REGENERATIVE AGRICULTURE IN RICE-WHEAT-MAIZE SYSTEM FOR INCOME GENERATION

Document Prepared by
Grow Indigo Pvt. Ltd.

Project Title	Regenerative agriculture in Rice-Wheat-Maize system for income generation
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1. PROJECT DETAILS

1.1. Summary Description of the Project

About 16% of the greenhouse gas (GHG) emissions in India come from agricultural activities.[1] The Rice-Wheat cropping system, prevalent across North-West India in the states of Punjab and Haryana, represents a substantial segment of the national food supply and occupies over four million hectares. Rice is planted in May/June rainy season and followed by wheat in the winter. Other crops which are also planted in these areas with Rice-Wheat systems are Maize, chickpea and other legumes. Unsustainable agriculture practices have led to rapid degradation of soil, water, and air quality. Prior to project implementation conventional agricultural practices such as flooded transplanted rice, intensive tillage, and crop residue burning, were practiced in the project area.

This project focuses on the adoption of regenerative agricultural practices such as reduced tillage *(ZT***)* and direct seeding of rice (DSR), which are proven to enhance soil carbon stocks, reduce methane emissions, and reduce water usage. Barriers to adoption of these practices, such as lack of incentives, information and knowledge gaps are addressed by the project proponent's comprehensive field support system. The field advisors play a critical role, providing continuous education and agronomic support to equip farmers with the necessary tools and knowledge. Project proponent has also developed multiple digital and social outreach tools to educate and share knowledge about carbon farming.

The initiative is structured as a grouped project and aims to reduce GHG emissions by an estimated 4,267,622 tons of CO_2e annually over a 20-year project crediting period. The initial instance of the project covers the first monitoring period from 06-May-2019 to 31-May-2022. It involves 3,324 fields, covering a total area of 11,636.1 hectares that have transitioned to regenerative practices. By implementing regenerative agriculture practices, such as Direct Seeded Rice and Reduced Tillage through the project, a total 57,463.83 tCO_2e of net GHG emission reduction has been achieved in the current monitoring period.

To implement the project effectively, the project proponent (PP) utilizes an array of science-based monitoring and quantification tools. This includes remote sensing capabilities for monitoring of agricultural practices and biogeochemical modeling for accurate quantification of GHG emissions and soil carbon stocks analysis. Additionally, the project employs tech-enabled data collection tools to enhance the accuracy, scalability and efficiency of data gathering processes, ensuring robust and reliable, information management throughout the project's lifecycle.

This is a 'first-of-a-kind project in India, offering smallholder farmers significant financial incentives through voluntary carbon markets. With 75% of the proceeds to the farmers, the financial model of the project ensures the continued commitment of participating farmers. Thus, beyond enhancing the overall climate impact, this approach also secures economic benefits and livelihood of the smallholder farming community.

[1] MoEFCC, I., 2018. Second Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Government of India, 3

***ZT is a representation of reduced tillage practice. Please read ZT as reduced tillage only, in all the project documents.

Audit Type	Period	Program	VVB Name	Number of years
Joint Validation and Verification	(06-May-2019—31-May-2022)	VCS - 2590 Regenerative agriculture in Rice-Wheat-Maize system for income generation	Earthood Services Pvt. Ltd.	Three years
Total	One	One	One	Three years

1.2. Sectoral Scope and Project Type

The project is under the sectoral scope 14 - Agriculture, Forestry, and other land use (AFOLU)-Agriculture Land Management (ALM) category. The project has been designed as a grouped project to include multiple project activity instances (PAI). An individual field in the Project adopting a set of regenerative agricultural activities is considered a "project activity instance," and all reports are made on a field basis with the support of project-level assessments.

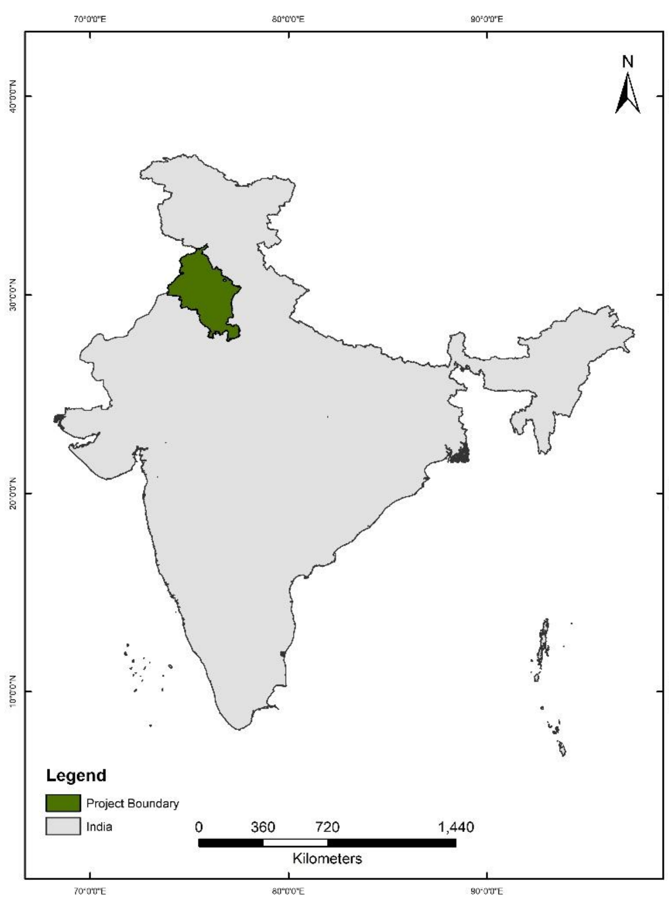

Figure 1: Project area shown on the map of India.

1.3. Project Eligibility

The Project includes eligible ALM activities such as reduced tillage in wheat and improved water management through direct seeding of rice, The project employs y VM0042 "Methodology for Improved Agricultural Land Management Version 1.0" and all relevant associated tools, modules, and guidelines, approved under the VCS Program. The project is aimed at increasing soil organic carbon (SOC) storage, and reducing net emissions of CO_2, CH_4, and N_2O through regenerative agricultural practices, and meets all VCS program criteria for GHG emission reductions and removals. The area included in the project has not been cleared of native ecosystems within the 10-year period prior to the project start date and is a voluntary carbon project that would achieve emissions reduction and/or removals. The project is in compliance with the criteria listed in section 2.1.1 of the VCS standard, v4.5 as outlined below:

1) **Criteria:** The seven Kyoto Protocol GHGs.

   Compliance Status: Yes

   Justification: The project results in the reduction of different GHGs such as N_2O, CO_2, and CH_4 from soil methanogenesis and reduced tillage.

2) **Criteria:** Ozone-depleting substances (ODS).

   Compliance Status: Not Applicable (NA)

   Justification: The project activity does not involve ODS emission.

3) **Criteria**: Project activities are supported by methodology approved under the VCS Program through the methodology development and review process.

   Compliance Status: Yes

   Justification: The project activities fall under the VM0042 methodology for Improved Agricultural Land Management v1.0 which quantifies the GHG emission reduction and SOC resulting from the adoption of improved ALM practices.

4) **Criteria**: Project activities are supported by a methodology approved under an approved GHG program, unless explicitly excluded (see the Verra website for exclusions).

   Compliance Status: Yes

   Justification: The project activities do not belong to any project categories that are excluded by VCS from being part of the VCS program.

5) **Criteria**: Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements.

   Compliance Status: Not Applicable (NA)

   Justification: This is not a Jurisdictional REDD+ program. Hence, this eligibility criterion is not applicable.

The project is eligible under the scope of the VCS Program as the project includes AFOLU activities (project category ALM) which is supported by an approved methodology VM0042: Methodology for Improved Agricultural Land Management (ALM) v1.0. The project activities do not generate GHG emissions primarily for the purpose of their subsequent reduction, removal, or destruction. Hence, the project meets the criteria set out in section 2.1.2 of VCS standard v4.5 and is applicable under the scope of the VCS Program. Additionally, the project does not fall under any of the categories of excluded projects specified in table 4 of the VCS Standard v4.5 section 2.1.3 and is therefore eligible under the scope of the VCS Program.

The project establishes consistency with section 3.1 of the VCS standard v4.5 and thus fulfils certain high-level requirements given in the standard as outlined below:

1. **Criteria:** Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1.

   Compliance Status: Yes

   Justification: This Project meets all applicable rules and requirements set out under the VCS Program, including the VCS standard v4.5. This Project is guided by the principles set out in Section 2.2.1 of the VCS standard.

2. **Criteria:** Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.14.1. The list of methodologies and their validity periods is available on the Verra website.

   Compliance Status: Yes

   Justification: The Project applies the approved methodology VM0042: Methodology for Improved Agricultural Land Management (ALM) v1.0, including the full application of any tools or modules referred to by the methodology, eligible under the VCS Program.

3. **Criteria:** Projects shall apply the latest version of the applicable methodology in all cases unless a grace period applies to the project as set out in 3.22 below. Projects shall update to the latest version of the methodology when reassessing the baseline or renewing a crediting period.

   Compliance Status: Yes

   Justification: The Project applies the applicable methodology i.e. VM0042 v1.0. As per section 3.22 of the VCS standard, where a methodology is revised, project proponents may apply the grace period criteria. The Project shall update to the latest version of the methodology when reassessing the baseline or renewing a crediting period.

4. **Criteria:** Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.

   Compliance Status: Yes

   Justification: The Project and the implementation of project activities does not lead to the violation of any applicable law, regardless of whether or not the law is enforced.

5. **Criteria:** Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program Definitions for the definition of model), the model shall meet the requirements set out in the VCS Methodology Requirements, and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or carbon dioxide removals).

   Compliance Status: Yes

   Justification: The project proponent has used DNDC model for quantification of GHG ERRs. The applied model meets the requirements set out in the VCS Methodology Requirements, and it was demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model leads to an appropriate quantification of GHG emission reductions or carbon dioxide removals). DNDC is one of the few models which has been rigorously tested in the rice ecosystem and thus the most appropriate model for this project. DNDC model is available free for research use and for commercial use a license is needed. PP has obtained an exclusive license for use of the model in the geography.

6. **Criteria:** Where projects apply methodologies that permit the project proponent to choose a third-party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet the requirements set out in the VCS Methodology Requirements.

   Compliance Status: Yes

   Justification: In this project, default factors have not been used by the PP. Quantification approach 1 (Measure and Model) has been applied to ascertain GHG emission data and meets the requirement set out in VM0042 v1.

7. **Criteria:** Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence.

   Compliance Status: Yes

   Justification: No such conflicts were observed in this project.

8. **Criteria:** Where projects apply methodologies from approved GHG programs, they shall conform with any specified capacity limits (see the VCS Program Definitions for the definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.

   Compliance Status: Yes

   Justification: The project applies VM0042 methodology and adheres to the specified capacity limits defined in the VCS Program Definitions. Additionally, it meets all relevant requirements set related to the application of the VM0042 v1.0 methodology and VMD0053 tool, as specified under the VCS program.

9. **Criteria:** Where Verra issues new VCS Program rules, the effective dates of these requirements are set out in Appendix 3 Document History and Effective Dates or equivalent for other program documents and are listed in a companion Summary of Effective Dates document which corresponds with each update.

   Compliance Status: Yes

   Justification: The project will update in accordance with the new Verra VCS Program rules, The effective dates of these requirements will conform with the Appendix 3 *Document History and Effective Dates* and listed in a companion- *Summary of Effective Dates* document which corresponds with each update.

The project establishes consistency with section 3.2 of the VCS standard v4.5 and thus fulfils high-level requirements related to AFOLU-specific matters, given in the standard:

1. **Criteria:** There are currently six AFOLU project categories eligible under the VCS Program, as defined in Appendix 1. Eligible AFOLU Project Categories below: afforestation, reforestation and revegetation (ARR), agricultural land management (ALM), improved forest management (IFM), reduced emissions from deforestation and degradation (REDD), avoided conversion of grasslands and shrublands (ACoGS), and wetland restoration and conservation (WRC). Further specification with respect to eligible activities which may be included within methodologies approved under the VCS Program can be found in the VCS Methodology Requirements.

Applicability Status: Applicable

Justification: The project is eligible under the VCS Program under section 3.2.1 of VCS standard v4.5, as it includes AFOLU activities specifically falling under the Agricultural Land Management (ALM) category, supported by the approved methodology VM0042 v1.0.

2. **Criteria:** Where projects are located within a jurisdiction covered by a jurisdictional REDD+ program, project proponents shall follow the requirements in this document and the requirements related to nested projects set out in the Jurisdictional and Nested REDD+ Requirements.

   Applicability Status: Not Applicable

   Justification: As per section 3.2.2 of VCS standard, there is no REDD+ component to the project, and the project is not located within a jurisdiction covered by any REDD+ program. Declaration for the same also provided to the VVB. /17/

3. **Criteria:** Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description. The implementation partner shall identify its roles and responsibilities with respect to the project, including but not limited to implementation, management, and monitoring of the project, over the project crediting period.

   Applicability Status: Not Applicable

   Justification: As per section 3.2.3 of VCS standard, the project does not have any additional implementing partner involved in the project. Therefore, all the roles including implementation, management, and monitoring of the project, over the project crediting period will be managed by the PP.

4. **Criteria:** The project proponent shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design. Where no new project activities have been implemented during a verification period, project proponents shall demonstrate that previously implemented project activities continued to be implemented during the verification period (e.g., forest patrols or improved agricultural practices of community members).

   Applicability Status: Applicable

   Justification: As per section 3.2.4 of VCS standard, the PP shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design using the technology tools developed by PP, using our team on the ground and other means necessary.

5. **Criteria:** For all IFM, Avoiding Planned Deforestation (APD) (except where the agent is unknown), Restoring Wetland Ecosystems (RWE), Avoiding Planned Wetland Degradation (APWD), Avoiding Planned Conversion (APC), and ALM project types, the project proponent shall, for the duration of the project, reassess the baseline every ten years. For all Avoiding Unplanned Deforestation and Degradation (AUDD), APD (where the agent is unknown), Avoiding Unplanned Conversion (AUC), and Avoiding Unplanned Wetland Degradation (AUWD) project types, the project proponent shall, for the duration of the project, reassess the baseline every six years.

   Applicability Status: Applicable

   Justification: Baseline reassessment shall be conducted following the criteria set out in section 3.2.5, 3.2.6, and 3.2.7 of the applicable VCS standard. The project proponent shall, for the duration of the project, reassess the baseline every ten years, as this project falls under ALM project category.

The following applicability conditions given in section 3.2.6 and 3.2.7 of the VCS standard shall apply with respect to the baseline reassessment:

1) The latest version of the VCS Program rules (including the latest version of the VCS Standard) and applied methodology or its replacement shall be applied at the time of baseline reassessment. The eligibility criteria for the grace periods for using the previous version of a methodology will be followed as set out in Section 3.22 and in the document history section of each VCS Program document.

2) The baseline shall be reassessed in accordance with the timelines in Section 3.2.5 of the VCS standard and shall be validated at the same time as the subsequent verification. The PP shall reassess the baseline every ten years during the project period, as this project falls under ALM project category.

3) The reassessment will capture changes in the drivers and/or behaviour of agents that cause the change in land use, hydrology, sediment supply and/or land or water management practices and changes in carbon stocks, all of which shall then be incorporated into revised estimates of the rates and patterns of land-use change and estimates of baseline emissions. Decadal LULC maps will be provided by the PP for verification at the time of baseline reassessment.

4) The validity of the original baseline scenario shall be reassessed. Such assessment shall include an evaluation of the impact of new relevant national and/or sectoral policies and circumstances on the validity of the baseline scenario. If still valid, the GHG emissions associated with the original baseline scenario shall be reassessed for the new baseline validity period following the provisions of the applied methodology. If no longer valid, the current baseline scenario shall be established in accordance with the VCS Program rules.

5) Ex-ante baseline projections beyond the baseline reassessment period specified in Section 3.2.5 of VCS standard 4.5 are not required.

6) Sections 1.14, 3.1-3.4, Section 4 and Section 5 of the project description shall be updated to reflect any changes as described in Section 3.2.6(3) and any updates to the baseline emissions quantifications.

The project shall apply all the criteria with respect to ALM baseline reassessment:

1. This project has set its baseline using historical management data specific to the project lands at validation, thus, the historical baseline shall be compared to published data on current common practice in the project region at the time of baseline reassessment. If significant difference is found between the historical baseline and current common practice, the project baseline shall be updated to reflect current common practice in the project region at each baseline reassessment event.

2) For projects that set their baseline using regional data on common practice (i.e., data not specific to the project lands), the baseline shall be updated to reflect current practices at each baseline reassessment event using similar datasets (e.g., agricultural census data) as those used to establish the baseline at validation. This is not applicable since this project has set its baseline using historical management data specific to the project lands (PAIs) and not regional data on common practice.

3) ALM projects focusing exclusively on reducing N_2O, CH_4 and/or fossil-derived CO_2 emissions (i.e., those that do not include soil organic carbon stocks) are exempted from the 10-year baseline reassessment requirement. This is not applicable since the project

includes quantification of SOC stocks and is therefore, not exempted from the 10-year baseline reassessment requirement.

6. **Criteria:** Where ARR, ALM, IFM or REDD project activities occur on wetlands, the project shall adhere to both the respective project category requirements and the WRC requirements, unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is deemed below de minimis or can be conservatively excluded as set out in the VCS Methodology Requirements, in which case the project shall not be subject to the WRC requirements.

   Applicability Status: Applicable

   Justification: The project shall adhere to the project category (in this case ALM) requirements set out in section 3.2.8 of the VCS standard.

7. **Criteria:** The project boundary for a WRC project shall include CH_4 emissions sources for all WRC activities and N_2O emissions sources for RWE activities, unless deemed de minimis or evidence is provided that it is conservative to exclude these sources.

   Applicability Status: Not Applicable

   Justification: Section 3.2.9 is not applicable as the project category is ALM.

8. **Criteria:** Non-Permanence Risk (Section 3.2.10 to 3.2.27): Projects shall prepare a non-permanence risk report in accordance with the AFOLU Non-Permanence Risk Tool at validation and verification. The non-permanence risk report shall be prepared using the AFOLU Non-Permanence Risk Assessment Calculator and shall be included as an annex to the project description or monitoring report, as applicable, or provided as a stand-alone document.

   Applicability Status: Applicable

   Justification: The project has prepared a non-permanence risk report in accordance with the AFOLU Non-permanence risk tool using the AFOLU Non-Permanence Risk Assessment Calculator and has been provided as a stand-alone document VCS_Non-Permanence-Risk-Report_v1.3(NPRR)/3/,/4/ to the VVB for validation and verification. The report has been prepared in conformance with the requirements and guidelines set out in section 3.2.10 to 3.2.27 of the VCS standard.

9. **Criteria:** Long-term Average GHG benefit (Section 3.2.28 to 3.2.30)

   Applicability Status: Not Applicable

   Justification: Section 3.2.28 to 3.2.30 is not applicable as the project category is ALM.

1.4. Project Design

The project is designed as a grouped project, encompassing multiple farms adopting a set of Agricultural Land Management (ALM) activities. Assuming more farms join and adopt these practices, additional project activity instances (fields) will be included post initial validation. This aligns with the VCS Standard's definition of grouped projects, facilitating the expansion of project activities. The eligibility criteria for inclusion of new project activity instances will adhere to sections 3.6.16, 3.6.17, and 3.6.18 of VCS Standard v4.5 and the VM0042 methodology criteria and demonstrated below. Initially, project activities are located within the geographical regions of Punjab and Haryana. **Figure 1** illustrates the project area map.

Eligibility Criteria

This project activity instances (current and new) meet the following eligibility criteria set out in Section 3.6.16 of the VCS standard v4.5:

1. Project instances must meet the applicability conditions set out in the methodology applied to the project.

   Justification: The applicability conditions set out in section 4 of the methodology VM0042, Version 1.0) apply to all project instances and explained here in brief and in detail in section 3.2 of JPDMR)

   - The Project introduces or implements one or more changes to pre-existing agricultural management practices which include: Reduce tillage/improve residue management; Improve water management/irrigation; Improve crop planting and harvesting by adoption of two practices in the project area such as RT and DSR.

