisive enabler of climate-positive impact.

2. Ex-ante estimate of impact

The estimations are based on the dry matter amounts of biomass and the resulting biochar. The C-sink is calculated as the expected amounts of biochar multiplied by the expected carbon content.

The established temporary C-sinks are based on the SPC fraction (25%) of the biochar or the lifetime of the products where the biochar is applied to temporary matrixes (e.g. cement/concrete in buildings).

The established permanent C-sinks are based on the PAC fraction of the biochar (75%), when the biochar is applied to soils and has a H/C ratio below 0.4.

The ex-ante estimate is based on the following values:

- Yield factor (feedstock to biochar): 0.25 t biochar (DM)/t feedstock (DM)
- PAC Fraction: 0.75
- Security Margin: 0.02 (tCO2e/t biochar)
- Biochar yield (relation t biochar / t feedstock) : 0.25
- Carbon Ratio of biochar Produced from Prosopis: 0.84 (based on Test Report)

Year of operation	**Amount of feedstock (t DM)**	**Amount of biochar produced (t DM)**	**Established Temporary C-sinks (t CO2e)**	**Established Permanent C-sinks (t Co2 e)**
1	20000	5000	3850	11450
2	25000	6250	4813	14313
3	125000	31250	24063	71563
4	150000	37500	28875	85875
5	200000	50000	38500	114500

Sum		130000	100100	297700

- Yield factor (feedstock to biochar): 0.25 t biochar (DM)/t feedstock (DM)
- PAC Fraction: 0.75
- Security Margin: 0.02 (tCO2e/t biochar)
- Biochar yield (relation t biochar / t feedstock) : 0.25
- Carbon Ratio of biochar Produced from Cotton Stalk: 0.7847 (based on Test Report)

Year of operation	**Amount of feedstock (t DM)**	**Amount of biochar produced (t DM)**	**Established Temporary C-sinks (t CO2e)**	**Established Permanent C-sinks (t Co2 e)**
1	20000	5000	3575	10625
2	120000	30000	21450	63750
3	150000	37500	26813	79688
4	200000	50000	35750	106250
5	250000	62500	44688	132813
Sum		185000	132275	393125

3. Technology and business cases

3.1. Artisan Biochar Producer

An Artisan Pro is a registered company or part of a registered company. An Artisan Pro may have several production units and artisans that run these. Artisan Pro biochar is professionally produced by a company, an association, or an individual using all sorts of eligible biomass found within a radius of *30 km* from the production site. Artisan Pro biochar is not necessarily applied back to the fields where the biomass was grown but is mostly traded to other farms and industries. Artisan Pro biochar is produced at a registered production site with registered production equipment. It can be produced by several trained Artisan Biochar Producers (i.e., employees of the certified company), though they work at the same site with the same equipment. The maximum annual biochar production is 1500 m^3 per year.

The (sample) contract between the Global Artisan C-Sink Manager and Artisan Biochar Producers (Artisan Pro) was presented to the Certifier (Annex 7.2).

3.1.1. Training of Artisan Biochar Producer

In this project, Global Artisan C-Sink Manager (Varaha ClimateAg Pvt Ltd) ensures that the Artisan Biochar Producers are qualified to produce high-quality biochar with low emissions through an internal training protocol. The Artisan Biochar Producer follows a biochar production training given by a qualified trainer and prove their proficiency in an exam. The training includes principles of feedstock selection and biomass drying, the biochar kiln operation principles, the volume measurement of the produced biochar, a biochar sampling procedure, and the proficient use of the Artisan smartphone app Kalki.

The details of content, duration and learning goals (internal training protocol) were presented to Carbon Standards and the Certifier (Annex 7.3).

3.2. Feedstock

The Global Artisan C-Sink Managers ensures that the biochar is made from biomass feedstock that originated from invasive wood of Prosopis Juliflora and cotton stalks only In the project the following feedstocks are used which are in line with the following sustainability criteria:

1. Air Quality Improvement: Biochar production eliminates the need for open burning of crop residues, significantly reducing air pollution and associated health risks.

2. Soil Health Enhancement: Biochar application improves soil structure, enhances nutrient retention, and supports microbial activity, reversing the negative effects of burning and soil degradation.

3. Biodiversity Restoration: Removing invasive plants and converting them to biochar helps restore native ecosystems, allowing local flora and fauna to recover and thrive.

4. Economic Benefits: The biochar production process can create new economic opportunities for farmers and local communities, transforming agricultural waste into a valuable resource and providing additional income streams.

5. Climate Change Mitigation: Biochar sequesters carbon, reducing greenhouse gas emissions and contributing to climate change mitigation efforts. This aligns with broader environmental sustainability goals and carbon offset initiatives.

3.2.1. Origin of feedstocks:

Cotton Stalk:

Geographic Regions: Cotton is predominantly grown in the states of Maharashtra, Madhya Pradesh, Orissa, Gujarat, Andhra Pradesh, Telangana, Punjab, and Haryana.

Agricultural Context: India is one of the largest producers of cotton globally. After the cotton is harvested, significant amounts of stalks remain as residue in the fields.

Challenges: Traditionally, these stalks are either burned or left to decay, posing environmental and agricultural challenges. Utilizing cotton stalks for biochar production offers a sustainable alternative.

Prosopis Juliflora:

The invasive bush, Prosopis juliflora is a native of Central America and the Caribbean islands.
In the early 1970’s, the government sprayed Prosopis Juliflora seeds by helicopter in the Greater Desert and Banni area of Kutch to reduce land salinization and desertification. It

has had the opposite and much more severe effects on the environment and local livelihoods. It rapidly captured the various pastoral and farmlands across India, severely disrupting the land use ecosystem and biodiversity. The annual spread rate for Prosopis as per compound interest formula has been estimated as 1.2% during 1977–1990, 0.4% during 1990–1999, 0.6% during 1999–2005 and 2.1% during 2005–2011. Overall annual rate of spread for Prosopis was 1% for the last three and half decades. The rate of spread of Prosopis is increasing with each passing year. The feedstock for biochar production primarily consists of this invasive species. However, before the project, Prosopis Juliflora was not utilized sustainably. Instead, it posed a significant threat to the local ecosystem as it overtook indigenous grass species and disrupted biodiversity.

Geographic Regions: Prosopis is predominantly found in the states of Gujarat, Maharashtra, Rajasthan, Uttar Pradesh, Madhya Pradesh, Tamil Nadu and Karnataka.

3.2.2. Leakage

The project currently utilizes two feedstocks: Prosopis Juliflora and Cotton Stalk. For both feedstocks, a detailed leakage analysis has been conducted to assess potential counterfactual scenarios and calculate the associated risks of carbon and market leakage.

Prosopis Juliflora

Prosopis is an invasive tree species subject to ongoing eradication efforts by the governments of Gujarat and other Indian states(Link). For example, in Gujarat, the State Forest Department has announced plans to restore at least 76,000 hectares of the Banni grasslands by removing Prosopis (Link). At the federal level, the Ministry of Agriculture, Cooperation & Farmers Welfare has designated Prosopis as a tree species exempt from felling and transit regulations when growing on non-forest or private land. In Gujarat, Prosopis is commonly referred to as *"Ganda Baval"*(Link).

Despite these policies, government eradication efforts have historically been slow and fragmented. The Gujarat Ecology Commission initiated restoration programs between 1995 and 2008, and the more recent forest department interventions began in 2017 (Link, Link). Nevertheless, Prosopis infestation has continued to spread, with estimates suggesting that 43–50% of the Banni grasslands are now covered by this invasive species (Link, Link).

Given this history, the most relevant counterfactual scenario is that Prosopis would continue to spread across Gujarat's Banni grasslands and village-adjacent common lands, with some harvesting for local fuel use persisting.

Type of leakage	Risk	Climate impact	Social impact

Activity shifting	Prosopis continues to be harvested for fuel, but from areas that are farther from villages once the village-adjacent common lands have been restored to grassland	None - since Prosopis harvest for fuel (i.e. "lopping") is not mechanized, traveling further on foot to harvest Prosopis for fuel does not have a net climate impact.	Due to the Government of India's extensive promotion of the Pradhan Mantri Ujjwala Yojana (PMUY) scheme to provide LPG connections to the rural Communities (Link), burning wood and charcoal for household cooking has decreased significantly in rural areas. As a result, we assess the social impact of losing Prosopis as a fuel source to be very minor.
Market	Demand for substitute fuels go up once Prosopis is less readily available	The IPCC emissions factor (tC / TJ) of wood or charcoal combusted as fuel are the highest among any fuel source available to smallholders (Link). Any substitute fuel for Prosopis, such as the rapidly growing access to liquified petroleum gas (LPG) provided to rural areas through the Government of India's PMUY (Link) scheme, would have a lower emissions impact. Moreover, Reducing the particulate emissions from combustion of wood and charcoal (i.e. "black carbon") is one of the fastest, cheapest, and most impactful ways of cutting emissions, according to Project Drawdown (Link).	Varaha's model requires cooperation with Gram Sabhas, the grassroots level democratic institutions "empowered to decide the overall framework of forest conservation and management, keeping in view the interests of the forest dwelling communities," as established by the Forest Rights Act of 2006 (Link) Gram Sabha Approval is required before Varaha can eradicate Prosopis from village-adjacent common lands. Gram Sabhas agree to eradication because the restored grassland serves as a new source of fodder for village livestock to graze. Therefore, project activities only take place on common lands when villagers assess that the

			economic benefits via livestock (a key part of smallholder livelihoods), outweighs the loss of free fuel. Any substitution into cleaner-burning fuels also has positive impacts on respiratory health.