   - Project activities must be implemented on land that is either cropland or grassland at the project start date and remains cropland or grassland throughout the project crediting period (i.e., land use change is not eligible, including conversion from cropland to grassland and grassland to cropland). The project activities have been implemented on land that is cropland since the project start date, which can be well proven by the LULC maps provided /34/.

   - The project area has not been cleared of native ecosystems within the 10-year period prior to the project start date. The project primarily focuses on adoption of regenerative practices in Rice-Wheat cropping system, crops which are native to the project area. Decadal LULC maps of the project area have been provided/34/ as a evidence of the same.

   - The project activity is not expected to result in a sustained reduction of greater than 5% in productivity, as demonstrated by peer-reviewed and/or published studies on the activity in the region or a comparable region. To estimate the effect of practice change on yield, PP has undertaken crop cutting experiments in the project location at the harvesting. Based on the statistical tests conducted, it is concluded that there was no significant effect on yield with practice change in the project area. This has been supported by a separate document named "Yield effects with practice changes"/40/.

   - As per the VM0042 methodology, the project activities implemented do not involve the application of biochar.

   - The project activity cannot occur on a wetland. Note that this condition does not exclude crops subject to artificial flooding where it can be demonstrated that crop cultivation does not impact the hydrology of any nearby wetlands. The LULC maps provided /34/ show that none of the fields intersect with any wetlands or water bodies. Thus, there is neither any conversion of land nor leading to drainage of any hydrological function in the project area and the project activity occurs on the agricultural cropland only.

   - The project activities do not introduce any non-native or invasive species in any of the project instances. Neither do any of the project activities allow any invasive species to thrive through project implementation. The different crop varieties reported by the farmers in the project area are Pusa 44, PR 11, PR 118, PR 121, PR 122, PR 123, PR 124, PR 125, PR 126, PR 127, PR 128, PR 198, PR 303, CR Dhan 303, Raja 133, Raja 135, PB 1509,for rice and HD 1105, HD 725, HD 2967, HD 3086, DBW 187, DBW 222, PBW 725, PBW 727 for wheat, respectively. All the above-listed varieties of rice and wheat are local and non-invasive species to the project area. The focus of our project – is adoption of regenerative practices only in Rice-Wheat cropping system (for this monitoring period) and the crop varieties grown by farmers in the pre-project scenario is continued to be grown in the project scenario also. No other non-native or invasive crop or crop variety was reported by the farmer, therefore, there is no introduction of any non-native or invasive species in the project area.

- Additional conditions for application of model for GHG ERRs quantification are justified in section 3.2 of the JPDMR

2. Use the technologies or measures specified in the project description.

   Justification: The technologies or measures (Agricultural Management Practices) specified in the project description are used within the whole project area and are applied in the same manner as specified in the project description. The project activity includes the adoption of two practices in the project area such as RT and DSR.

3. Apply the technologies or measures in the same manner as specified in the project description.

   Justification: The project has been implemented in the same manner as specified in the project description.

4. Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.

   Justification: The entire geographic project area within which the project instances are located is subject to the baseline scenario and modeling domain determined in the project description and model validation report. The baseline survey was conducted in the project area to determine the baseline scenario of the project activity.

5. Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) consistent with the initial instances, or face the same investment, technological and/or other barriers as the initial instances.

   Justification: The Project activity meets the additionality requirements as per the applied methodology VM0042, v1.0 For the first project activity instance the additionality has been proven for the states of Punjab and Haryana. The characteristics with respect to additionality are consistent for the initial instances as well as for the total geographic project area. There are significant cultural, knowledge, and technical barriers to the adoption of regenerative agriculture practices by farmers in the project area for all project activity instances (See section 3.5 of JPDMR).

In addition, the VCS Standard v4.5 requires that grouped projects allow for the inclusion of new project activity instances subsequent to the initial validation of the project. Inclusion of new instance area (fields) for project implementation will adhere to the eligibility criteria set out in the section 3.6.16, 3.6.17, and 3.6.18 of the VCS standard. New project activity instances within this project will meet the following criteria set out in section 3.6.17 of VCS standard:

1. Occur within one of the designated geographic areas specified in the project description.

2. **Justification:** The first project activity instance is located within the geographic boundary of India and is implemented in the states of Punjab and Haryana. 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.

   Justification: The project activity instance meets a complete set of eligibility criteria as per the VCS standard v4.5 requirement.

3. Be included in the monitoring report with sufficient technical, financial, geographic, and other relevant information to demonstrate conformance with the applicable set of eligibility criteria and enable evidence gathering by the validation/verification body.

   Justification: All the technical, financial, geographic, and other relevant information is mentioned clearly in the JPDMR and is in compliance with the applicable set of eligibility criteria and supporting documents have been submitted to the VVB to enable evidence gathering during validation/verification.

4. 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).

   Justification: The project documents clearly establish Grow Indigo Pvt. Ltd. (PP) as the project owner. This aligns with the definition of a Project Owner under the VCS Standard (Section 3.7, subsection 6). PP assumes full responsibility for the project, including registration, monitoring, measurement, reporting, and verification (MRV) of GHG reductions and removals. Additionally, legally binding agreements are signed with participating farmers, outlining their obligations and assigning all legal rights to the generated carbon credits to PP 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)/28/.

5. Have a start date that is the same as or later than the grouped project start date.

   Justification: The project start date for project instance is the same as the grouped project activity start date.

6. Only be eligible for crediting from the later of start date of the project activity instance or the start date of the verification period in which they were added to the grouped project, through to the end of the project crediting period.

   Justification: The first project activity instance is eligible for crediting from the start date of instance until the end of project crediting period from 06/05/2019 to 05/05/2039.

7. Not be or have been enrolled in another VCS project.

   Justification: All project activity instances will be included under the grouped project activity, thus fulfilling this eligibility criteria. All new project activity instances shall not be included in any other GHG emission reduction or removal project.

8. Adhere to the clustering and capacity limit requirements for multiple project activity instances set out in 3.6.8 - 3.6.9.

   Justification: All PAI are included under the grouped project activity, thus fulfilling this eligibility criteria. Any new project activity instance included in the grouped project must adhere to the clustering and capacity limit requirements for multiple project activity instances set out in 3.6.8 - 3.6.9 of VCS standard 4.4 will be included in relevant monitoring reports with sufficient technical management, financial, geographic, and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation verification body.

Fields that have not adopted regenerative practices and are still using conventional practices will be targeted by PP to identify potential locations within the project area covering the states of Punjab, Haryana. Project practices will be introduced through influential farmers/farmer organizations. Further, PP will also approach the local authorities for strategizing the regenerative agricultural practice implementation in the potential fields in the project area. This approach will be used by PP to identify future areas for project implementation.

1.5. Project Proponent

Organization name	Grow Indigo Private Ltd
Contact person	Umang Agarwal Usha Barwale Zehr
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Email	umang.agarwal@growindigo.co.in usha.zehr@growindigo.co.in

1.6. Other Entities Involved in the Project

Organization name	Indian Agricultural Research Institute (IARI)
Role in the project	Knowledge partner
Contact person	Prof V. K. Sehgal
Title	Principal Scientist and Head, Agricultural Physics Division
Address	Indian Agricultural Research Institute (IARI), Pusa Campus, New Delhi, Pin:110012
Telephone	+91-9899034144
Email	vksehgal@gmail.com

Organization name	International Maize and Wheat Improvement Center (CIMMYT)
Role in the project	Knowledge partner
Contact person	Dr. M. L. Jat
Title	Principal Scientist,

Address	Borlaug Institute for South Asia (BISA) NASC Complex, Pusa, New Delhi
Telephone	+91-9999108787
Email	m.jat@cgiar.org

1.7. Ownership

Grow Indigo Pvt Ltd., the Project Proponent is owner of the project as defined in VCS Standard Section 3.7, subsection 6. PP operates a Carbon Program to boost smallholder farmers' income through the adoption of regenerative agricultural practices, resulting in GHG emission reductions and removals and positive environmental and economic outcomes. In pursuance of the same, PP enters into legally binding agreements with the concerned farmer in order to secure the latter's participation in the Carbon Program. PP's obligations extend to project registration, monitoring, measurement, reporting and verification of GHG emission reductions and/or removals associated with the regenerative practices.

Farmer is liable to enrol specific fields of their land in PP's Carbon Program. While the agreement allows the farmer to retain their discretion in relation to the adoption of any agricultural practice, the ultimate payment by PP to the farmer is subject to the latter's compliance with all eligibility requirements and the issuance and sale of Carbon Credits establishing control over project activities.

The entire responsibility relating to project registration, reporting, verification, monitoring, measurement of the GHG emission reductions and/or removals and other regenerative practices rests on PP. Also, the GHG credits will be issued to PP. PP is required to inform the farmer regarding the regenerative practices which may be in compliance with the VCS program and VCS Standard (pursuant to which farmers may exercise their discretion) and PP exercises a definite degree of control and operation over these activities in terms of monitoring, measuring, verifying and reporting the same to Verra Registry. PP possesses project ownership and in turn has assumed the role of a project proponent in relation to the project activities which may be undertaken by the farmer in pursuance of the legal agreement. The Project Proponent (PP) has established ownership over the project itself, along with the legal right to control and operate the program activities. However, within the project area, the individual fields are owned by the farmers or managed by them under rights to farm the land. This delineation affirms that while the PP maintains rights to conduct project activities, the farmers retain ownership and rights to access and use the land and its resources. Thus, establishing ownership of the project by the PP, the legal right to control and operate the program activities.

Legal agreement and documentation:

The title of the agreement between PP and PAI is "Agreement with the farmer for regenerative agriculture and income generation". In the initial days of the project, the agreement was a printed document which was signed by the farmer. Over the course of the project, the agreement has been digitized and digitally signed. PP's field team visits each farmer and reviews the agreement with the farmer in local language and then the agreement is signed while the farmer is being enrolled. In some cases, the agreement is signed in subsequent visits to the farmers. The agreement is for the entire duration of the project crediting period.

The legal agreement entered between PP and each farmer includes:

PP's obligations such as project registration, MRV, finding buyers for carbon credits and sharing 75% of the net realization as payment with the farmers.

Farmer's obligation including enrolment of specific fields of the land in the project, meeting eligibility criteria, attestation that he/she is authorized to use the land and has the right to enter into this agreement, participation in the MRV process, attestation that this is the only project this land is a part of, and assigns all its legal rights in and to such carbon credits to PP (issuance, forwarding, sale of carbon credits as issued units under any standard)

The agreement also contains general terms including the duration of the agreement (for the length of the project), termination conditions, dispute resolutions, payment terms, etc.

We recognize the need to address the diverse land ownership systems across the states in project area, i.e. Haryana, Punjab. Therefore, the land records of the farmers are validated by one or more of the following:

1. Physical land records presented by farmers.
2. Attestation/verification by local government authority
3. Land records that are publicly available in some of the project area based on GPS coordinates, wherever possible.

PP's QC process mandates that the legal agreement is in place and verification of land records are carried out with one of the above options. All land record verification procedures is documented for each PAI with the participating farmers. In rare instances, where obtaining land records through the standard methods could prove challenging, our process is to document the reasons for the difficulty and explore alternative verification methods in consultation with the farmer and relevant authorities. No such instance has appeared till date. We are committed to transparent and robust land tenure verification.

Our digital application has been set to avoid duplicate enrolment of fields in our program. In addition, the farmer attests that they have exclusively engaged with PP for the carbon program for each PAI to ensure no double claim happens. In addition, any identification with databases of Auditors or other database of geofenced fields have been cross checked to remove any doubtful cases of double claiming, and these have been dropped from our program.

Eligibility for participating in Grow Indigo Carbon program. The VCS Standard Section 3.7, subsection 6, requires the participation of the person who is "the holder of the statutory, property or contractual right in the land". In simpler terms, this refers to the farmer. Tenant farmers therefore can participate in carbon programs on leased land if they have management rights over the farm. Agricultural land leases are largely informal in India. Restrictive land leasing laws have forced tenancy to be informal and oral. Table 1 summarizes the State specific legalities on leasing of land in Haryana and Punjab where all our initial PAIs are located.

Table 1: State-specific legalities on land leasing in Haryana and Punjab[2]

Aspect	Haryana	Punjab
Governing law	Punjab Security of Land Tenures Act, 1953 for the erstwhile Punjab area and	Punjab Tenancy Act, 1887, The PEPSU Tenancy and Agricultural Lands Act, 1955, as amended in 1957, 1959,

2 Link accessed on 20th May 2024. https://www.niti.gov.in/sites/default/files/2020-05/Report-of-the-Expert-Committee-and-Model-Law-on-Agricultural-Land-Leasing.pdf

Aspect	Haryana	Punjab
	PEPSU Tenancy and Agricultural Land Act, 1955 for PEPSU area, as amended up to date	1962, 1968 and 1969; Punjab Security of Land Tenancy Act, 1953 as amended in 1955, 1957, 1959, 1962, 1968 and 1969 and Punjab Land Reforms Act, 1972.
Leasing permitted	Yes	Yes
Minimum lease term	3 years	N/A
Maximum lease term	6 years	N/A
Proportion of land leased	14.9%	24.62%
Lease termination grounds	A tenant generally enjoys security of tenure, except in specific cases like failing to pay rent, improper land use, exceeding land holding limits, or if the land is reserved or owned by a small landowner.	

Sharing of carbon revenues

As per the legally binding agreement between the farmer and PP, 75% of the net realization from carbon credit sales are paid to the farmer. Any change in land or tenancy ownership will be recorded over the course of making payments to the farmers and will be reported in subsequent monitoring reports.

Additionality safeguards

This project has two components, i.e. emission reductions and carbon sequestration. There is no permanence risk associated with emission reductions. However, carbon stored in the soil may be released through tillage practices leading in reversals. The risk of reversals is mitigated with continuous knowledge sharing, communication and awareness with the farmer and a long-term agreement with the farmers for the entire project crediting period. Moreover, the monitoring plan requires all changes in tenancy or land ownership to be recorded and reported in subsequent monitoring reports. In the case of agricultural carbon programs where large land holdings (>20 ha) is involved, the farmer may be paid over time, as a form of deferred compensation, to ensure there is an incentive to maintain the carbon stored in the soil. However, in a smallholder farming system in India, we have adopted the approach of making full payment to the farmers on the sale of carbon credits, to encourage a continuation of their participation in the project activities and continuous engagement with the farmers.

1.8. Project Start Date

The proposed grouped project activity comprises two project activities: Direct-Seeded Rice (DSR) and Reduced Tillage in Wheat, that are implemented in current project activity instances (PAIs) As agricultural activities in the study area typically commence from the start of May, which marks the beginning of land preparation for the kharif (monsoon) season, followed by crop (for this project instance - Rice) sowing, fertilizer application, irrigation events, harvesting, etc. Therefore, the earliest action done by farmers which led to the generation of GHG emission reductions or removals by adoption of regenerative agricultural practices or changes in existing practices began from here, and the project aims to achieve reductions or removals of GHG emissions from 06/05/2019, i.e. the project start date of Direct seeding of rice (DSR).

According to the VCS Standard v4.5, the project start date is defined as the date on which activities that lead to GHG emission reductions or removals are implemented. For Agricultural Land Management (ALM) projects, the sowing date is generally the most appropriate indicator of the project start. For this project, the start date is 06/05/2019, which is the earliest documented date of adoption of the Direct Seeded Rice (DSR) (sowing) practice among project fields, accurately marking the beginning of emission reduction activities aligned with project objectives. The project start date was validated through remote sensing analysis, in conjunction with farmer reported data, provided as supporting document/49/.

1.9. Project Crediting Period

The project activities do not focus exclusively on GHG emission avoidance but also on increasing the SOC stock. Thus, the project crediting period is 20 years, starting from 06/05/2019 and up to 05/05/2039. This crediting period may be renewed four times with a total project crediting period not to exceed 100 years, i.e., the final project crediting date is 05/05/2119 unless the program ceases to exist before that date.

The non-permanence risk report/3/, in accordance with section 2.4 of the VCS standard and section 2.2.4 of the "AFOLU Non-Permanence Risk Tool v4.0,"/4/ demonstrates a project longevity of 30 years through a contractual agreement between the PP and the farmer, obligating the farmer to maintain the project activities until the life cycle of the project, which is until 05/05/2049, while the crediting period will be until 05/05/2039.

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	NA
Large project	The project will result in an average annual emission reduction or removal of 4,267,622 tCO2e over a 20-year period.

The ERR estimations (vintage year-wise) given in the table below are based on the GHG mitigation potential of rice-wheat-maize cropping system in the project area as per peer-reviewed literature.[3]

[3] Jat, H. S., Kumar, V., Datta, A., Choudhary, M., Kakraliya, S. K., Poonia, T & Sharma, P. C. (2020). Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. Scientific reports, 10(1), 19267.

Year	Estimated GHG emission reductions or removals (tCO_2e)
2019	5,512
2020	95,044
2021	570,264
2022	1,743,864
2023	3,815,464
2024	5,104,664
2025	5,104,664
2026	5,104,664
2027	5,104,664
2028	5,104,664
2029	5,104,664
2030	5,104,664
2031	5,104,664
2032	5,104,664
2033	5,104,664
2034	5,104,664
2035	5,104,664
2036	5,104,664
2037	5,104,664
2038	5,104,664
2039	2,552,332
Total estimated ERs	**85,352,440**
Total number of crediting years	20 years
Average annual ERs	**4,267,622**

1.11. Description of the Project Activity

There is no REDD+ component to the project, and the project is not located within a jurisdiction covered by any REDD+ program. Declaration for the same has been provided to the VVB /17/.

The Rice-Wheat-Maize system in the North-West India, comprising of the states of Punjab and Haryana, accounts for a significant portion of the food supply in the country. According to the land use statistics data for 2017-2018, 85.03% and 84.09% of the available geographical area in

Haryana and Punjab[4] respectively were under agriculture. Puddled transplanted rice (TPR) followed by intensively tilled (CT) wheat being the most predominant cropping system in the project area. In 2019, these were the only states where the contribution of rice and wheat to total agricultural production exceeded 45% that year[5].

Several sustainability issues are associated with the Rice–Wheat cultivation system, including reduced water availability due to over-extraction of groundwater, decline in land productivity due to depletion of available nutrients, degradation of the soil structure, and deterioration of soil health, increased GHG emissions caused by intensive tillage, crop residue burning and excessive use of synthetic fertilizers, loss of biodiversity, waterlogging and salinity issues, increased pests pressure and weed infestation. In the western Indo-Gangetic plains, deterioration in soil, water and environmental quality coupled with low profitability jeopardize the sustainability of the dominant Rice-Wheat system. Free water and electricity for farmers further exasperate this problem. The traditional rice transplanting method is also quite labour-intensive. The Covid-19 pandemic highlighted labour shortage, resulting in an increase in demand for labour and wages above average, adding an economic burden to the farmer. The increased production costs lead to lower profitability for farmers and higher GHG emissions. Addressing sustainability while continuing to increase food production is a significant challenge. Promoting regenerative agricultural practices that maintain or enhance food production while incentivizing farmers is extremely important. Balancing the dual goals of food production and sustainability is essential to ensure long-term agricultural viability and soil, water, and environmental health.

Potential sustainable interventions to mitigate the issues include resource regenerative interventions such as crop residue management, N-fertilizer management, manure/ compost application, ZT, laser land levelling, DSR, agroforestry, incorporation of legumes, green manuring, crop rotation, and crop diversification. These interventions have the potential to reduce energy, water, and carbon footprints from the traditional Rice–Wheat cultivation system in the project area. Despite several efforts in the past to promote regenerative agricultural practice in various regions, there are significant barriers for farmers to adopt such practices because of the trade-offs involved, lack of incentives, and socio-cultural beliefs, adequate technical information and knowledge gaps. For example, crop residue removal from the field for other purposes, such as fodder, fuel, and fencing, is a traditional practice for managing residue. Farmers burn most of the paddy straw in situ to prepare fields for the timely sowing of wheat, resulting in environmental pollution and the depletion of plant nutrients and soil organic matter. Similarly, practicing zero or reduced tillage requires altering farm equipment and substituting conventional crop planting and weed-control methods. The practices implemented in the first project instance are: Direct seeding of rice and Reduced tillage in wheat.