Varaha’s project model requires Gram Sabha approval before Prosopis removal from common lands. Villagers consent because restored grasslands provide valuable livestock fodder, directly supporting smallholder livelihoods. Thus, social benefits outweigh the minor loss of free fuel, which is increasingly substituted by LPG.

Long-Term Outlook: By combining community-driven Prosopis removal with biochar production, Varaha envisions restoring a substantial portion of invaded land back to biodiverse grasslands. This yields permanent carbon removal, improved fodder access, and a transition to cleaner fuels in rural households.

Cotton Stalk

Cotton stalk is the residual stem left after cotton harvest. Farmers typically uproot the stalks to clear their fields for the next planting season. On average, every hectare of cotton cultivation produces about three tons of cotton stalk residue.

Currently, the dominant disposal method is open-field burning. More than 95% in Maharashtra’s key cotton-growing districts, is burned annually. This persists due to limited farmer awareness, weak collection infrastructure, lack of alternative markets, and insufficient policy interventions.

Varaha conducted a survey of over 300 farmers across two states and seven districts covering five growing seasons (2020–2024). The survey revealed that 95–100% of farmers consistently burned their cotton stalks (Link to survey results).

Counterfactual vs. Project Scenario

Counterfactual (Business-as-Usual): Farmers continue burning cotton stalks in their fields, releasing approximately 850 kg CO_2e per ton of stalk burned (Tandon & Sundaramoorthy, 2010).

Project Scenario: The stalks are instead converted into biochar, sequestering around 715 kg CO_2e per ton of stalk.

Leakage Considerations

- Cotton stalk is a waste product with no significant industrial or domestic fuel use.
- With LPG access via PMUY, rural households do not rely on cotton stalks for cooking fuel.
- Cotton-growing districts lack major energy-intensive industries capable of consuming cotton stalk biomass.
- Due to its low bulk density, transporting cotton stalks to potential industrial markets is financially unviable.
- Accordingly, there is no material risk of market leakage from diverting cotton stalks into biochar production.

Conclusion

Both feedstocks used in this project — Prosopis Juliflora and Cotton Stalk — are demonstrably additional. Prosopis removal contributes to invasive species management and grassland restoration while avoiding fuelwood leakage risks. Cotton stalk utilization prevents open-field burning, conserves carbon, and creates permanent sequestration through biochar without displacing existing uses. In both cases, the project delivers significant climate, environmental, and community co-benefits alongside robust carbon removal.

3.2.3. Methane emission during storage of biomass

To avoid methane emissions during storage of biomass the following measures are taken:

S. No.	Condition	Rationale
1	The feedstock must not be used from freshly cut or from a feedstock pile where it rained upon.	Dried feedstock with moisture =<15% is used for Biochar production and to ensure that moisture meter is also kept at the production site which helps to decide feedstock moisture level. 

2	Feedstock needs to be stored airy and protected from rain.	While storing the feedstock, precautions are taken such as the storage place should be airy and the feedstock should not get exposed to the rain in case it occurs.
3	To avoid methane emissions from feedstock storage, wet feedstock must not be piled higher than a meter. Otherwise, the humid feedstock will self-heat, consume the oxygen inside the pile and decompose anaerobically, which produces significant amounts of methane.	To avoid methane emissions from feedstock storage, feedstock is dried on the land where it was uprooted and left to dry until wood moisture gets to 15% or lower. It helps to avoid methane emissions from storage. While piling up the feedstock, it is not piled higher than one meter to ensure air circulation and avoid anaerobic conditions which can produce methane potentially. 
4.	When feedstock gets exposed again to rain, a new period of at least three days of thinly layered sun drying has to start.	In case Feedstock gets exposed to rain, as per SOP set at Artisan Producers level, it is sundried for at least three days to cut down moisture trapped in feedstock and it is used for processing only after checking the moisture of feedstock with Moisture meter
5	Humidity and Moisture level in the Feedstock	To ensure high-quality biochar production and compliance with project standards, Varaha follows a strict feedstock moisture protocol: 1. **Sampling and Measurement** From every batch, a representative piece of wood log is selected. Its moisture content is measured using a calibrated digital moisture meter to ensure accuracy and consistency.

2. **Verification and Recordkeeping**
   A geotagged and timestamped image of the measurement is captured and uploaded to the Varaha app. This creates a verifiable digital record of the feedstock condition for each batch.

3. **Moisture Thresholds**
   Only batches with a moisture content of **15% or lower** are permitted for biochar production.

This protocol ensures that all feedstock used in Kon-Tiki kilns meets stringent quality standards, while also building digital transparency into the monitoring system. Through this process, Artisan Biochar Producers not only learn how to check feedstock moisture but also actively participate in a verifiable monitoring framework that reinforces the project's credibility.

Moisture-content readings plus timestamped, geotagged photos of the moisture meter-inserted in the biomass sample for each batch are added to the monitoring report Annexure for auditor's verification as well.

3.3. Production unit

Biochar is produced via pyrolysis technology. Pyrolysis means the thermo-chemical decomposition of the feedstock under the exclusion of oxygen.

By converting sustainable biomass into biochar by pyrolysis, a long-term carbon reservoir is created. The produced biochar poses a potential of C-sink (C-sink potential). It could still be burned. By safety measures, such as marketing and labeling the biochar with the aim of becoming a C-sink and monitoring all distribution channels in a digital Measurement, Reporting, and Verification tool (dMRV), it is ensured in the best possible way, that the biochar is used to form a C-sink. C-sink certificates are only issued for those parts of the biochar for which it can be proven that they have been put in a matrix. Without the project, no C-sink would be created, as non-pyrolytic biomass does not ensure persistent carbon storage. The produced biochar is certified under the Global Artisan C-Sink standard, what guarantees that the biomass feedstock is sustainably procured and produced, biochar fulfills the analytical threshold values, so no damage is caused to the environment, emissions limits of the pyrolysis unit are adhered to, and storage procedures are environmentally sound. The biochar production follows the Global Artisan C-Sink standard, which ensures:

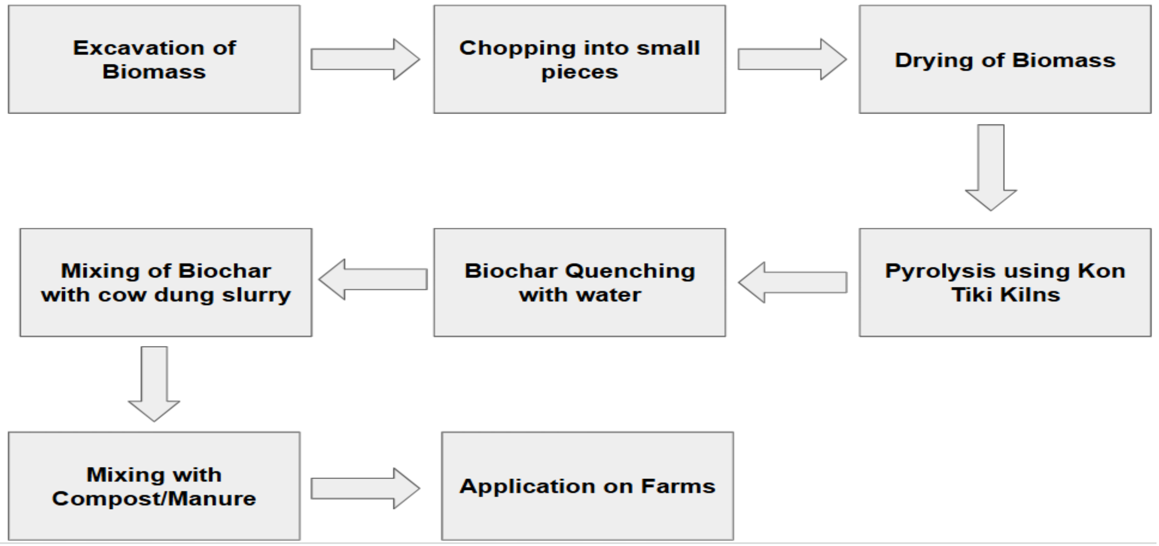
- Only trained Artisan Biochar Producer are allowed to produce biochar
- Minimization of risks on human health, social and environmental impacts
- No forest wood and slash of forest trees are permitted as feedstock

Description of the pyrolysis unit, i.e. Kontiki

Flame Curtain Pyrolysis (the Kon-Tiki method)

The principle of flame curtain pyrolysis consists of pyrolyzing biomass layer by layer in a conically-, polygonal-, rectangular-, or cylindrical-formed metal, concrete, or soil kiln.
A fire is started in the kiln, and the 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 flame curtain 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 up the fresh biomass layer, which starts to pyrolyze.
The biochar below the upper pyrolysis layer is shielded 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 metal kiln or soil pit is filled.
The pyrolysis process is then actively ended by quenching with water or a nutrient solution (e.g., diluted urine, dissolved fertilizer) which is fed into the kiln from below if possible or, where water is not easily available, by snuffing with a layer of soil.

3.3.1. Example of biochar production flowchart



3.4. Suitability of Artisan Biochar for Agriculture

Based on the Global Artisan C-Sink standard, Kon-Tiki and TLUD biochar was extensively analyzed following the EBC and WBC analytical requirements. All biochar that was produced from eligible feedstock with the Artisan endorsed technologies fulfilled all requirements of EBC and WBC certification. PAHs and other potential contaminants were found with generally low contents that allowed in all cases the certification as WBC-Agro. As PAH contents of biochar are mainly technology dependent and generally low in Kon-Tiki and TLUD biochars, the Global Artisan C-Sink standard does not require its regular analysis. Meeting the PAH thresholds is covered by the pyrolysis-type accreditation of the *Kon-Tiki.* Therefore, biochar produced under the Artisan Standard are suitable for agricultural uses as they fulfill all requirements of WBC-Agro.