As more of these solutions become available, incentivizing farmers in India to adopt these practices will enhance soil organic carbon (SOC) sequestration and reduce greenhouse gas (GHG) emissions. Compared to prevailing (conventional) farming practices, results suggest that regenerative rice management increased profitability by 13% and energy use efficiency (EUE) by 21% while reducing irrigation water application by 19% and global warming potential (GWP) by 28%. By substituting regenerative agriculture-based maize for rice, similar mean profitability gains were realized (16%), but transformative improvements in irrigation (−84%), EUE (+231%), and GWP (−95%) were observed compared to conventional farmer practices.

The project activities have been designed to be flexible, adaptive and responsive to the needs of each local context while maintaining ecological and technical rigour. The list of project activities

[4] more-than-84-of-geographical-area-in-punjab-haryana-under-agriculture- accessed on 10-July-2023

[5] Agricultural statistics at a glance 2019 - accessed on 30-Apr-2023

that will remove and reduce GHG emissions, with implementation timeline and expected outcomes is presented in Table 2.

Table 2: List of project activities with implementation timeline and expected outcomes.

Project activities	Implementation start	Monitoring period (MP)	Outcomes
Adopt reduced or no-till agricultural practices	2019	2019-22 (MP1 and subsequent MPs)	Improved soil carbon
Adopt direct seeding of rice	2019		Reduced methane emission

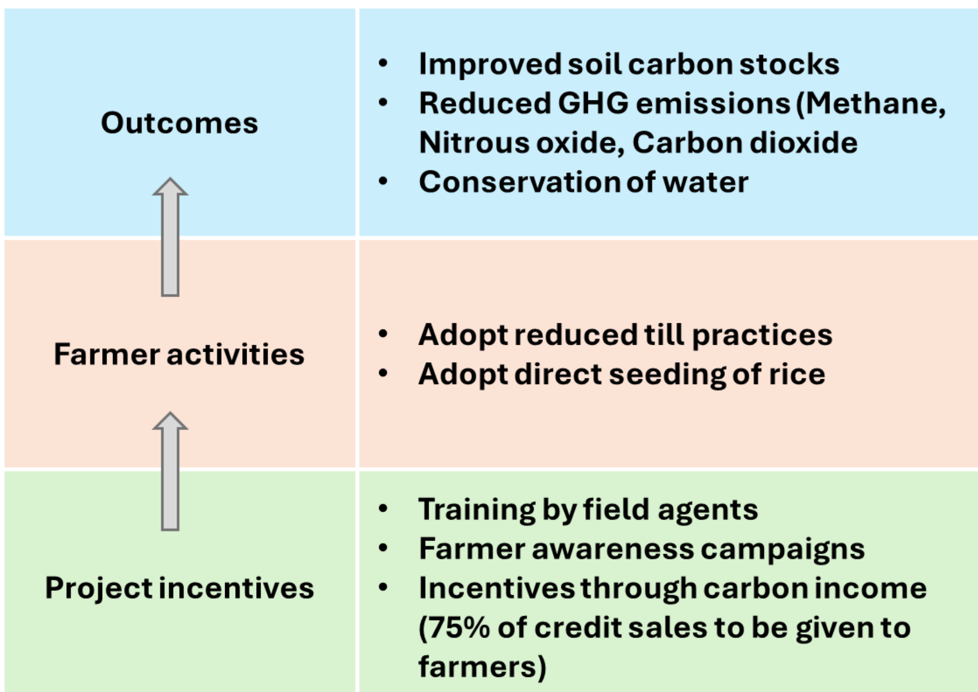

Figure 2: Summary of project theory of change.

Participating farmers are required to adopt at least one project regenerative practice to be eligible for the program. The project activity includes training and support to the participating farmers to improve agricultural land management, and incentivise via carbon credit revenue by adoption of project regenerative practices. A summary of the project's theory of change from farmer incentives, leading to outcomes is represented in figure 2.

In the baseline scenario, agricultural practices were characterized by conventional methods that contributed to higher greenhouse gas emissions and lower soil health. For rice cultivation, the traditional method of transplanted rice (TPR) required up to 35 irrigation cycles during the kharif season, leading to excessive water usage and higher methane emissions from flooded fields. Similarly, for wheat cultivation, farmers used conventional tillage with a tillage depth ranging from 5 to 30 cm and a frequency of 3 to 10 times during the rabi season. This intensive tillage practice disturbed the soil structure and increased carbon emissions.

In contrast, the project scenario introduces more sustainable agricultural practices aimed at reducing environmental impact and enhancing soil health. The project advocates for direct seeded rice (DSR), which reduces the frequency of irrigation to a maximum of 20 times. This method not only conserves water but also lowers methane emissions by minimizing the duration of field flooding. Similarly, project promotes reduced tillage (RT) for wheat, which involves a significantly reduced tillage depth of 0 to 5 cm and a frequency of up to 3 times. This practice helps maintain soil structure, reduce carbon emissions, and improve soil carbon sequestration. These regenerative practices collectively contribute to lowering the environmental footprint of farming activities and enhancing the sustainability of agricultural production. Given below is the comparison of the practice changes in baseline and project scenarios.

Table 3: Comparison between baseline and project scenario

	Baseline Scenario	Project Scenario
Project Activity	Transplanted rice	Direct seeded rice
Irrigation frequency (During rice growing season)	35 times	20 times
Project Activity	Conventional tillage	Reduced tillage
Tillage depth	5-30 cm	0-5 cm
Tillage frequency	3-10 times	0-3 times

Knowledge provided by knowledge partner CIMMYT and PP through training and awareness programs, coupled with the potential revenue from the sale of Verified Carbon Units (VCUs), serves as a crucial incentive for farmers to consider changing their traditional practices. Regular interaction between enrolled farmers and technical staff (Kisan advisors, and agricultural experts from Grow Indigo) further promotes the adoption of regenerative farming methods. These programs help farmers understand the long-term economic and environmental benefits of these practices and easing the transition to regenerative practices. The project ensures that farmers are well-equipped with knowledge and technical assistance to adopt these practices effectively.

For participation in the program, the farmer provides PP with full, free, prior and informed consent to use their attested agricultural practice data. A summary of the theory of change is presented in Figure 2 that articulates the planned project incentives, farmer activities, and project outcomes. The farmer must adopt at least one regenerative practice (i.e. DSR or ZT) to be eligible in the program. There are optional extensions by adopting more than one practices, to provide a framework for advancing ambition and correspondingly greater support and incentives for the activity implementation. The implementation schedule of project activities for the first monitoring period is given in Table 4.

The project is firmly committed to the principles of inclusivity and non-discrimination. We actively encourage participation from farmers of all backgrounds, regardless of gender, social status, religion, or cultural affiliation. The project participation framework is transparent and equitable, ensuring access for all interested farmers who meet the program's eligibility criteria.

Furthermore, the project activities themselves are designed to be gender-neutral and culturally agnostic. No specific agricultural variety or practice will be promoted that might favour one group over another. Our focus is on providing a framework that can be adapted and implemented effectively across diverse contexts, empowering each farmer to choose the most suitable regenerative practices for their land and circumstances. This approach ensures that the project's benefits are widely accessible.

While many initiatives in India have focused on promoting regenerative agricultural practice, there has not been a project that measures, monitors, and validates GHG reduction and issues carbon credits, thus sustaining these practices by incentivizing farmers in India. By linking smallholder farmers to carbon marketplaces, this project aims to overcome these critical barriers to adoption by enabling additional income opportunities for the farmers. With a cash incentive and proper training and awareness regarding the environmental benefits, the smallholder farmers in the project area are encouraged to adopt these practices more readily and contribute to sustainability and reduce GHG emissions. A voluntary carbon marketplace for agricultural carbon credits, will create additional income opportunities for the very first time for smallholder farmers in India via this project.

In the initial phase, PP has leveraged the support from our knowledge partner CIMMYT, and agricultural officers from agriculture extension centres (Krishi Vigyan Kendras) in the project area to outreach early established engagement and to overcome the technical barriers and knowledge gaps. It is imperative to provide training and capacity building on regenerative agriculture to farmers in the project area. This knowledge, coupled with the potential revenue from the sale of Verified Carbon Units (VCUs), serves as a crucial incentive for farmers to consider changing their traditional practices. Additionally, regular interaction between enrolled farmers and technical staff (field agents who are also called Kisan advisors, and agricultural experts from Grow Indigo helped to promote the adoption of sustainable farming and monitoring the implemented activities in the project area.

Table 4: The implementation schedule of project activities for the first monitoring period

Sl. No.	Project Activity	Implementation start year
1.	Various training and awareness programs on regenerative crop cultivation practices including cooperative use and rental services of machinery conducted by CIMMYT in 9 districts of Punjab and 7 districts of Haryana	For period 2018-20
2.	Engagement meeting with partners i.e., CIMMYT, IARI	February 2019
3.	On-field Data collection a. Field team's in-person engagement with farmers b. Survey and manual Data collection of farmers	From December 2019
4.	Lockdown due to covid 19 (Mar 2020 to June 2021) a. Virtual interaction with knowledge partner CIMMYT b) Online internal meetings for project implementation and App development, etc. c) Training at Karnal with field team d) Online stakeholder consultations with farmers representative and field team for data collection training, and geotagging etc.	From March 2020 to June 2021
5.	Post covid on-site stakeholder engagements training and awareness on regenerative agricultural practices	Since July 2021
6.	Ground Truthing for rice with knowledge partner IARI	Jul 2021
7.	Listing of project on Verra	Sept 2021

Sl. No.	Project Activity	Implementation start year
8.	Monitoring of implemented project practice through remote sensing and frequently visit by kisan advisors (Field agents)	Ongoing
9.	Training of Field agents	Periodic and continuous starting 2021
10.	Crop cutting trials	Oct 2021
11.	Ground Truthing for wheat	Nov-Dec 2021
12.	Soil sampling	Nov-Dec 2021
13.	Agreement signing (non-digital) after checking eligibility of farmers	Mar 2022
14.	Transfer of manually collected survey data of farmers, along with the ongoing collection of new data using the mobile app in digital mode	Ongoing since Apr 2022 till all data was transferred into digital app
15.	Model cal/val (with IARI)	Feb-Nov 2022
16.	Quantification	Nov 2022 to Jan 2023
17.	Reporting to VVB	Feb 2023
18.	Agreement signing (digital mode through mobile app) (based on corrective action for VVB finding)	Mar 2023

An interesting development emerged during the first project monitoring period. The governments of Haryana and Punjab launched pilot schemes promoting the adoption of DSR, a core regenerative practice within our project boundary framework. Haryana's 2021 DSR subsidy scheme covered approximately 7,000 hectares[6]. Similarly, Punjab's 2022 cash incentive program for farmers transitioning to DSR highlights the growing recognition of the need for regenerative agricultural practices[7]. Importantly, any government incentives received by participating farmers go directly to them. Additionally, these government schemes are not performance-based. Payments are not linked to achieved methane emission reductions. This eliminates the risk of double counting and ensures accurate project impact measurement.

PAIs (fields) include the implementation and maintenance of one or more new agricultural land management practices, all of which are expected to increase SOC storage and reduce emissions of CO_2, CH_4, and N_2O over the crediting period of the Project. The effect of the adoption of Project activities are quantified using Quantification Approach 1, i.e. measure and model. Project activities on each field are reviewed through a series of checks to confirm they meet all applicability conditions and additionality requirements.

[6] Link accessed on 21st May 2024. https://www.hindustantimes.com/cities/chandigarh-news/haryana-farmers-surpass-government-target-on-direct-seeded-rice-101686327979286.html

[7] Link accessed on 21st May 2024. https://www.cgiar.org/news-events/news/agricultural-policy-in-punjab-india/#:~:text=Not%20willing%20or%20able%20to,million%20hectares%20to%20this%20practice

1.12. Project Location

The project is implemented in the Indian States of Punjab, and Haryana, with the initial project activity instances located within a geographical reach of these states, and varying practices. The project aims to cover approximately 1.53 million hectares during the entire project crediting period by inclusion of additional PAIs (fields) and practices in subsequent monitoring periods, The eligibility criteria for the inclusion of new project activity instances follows VCS Standard v4.5 and the methodology criteria outlined under the Methodology VM0042 v1 for Improved Agricultural Land Management approved under the VCS Program. All enrolled farms have been geotagged/fenced, and the KML file provides the coordinates of the larger project area.

The first monitoring period includes fields enrolled in 10 districts such as, Amritsar, Bhatinda, Fategarh Sahib, Fazilka, Ludhiana, Moga, Muktsar, Patiala, Sangrur in Punjab and 11 districts such as, Ambala, Bhiwani, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Rohtak, and Sirsa in Haryana given in figure 3.

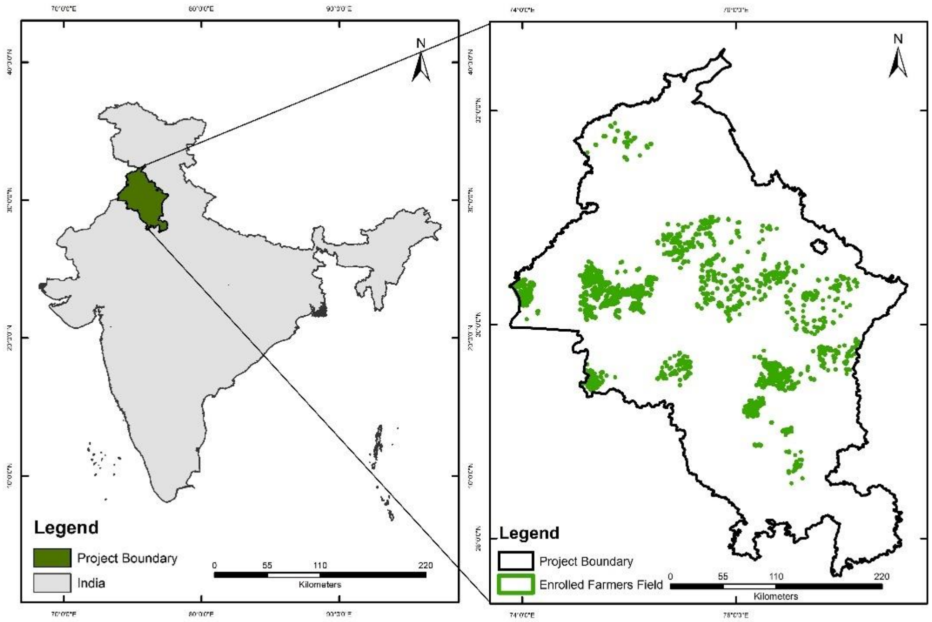

Figure 3: Location of the first PAIs (enrolled fields) in the project area.(Source: Survey of India (https://onlinemaps.surveyofindia.gov.in/Product_Specification.aspx, Ministry of Science & Technology)

1.13. Conditions Prior to Project Initiation

The project has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal, or destruction. Rather, the project has primarily been implemented to improve agricultural management practices in the project area, in the absence of any regulations.

The environmental conditions that are relevant to the project include information on climatic and edaphic conditions in the project area and are demonstrated in soil map (**Figure 4**), rainfall map (**Figure 5**), elevation map (**Figure 6**), ground water level map (**Figure 7**), and surface water river network map (**Figure 8**) respectively. The land use and land cover (LULC) map is presented in **Figure 9**.

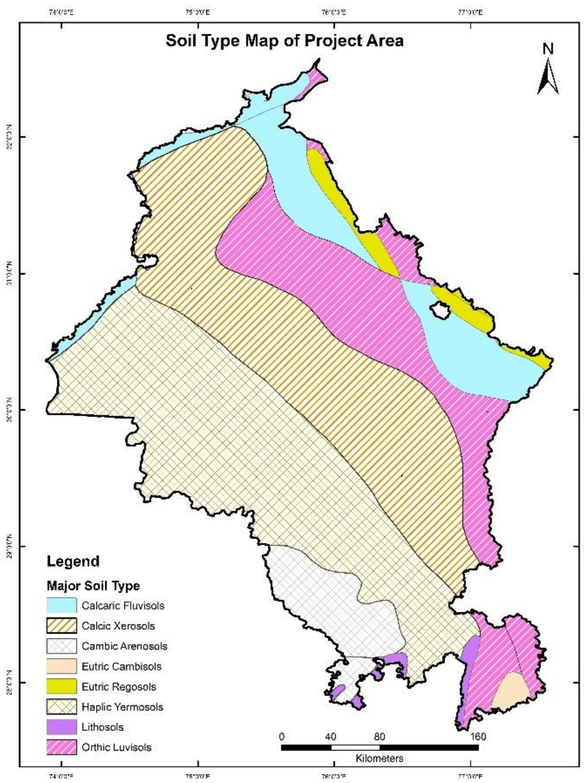

Figure 4: Soil map for the project boundary[8].

Rice cultivation is one of the most significant sources of methane emission. Conventional transplanted rice requires continuous flooding of rice fields, which creates anaerobic conditions that promote the activity of methanogenic bacteria. A large amount of methane is produced by the action of methanogenesis in flooded rice fields (20 - 229kg/ha/season) based on soil and weather conditions.[9] Contrary to the transplant method, the DSR method does not require the fields to be continuously submerged with water, leading to less anaerobic conditions and lower methane emission (up to a maximum of 80% reduction).[10] Thus, the DSR method not only consumes relatively lower amount of water (30-50%)[8] compared to conventional transplanted rice, but it also emits a lower amount of methane and reduces the energy demand for pumping water for irrigation. Moreover, a reduction in groundwater demand would also lead to improvement in groundwater levels and quality.

[8] Source: https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/446ed430-8383-11db-b9b2-000d939bc5d8]

[9] Khosa, Maninder & Sidhu, Bryan & Benbi, D.. (2010). Effect of organic materials and rice cultivars on methane emission from rice field. Journal of environmental biology / Academy of Environmental Biology, India. 31. 281-5.

[10] Dipak Kumar Gupta, A. Bhatia, A. Kumar, T.K. Das, N. Jain, R. Tomer, Sandeep K. Malyan, R.K. Fagodiya, R. Dubey, H. Pathak, Mitigation of greenhouse gas emission from rice–wheat system of the Indo-Gangetic plains: Through tillage, irrigation and fertilizer management, Agriculture, Ecosystems & Environment, Volume 230, 2016, Pages 1-9.

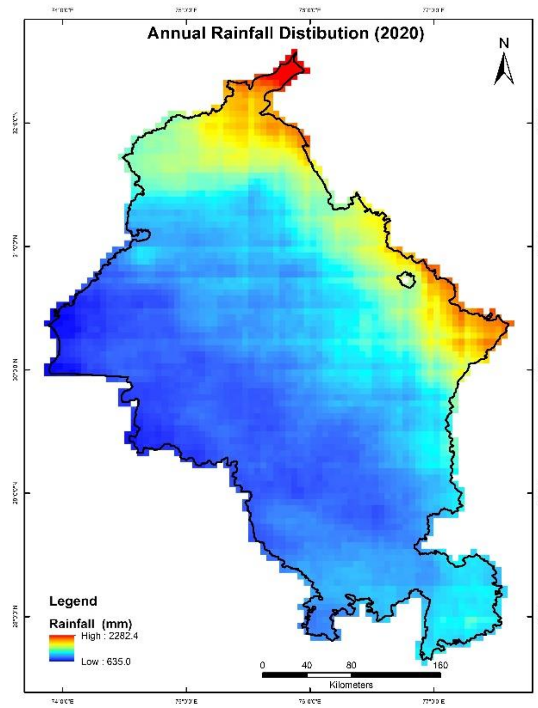

Figure 5: Annual rainfall map for the project boundary[11].