The sampling plan was presented to Carbon Standards International (Annex 7.4).

3.5. Application and trade of biochar

The following applications are possible for this project:

- Geological C-sink (biochar applied to soil)

The majority (>90%) of the biochar produced under this project is distributed free of cost to farmers within the same villages where production takes place, ensuring immediate local benefit and soil health improvement.

- Prosopis Sites: Biochar is provided to farmers within the same village where it is produced that within the project (artisan pro) boundary.
- Cotton Stalk Sites: Biochar is returned specifically to the same farmers who supplied the feedstock biomass.

Varaha's digital MRV (d-MRV) system guarantees full traceability of biochar application through geotagged, time-stamped photos, farmer distribution logs, and written records.

1. On-site mixing with geotagged proof

(a) Each artisan producer mixes biochar with fresh cow dung in a 1:1 ratio before leaving the site.

(b) The mixing process is fully documented with geotagged, time-stamped photos uploaded immediately to Varaha's d-MRV app.

(c) Because the amendment cannot be reversed, there is no risk of reversal after this step.

3.6. Methane emissions compensation

Compensation of methane emissions by growing additional biomass

To compensate methane emissions, the Varaha will ensure the plantation of trees is according to Global Tree C-Sink Standard. The project is developed to create agroforestry on annual and perennial crop land, re- and afforestation.

Note- Varaha has already planted the trees to offset the methane emissions generated by the project but right now we are in the project getting these plantations registered on the Global Tree C-sink.

The local tree species are evaluated for their cooling potential and a comprehensive plantation plan is devised with the local NGO partners and implemented parallel to the production Activity. The plantations are done in community-protected areas where there is strong oversight from the government authorities against deforestation. We will also be monitoring the plantations using Varaha's remote sensing models that have been developed for the other projects. Also, the areas from where the Prosopis Juliflora is removed shows recovery of good biomass generation in the form of grasses as the grasses now get the opportunity to grow well in absence of the invasive wood.

For the biochar that we have produced 46,000 tons, based on the CSI methodology, we have done 1366 tons of methane emission, we are required to plant 59,582 trees as per the methane calculation toon instead, we have already planted 1,92,184 trees in 2024 and are planning to plant an additional 50,000 trees in 2025.

The assumed values and the basis for the calculation were presented to the certifier (Annex 7.5).

Offsetting methane emissions with the SPC-fraction of biochar

The global warming effect of methane emissions caused by a Kon-Tiki can at least partly be offset by the global cooling effect of the first 20 years of the SPC fraction. To calculate it correctly, the annual global cooling of the SPC for each of the first 20 years must be summed-up and match the GWP100 of the CH_4 emission to be compensated.

Varaha would be utilizing the corresponding SPC credits corresponding to each prosopis and cotton stalk based biochar C-sink to offset the methane emission generated during the biochar production.

As mandated by the Methodology the amount of methane emission per ton biochar is 30 kg

Emission per ton Biochar = 30 kg CH4
- 1 t CH4 = 1270 t ACO2 of AGWP
- 1 t CO2e CINK20 = 20 t ACO2 AGWP = 20 t ACO2 AGCP
- 1 t CH4 = 63.5 t CO2e CINK20
- 30 kg CH4 = 1.9 t CO2e CINK20

Calculation for Prosopis Juliflora –

- Carbon Content in Biochar= 84%
- Total Biochar Carbon in t CO2e= 3.08
- AGCP(20) of SPC in t ACO2e : 8.9
- Methane emissions compensable with SPC : 23% | 0.01 t CH4

Calculation for Cotton Stalk–

- Carbon Content in Biochar= 78.47%
- Total Biochar Carbon in t CO2e= 2.88
- AGCP(20) of SPC in t ACO2e : 8.2
- Methane emissions compensable with SPC : 22% | 0.01 t CH4

For the Remaining 77% emission we are registering a project under the global tree C - sink.

Till date the project has retired 12,315.076 Tons CINK 20 equivalent to 193.938 Tons of CH4 emissions (Retirement Certificates for the same can be found in Annex 7.6).

The assumed values and the basis for the calculation were presented to the certifier (Annex 7.6).

Compensation of methane emissions by avoiding GHG-emissions from burning crop residues

The baseline scenario for cotton stalk biomass utilized by the project is open burning, as detailed in Section 3.2.2 (Leakage) and Section 1.3 (Baseline Scenarios) of the PDD. Under this baseline, methane emissions from open burning are higher than the methane emissions generated during biochar production in Kon-Tiki kilns.

This would allow the project to demonstrate that methane emissions are offset through the avoided emissions pathway (i.e., preventing open burning). However, in order to adopt the most conservative approach, the project has decided not to use this avoided emissions pathway for methane compensation. Instead, the project will offset all methane emissions through a combination of SPC credit retirement and additional biomass plantations.

Note - To study the moisture content in the feedstock and GHG emissions during pyrolysis, Varaha conducted two studies, one in collaboration with the Indian Institute of Technology (IIT) Bombay and one independently, where it was established that the methane emissions from a tonne of biochar produced were well below the 30 kg Methane Emission Factor . (IIT Bombay Study) (Independent Study). *The figure of 30 kg* CH_4 *per ton of biochar, based on Kon-Tiki kilns, represents the highest possible value and is conservative for our case.*

3.7. digital Monitoring, Reporting and Verification (dMRV)

Technically, the C-Sink Artisan certification procedure is based on a digital monitoring, reporting, and verification (dMRV) tool, which is usually a dedicated smartphone application.

In this project, Varaha's dMRV system KALKI, endorsed by Carbon Standards will be used to fulfil the requirements of the Global Artisan C-Sink Standard. Our detailed D-MRV documentation can be accessed using this document (Annex 7.10)

3.8. Planned business development

You can access our business development and scale-up plan document through the following document (Annex 7.12)

3.9. Internal Control System

A blueprint of an Internal Control System (ICS) was presented to the Certifier (Annex 7.7).

4. Determination of C-sink

4.1. Monitoring

All data that is required to calculate the C-sink is entered into our dMRV System named KALKI which was developed by Varaha Climate Ag Pvt ltd. Our dMRV is endorsed by CSI, refer certificate (Annex 7.10)

The data will be monitored as mentioned below.

4.1.1. General data

Parameter	**Monitoring frequency**	**Source of data**
Artisan Biochar Producer Registration	per registration cycle	Annex 7.1
Proof of successful participation in an artisan biochar workshop	per registration cycle	Annex 7.13
Producers list	per registration cycle	Annex 7.1

H/Corg ratio	per artisan pro per year	Annex 7.14
C-content of biochar	per artisan pro per year	Annex 7.14
Bulk density of biochar	per artisan pro per 500 m3 of volume	Annex 7.10
Feedstock preparation	per feedstock type	Annex 7.10
Documentation of technology used	per Artisan Biochar Producer	Annex 7.10
Volume measuring device	per Load	Annex 7.10

The following general data will be monitored:

Definition of a production load	per production unit type	Annex 7.10

The following general conversion rates are fixed ex-ante:

Parameter	**Ex-ante definition; value**	**Source of data**
CO_2 emissions from diesel	2.7 kg CO_2eq / l diesel	Methodology, Juhrich, 2016
CO_2 emissions from heavy fuel	65 t CO_2eq / TJ	Methodology, Juhrich, 2016

4.1.2. Artisan Biochar Production

Parameter	Monitoring frequency	Source of data
Annual on-site inspection	per year	Annex 7.10
Feedstock type	per load	Annex 7.10
Moisture content of feedstock	per load	Annex 7.10
Total amount of feedstock (dry matter) used for the load	per load	Annex 7.10
Average feedstock size	per load	Annex 7.10
Location of production unit	per load	Annex 7.10
Registration of each biochar production load	per load	Annex 7.10
Amount of biochar produced	per load	Annex 7.10
Proof of retention sample	per load	Annex 7.10
Documentation of biochar mixing to matrix	per load	Annex 7.10
Amount of volume applied to each matrix	per load	Annex 7.10
Receiver address/location when biochar (mix) is sold	per trade	Annex 7.10

4.1.3. Compensation of Fossil Emissions

All fossil CO_2 emissions are offset by long-term carbon sinks before the registration of a biochar C-sink is validated in the Global C-Sink Registry.
CO_2 is only offset with geological C-sinks, such as the persistent aromatic carbon (PAC) fraction of soil-applied biochar, that are registered in the Global C-Sink Registry.
The emission offsets are realized with the registered permanent biochar C-sink whose production had caused the emission.

Parameter	Monitoring frequency	Source of data
Proof of compensation	annually	Global C-Sink Registry

4.1.4. Production unit

☒	The production unit used in the project has a system certification, see system endorsement.

	Pyrolysis system Kon-tiki/Soil pit is accredited by Carbon Standards. The maximum methane emission for Kon-tiki/Soil pit is known to be 30 kg CH_4/t DM biochar produced.

Accordingly, ex-ante definition of the following parameter:

Parameter	**Ex-ante definition; value**	**Source of data**
[CH_4_emissions_pyrolysis]	30 kg CH_4/t DM biochar	Global Artisan C-Sink Standard Version 2.1A

4.1.5. Compensation of methane emissions

Methane compensation is defined as creating a carbon sink for 20 years that has a climate cooling effect equal to the climate warming effect of a methane emission over 100 years after the emission occurred. Thus, the total climate forcing of a methane emission is compensated within 20 years after the initial emission.