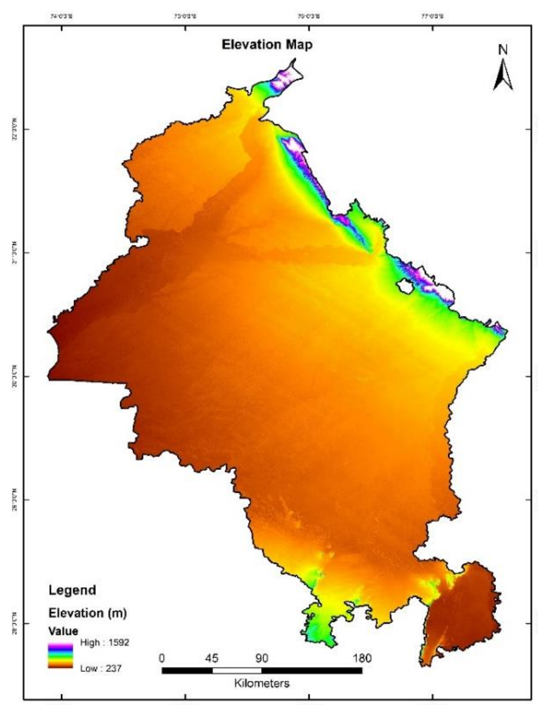

Figure 6: Elevation map for the project boundary[12].

11 Source: https://www.imdpune.gov.in/

12 Source: https://earthexplorer.usgs.gov/

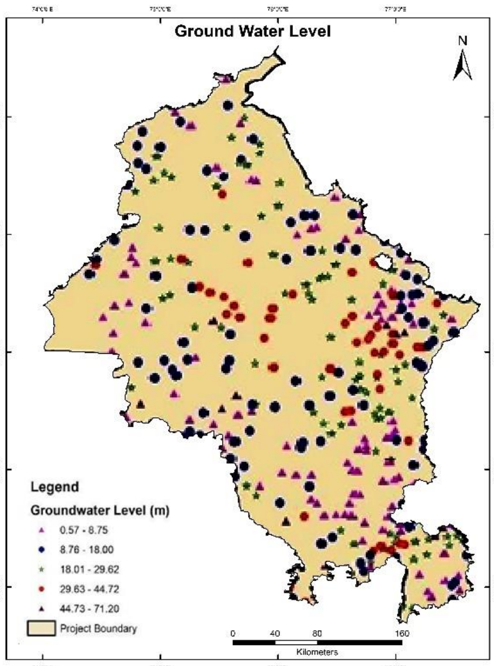

Figure 7: Groundwater level for the project boundary[13].

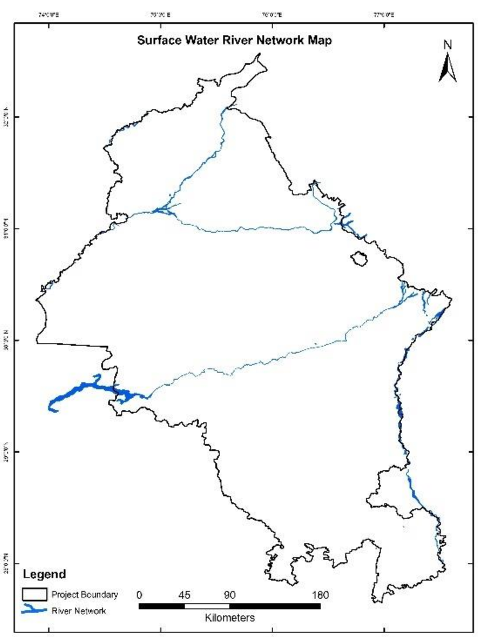

Figure 8: Surface water river network map for the project boundary[14].

[13] Source: https://cgwb.gov.in/GW-data-access.html

[14] Source: derived from sentinel data https://scihub.copernicus.eu/dhus/#/home

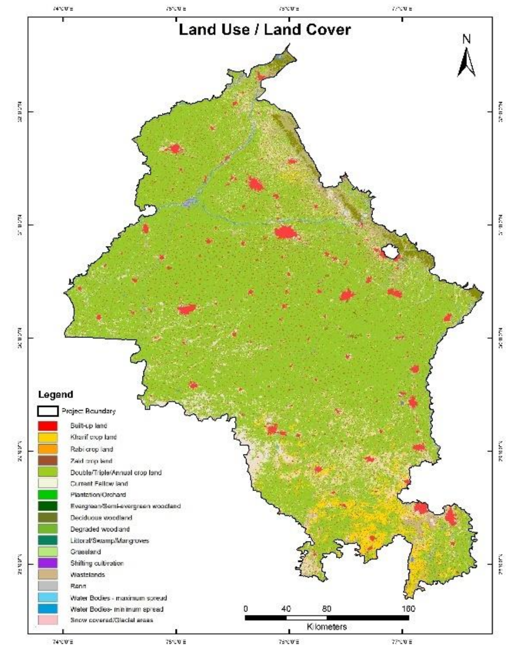

Figure 9: Land use and land cover map for the project boundary[15]

The project builds on the following practices, which are known, and one or more of them are being used by farmers, but are not common practice in the region. The project will work with multiple practices as described below:

1. Tillage – Reduced ZT with drill/ direct-seeding

Traditional (Common) practices among farmers in the region include burning crop residue followed by tillage. A key reason for the residue burning is the need to clear the field in short duration to be able to get the next crop sown before winter sets in. In a no-tillage system, crops are sown without prior tillage in the soil. Very shallow (<5 cm) disturbance is made during seed sowing, which significantly benefits soils by minimizing SOC loss. SOC build-up in a reduced tillage system is associated with microbial activity and root growth, improved nutrient and water availability, better soil structure, and aggregation by protecting Carbon from mineralization, pH, and temperature. The energy requirement of reduced tillage is less, so GHGs emission is lower. GHG emissions were reduced by 1.5 tCO_2e ha−1 year−1 in reduced-tillage-based wheat and maize systems[16]. Impact of various regenerative agriculture practices on the Rice-Wheat system in North-West India is given in table 5.

The project is not implemented to generate GHG emissions for subsequent reduction, removal, or destruction. None of the agricultural land management practices promoted in the project lead to a net increase in GHG emissions. The conditions existing prior to the project initiation are the same as in baseline scenario mentioned in section 3.4. Moreover, this project does not affect the environmental conditions, including climate, hydrology, topography, soils, type of vegetation, ecosystems, etc. Therefore, the present and prior environmental conditions of this project are the same and it can be concluded that the project was not implemented to generate GHG emissions for subsequent reduction.

[15] Source: https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php

Table 5: Impact of various regenerative agriculture practices on the Rice-Wheat system in North-West India. [16]

Technology/ practice	Crops or cropping systems	Productivity gain (kg/ ha)	Profitability ('000 INR / ha)	Water (%)	GHG mitigation (kg CO_2 eq/ ha)
Laser land levelling (LLL)	Rice-Wheat & Maize-Wheat	350-645	11-16	15-20	400-600
Reduced tillage (ZT) without residue	Wheat	300-450	8-12	-	1000-1500
ZT with residue	Wheat	410-660	11-17	6-10	1500-2000
Direct seeded rice (DSR)	Rice	±150-22	9-11	12-18	1000-2250
Permanent beds	Maize-Wheat	450-950	16-26	65-70	800-1000
Site-specific nutrient management (SSNM)	Rice-Wheat & Maize Wheat	350-650	12-16	-	500-1000
Sub-surface drip irrigation	Rice-Wheat	280-550	11-16	40-50	500-1500
Legumes inclusion (Mungbean)	Rice-Wheat; Maize Wheat	320-350	13-18	-	65-120
Portfolio of practices (LLL+ZT+Mulch+SSNM)	Rice-Wheat	110-220	20-26	15-20	2800-3000

[16] Pathak, H., Srinivasarao, C. H., & Jat, M. L. (2021). Conservation agriculture for climate change adaptation and mitigation in India. Journal of Agricultural Physics, Vol. 21, No. 1, pp. 182-196

1.14. Compliance with Laws, Statutes and Other Regulatory Frameworks

India does not regulate GHG emissions from Agriculture in the smallholder farming systems. However, the project will comply with all applicable laws and regulatory frameworks. The following legislations are considered in the legal review for the project:

- Essential Commodities (Amendment) Act, 2020
- Fertilizer Control Order, 1985
- Seeds Bill, 2004
- Insecticide (Amendment) Act, 2000
- Protection of Plant Varieties and Farmers' Rights Act, 2001
- Farmers & Farm Workers Commission Act, 2017
- National Biodiversity Act, 2002
- Punjab Preservation of Subsoil Water Act, 2009
- Haryana Preservation of Subsoil Water Act, 2009
- The Haryana Water Resources (Conservation, Regulation and Management) Authority Act, 2020
- Uttar Pradesh Ground Water (Management and Regulation) Act, 2019
- Delhi Groundwater Regulation Direction, 2010
- Environment (Protection) Act, 1986
- Air (Prevention and Control of Pollution) Act, 1981
- Water (Prevention & Control of Pollution) Act, 1974

1.15. Participation under Other GHG Programs

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

The project or any of its activities have not been registered and are not seeking registration under any other GHG program.

Projects Rejected by Other GHG Programs

The project or any of its activities have not been rejected by any other GHG program/s.

1.16. Other Forms of Credit

Emissions Trading Programs and Other Binding Limits

The agricultural project activities are not eligible under the Kyoto Protocol since there are no emission trading limits for agriculture projects in Non-Annex I countries. GHG emission reductions or removals generated by this project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions. Therefore, this project will only generate net GHG emission reductions on an additional and voluntary basis.

Other Forms of Environmental Credit

The project is not planned or being considered to create any other forms of environmental credit.

Supply Chain (Scope 3) Emissions

As a project proponent is implementing a carbon project, we ensure that the project is being carried out in compliance with the guidelines set by the VCS. This includes measuring and monitoring the carbon emissions accurately, following approved methodologies, and providing evidence of the project's impact. Our project activities do not impact the emissions of goods and services in any supply chain. The PAIs considered eligible are specific to VCS 2590. Produce from eligible PAIs in this monitoring period are not included in any Scope 3 emissions calculations. Therefore, there is no potential risk of double claiming for Scope 3 emissions.

1.17. Sustainable Development Contributions

Sustainable Development Contributions Activity Description

The project has the potential to significantly contribute to multiple United Nations' Sustainable Development Goals (UN SDGs) targets and indicators[17] through defined measures for tracking the benefits. As per the updates released by Verra on January 20th, 2022, the project must demonstrate contributions to at least three UN SDGs by the end of the first monitoring period. The project proponent has demonstrated that this project contributes significantly to 3 major UN SDGs that are specific to the project. The project covers the states of Punjab, Haryana, as shown in **Figure 1**.

SDG Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture: Proportion of agricultural area under productive and sustainable agriculture.

The project plans to implement sustainable agricultural practices on 1.7 million hectares of project area in the 20 years lifetime.

SDG Goal 6. Ensure availability and sustainable management of water and sanitation for all: Change in water-use efficiency over time.

Adopting regenerative practices will substantially increase water-use efficiency in agriculture and ensure the availability of freshwater to address water scarcity.

SDG Goal 13. Take urgent action to combat climate change and its impacts: Tons of greenhouse gas emissions avoided or removed.

The core prospect of the project is to promote regenerative agriculture practices amongst rice-wheat-maize farmers in the project location and contribute to reduction of GHG emissions,

[17] Global indicator framework for the Sustainable Development

improve soil organic carbon sequestration and subsequently generate carbon credits. These carbon credits will be utilized to incentivize farmers adopting regenerative agricultural practices. The project will reduce GHG emissions by 4,267,622-ton CO_2e annually at an average during the 20-year project lifetime.

Sustainable Development Contributions Activity Monitoring

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	2.4.	2.4.1 Proportion of agricultural area under productive and sustainable agriculture	Implemented activities to increase	The project enhances the area under sustainable agriculture by implementing regenerative agriculture practices, such as Direct Seeded Rice and Reduced Tillage in the project area. Total project area under sustainable agriculture for this monitoring period is 11,636.1 ha.	The project enhances the area under sustainable agriculture by implementing regenerative agriculture practices, such as Direct Seeded Rice and Reduced Tillage in the project area. Total project area under sustainable agriculture for this monitoring period is 11,636.1 ha. and is expected to be increasing till the end of crediting period with many farmers anticipated to participate in our carbon program.
2)	6.4	6.4.1 Change in water-use efficiency over time.	Implemented activities to increase	This project is contributing to a total water saving of about 1 to 8 million litres per hectares of the current DSR project coverage area i.e., 9,736.8 ha. Years (Calculations have been made based on literature review of several reference papers available for the project area, provided in the supporting document /42/	This project is contributing to a total water saving of about 1 to 8 million litres per hectares of the current DSR project coverage area i.e., 9,736.8 ha. years (Calculations have been made based on literature review of several reference papers available for the project area, provided in the supporting document/42/ and will be monitored till the end of crediting period.
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By implementing regenerative agriculture practices, such as Direct Seeded Rice and Reduced Tillage through VCS 2590 project, a total 57,463.83 tCO_2e of net GHG emission reduction has been achieved in the current monitoring period.	By implementing regenerative agriculture practices, such as Direct Seeded Rice and Reduced Tillage through VCS 2590 project, a total of 57,463.83 tCO_2e of net GHG emission reduction has been achieved in the current monitoring period and is estimated to be 85,352,440 tCO_2e over the entire crediting period of 20 years.

1.18. Additional Information Relevant to the Project

Leakage Management

The manure applied in the project is produced on-site from farms within the project area and is not sourced from outside of the project area. There is no livestock displacement as the cropland in the project area does not allow grazing at any time of the year.

Crop cutting trials in the project area were conducted by the PP. The data from the crop cutting trials were analysed (Section 7.4). The data of the productivity analyses from crop cutting trials conducted at the end of the rice and wheat growing seasons, respectively, is shown in Table 25 in section 7.4. The results indicate that the decline in productivity (yields) was only 3.24 % and thus within the established range of less than 5% (as recommended by VM0042 methodology) due to adoption of regenerative practices (DSR and ZT) promoted through our project. Leakage calculations were done using the equation 29 of VM0042, V1.0. We also conducted further statistical analysis (student's t-test at 95% confidence level) for verifying our results. No statistical significance was found in the change in productivity. Since the productivity decline was less than 5%, a leakage deduction of 0% was applied in the calculation of net GHG emission reduction /2/. The project will demonstrate that in every 10 years the productivity of each crop/livestock product has not declined by more than 5% in the project scenario.

Commercially Sensitive Information

All farmers' data are considered commercially sensitive information, especially their basic details. Grow Indigo will provide locations of project activity instances, management data, soil samples etc. to the registry and verifiers for transparency and verification. However, all data or identifying information have been redacted from this report to protect privacy.

Further Information

Additional information provided in the Appendix or as an annex in case required.

2. SAFEGUARDS

2.1. No Net Harm

The approach to farming in the project scenario is intended to restore the health of the soil over time, through continuous and adaptive practice change, thereby rebuilding soil carbon losse and reducing excess emissions that result from conventional agricultural practices. These eligible practices will result in an overall improvement relative to historical management practices, and thus the project activity is unlikely to result in significant negative non-GHG impact. There is no potential negative environmental and socio-economic impact of the envisaged project. The project shall not introduce any invasive species nor allow an invasive species to thrive through project implementation. The project activities neither involve nor promote alterations in the application of synthetic fertilizers, pesticides, insecticides, biologicals, or any other inputs with possible adverse effects. Farmers adhere to the recommended fertilizers dosage as provided by local Krishi Vigyan Kendras (KVKs). Based on the literature review of government websites[18] [19], the recommended

[18] Department of agriculture and farmer welfare. Government of Punjab. https://agri.punjab.gov.in/?q=fertilizers accessed on 28th April 2023.

[19] Department of agriculture and farmer welfare. Government of Haryana. https://agriharyana.gov.in/ accessed on 28th April 2023.

fertilizer dose for rice in Punjab and Haryana can vary based on factors such as soil fertility, cropping system, and specific location. However, the general recommended fertilizer dose for rice in these regions is as follows: Nitrogen (N): Typically, a total of 120-150 kg/ha is recommended. This can be divided into two or three split applications, with the first dose applied at the time of transplanting and subsequent doses given at regular intervals during the crop growth stages. Phosphorus (P): Around 40-60 kg/ha of phosphorus is generally recommended for rice cultivation. It is typically applied as a basal dose before transplanting. Potassium (K): The recommended potassium dose for rice is approximately 40-60 kg/ha. It is usually applied as a basal dose before transplanting. The recommended fertilizer dose for wheat in these regions is as follows: Nitrogen (N): Approximately 120-150 kg/ha, Phosphorus (P): Around 60-80 kg/ha, Potassium (K): Typically, 40-60 kg/ha. These recommendations may be subject to adjustment based on the specific requirements of the soil and crop, which can be determined through soil testing and consultation with local agricultural extension services or Krishi Vigyan Kendras (KVKs are an integral part of the National Agricultural Research System in India).

With regard to use of chemical weedicides in DSR, PP adheres to the guidelines[20] of state agricultural universities. These weedicides are all government-approved, as the Registration Committee "evaluates their safety and efficacy based on the field trials conducted at State Agriculture Universities/ICAR institutes and lab studies conducted at NABL/ISO:17025/ and GLP accredited laboratories" before granting approval. According to the Ministry of Agriculture, "the registered pesticides if used as per Label and Leaflets do not pose any harm to human beings, animals, environment and living organisms other than pests”.[21]

No potential negative environmental or socio-economic impacts have been identified for the envisaged project. Additionally, no complaints have been received during the current monitoring period through the established grievance mechanism or any other platforms. Refer section 2.5 for further information and evidence.

2.2. Local Stakeholder Consultation

The project is firmly committed to the principles of inclusivity and non-discrimination. Project proponent actively encourage participation from farmers of all backgrounds, regardless of gender, social status, religion, or cultural affiliation. The project participation framework is transparent and equitable, ensuring access for all interested farmers who meet the program's eligibility criteria. Furthermore, the project activities themselves are designed to be gender-neutral and culturally agnostic.

The proponent has made a comprehensive effort to utilize all effective communication channels so that all stakeholders can perceive, engage, and communicate with the project. This includes a permanent and active presence in the local and regional communities, a phone helpline, a website, and social media accounts. The Project Proponent has also actively engaged with local government officials and the scientific community to seek support regarding this project.

The location of the stakeholders are in the vicinity of the project area only. The stakeholders listed below have been identified for engagement to obtain comments and queries:

- Local farmers and farming communities
- Government agriculture departments

[20] see pg 8 here: https://www.pau.edu/content/ccil/pf/pp_kharif.pdf

[21]See page 1 of link: https://sansad.in/getFile/loksabhaquestions/annex/1710/AU1069.pdf?source=pqals#:~:text=evaluates%20their%20safety%20and%20efficacy,the%20studies%2C%20Registration%20Committee%20approves

- Research and non-government organizations

The local consultation meetings were open and accessible to all stakeholders. It was communicated effectively through multiple channels like emails, public display banners, farmer group, Universities etc.,

Stakeholder engagement process for project was designed to ensure that all participating farmers were fully informed and trained before adopting regenerative practices, with ongoing support during implementation. The PP collaborated with key institutions i.e., CIMMYT and leveraged with existing agricultural networks to identify and engage farmers in the project areas of Haryana and Punjab. Through structured outreach, awareness sessions, and in-person interactions, the PP's field teams built a comprehensive network of farmers aligned with project eligibility criteria.Each participating farmer received sufficient training both prior to adopting regenerative agricultural practices and throughout their implementation. These engagements included detailed technical trainings and awareness on regenerative practices, data collection on field, baseline practices, and geotagged field locations, followed by verification and onboarding procedures.
The PP's field teams expanded their outreach through direct in-person meetings with farmers and ongoing training sessions to ensure continued compliance and support. This approach enabled the project to reach farmers adopting regenerative practices at different stages, backed by robust onboarding procedures and continuous field engagement.

Even during the challenges posed by the COVID-19 pandemic, the PP conducting virtual consultations and training sessions to maintain consistent communication with farmers through farmers representatives.

After Covid restriction eased, the PP planned and organized multiple awareness campaigns and training workshops on the ground, as well as reached out to the farmers through digital channels on a regular basis. The efforts of these campaigns aimed to educate prospective farmers on adopting regenerative agriculture practices and encourage participation in the program. During this monitoring period, about ten physical stakeholder engagement meetings and fourteen virtual meetings were conducted in the project area (Punjab and Haryana). Out of the 2,910 farmers enrolled in the first monitoring period, about 10% were consulted initially due to COVID restrictions. However, all stakeholders (farmers) participating in the program were fully engaged and consulted during data collection as part of the comprehensive stakeholder consultation process. Additionally, our field extension officers shared information with each of our enrolled farmers in a one-on-one session. Information regarding stakeholder engagement and consultations is given in table 6.

Table 6: Information regarding stakeholder engagement and consultations

Region	Date	Stakeholder category	Place	Mode of meeting
Preliminary Stakeholder meetings before project start date				
Punjab Haryana	For 2018-20	Training and awareness programs on regenerative crop cultivation practices organized by CIMMYT	9 districts of Punjab 7 districts of Haryana	On-site
New Delhi	23rd Feb, 2019	Various farmers, agriculture bureaucrats from the Government of India, and representatives from esteemed agriculture research and science institution including CIMMYT, IARI etc.	IARI & NASC, New Delhi	On-site
Stakeholder consultation held during project implementation and monitoring phase				

Region	Date	Stakeholder category	Place	Mode of meeting
Haryana	23rd Dec 2019	Shri Kailash Choudhary, Union Minister, and local farmers	Nadana, Karnal, Haryana, India	On-site
Punjab and Haryana	Dec 2019 onwards	In-person interviews, data collection, and geotagging of farmers' fields	Covering villages of Punjab and Haryana	On-site
Punjab	18th May 2021	Representative of Farmer's forum India (BKS), CIMMYT and CGIAR	-	Virtually
Punjab	10th June 2021	Representatives from esteemed global agriculture research and science institution	-	Virtually
Haryana	13-14th July 2021	Local farmers and farming community	Karnal	On-site
Delhi	15 Sept 2021	The Nature Conservancy (TNC India), International Maize and Wheat Improvement Centre (CIMMYT), Borlaug Institute for South Asia (BISA), Syngenta Foundation India (SFI) and Tata Trusts, Local farmers and farming community	-	Virtually
Punjab	27 Sept 2021	Officials of the Department of Agriculture, Govt of Punjab, and CIMMYT, Local farmers and farming communities	Mohali	On-site
Punjab	15th September 2021	Scientists of Indian agricultural research institute, (CIMMYT), Central soil salinity research institute	-	Virtually
Punjab	13th and 14th October 2021	Chief agriculture officers of Bhatinda and local farmers	Bhatinda	On-site
Haryana	29th March 2022	The Nature Conservancy (TNC India), International Maize and Wheat Improvement Centre (CIMMYT), Central soil salinity research institute (CSSRI), various regional farmers.	Karnal	On-site

Most of the meetings were held within the project area to ensure relevance and accessibility to the primary stakeholders like farmers. There is no negative impact foreseen due to implementation of our project on local stakeholders and areas outside the project. Rather, there are positive impact on the soil, air human health particularly women health and water quality due to improved soil health and reduced emissions by adoption of regenerative agricultural practices in the project area, which would benefit the stakeholders residing within, outside or on the edge of the project.

Virtual consultation with multiple stakeholders

During covid-19 period the stakeholders have been engaged actively and were excited about the incentive model for adopting regenerative agriculture. The system for ongoing communication with local stakeholders is as follows:

Consultation meetings/21/with the stakeholders are conducted regularly to seek feedback and inputs. Queries raised by the stakeholders are answered during the meetings. The field coordinators and agronomists who are part of the farmer enrolment and project monitoring activities are directly in touch with the farmers enrolled in the project. They are connected through phone calls and messaging apps with the farmer community in the project area. The coordinators also regularly visit the project geographies to interact with the enrolled farmers. In addition, the close proximity of the villages enables direct communication between the farmers and key stakeholders such as GI field coordinators, agronomists, and project partners, including government agricultural officers.

Figure 10: Project proponents participated in virtual consultation with multiple stakeholders facilitated by TNC – Sep 2021

Farmer awareness camps and meetings

The PP conducted farmer awareness camps and meetings/21/. These meetings were designed to inform prospective farmers of the project details and answer any questions or concerns brought forward. Seminars were also held for enrolled farmers to inform them regarding next steps: planning, development, monitoring, and implementation of the GI carbon program. Farmers were provided with information about regenerative agricultural practices that would lead to reduction of GHG emissions and increased carbon sequestration in their farms. PP has also developed extensive social media reach via whatsapp, facebook, youtube and call center to reach farmers and create awareness as well as address any queries they may have.

Figure 11: Farmer awareness and education on regenerative agricultural practices

Farmer onboarding

The Grow Indigo Carbon Project identified and engaged participating farmers through a phased, structured approach, supported by collaboration with knowledge partners such as CIMMYT. Initial farmer training and consultation sessions were conducted by CIMMYT, beginning in July 2018, in the project areas of Haryana and Punjab, introducing regenerative agricultural practices such as Direct Seeded Rice and reduced tillage. These sessions laid the technological training to farmers, groundwork for farmer awareness and understanding of the project's objectives among the initial participating farmers.

Through in-person interaction, Grow Indigo played a more direct role in engaging and training farmers across Haryana and Punjab. From end of 2019, the project team initiated in-person meetings with each farmer, ensuring direct communication and onboarding to address individual concerns and questions. Structured awareness sessions, onboarding meetings, and training camps were conducted to ensure that both initial adopters and new adopters of regenerative practices were fully informed and trained. Each participating farmer received continuous training and guidance prior to adoption and throughout the implementation of regenerative practices.

The onboarding process included the systematic collection of detailed farmer data, covering the regenerative agricultural practices adopted (after start date), baseline farming practices, crop types, personal information, and geotagged field locations etc. This collected data was further quality checked to assess the eligibility for inclusion of the field in the project. Eligibility was further confirmed based on the baseline schedule of activities, starting from 1st June 2016, and covering the Project period from 6th May 2019 to 31st May 2022 (for the first PAI).

Once eligibility of farmers was confirmed, the kisan advisors visited them to sign an agreement with the PP to officially join them into Grow Indigo's carbon program.

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Figure 12: Farmer enrolment and onboarding with proper documentation.

Stakeholder consultation and farmer meeting, Mar 2022

As a crucial part of the project efforts made to promote sustainable land management practices, Proponent conducted meetings in different regions of the project area with farmers and other technical and non-technical stakeholders. These meetings aim to educate farmers on the benefits of regenerative practices that improve soil carbon and health, leading to increased agricultural productivity. We emphasize the importance of proper awareness of land management practices and provide clear guidelines on how farmers can adopt new practices and monitor changes in soil carbon. We also highlight the incentives available to farmers for following good regenerative practices, which can help smallholder farmers become more profitable and economically secure. By working together with our stakeholders, we promote sustainable and profitable agriculture for the long-term benefit of all involved.

Figure 13: Stakeholder consultation and farmer meeting, Mar 2022

Figure 14: Stakeholder consultation and farmer meeting, Mar 2022

Meeting with Chief Agri and nodal officer.

On 13th and 14th of October 2021, the PP had a meeting with the chief agriculture officers of Bhatinda.

On 28th of September 2021, the PP held a workshop with the Government of Punjab agriculture department in Chandigarh.

Figure 15: Meeting with Chief Agri and nodal officer.

Punjab agriculture officers training program at Mohali – Sep 27, 2021

The training program at Mohali was attended by the Director, Joint Director, Chief Agri and nodal officers of CIMMYT, and BISA teams, including 23 attendees. It provided an overview of the Carbon program and training on monitoring plan and mobile Application. The carbon management App was also tested on the field and updated.

Figure 16: Punjab agriculture officers training program at Mohali – Sep 28, 2021

Ground truthing and soil sampling

After COVID-19 restriction eased, to check the eligibility and monitor the implemented project practice, a ground truth survey was conducted for crop practice identification (DSR/TPR) in the month of July 2021.

For tillage practices (conventional/regenerative) the ground truthing was conducted in the month of December 2021. All the ground verified fields of farmers were geotagged using the Grow Indigo carbon management application. The soil samples were also collected for two different depths (0-15 cm and 15-30 cm) in the defined project area. Soil samples were collected in different locations in the project area during December 2021. These samples were further sent to a nationally accredited soil testing laboratory for various soil parameter analyses (soil organic carbon, bulk density, texture, pH, Clay fraction, field capacity, wilting point, conductivity, porosity).

Figure 17: Ground Truthing tillage

Self-paced educating videos for farmers about carbon farming.

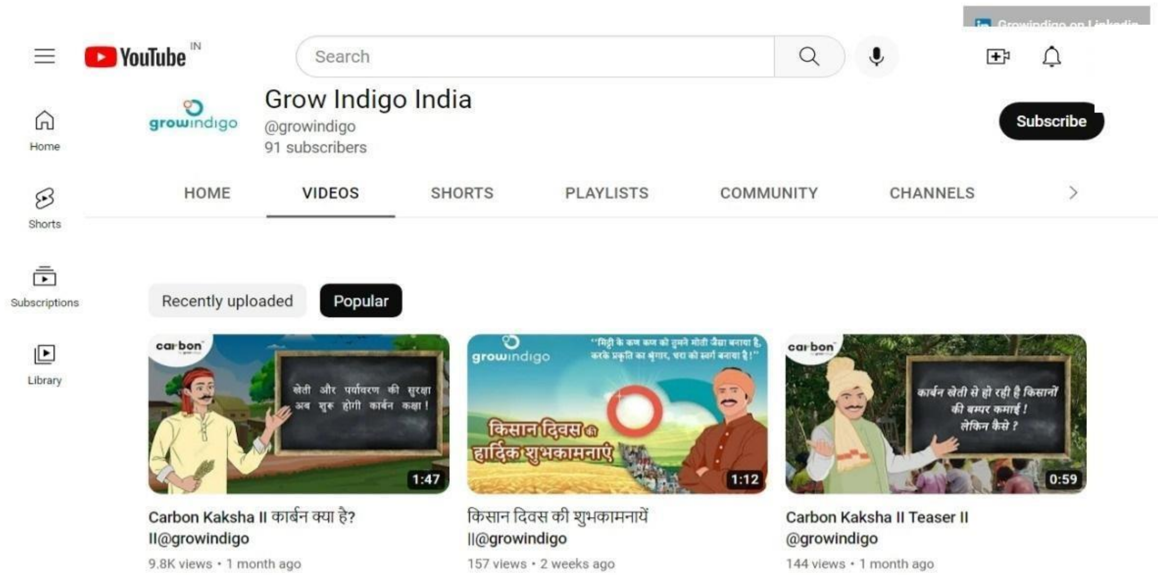


Figure 18: YouTube channel has been stared with educational videos for farmers to understand benefits of carbon farming and regenerative agriculture

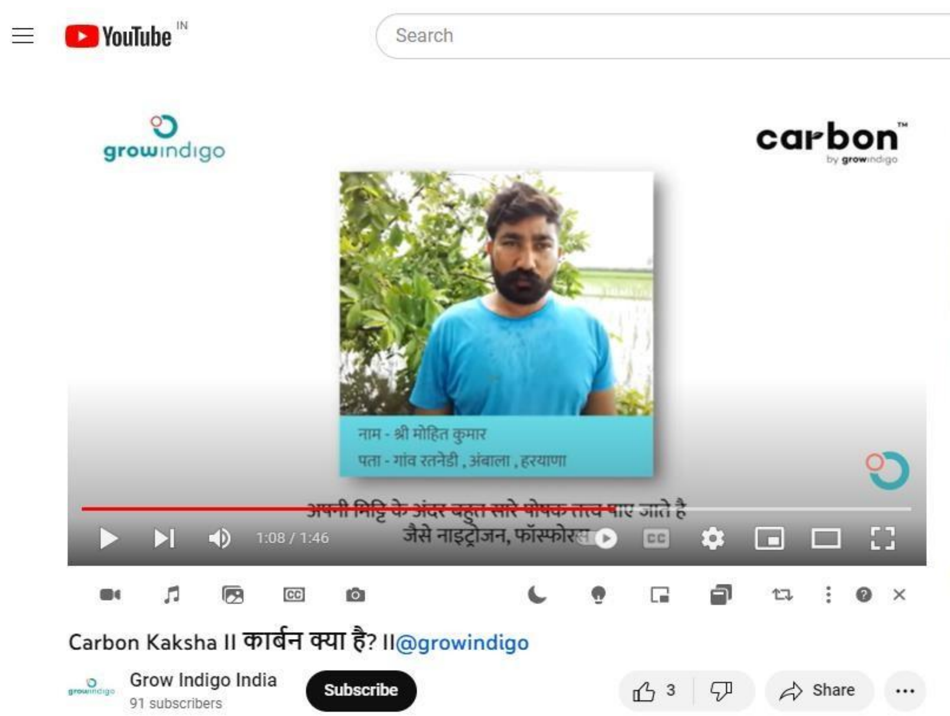


Figure 19: Farmers to Farmer - exchange of views and experience

The folder containing details of all the stakeholder engagement meetings held before the project start date and during the project monitoring period and various communications, SOP for stakeholder engagement, communication channels have been shared separately, as supporting documents/20/ with the VVB.

Examples of feedback/inputs received during consultation are given below:

a) Farmers expressed their inclination to stick to conventional / traditional practices due to limited technical knowledge related to soil, water, residue management, and other resource management and lack of awareness about sustainable agriculture practices. There are significant cultural, knowledge and technical barriers to the adoption of regenerative agriculture practices.

Action taken: The PP has provided technical support to the farmers in the project area through training programs and workshops conducted during this monitoring period. This project has leveraged support from recognized or accredited agricultural universities or institutions and agriculture extension centres (Krishi Vigyan Kendras) to overcome the technical barriers. Technical support for farmers tailored to the local conditions, regarding GI carbon program and adoption of regenerative agricultural practices and their benefits on soil health and climate, has been provided through comprehensive training programs conducted in the project area during this monitoring period. The traditional beliefs among farmers, like tillage to improve soil and crop productivity and residue burning to reduce pests and diseases and increase soil fertility, are major social and cultural barriers that has been addressed through the interaction of the participating farmers with the PP technical staff, field coordinators, and agricultural experts on a regular basis, who create awareness, educate and train the farmers.

b) There is a lack of incentives to follow these sustainable agriculture practices.

Action taken: Project will provide majority of the carbon credit sales value, that is generated from the adoption of regenerative agriculture practices in the project area on the project participant's land. With this, Grow Indigo – carbon program encourages them to adopt regenerative agriculture practices.

c) Farmers suggested that stakeholder meetings should be conducted on regular basis for better communication and implementation of the project.

Action taken: Interaction of the participating farmers with the PP technical staff, field coordinators, and agricultural experts will be conducted on a regular basis, and the PP will continue this interaction, support, and training throughout the project lifetime.

How the project has or will communicate the following

1. The project design, implementation, monitoring results

   Project design, implementation, and monitoring results have been communicated to the farmers through digital circulation, social media (WhatsApp and call centre) as well as through in-person visit by GI field co-ordinators to the project participant's field. Farmers are also supported to develop their own communication platforms to share their implementation experience and monitoring results with each other through WhatsApp groups.

2. The risks, costs, and benefits of the project to the stakeholders

   Field coordinators directly communicated with the project participants through in-person visits, telephonic conversations, and WhatsApp to explain the project risks, costs, and benefit to local stakeholders. Workshops and focus group meetings were held regularly to ensure full transparency of any new risks or costs, as well as potential benefits to all stakeholder groups.

3. Relevant laws and regulations covering workers' rights in the host country.

   The project supports farmers with training on relevant laws related to worker rights and general employment good practice. These trainings are carried out by GI technical staff, field coordinators, and agricultural experts who are fluent in and able to deliver the training and associated materials in local languages.

4. Environmental and economic benefits of the project

   The implementation of project activities has beneficial impacts on the environment, including GHG emission reduction, carbon sequestration, ground and surface water conservation, healthier soils, improved soil biodiversity, and improved farm incomes through carbon revenue.

5. The VCS Program validation and verification process and VVB site visit

   After receiving the list of sites shortlisted for field visit by the VVB, the VCS Program validation and verification process and agenda of site visit was communicated by the GI field coordinators via telephonic conversation in the local language, followed by an in-person visit by field coordinators to the shortlisted farmers' fields. FPIC information is given in table 7 below.

Table 7: Free Prior and Informed Consent

Obtaining consent	The property and land use rights of local stakeholders have been respected, and free, prior consent has been obtained from the enrolled farmers through formal agreements. PP conducted consultations with farmers to explain the agronomic benefits and carbon potential of the project activities. If a farmer shows interest in joining the project, the contract details are thoroughly discussed for enrolment. Farmers who decide to participate, provided their consent through a formal Farmer's Agreement.
Outcome of FPIC	Farmers gained knowledge and understanding about greenhouse gases (GHG) and their environmental impact, which led to increased awareness and involvement in the project, as well as an understanding of the benefits of carbon credits.

2.3. Environmental Impact

This project does not require any environmental impact assessment as per the law of India. It is anticipated that the project activities will have beneficial impacts on the environment, including GHG emission reduction, carbon sequestration, ground and surface water conservation, healthier soils, improved soil biodiversity, and improved farm incomes. The project shall not introduce any invasive species nor allow an invasive species to thrive through project implementation. The project activities do not introduce nor promote the use of fertilizers, chemical pesticides, biological control agents or other inputs with possible adverse effects.

2.4. Public Comments

No comments were received during the 30-day period after listing of the project.

2.5. AFOLU-Specific Safeguards

Local stakeholder identification:

- One of the primary goals of the project is to identify interested stakeholders. Local stakeholders refer to individuals, groups, or organizations sharing common interest in the project, which may be because of the project location, its characteristics, its impacts, or matters related to project participant's interest. These stakeholders should be engaged throughout the life cycle of the project and any concerns or issues raised are monitored and mitigated strategically. The local village representatives and agricultural officials were considered as the key informants and focus groups who have the best knowledge regarding the local farmers. The potential stakeholders may include: Project participants: farmers

- Community leaders
- Local governments (panchayat, department of agriculture council of farmers)
- Nonprofit or voluntary social development organizations, such as environmental NGOs
- Agriculture extension centres, Krishi Vigyan Kendras (KVKs)
- Recognized or accredited agricultural universities or institutions and
- Agricultural science and technology firms

Process to ensure ongoing communication with local stakeholders, and a grievance redressal procedure:

Details of the processes to ensure ongoing communication and consultation with local stakeholders is given in the SOP for stakeholder engagement document/20/. The field coordinator appointed by the project proponents would record and report any dissatisfaction among local communities and farmers. The PP has a well-defined grievance redressal procedure to resolve any conflicts which may arise between the PP and local stakeholders. The grievance redressal mechanism/27/ for complaints related to VCS 2590 states all the actions and procedures the PP takes/follows to safeguard the interests of the stakeholders.

1. Farmers can raise a complaint through email or phone number, provided on Grow Indigo website (https://www.growindigo.co.in/contactus). Or

2. Alternatively, the farmers may contact Grow Indigo's field agent directly or through the WhatsApp channel. (+91 9990577474); all enrolled farmers have access to this WhatsApp number). The complaints will be resolved within a duration of 2 weeks.

3. Farmer also has an option of registering feedback/complaint through farmer portal App.

4. If the complainant is not satisfied with the resolution provided, he/she can file for a review.

So far, no complaints have been received during validation and current monitoring period through the grievance mechanism or any other channels.

Risks to local stakeholder resources due to project implementation and how the project will mitigate such risks:

No risks to local stakeholders due to project implementation have been identified. The nature of the project design is to improve stakeholder resilience to climate change.

There are significant cultural, knowledge and technical barriers to the adoption of regenerative agriculture practices. Traditionally, farmers stick to conventional farming methods due to limited technical knowledge related to soil, water, residue, and other resource management. The PP will not only train them regarding regenerative agriculture practices but also provide technical support throughout the project's lifetime. This project will leverage support from international educational institutions and extension agencies to overcome these barriers. The traditional beliefs among farmers, like tillage to improve soil and crop productivity and residue burn to reduce pests and diseases and increase soil fertility, are major social and cultural barriers that can be addressed by the interaction of the participating farmers with the PP technical staff, field coordinators, and agricultural experts on a regular basis, during the project lifetime.