Parameter	**Monitoring frequency**	**Source of data**
Proof of compensation	per C-Sink Unit	Annex 7.5 & 7.6

4.1.6. Margin of Security

For this project, the emissions based on the system boundaries are accounted for.
To also address GHG emissions caused by activities not tracked in detail, a *Margin of Security* is applied.

This includes, for example, the emissions caused by:
- the fuel for transportation of the biomass feedstock to the kiln,
- or the transportation of the biochar to the field (up to 100 km),
- the displacement of the kiln
- a pump for quenching water
- fuel for a chain saw for pruning, milling, and blending of the biochar

$$[Margin\ of\ Security] = [produced\ biochar\ (t)] * 0.02\ (t\ CO2e\ per\ ton\ of\ biochar)$$

4.1.7. Methane emissions

During biomass storage and pyrolysis process methane emissions are produced. They are calculated according to the following formula:

$$\begin{aligned}[Total\ methane\ emissions] \\ &= [Feedstock\ storage\ emissions\ per\ batch] \\ &+ [CH4\ emissions\ from\ pyrolysis\ of\ entire\ batch]\end{aligned}$$

4.1.7.1. Methane emissions from the storage of biomass

If methane emissions are negligible according to Section 3.2.3 **Error! Reference source not found.**: 0 tCH_4

4.1.7.2. Methane emissions from production unit

Emissions are calculated in **kg CH_4.**

$$[CH4\ emissions\ from\ production\ unit\ per\ load] = [CH4\ {emissions}_{pyrolysis}] *\ [amount\ of\ biochar\ dry\ matter]$$

4.1.7.3. Compensation of the methane emissions

The AGWP_CH4(100) must then be compensated by a same-sized absolute global cooling potential (AGCP) over a maximum of 20 years. The compensating global cooling starts in the same year as the CH_4 emission occurred, provide annual global cooling in every following year, and finalize the compensation latest 20 years after the methane emission.

In order to claim that methane emissions where compensated it must be proven that

$[AGCP(20)] \geq [AGWP\_CH4(100)]$.

4.1.7.4. Absolut Global Warming Potential of methane emissions

The Absolute Global Warming Potential of the methane emissions are calculated based on:

$$AGWP\_CH4(100)\ = \sum_{t=0}^{99} (IRF\left(CO_{2,a}(t)\right) *\ [CO_2e\ of\ CH_4\ emissions\ per\ load]\ )$$

To calculate the *Absolute Global Warming Potential (AGWP)* over 100 years we are using Jeltsch-Thömmes & Joos (2019)[1] to calculate the decay of the CO_2. Greenhouse gases decay in the atmosphere. The quantities of CO_2 still present in the atmosphere each year are added up over the 100 years, resulting in the absolute global warming potential (AGWP) over 100 years.

The decay is described by the equation:

$$\left[IRF(CO_{2,a}(t))\right] = a_0 + \sum_{i=1}^{5} a_i * \exp\left(\frac{-t}{\tau_i}\right) for\ t \geq 0$$

With the values

i	**ai**	**ti**
0	0.008	
1	0.044	68521
2	0.112	5312
3	0.224	362
4	0.31	47
5	0.297	6

---

[1] Jeltsch-Thömmes, A., Joos, F., 2019. The response to pulse-like perturbations in atmospheric carbon and carbon isotopes 1–36.

The resulting methane emissions of the produced biochar are calculated as below, with the GWP100 (CH_4) value of 25 CO_2e.

$$[CO_2e\ of\ CH_4\ emissions\ per\ load] = [Total\ methane\ emissions] * [GWP100_{CH4}]$$

4.1.7.5. Absolut Global Cooling Potential of SPC fraction

The Absolut Global Cooling Potential (AGCP) of the SPC for the first 20 years is calculated as follow:

$$[AGCP(20)] = \sum_{t=0}^{20} (C_{remain}(t, SPC) * \ IRF(CO_{2,a}(t) * M_{biochar} * C_{content})$$

With:

C_{remain} (t, SPC) as the adjusted equation 2 of Global Artisan C-Sink Standard for the SPC fraction of the biochar (25%)

$$[C_{remain}(t, SPC)] = \frac{1}{1000} * (750 + 45 * \ e^{-0.5232*t} + 205 * \ e^{-\ 0.009966*t}) - 0.75$$

4.1.8. Calculation of leakage emissions

The leakage emissions are calculated based on the results of the assessment in chapter 3.2.2.

$$\boxed{[Leakage\ emissions] = 0\ tCO2e * \ [amount\ of\ biomass\ dry\ matter\ (batch)]}$$

5. Registration of C-sink

Biochar carbon sinks is registered with the geo-localized area where the biochar or its derived products have been applied.
In certain specific instances where marginal quantities of biochar are applied or utilized in products, the registration of so-called diffuse carbon sinks (i.e., non-geo-localized) is permitted.