The project does not present any risks to the well-being, food security, or working conditions of stakeholders, as the working conditions on farms remain same between the baseline and project scenarios. The activities, such as direct seeding of rice and reduced tillage, are expected to significantly improve working conditions. like, DSR reduces physical strain on farmers by eliminating long hours in standing water, which also lowers the risk of waterborne diseases. Reduced tillage improves soil organic matter and moisture retention, supporting healthier crops with fewer chemical inputs. This leads to reduced toxic residues in food, promoting better health for both producers and consumers. Agricultural Land Management (ALM) practices will improve environmental outcomes without negatively affecting crop yields and will enhance the resilience of the farming system to climate change by reducing or removing greenhouse gas emissions through improved agricultural practices. By providing training and capacity-building to farmers it will promote adoption of regenerative agriculture, thus contributing towards enhancing farmers well-being, food security, working conditions, etc.

Since the project is promoting improved agricultural practices, hence no risks have been identified to the safety of minority and marginalized groups, including women, girls, and children.

The project proponent has respected the internationally proclaimed human rights and reaffirms its belief in fundamental human rights, dignity and worth of person, and equality of rights of men and women for participation in consultation and project activities.

Project implementation will not impact local stakeholder's property rights without the free, prior, and informed consent.

The project proponent or any other entity involved in project design or implementation shall not be involved in any form of discrimination or sexual harassment. To mitigate the risk, PP has a Prevention of Sexual Harassment (PoSH) policy and committee in place/48/. Furthermore, regular trainings and awareness sessions are also conducted by external experts to build awareness and sensitize the team on this important and sensitive matter.

The project proponent has entered into legal agreement with the project farmers for their voluntary participation in the project. The land rights of the farmer are retained with the farmer and same is explained in detail in section 1.7 above. Thus, property rights of the farmers are respected.

Direct seeded rice (DSR) and reduced tillage (ZT) have a significant positive impact on natural resources by promoting sustainable agricultural practices. DSR conserves water, while ZT improves soil health by minimizing disruption, fostering a healthier environment for microorganisms and enhancing soil biodiversity. Both practices help conserve vital resources like water and soil, while also reducing greenhouse gas emissions, contributing to overall environmental sustainability in positive manner.

Effective weed management is essential for maintaining crop yields in direct seeding of rice (DSR). Recognizing the inherent challenges of weed control in this method, the project emphasizes sustainable practices such as manual weeding to lessen reliance on chemical weedicides and reduce environmental impact. Farmers receive training in effective weed management techniques that aim to preserve productivity while limiting chemical use. However, in instances where manual weeding is not feasible due to labour constraints or specific agronomic conditions, the judicious and limited use of chemical weedicides is inevitable as a supplementary measure. The project's primary measure of success is overall yield outcome, which serves as a key indicator that recommended effective weed management strategies. To mitigate the risks associated with chemical application the project proponent raises awareness among farmers about state agricultural university guidelines and the use of government-approved weedicides, which are considered safe and effective based on rigorous evaluations and pose no net environmental harm when used as directed.

The project proactively communicated the potential risks and costs associated with adopting regenerative agriculture practices to all stakeholders, particularly smallholder farmers, through a combination of in-person meetings, awareness sessions, and virtual consultations. During these engagements, farmers were informed in clear and accessible language about the upfront investment costs required for transitioning to practices such as DSR and reduce Tillage, as well as the project-level risks including possible delays in carbon credit issuance and revenue payouts. To mitigate these risks, the PP provided continuous technical support and hands-on training to efficient implementation of project practices. The PP transparently outlined expected timelines for carbon revenue distribution and highlighted that payments are contingent on third-party verification and successful credit issuance processes.

3. APPLICATION OF METHODOLOGY

3.1. Title and Reference of Methodology

- VM0042: Methodology for Agriculture Land Management, version 1.0, 19 October 2020, sectoral scope 14
- VMD0053: Model calibration, validation, and uncertainty guidance for the methodology for improved agricultural land management, version 1.0, 19 October 2020, sectoral scope 14
- VCS Standard, version v4.5 dated 29 August 2023
- VCS Registration & Issuance Process, version v4.3, 17 January 2023
- VCS project description template, version v4.2, 21 December 2022
- VCS program guide, version v4.3, dated 17 January 2023
- AFOLU Non-Permanence Risk Tool, v4.0, 19 September 2019

3.2. Applicability of Methodology

With the project activities envisaged, the methodology VM0042 v1.0 and VMD0053 v1.0 are applicable. This methodology quantifies the GHG emission reductions or removals and SOC sequestration resulting from the adoption of improved agricultural land management (ALM) practices. Such practices include, but are not limited to, reductions in tillage, and improved sowing and water management, this methodology quantifies the net emissions of CO_2, CH_4, and N_2O from project activities. The scope of the methodology is global and applies to a broad range of agricultural management project activities that increase SOC storage and/or decrease net GHG emissions compared to the baseline scenario.

The VM0042 methodology is applicable for this project due to the following:

1. The project must introduce or implement one or more new changes to pre-existing agricultural management practices, which are:

i. Reduce fertilizer application.

ii. Improve water management.

iii. Reduce tillage and residue management.

iv. Crop planting and harvesting

v. Improve grazing practices.

Appendix 1 in VM0042 1.0 provides a non-exhaustive list of eligible ALM practices. A change in practice constitutes the adoption of a new practice, cessation of a pre-existing practice, or adjustment to a pre-existing practice that results in GHG emissions reduction or removal.

Justification: The project activity instances are eligible to adopt one or more of the listed management practices in Appendix 1 in VM0042 v1.0. The details are provided in section 1.11.

Projects that introduce or implement quantitative adjustments (e.g., decrease in fertilizer application rate) must exceed five percent of the pre-existing value, calculated as the average value over the historical look-back period, developed for the baseline schedule of activities (see Section 6). Appendix 1 gives additional details and guidance on practices and on determining practice change.

Justification: The project is in compliance with this applicability condition as the project area is subjected to fertilizer application in both baseline and project scenarios, but no adjustments or modifications have been adopted in the project and baseline scenarios.

2. Project activities must be implemented on land that is either cropland or grassland at the project start date. The land must remain cropland or grassland throughout the project crediting period (i.e., land use change is not eligible, including conversion from cropland to grassland and grassland to cropland).

Justification: The project activity instances in the project area fulfil this criterion. This is supported by satellite imagery or LULC map/34/.

3. The project area must not have been cleared of native ecosystems within the 10-year period prior to the project start date.

Justification: The project focuses on agricultural land that has been in the cropping system for at least 10 years and no clearance of any native ecosystems within the 10-year period prior to the project start date has taken place. This has been supported by satellite imagery in the form of LULC map/34/

4. The project activity is not expected to result in a sustained reduction of greater than 5%[22] in productivity, as demonstrated by peer-reviewed and/or published studies on the activity in the region or a comparable region.

Justification: The project activity has not caused a sustained reduction in productivity of greater than 5 percent, as demonstrated by peer-reviewed and/or published studies on the activity in the region or a comparable region. To estimate the effect of practice change on yield, crop cutting trials were conducted in the project location at the end of harvesting. Based on the statistical tests conducted, it is concluded that there was no significant effect on yield with practice change in the project area/40/.

5. If the project activity involves the application of biochar, it must be produced using feedstock that would otherwise have been left to decay in aerobic or anaerobic conditions or been burned in an uncontrolled manner.

[22] 5% is the *VCS Methodology Requirements* threshold for emissions that can be considered *de minimis*.

Justification: The project activity does not include the application of biochar as a soil amendment.

The methodology is not applicable under the following conditions:

6. The project activity cannot occur on a wetland. Note that this condition does not exclude crops subject to artificial flooding where it can be demonstrated that crop cultivation does not impact the hydrology of any nearby wetlands.

Justification: The project activity does not occur on a wetland. The inclusion of new project instances will ensure that they do not occur on wetlands. This is supported by satellite imagery /6/.

Additional conditions for application of model: Empirical or process-based models used to estimate stock change/ emissions via Quantification Approach 1 must be:

a) Publicly available, though not necessarily free of charge, from a reputable and recognized source (e.g., the model developer's website, IPCC, or government agency). Sufficient conceptual documentation of inputs, outputs, and information on how the model functionally represents SOC dynamics must be accessible to the public. Providing the source code or an API for independent replication of calculations is not required.

Justification: The VM0042 methodology does not mandate the use of any specific model. Rather, this methodology is applicable where empirical or process-based models are used to estimate stock change/emissions that meet specific conditions. The project uses the DNDC 9.5 model for the quantification of SOC and methanogenesis. This model is publicly available for research purposes and PP has obtained an exclusive license to use the model in the geography. This is one of the only models which has been extensively researched for rice crop and has also been validated by IME for use within the project area.

b) Shown in peer-reviewed scientific studies to successfully simulate changes in SOC and trace gas emissions resulting from the changes in ALM practices included in the project description.

Justification: The DNDC 9.5 model is scientifically proven, peer-reviewed, and sourced from reputable and recognized sources. Peer-reviewed studies[23],[24] have shown the applicability of DNDC model in the project area and conditions.

c) Able to support repetition of the project model simulations. This includes clear versioning of the model used in the project and stable software support, as well as fully reported sources and values for all parameters used with the project version of the model. Where multiple sets of parameter values are used in the project, clearly identify the sources of varying parameter sets and how they were applied to estimate stock change/ emissions in the project. Acceptable sources include peer-reviewed literature and statements from appropriate expert groups that demonstrate evidence of expertise with the model via authorship of peer-reviewed model publications or authorship of reports for entities supporting climate-smart agriculture. These sources must describe the datasets and statistical processes used to set parameter values.

Justification: The project has used scientifically proven, publicly available, peer reviewed DNDC 9.5 model as per the guidelines of VMD0053 and VM0042 that can support the repetition of the project model simulation changes in SOC/ trace gas emissions as a result of project activities implemented in the project locations. Our project employs the DNDC 9.5 mode[25] for accurate quantification of

[23] Jha, P., Lakaria, B.L., Vishwakarma, A.K., Wanjari, R.H., Mohanty, M., Sinha, N.K., Somasundaram, J., Dheri, G.S., Dwivedi, A.K., Sharma, R.P. and Singh, M., 2021. Modeling the organic carbon dynamics in long-term fertilizer experiments of India using the Rothamsted carbon model. Ecological Modelling, 450, p.109562

[24] Pathak, H., Li, C. and Wassmann, R., 2005. Greenhouse gas emissions from Indian rice fields: calibration and upscaling using the DNDC model. Biogeosciences, 2(2), pp.113-123.

[25] https://www.dndc.sr.unh.edu/. Accessed on 23rd January 2022.

SOC and methanogenesis processes. This model is publicly accessible via the University of New Hampshire's website for research purposes[21]. Additionally, the PP holds exclusive commercial rights to utilize the DNDC model within the project area. The model has been validated by the IME and the details (input parameters, calibration details, validation dataset) are provided in the model validation report (MVR)/36/. The MVR also describes the statistical approaches adopted in uncertainty calculations.

d) Validated per datasets and procedures detailed in Section 5.2 of VMD0053 Model Calibration and Validation Guidance for Methodology for Improved Agricultural Land Management. Model prediction error must be calculated using datasets as described in Section 5.2.5 of VMD0053 and must use the same parameters or sets of parameters applied to estimate stock change/ emissions in the project.

Justification: The model calibration, validation, and model prediction error has been calculated as per the guidelines of VMD0053. The MVR also describes the statistical approaches adopted in uncertainty calculations/45/. The same set of parameters that were applied during the calibration were also applied for validation and quantification (for emission sources CH_4, N_2O and SOC). More specific details can be referred to in IME validated, Model Validation Report.

Using the same model version in the baseline and project scenarios. Further, the same parameters/ parameter sets must be used in the baseline and project scenarios. Model input data must be derived following the guidance in table 6 and table 8 of VMoo42 v1.0. Model uncertainty must be quantified following guidance in Section 8.6. Models may be recalibrated or revised based on new data, or a new model may be applied, provided the above requirements are met.

Justification: The same model version DNDC 9.5 has been used in both the baseline and project scenarios. The details of parameters/ parameter set that were applied in the baseline and project scenarios are elaborated in the MVR/36/ validated by the IME. Model input data was derived following the guidance table 6 and table 8. Model uncertainty was quantified following guidance in section 8.6.

3.3. Project Boundary

The relevant GHG sources identified for the project and baseline scenarios are listed in the table below. The locations included at the time of validation are limited to those for which the baseline data on farmer practices, climatic, and soil conditions are available from Govt. reports or farmer surveys, and the SOC measurements are available for farms spread across various strata in the project boundary.

Selected carbon pools in the baseline and project scenarios are given in the table below

Source	Included?	Justification/ Explanation
Above-ground woody biomass	No	The project activity does not include agroforestry. Hence, any changes in above-ground woody biomass is not included in the project scenario.
Above-ground non-woody biomass	No	Carbon pool is not included because it is not subject to significant changes or potential changes are transient in nature.
Below ground woody biomass	No	The project activity does not include any change in woody biomass. Hence, this pool is not considered.

Source	Included?	Justification/ Explanation
Below ground non-woody biomass	No	Carbon pool is not included because it is not subject to significant changes or potential changes are transient in nature.
Deadwood	No	Carbon pool is not included because it is not subject to significant changes or potential changes are transient in nature.
Litter	No	Carbon pool is not included because it is not subject to significant changes or potential changes are transient in nature.
SOC	Yes	The project activities such as reduced tillage will increase the overall net SOC pool in the project scenario.
Wood products	No	Carbon pool is optional for ALM project methodologies and is therefore excluded from the project boundary

GHG Sources included or excluded from the baseline and project scenarios are given in table below.

Source		Gas	Included?	Justification/Explanation
Baseline	SOC	CO_2	Yes	Included in the baseline scenario as CO_2 is a major source affected by the project activity. .
		CH_4	No	Not applicable to this project
		N_2O		
		Other		
	Fossil fuel	CO_2	No	No activities resulting in changes to fossil fuel consumption are occurring in the baseline for the project activity. Therefore, fossil fuel consumption is not included in this project.
		CH_4		
		N_2O		
		Other		
	Soil methanogenesis	CO_2	No	Not applicable to this project
		CH_4	Yes	Major GHG source subject to the project activity, as conventional rice farming practices release higher methane emissions from flooded fields. The DNDC 9.5 model has been used to quantify soil methanogenesis.

Source		Gas	Included?	Justification/Explanation
		N_2O	No	Not applicable to this project
		Other		
	Enteric fermentation	CO_2	No	Livestock are not considered in the baseline scenario. Hence it is excluded from the project.
		CH_4		
		N_2O		
		Other		
	Manure deposition	CO_2	No	There is no manure decomposition expected in the project; therefore, it is excluded.
		CH_4		
		N_2O		
		Other		
	Use of nitrogen fertilizers	CO_2	No	Included in the project boundary as synthetic nitrogen fertilizers were applied in project and baseline scenarios, so N2O emissions from nitrogen fertilizers were quantified.
		CH_4		
		N_2O	Yes	
		Other	No	
	Use of nitrogen fixing species	CO_2	No	There are no nitrogen fixing species that are planted in the baseline scenario. Hence, it is excluded.
		CH_4		
		N_2O		
		Other		
	Biomass burning	CO_2	No	Excluded because it does not meet additionality (regulatory surplus) criterion.
		CH_4		
		N_2O		
		Other		
	Woody biomass	CO_2	No	The project activity does not include agroforestry activity. Hence, it is excluded.
		CH_4		
		N_2O		
		Other		

Source		Gas	Included?	Justification/Explanation
Project	SOC	CO_2	Yes	The SOC pool is included in the project because it is expected to increase and is sensitive to project interventions and plays a key role in emission reductions. Project activities, such as sustainable land management, result in a net increase in SOC.
		CH_4	No	Excluded from this project
		N_2O		
		Other		
	Fossil fuel	CO_2	No	Excluded from this project.
		CH_4		
		N_2O		
		Other		
	Soil methanogenesis	CO_2	No	Excluded from this project
		CH_4	Yes	Methane emissions resulting from project scenarios are included. The DNDC 9.5 model has been used to quantify soil methanogenesis.
		N_2O	No	Excluded from n this project
		Other		
	Enteric fermentation	CO_2	No	Livestock are not considered in the project scenario. Hence it is excluded from the project.
		CH_4		
		N_2O		
		Other		
	Manure deposition	CO_2	No	There is no manure decomposition expected in the project; therefore, it is excluded.
		CH_4		
		N_2O		

Source		Gas	Included?	Justification/Explanation
		Other		
	Use of nitrogen fertilizers	CO_2	No	The project area has been subjected to use of synthetic N-fertilization, for which survey data has been collected and emissions are quantified (modelled) in project scenarios.
		CH_4		
		N_2O	Yes	
		Other	No	
	Use of nitrogen fixing species	CO_2	No	There are no nitrogen fixing species planted in the project scenario. Hence, it is excluded.
		CH_4		
		N_2O		
		Other		
	Biomass burning	CO_2	No	Excluded because it does not meet additionality (regulatory surplus) criterion.
		CH_4		
		N_2O		
		Other		
	Woody biomass	CO_2	No	The project activity does not include agroforestry activity. Hence, it is excluded.
		CH_4		
		N_2O		
		Other		

The project activities have taken place only in some parts of the project area. The baseline information on common farmers practice in the region has been documented in several publications[26].

The project activities are implemented in 10 districts such as, Amritsar, Bhatinda, Fategarh Sahib, Fazilka, Ludhiana, Moga, Muktsar, Patiala, Sangrur in Punjab and 11 districts such as, Ambala, Bhiwani, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Rohtak, and Sirsa in Haryana only as shown in Figure 20 (also provided in above section 1.12).

[26] Jat, HS; Kumar, V; Datta, A; Choudhary, M; Yadvinder-Singh; Kakraliya, SK; Poonia, T; McDonald, A; Jat, ML and Sharma, PC.2020. Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. Nature Scientific Reports. 10:19267, https://doi.org/10.1038/s41598-020-76035-z

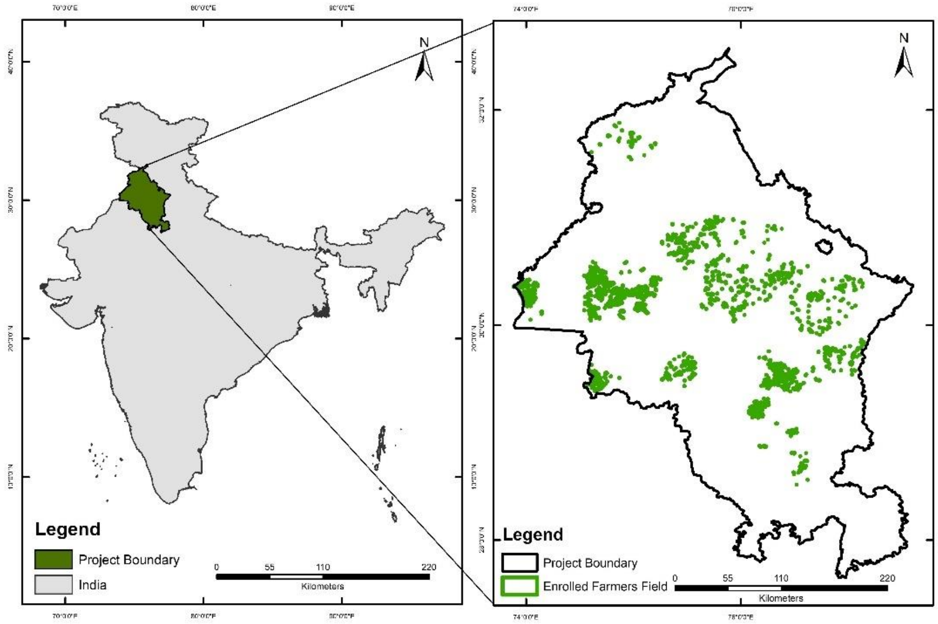


Figure 20: Location of the first PAIs (enrolled fields) in the project area

3.4. Baseline Scenario

There are two major cropping seasons (known as Kharif and Rabi) in the project area based on agricultural practices and climatic conditions. Majorly, Rice is grown as a Kharif crop[27] [28] (sowing window: May to July; harvesting window: September to November) and Wheat is grown as a Rabi crop[29] [30] (sowing window: October to November; harvesting window: March to April). As per VM0042 v1, the baseline scenario is the continuation of traditional pre-project management activities. All the PAIs in this project follow Rice-Wheat crop rotation. The baseline scenario includes agricultural practices such as flooded, transplanted rice[31] [32] and conventionally tilled wheat system [33] [34] [35]. A rice nursery is prepared for growing seedlings close to the actual farm. Rice is pre-dominantly grown by transplanting 30–35-day old seedlings into puddled water saturated with

[27] Upadhyay, G., Ray, S. S., & Panigrahy, S. (2008). Derivation of crop phenological parameters using multi-date SPOT-VGT-NDVI data: A case study for Punjab. Journal of the Indian Society of Remote Sensing, 36, 37-50.

[28] Package of practices for Kharif crops 2022, Link https://kvk.icar.gov.in/API/Content/PPupload/k0704_105.pdf. accessed on 28 November 2022

[29] Panigrahy, S., Upadhyay, G., Ray, S. S., & Parihar, J. S. (2010). Mapping of cropping system for the Indo-Gangetic plain using multi-date SPOT NDVI-VGT data. Journal of the Indian Society of Remote Sensing, 38, 627-632.

[30] Saxena, P., Sonwani, S., Srivastava, A., Jain, M., Srivastava, A., Bharti, A., ... & Bhardwaj, S. (2021). Impact of crop residue burning in Haryana on the air quality of Delhi, India. Heliyon, 7(5).

[31] Nayak, H. S., Silva, J. V., Parihar, C. M., Kakraliya, S. K., Krupnik, T. J., Bijarniya, D., ... & Sapkota, T. B. (2022). Rice yield gaps and nitrogen-use efficiency in the Northwestern Indo-Gangetic Plains of India: Evidence based insights from heterogeneous farmers' practices. *Field Crops Research*, *275*, 108328.

[32] Bhattacharyya, R., Das, T. K., Sudhishri, S., Dudwal, B., Sharma, A. R., Bhatia, A., & Singh, G. (2015). Conservation agriculture effects on soil organic carbon accumulation and crop productivity under a rice–wheat cropping system in the western Indo-Gangetic Plains. European Journal of Agronomy, 70, 11-21.

[33] Gupta, D. K., Bhatia, A., Kumar, A., Das, T. K., Jain, N., Tomer, R. & Pathak, H. (2016). Mitigation of greenhouse gas emission from rice–wheat system of the Indo-Gangetic plains: Through tillage, irrigation and fertilizer management. Agriculture, Ecosystems & Environment, 230, 1-9.

[34] Keil, A., Krishnapriya, P. P., Mitra, A., Jat, M. L., Sidhu, H. S., Krishna, V. V., & Shyamsundar, P. (2021). Changing agricultural stubble burning practices in the Indo-Gangetic plains: is the Happy Seeder a profitable alternative?. *International Journal of Agricultural Sustainability*, *19*(2), 128-151.

[35] Chaudhary, V. P., Chandra, R., Chaudhary, R., & Bhattacharyya, R. (2021). Global warming potential and energy dynamics of conservation tillage practices for different rabi crops in the Indo-Gangetic Plains. Journal of Environmental Management, 296, 113182.

anaerobic soil conditions, and the field is kept flooded for most of the growing season [36] . On the other hand, wheat is sown on well aerated, intensively tilled soils[37] [38] After rice is harvested, farmers use a variety of tilling machines (rotavator, disk harrow, disk plough, and others).

The baseline scenario of the project includes implementation of CT and TPR in the project area, i.e. the states of Haryana and Punjab. Our baseline assessment was based on surveys conducted with the farmers that enabled documentation of crop management practices, use of fertilizer, practice of crop establishment (transplanted or DSR), irrigation system and tillage / crop residue management for the previous t-3 years (2016-2018). The practices reported were observed to be in line with the traditional/mainstream pattern of farming (i.e., transplanting for rice and conventional tillage for wheat) in the project area. An illustration of the baseline scenario, common to the project area, is presented in figure 21. The baseline practices obtained from farmer surveys were found to be coherent with the recommended package of practices by the state agriculture extension booklets[39].

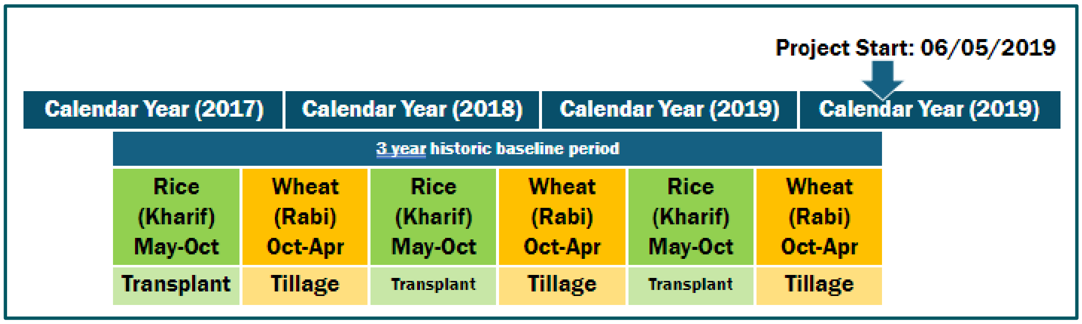


Figure 21: Representation of baseline scenario in the project area, i.e. the states of Haryana, and Punjab

Puddled transplanted rice in India contributes >24% of the total agricultural CH_4 emission (3.37 Mt) while about 0.14 Mt N_2O is emitted due to application of nitrogenous fertilizers in rice, wheat and other crops[40]. Anaerobic rice fields are thus a major source of GHG emissions while the intensive tillage and frequent irrigation consume high amount of energy and are also a significant source of CO_2 emissions[41]. Reducing atmospheric concentrations of GHGs is urgently required if we are to meet the Paris Agreement target of keeping global warming below 1.5 °C globally[42]. Due to the relatively short lifetime of CH_4 in the atmosphere (approximately 9 years), reductions in CH_4 could have a significant impact on short term trends in global warming. Reducing concentrations

[36] Nayak, H. S., Silva, J. V., Parihar, C. M., Kakraliya, S. K., Krupnik, T. J., Bijarniya, D., ... & Sapkota, T. B. (2022). Rice yield gaps and nitrogen-use efficiency in the Northwestern Indo-Gangetic Plains of India: Evidence based insights from heterogeneous farmers' practices. *Field Crops Research*, *275*, 108328.

[37] Gupta, D. K., Bhatia, A., Kumar, A., Das, T. K., Jain, N., Tomer, R. & Pathak, H. (2016). Mitigation of greenhouse gas emission from rice–wheat system of the Indo-Gangetic plains: Through tillage, irrigation and fertilizer management. Agriculture, Ecosystems & Environment, 230, 1-9.

[38] Bhatt, R., Singh, P., Hossain, A., & Timsina, J. (2021). Rice–wheat system in the northwest Indo-Gangetic plains of South Asia: issues and technological interventions for increasing productivity and sustainability. Paddy and Water Environment, 19(3), 345-365.

[39] Package of practices for Kharif crops 2022, Link https://kvk.icar.gov.in/API/Content/PPupload/k0704_105.pdf. accessed on 28 November 2022

[40] Dipak Kumar Gupta, A. Bhatia, A. Kumar, T.K. Das, N. Jain, R. Tomer, Sandeep K. Malyan, R.K. Fagodiya, R. Dubey, H. Pathak, Mitigation of greenhouse gas emission from rice–wheat system of the Indo-Gangetic plains: Through tillage, irrigation and fertilizer management, Agriculture, Ecosystems & Environment, Volume 230, 2016,Pages 1-9,ISSN 0167-8809

[41] Gupta, D.K., Bhatia, A., Kumar, A., Chakrabarti, B., Jain, N., Pathak, H., 2015. Global warming potential of rice (Oryza sativa)-wheat (Triticum aestivum) cropping system of the Indo-Gangetic Plains. Indian J. Agric. Sci. 85, 807–816.

[42] Nisbet, E.G., Fisher, R.E., Lowry, D., France, J.L., Allen, G., Bakkaloglu, S., Broderick, T. J., Cain, M., Coleman, M., Fernandez, J., Forster, G., Griffiths, P.T., Iverach, C.P., Kelly, B.F.J., Manning, M.R., Nisbet-Jones, P.B.R., Pyle, J.A., Townsend-Small, A., alShalaan, A., Warwick, N., Zazzeri, G., 2020. Methane mitigation: methods to reduce emissions, on the path to the Paris agreement. Rev. Geophys. 58 https://doi.org/ 10.1029/2019rg000675.

of N_2O is important in the longer term, as it has an expected lifetime of approximately 116 years[43], thus mitigation efforts would take several decades to reduce concentrations effectively. Reducing the environmental impacts of traditional rice production is an important step in mitigating emissions of GHGs at the global scale, and some success has been achieved in reducing GHG emissions by changing management practices.

For each PAI (field), a schedule of activities in the baseline scenario (table 8) was determined by collecting survey and attestations from farmers. The interval over which the practices were assessed for this project was 3 years, which marked the baseline period (exhibiting conventional practices). The sample units are defined as sampled fields of 1 acre size. Practice changes were adopted by the farmers after the project start date, i.e., 06-May-2019. For each year, t = -1 to t = -3, i.e. 01-May-2016 to 05-May-2019 (Figure 21), which refers to the baseline period, the information on agricultural management practices was determined, as per the requirements presented in Table 4 of VM0042 v.1.0. In the baseline scenario, agricultural management practices for wheat and rice follow conventional methods. Planting typically occurs between May and July for rice and October to November for wheat, with harvests following in September-October and March-April, respectively. Average crop yields for rice range from 3 to 6 tons per hectare (t/ha), while wheat yields fall between 2 and 5 t/ha. Farmers primarily rely on synthetic nitrogen fertilizers, applying urea (0.12 to 0.15 t/ha) and DAP (0.05 t/ha) to their fields. Tillage practices involve a depth of 5-30 cm and are repeated 3-5 times for rice and 3-9 times for wheat throughout the growing season. Over 70% of crop residue is typically removed after harvest. Water management relies on irrigation, with rice fields requiring up to 35 applications per season compared to 3-5 for wheat. Data collection for all management practices relies on farmer surveys and attestation, except for land cover classification data used to exclude grazing practices. Table 8 provides baseline schedule of activities for sample units and justification of data hierarchy.

Baseline survey methodology

A schematic representation of field survey is shown in Figure 2. The baseline survey was conducted during 2021-2022, employing a well-defined process. Grow Indigo field agents conduct on-site visits to farmers' fields. Grow Indigo's mobile application facilitates these surveys. This app includes seasonal agronomy surveys with questions related to agricultural practices (as per Table 4 of VM0042), farmer contact information, and field details such as land ownership. Leveraging the Google Maps API, the agents can directly geofence farmer fields within the app.

The Field Agents gather the farmer's personal details first. Then, they geofence each field. Finally, they collect seasonal agronomy survey data specific to each field (PAI) for the baseline period (2016-2017, 2017-2018, 2018-2019) and the project period (2019-2020, 2020-2021, 2021-2022) marking the first monitoring period. The app functions on Android devices, operable online and offline for Field Agents. Collected data is stored in an MS SQL database. Personal information is masked and confidential, with access limited to the IT database management team. All data is retained, maintaining a historical record from inception. Cross-functional teams like Remote Sensing, Modeling, Projects, or Business can access the anonymized data for analysis on a need basis.

[43] Prather, M.J., Hsu, J., DeLuca, N.M., Jackman, C.H., Oman, L.D., Douglass, A.R., Fleming, E.L., Strahan, S.E., Steenrod, S.D., Søvde, O.A., Isaksen, I.S.A., Froidevaux, L., Funke, B., 2015. Measuring and modeling the lifetime of nitrous oxide including its variability. J. Geophys. Res. Atmos. 120, 5693–5705. https://doi. org/10.1002/2015jd023267.

Figure 22: Schematic representing the field survey methodology

Following data collection, a polygon QA/QC process ensures the accuracy of field boundaries. Boundaries geotagged by the Grow Indigo mobile application are overlaid on high-resolution satellite imagery. Any discrepancies are identified by comparing the boundaries to land use features on the imagery (e.g., built-up areas, scrublands, roads, brick kilns). Non-agricultural land and agricultural plantations are excluded during this process.

For Quantification Approach 1, the baseline is modelled for each sample unit. The model serves to project stock change/emissions resulting from the schedule of agricultural management activities taking place in the baseline scenario (derived above). Only QA1 is used in the first monitoring period, therefore subdivisions of the project area using different quantification approaches is not required. The schedule of activities, beginning with year t = -3, are applied in the baseline scenario, from t = 1 onward.

Table 8: The baseline schedule of activities for sample units and justification of data hierarchy

	Agricultural Management Practice	Qualitative specification	Quantitative specification	Justification /Explanation
1	Crop planting and harvesting	• Crop type(s): Rice, Wheat	• Approximate date(s) planted: Appli cable Rice: May to July Wheat: October to November • Approximate date(s) harvested: Applicable Rice: September to October	Applicable. Rice and wheat crops are the primary crops that the project activities are targeting. No significant adoption of DSR or ZT is taking place, so farmers follow transplanting (TPR) approach to sow rice and conventional tillage (CT) before sowing of wheat. Determining crop planting and harvesting information requires farmer surveys and is confirmed by farmer attestation. The above-mentioned resources are applicable data sources according to the hierarchy of

	Agricultural Management Practice	Qualitative specification	Quantitative specification	Justification /Explanation
			Wheat: March to April Crop yield: Applicable Rice = 3 to 6 t/ha Wheat = 2 to 5 t/ha	prioritization and conservatism described in Box 1 in VM0042 v1.0, as described below: 1. In the baseline scenario, no management activities are being recorded by the farmers, and no historical management records are available in the form of documented evidence, management logs, receipts or invoices, remote sensing, etc. 2. No historical management plans supported by one or more forms of documented evidence pertaining to the project area are available. 3. The baseline management practices were determined in consultation with and substantiated with a signed attestation from the farmer or landowner. The attested values do not deviate significantly from other evidence-supported values for similar fields. The determination of the sufficiency of data is subject to the discretion of the validator. In circumstances where this requirement cannot be met, option 4 must be followed.
2	Nitrogen fertilizer application	• Manure (Y/N) • Compost (Y/N) • Synthetic N fertilizer (Y/N)	• Manure type application rate: Not applicable • Compost type application rate: Not applicable • N application rate in synthetic fertilizer: Applicable Urea = 0.12 to 0.15 t/ha	Manure and compost: Not applicable Synthetic N-fertilizer: Applicable The project area includes cropland and has been subjected to use of synthetic N-fertilization, for which farmer survey data has been collected and emissions are quantified (modelled). Determining nitrogen fertilizer application information requires farmer surveys and is confirmed by farmer attestation.

	Agricultural Management Practice	Qualitative specification	Quantitative specification	Justification /Explanation
			DAP = 0.05 t/ha	The above-mentioned resources are applicable data sources according to the hierarchy of prioritization and conservatism described in Box 1 in VM0042 v1.0, as described below: 1. In the baseline scenario, no management activities are being recorded by the farmers, and no historical management records are available in the form of documented evidence, management logs, receipts or invoices, remote sensing, etc. 2. No historical management plans supported by one or more forms of documented evidence pertaining to the project area are available. 3. The baseline management practices were determined in consultation with and substantiated with a signed attestation from the farmer or landowner. The attested values do not deviate significantly from other evidence-supported values for similar fields. The determination of the sufficiency of data is subject to the discretion of the validator. In circumstances where this requirement cannot be met, option 4 must be followed.
3	Tillage and/or residue management	• Tillage (Y/N) • Crop residue removal (Y/N)	• Depth of tillage: Applicable Rice: 5-30 cm, Wheat: 5-30 cm • Frequency of tillage: Applicable Rice: 3-5 times Wheat: 3-9 times	Applicable Determining tillage depth and frequency, and percentage of crop residue removed, requires farmer surveys, and is confirmed by farmer attestation. The above-mentioned resources are applicable data sources according to the hierarchy of prioritization and conservatism described in Box 1 in VM0042 v1.0, as described below:

	Agricultural Management Practice	Qualitative specification	Quantitative specification	Justification /Explanation
			• Percentage of crop residue removed: Applicable More than 70% removed	1. In the baseline scenario, no management activities are being recorded by the farmers, and no historical management records are available in the form of documented evidence, management logs, receipts or invoices, remote sensing, etc. 2. No historical management plans supported by one or more forms of documented evidence pertaining to the project area are available. 3. The baseline management practices were determined in consultation with and substantiated with a signed attestation from the farmer or landowner. The attested values do not deviate significantly from other evidence-supported values for similar fields. The determination of the sufficiency of data is subject to the discretion of the validator. In circumstances where this requirement cannot be met, option 4 must be followed. In addition to farmer attested data, tillage practice is qualitatively validated using remote sensing-based methodology. This is applicable as the first option in the hierarchy of information inputs from Box 1 in VM0042 v1.0. This approach was conservative, leading to some farmer-reported adoptions being disqualified (see section 6.3 of JPDMR for more details).
4	Water management / irrigation	• Irrigation (Y/N) • Flooding (Y/N)	Irrigation rate: Applicable Rice: upto 35 times per season Wheat: 3-5 times per season	Applicable Determining water management and irrigation information requires farmer surveys and is confirmed by farmer attestation.

	Agricultural Management Practice	Qualitative specification	Quantitative specification	Justification /Explanation
				The above-mentioned resources are applicable data sources according to the hierarchy of prioritization and conservatism described in Box 1 in VM0042 v1.0, as described below: 1. In the baseline scenario, no management activities are being recorded by the farmers, and no historical management records are available in the form of documented evidence, management logs, receipts or invoices, remote sensing, etc. 2. No historical management plans supported by one or more forms of documented evidence pertaining to the project area are available. 3. The baseline management practices were determined in consultation with and substantiated with a signed attestation from the farmer or landowner. The attested values do not deviate significantly from other evidence-supported values for similar fields. The determination of the sufficiency of data is subject to the discretion of the validator. In circumstances where this requirement cannot be met, option 4 must be followed.
5	Grazing practices	• Grazing (Y/N) • Animal type (if applicable) • Harvesting/mowing (Y/N)	• Animal stocking rate, i.e., number of animals and length of time grazing in a given area annually: Not applicable • Frequency of harvest: Not applicable	Not applicable. No grasslands are included in the baseline scenario. Any areas defined as grassland by applying a combination of National Land Cover classification data from 2005 to 2021 and remote sensing imagery, such as from Sentinel and Landsat, are excluded from the eligible project areas. Land cover classification is a form of remote sensing and is therefore applicable as the first option in the hierarchy of information

	Agricultural Management Practice	Qualitative specification	Quantitative specification	Justification /Explanation
				inputs from Box 1 in VM0042 v1.0.

The VM0042 methodology lists three approaches for quantification of contributing sources for CO_2, CH_4, and N_2O. Quantification approach for each GHG emission source and pool is given in table 9 below.