The following information are registered for biochar carbon sink:

1. Feedstock of biochar production
2. Technology of production
3. Date or period of production
4. C-content and H/C ratio of biochar (Tested via a CSI Accredited Laboratory; The Carbon content is always greater than 75%)
5. Matrix into which the biochar was mixed (compost, manure, feed, cement etc.)
6. Location of the C-sink (vector file of field location; for fields < than 1000 m2 one GPS point per field is sufficient, for C-Sink Networks and C-Sink Villages only the vector file of the network and village, respectively, is needed)
7. Amount of biochar applied in tons (dry matter tons)
8. Date of application
9. Owner of the C-sink site (name, address, birth date – not necessary for C-Sink Network and C-Sink Village)
10. C-sink project design document
11. Validation report of the validation body
12. Verification report of the verification body
13. Monitoring plan of the operation
14. Confirmation of the compensation of the emission portfolio of the biochar

5.1. Calculation of C -sink

The C-sink is registered in the Global C-sink Registry.

Based on the Global Artisan C-Sink standard, the calculation of the carbon for C-sink at day of application is:

$$[Carbon\ for\ C - sink\ (kg\ C)] = [dry\ mass\ of\ biochar\ applied\ (kg)] * [Carbon\ content\ (\%)]$$

However, every biochar C-sink underlies a time-dependent evolution, and the C-sink is a measure of the mass of carbon that is physically present in the C-sink matrix at any given moment in time since the establishment of the C-sink. The size of a biochar C-sink is, thus, a function of the type of biochar determining its specific persistence in a specific C-sink matrix and the time since the application to the C-sink matrix.

$$C - sink(year) = C - sink(year = 0) * specific\ persistence\ (year)$$

5.1.1. Geological C-sink

According to the Global Artisan C-Sink standard, Biochar made in a Kon-Tiki reach highest treatment temperatures above 650°C and present an H/Corg ratio well below 0.4, indicating a PAC fraction of at least 75% when applied to soil. Certified artisan biochar is, therefore, registered with a PAC-fraction of 75% and SPC fraction of 25% in the Global C-Sink Registry.

The remaining carbon for soil-applied biochar is calculated with the following conservative approximation:

$$C_{remain}(years) = \frac{M_{BC} * C_{Content}}{1000} * (750 + 45 * \ e^{-0.5232 * years\ of\ decay} + 205 * \ years\ of\ decay)$$

For the compensation of the GHG emissions within the system boundaries, only the PAC fraction is used.

6. Public consultation

During public consultation the following comments were raised:

Comment	**Was comment taken into account (Yes/ No)?**	**Explanation/ justification (Why? How?)**
How biochar production from Prosopis species will benefit the community.	yes	Enhancing Biodiversity and Livelihoods: Grassland Restoration: The project addresses the ecological challenge of invasive Prosopis Juliflora by facilitating its removal. This targeted approach allows for the restoration of the natural Banni grassland ecosystem, promoting biodiversity and fostering a healthier environment. Regenerative Biochar Application: The biochar produced from the removed Prosopis is then strategically applied to the restored land. This application acts as a soil amendment, enhancing soil fertility and promoting the regeneration of native grasses. This enriches the ecosystem and creates a more sustainable foundation for the grassland. Community Empowerment: The entire process, from Prosopis removal to biochar production and application, actively engages local communities. This creates employment opportunities, empowers local residents, and fosters a sense of ownership in the project's success.
How biochar is different from the coal they are producing conventionally	yes	Sustainable Carbon Sequestration: Biochar production utilizes the pyrolysis method within kilns. This process minimizes emissions compared to traditional burning methods. The resulting biochar acts as a stable form of carbon that is then incorporated back into the soil. This approach effectively sequesters carbon in a long-term and beneficial way,

		promoting a more sustainable carbon cycle.

We have conducted public consultations and training at all the Artisan Pro locations pictures and videos of these trainings can be found in this document (Annex 7.3)

7. Annexes

Please submit the annexes in a separate folder and adjust the numbering accordingly.

7.1. Producer lists and GPS coordinates
7.2. Sample contract between Artisan C-Sink Manager and Artisan Biochar Producer (Make sure to add the clause of the ownership/ transfer of the C-Sink)
7.3. Internal training protocol
7.4. Sampling Plan
7.5. Additional information on methane compensation through growing additional biomass/ Certificate as Tree C-Sink Manager.
7.6. Screenshot of SPC online calculator with description and explanation.
7.7. Blueprint of the Internal Control System (ICS)
7.8. Template Internal Inspection Report
7.9. Social responsibility declaration
7.10. Varaha DMRV
7.11. Grassland Restoration Plan
7.12. Scale up plan
7.13. Training Video Sample
7.14. Biochar lab reports (These are the lab reports for 120 Artisan Pros, we will keep adding the new ones here as they come)