Table 9: Quantification approach for each GHG emission source and pool is given below:

GHG/ Pool	Source	Quantification Approach 1: Measure and Model	Quantification Approach 2: Measure and Re-measure	Quantification Approach 3: Default
CO_2	Soil organic carbon	X	-	-
	Fossil fuel	-	-	-
	Woody biomass	-	-	-
CH_4	Soil methanogenesis	X	-	-
	Enteric fermentation	-	-	-
	Manure deposition	-	-	-
	Biomass burning	-	-	-
N_2O	Use of nitrogen fertilizers	X	-	-
	Use of nitrogen fixing species	-	-	-
	Manure deposition	-	-	-
	Biomass burning	-	-	-

Baseline Stratification Plan

The project activities took place only in some parts within the project boundary (Haryana, Punjab). The state of Punjab lies roughly 29° 30' N latitudes, 73° E and 77° E longitudes and has been classified into five agro-climatic zones based on homogeneity, rainfall pattern and distribution, temperature, soil texture and cropping pattern (predominantly rice-wheat cropping system). While the state of Haryana lies in the area bounded by 27°39', 31°N latitudes and 74°30' E longitudes form the eastern part of the table land between the Sutlej and Yamuna rivers to the South and to north of Rajasthan desert. The state has 4 topographic divisions. The two states, Haryana and Punjab share similar agro-ecological conditions with similar soil textures such as Loamy, Sandy loam, Silt, Silty clay loam, and Sandy soil types. The soil map (Figure 4) indicates the physical areas of the project boundary (Haryana and Punjab) along with the agro-ecological zones and soil types shared by these two states. The above-mentioned similarities are foundational criteria to demonstrate that baseline scenario is homogeneous. Within the project area, the Rice-Wheat cropping system is prominent with a large number of farmers geographically scattered, and thus stratified random sampling approach was adopted to best represent the entire project area. The soil map of the project area (Figure 4) shows four predominant soil types which have been identified as strata 1-4.

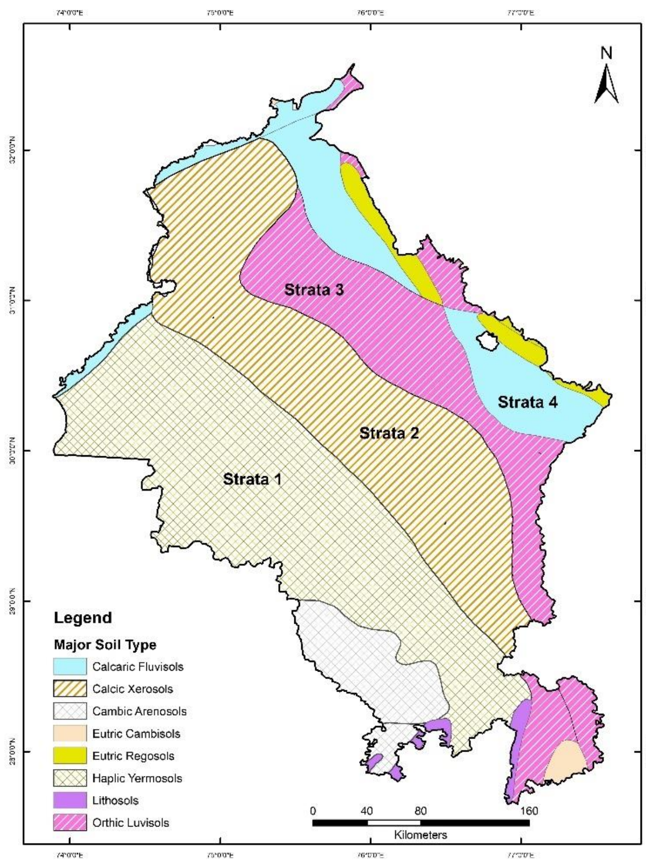


Figure 23: Stratification based on soil types in the project area.

Stratified random sampling was used to select fields for soil sampling. Strata were defined by grouping fields based on practice categories and soil types given in figure 23. Considering practice categories (CT/ ZT and TPR/ DSR) as part of stratification, also renders this sampling stratification approach suitable for project scenario. Samples collected to serve as baseline fields were also spread out geographically in the project area. Out of total 50 samples collected, 45 sampled fields were modelled, of which 16 were baseline fields. Geographic locations of sampling points were recorded during data collection. Table 10 lists the information collected at the time of soil sampling. Soil sampling for subsequent monitoring periods will be based on pre-identified sampling locations. Both the pre-identified locations and actual sampling locations will be recorded. The sample size will be adjusted to account for any new PAIs that may be included. E.g. if the no. of fields in the program increases, the no. of baseline sample fields may also increase to appropriately cover all the strata.

Table 10: Proforma of information collected at the time of soil sampling.

S.No.	Item
1	Unique soil sample ID
2	Farmer name
3	Phone no
4	Sample location GPS coordinates (Lat, Lon)
5	Date of sampling
6	Historical crop and practice information (CT/ ZT and TPR/ DSR)
7	Sample type

S.No.	Item
	• Soil bulk density 0-15cm • Soil organic carbon 0-15cm • Soil bulk density 15-30cm • Soil organic carbon 15-30cm
8	Name of the field coordinator
9	Any other relevant observations

Impact of COVID-19 Lockdown

The initial soil sampling campaign was delayed due to a nationwide lockdown and subsequent movement restrictions during the COVID-19 pandemic. As a result, the sampling area was reduced. To account for this, spatial autocorrelation analysis was employed to adjust our uncertainty estimates, as recommended by the independent modeling expert (IME). For further details, please refer to the Model validation report/36/ and IME reports.

Agricultural production estimates of commercial food crops for our project activities, i.e. rice and wheat, were evaluated for the baseline period from 2016-2019. Published state-wise agricultural production data is presented in Table 11.

Table 11: Rice and Wheat crop production (in million tons) statistics for Haryana and Punjab during the baseline period 2016-19.[44]

State	Rice	Rice	Rice	Wheat	Wheat	Wheat
	2016-17	2017-18	2018-19	2016-17	2017-18	2018-19
Haryana	4.45	4.88	4.52	12.31	12.27	12.57
Punjab	12.64	13.38	12.82	17.64	17.83	18.26

Baseline re-evaluation will occur every 10 years in accordance with Section 6 in the VM0042 methodology. At the end of each baseline period, production of the commercial crop(s) in the baseline scenario will be re-evaluated. Published state-wise agricultural production data from within the five years immediately preceding the end of the current baseline period will be consulted. Where there is evidence of continued production of the relevant commercial crop(s) using the same ALM practices in the region, the baseline scenario will be valid as is, continuing with the previous schedule of activities.

Where there is no evidence of continued production of the relevant commercial crop(s), a new schedule of ALM activities (evaluated against common practices in the region) will be developed based on written recommendations for the sample field provided by independent professional agronomists, agricultural experts such as soil scientists and government agricultural extension agents. Recommendations would provide sufficient detail to produce the minimum specifications on ALM practices for the baseline scenario as outlined in Table 4 of VM0042.

Common practice assessment and regulatory surplus will also be re-evaluated at the time of baseline re-assessment following the VCS standard and VM0042 methodology.

[44] https://aps.dac.gov.in/APY/Public_Report1.aspx

3.5. Additionality

Additionality has been assessed in accordance with the procedures set out in the methodology VM0042 Methodology for Improved Agricultural Land Management, v1.0. A project method for the demonstration of additionality is required, including:

i. the demonstration of a regulatory surplus;

ii. the identification of barriers that would prevent the implementation of a change in the pre-existing agricultural practices; and

iii. the demonstration that the adoption of the suite of proposed activities is not common practice.

A summary of project additionality assessment is given below:

Demonstration of Regulatory Surplus:

In India, there is no legal policy, or regulatory framework to enforce the regenerative agricultural practices promoted under this project. The National Green Tribunal (NGT) issued an order on 10 December 2015, explicitly prohibiting agricultural residue burning across the NCT of Delhi, and the states of Rajasthan, Punjab, Uttar Pradesh, and Haryana. This legal mandate prohibits crop residue burning, as detailed in the referenced order (Press Information Bureau, Government of India). Due to this prohibition, the project cannot demonstrate regulatory surplus for biomass burning, leading to its exclusion from carbon credit calculations.

The Green Revolution[45] in the 1960s saved India from starvation but made it the world's largest extractor of groundwater, with India extracting more than 251 cubic km of groundwater annually, accounting for over 90% of the water usage in agriculture worldwide.[46] There are some regulations in place for sustainable agricultural practices, but they do not explicitly mention mandatory adoption of regenerative agricultural practices.

To ensure compliance with all applicable laws and regulatory frameworks, the project considers the following legislations for review:

- Essential Commodities (Amendment) Act, 2020
- Fertilizer Control Order, 1985
- Seeds Bill, 2004
- Insecticide (Amendment) Act, 2000
- Protection of Plant Varieties and Farmers' Rights Act, 2001
- Farmers & Farm Workers Commission Act, 2017
- National Biodiversity Act, 2002
- Punjab Preservation of Subsoil Water Act, 2009
- Haryana Preservation of Subsoil Water Act, 2009
- The Haryana Water Resources (Conservation, Regulation and Management) Authority Act, 2020
- Delhi Groundwater Regulation Direction, 2010
- Environment (Protection) Act, 1986

[45] Environmental consequences of agricultural development: a case study from the Green Revolution state of Haryana, India - ScienceDirect - accessed on 31st Aug 2021

[46] India seeks to arrest its alarming decline in groundwater (worldbank.org) India seeks to arrest its alarming decline in groundwater (worldbank.org)-accessed on 30-June-2022

- Air (Prevention and Control of Pollution) Act, 1981
- Water (Prevention & Control of Pollution) Act, 1974

Despite the presence of several Acts and policies related to agriculture and the environment, the adoption of regenerative agriculture practices remains low in India. In 2019, Punjab brought 5.62 lakh hectares under Direct Seeded Rice (DSR), its highest ever.[47] The Punjab Preservation of Subsoil Water Act, 2009, the Punjab Water Act, 2019, the Haryana Preservation of Subsoil Water Act, 2009, and the Haryana Water Resources (Conservation, Regulation, and Management) Authority Act, 2020, mention sustainable agriculture practices but lack explicit regulations mandating regenerative agricultural practices.

Acts such as the Essential Commodities (Amendment) Act, 2020, and the Seeds Bill, 2004, primarily focus on seed and fertilizer regulation. The Haryana Preservation of Subsoil Water Act, 2009, prohibits the cultivation of paddy before 15th May and transplanting before 15th June but does not provide explicit guidance on mandating DSR. The adoption of DSR is optional for farmers and is being promoted by the government through various awareness campaigns and subsidies. Therefore, the practice of DSR is additional, as no legislation regulates it. Similarly, there is no legislation to regulate excessive tillage of farmlands or to mandate the adoption of DSR in any state in India, including Punjab and Haryana.

The regulatory surplus analysis of policies and acts in Punjab and Haryana reveals the absence of any explicit mandatory regulations for adopting regenerative agricultural practices. Therefore, our project aims to incentivize regenerative agriculture through carbon credits and awareness initiatives in the project area. Therefore, the regulatory surplus requirements of the VM0042 methodology are met.

In addition to regulatory surplus, additionality assessment has been demonstrated using the two-step framework given in the VM0042 methodology as below:

Step 1: Identify barriers that would prevent the implementation of a change in pre-existing agricultural management practices and adoption of ZT and DSR in the project area:

In the Project Area, peer-reviewed literature[48] shows that farmers face significant barriers to adopt regenerative farming practices, including reduced till farming and Direct Seeded Rice[49].The major barriers to adoption and expansion of regenerative agriculture technologies in the Indian agriculture have been the deeply entrenched traditional methods prevail having impact on scaling-up of technologies and capacity building of farmers.[50] These barriers can be classified as follows:

Technological barriers and knowledge gaps: Traditionally, farmers stick to conventional farming methods due to limited technical knowledge related to soil, water, residue, and other resources management[51]. Many farmers are unaware of the benefits and practical applications of regenerative approaches and may be hesitant to invest in these solutions. Farmers lack proper knowledge and training to adopt and implement regenerative agriculture practices like DSR and ZT . Changing a practice requires significant awareness, time, resources, and training, and substantial risk is assumed and therefore adopting regenerative practice can be considered as a technological barrier for small holder farmers in the project area.

[47] https://indianexpress.com/article/cities/ludhiana/punjab-brings-5-62-lakh-hectares-under-dsr-its-highest-ever-7432636/

[48] Aryal, J. P., Rahut, D. B., Maharjan, S., & Erenstein, O. (2018, August). Factors affecting the adoption of multiple climate-smart agricultural practices in the Indo-Gangetic Plains of India. In *Natural Resources Forum* (Vol. 42, No. 3, pp. 141-158). Oxford, UK: Blackwell Publishing Ltd.

[49] Khangura, R., Ferris, D., Wagg, C., & Bowyer, J. (2023). Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health. Sustainability, 15(3), 2338.

[50] Pathak, H., Chakrabarti, B., & Aggarwal, P. K. (2012). Promotion of low carbon technologies in Indian agriculture: Opportunities and constraints. Low carbon technologies for agriculture: A study on rice and wheat systems in the indo-gangetic plains, 66.

[51] Krishna, V. V., & Veettil, P. C. (2014). Productivity and efficiency impacts of conservation tillage in northwest Indo-Gangetic Plains. Agricultural Systems, 127, 126-138.

Social and cultural barriers: In the project area, the adoption of regenerative agricultural practices face significant barriers stemming from both economic and socio-cultural factors. The farmers in rural areas have been resistant to implementing substantial changes to their traditional practices over the past several decades due to lack of requisite knowledge and information.[52] There exists a traditional belief among farmers that tillage can improve soil health leading to increased crop productivity and burning of crop residue helps to reduce pests and diseases and increase soil fertility. These traditional beliefs act as major social and cultural barriers to the adoption of regenerative practices in the project area as farmers are reluctant to transition from these cultural beliefs.[53] Social costs also come into play, as farmers may have to deal with resistance from their peers or local communities who are comfortable with conventional farming practices. Trust and tradition are essential for survival, so it's natural for new ideas that challenge established practices to be met with scepticism. However, the same sentiments of pride and fear that bind farming communities together can also hinder the adoption of innovative and experimental approaches. This resistance to change creates a substantial socio-cultural barrier to the adoption of regenerative agricultural practices in the project area.

Barriers to adoption of ZT and DSR in the project area

- **Barriers to adopt Reduced tillage:** The residue of the paddy crop is burnt in situ, which is a traditional management practice in northwestern (NW) India- Punjab and Haryana.[54] A key obstacle lies in the narrow window between harvesting the Kharif (rice) crop and sowing the Rabi (wheat) crop. This tight timeframe leaves farmers with few options besides burning the rice crop residue. Burning is chosen for its speed and affordability, swiftly clearing fields for tillage. However, this practice persists due to limited knowledge of alternative uses for straw, as well as the lack of access to appropriate machinery and the associated costs and proper training to operate the machineries used for reduced till. Thus, pose a barrier to adopt ZT practice over CT in the project area.
- **Barriers to adopt Direct Seeded Rice:** Much of the rice in the project area is transplanted rice. Key barriers for non-adoption of DSR are weed infestation challenges, and limited availability of options for mechanization for farm operations. Thus, pose a barrier to adopt DSR practice over TPR in the project area.

How the Project Activities Help Farmers Overcome Barriers:

1. **Training Programs**: The project provides extensive training and awareness programs to educate farmers about the benefits and techniques of regenerative agriculture. This includes workshops, field demonstrations, and continuous technical support throughout the project duration.
2. **Technical Support:** Continuous technical support is provided to farmers to help them implement ZT and DSR practices effectively. This includes guidance on nutrient management, weed management, and the use of appropriate fertilizers and seeds. Ensuring that crop yield is not negatively impacted is crucial, and effective weed management plays a key role in achieving this for DSR. The amount of weedicide used in DSR compared to TPR can vary depending on soil conditions, weed pressure, and farmer management practices. The project acknowledges that weed management is a challenge for DSR. To address this challenge without increasing reliance on chemical weedicides, we have encouraged

[52] Loch, A., Cummins, J., Zuo, A., Yargop, M. R., & Huttner, E. (2018). project Value chain and policy interventions to accelerate adoption of Zero Tillage in rice-wheat farming systems across the Indo-Gangetic Plains.

[53] Lohan, S. K., Jat, H. S., Yadav, A. K., Sidhu, H. S., Jat, M. L., Choudhary, M., ... & Sharma, P. C. (2018). Burning issues of paddy residue management in north-west states of India. Renewable and Sustainable Energy Reviews, 81, 693-706.

[54] Phogat, M. (2020). A review on Zero Tillage as a sustainable approach for crop residue burning. IJCS, 8(5), 2534-2538.

practices such as manual weeding. Farmers are trained in effective weed management to support sustainable practices while minimizing chemical inputs.

3. **Financial Incentives:** While the project does not provide direct financial support before implementation, it ensures that farmers receive seventy-five percent (75%) of the carbon credit sales value, as per the legal agreement, after the project is implemented. This provides a sustainable income source to the farmers.
4. **Use of Equipment and Resources:** The project, in collaboration with its knowledge partners offered comprehensive training and live demonstrations on regenerative agriculture practices. Through these sessions, farmers were introduced to innovative techniques such as Direct Seeded Rice (DSR) and reduced tillage. The goal is was to showcase the benefits and practical applications of these regenerative agricultural interventions, enabling farmers to adopt more sustainable, resource-efficient farming methods while utilizing advanced equipment., While access to machinery can be a challenge for smallholder farmers, the project focuses on building awareness and technical capacity so that farmers can explore available options, including cooperative use and rental services. Additionally, the anticipated revenue from carbon credits serves as an incentive for farmers to transition to these practices and making regenerative agriculture a more viable long-term choice.
5. **Community Engagement:** The project engages with the farming community to address cultural and social barriers. Regular visits from GI Technical team and experts help build trust and encourage farmers to adopt new generative practices. Community meetings, peer learning sessions and You Tube videos are provided to share success stories and best practices.

The project proponent provides necessary training and continuous technical support to help farmers overcome these barriers. The financial incentives from carbon credits and increased productivity will further support farmers in sustaining these practices.

Step 2: Demonstrate that the adoption of the suite of proposed project activities is not common practice.

According to the VM0042 v1.0 methodology, grouped projects involving various activities must demonstrate a collective adoption rate of less than 20%. This rate is determined by weighing the implementation of each regenerative agriculture practice or combination thereof within the project area, utilizing publicly available data.

Based on the information provided in the CEEW report "Sustainable Agriculture in India 2021[55]," it can be concluded that regenerative agriculture practices are not widely adopted by most farmers in India. The Council on Energy, Environment and Water (CEEW) is one of Asia's leading not-for-profit policy research institutes and a think tank based in Delhi, India. This report on regenerative agriculture was one of the pioneering efforts to reflect Indian regenerative agriculture scenario that helped information gaps about adoption, on-ground prevalence, and impact of sustainable agriculture. The report contains meticulously analysed data which reports that the adoption of regenerative agriculture practices by farmers in the project area is merely 4% (less than five million hectares). This reinforces the fact that regenerative agriculture is far from mainstream agriculture in India. The report also reveals that smallholder farmers, who make up the majority of India's agricultural sector, face significant challenges in adopting regenerative agriculture practices due to various factors such as limited access to finance, lack of knowledge and skills, and poor market linkages. Overall, while there are some initiatives to promote regenerative agriculture in India, the adoption of these practices remains limited, and significant efforts are required to promote their

[55] Gupta, N., Pradhan, S., Jain, A., & Patel, N. (2021). *Sustainable Agriculture in India 2021*. CEEW Report, 122p. https://www. ceew. in/sites/default/files/CEEWFOLU-Sustainable-Agriculture-in-India-2021-20Apr21. pdf.

widespread adoption among farmers to improve agricultural sustainability, enhance farmers' livelihoods and protect the environment.

As per VM0042 methodology, evidence must be provided in the form of publicly available information contained in

1. Agricultural census or other government (e.g., survey) data;
2. Peer-reviewed scientific literature.
3. Independent research data; or
4. Reports or assessments compiled by industry associations.

In line with peer-reviewed scientific literature (as per option 2 above), literature evidence has been used to prove that the adoption rate of ZT in Punjab and Haryana was 14% and 3%, respectively, in 2021-2022, which proves that the adoption rate at state-level is still below the 20% threshold during the project monitoring period. The datasets provided as supporting documents to the publication[56] were meticulously analysed to arrive at these adoption rate numbers.

As the penetration rate for ZT is less than 20% during the monitoring period, it is expected to be much lower than the calculated rate, before project start date. Further this was cross-checked with the published news article[57] [58] that reports the aggregated adoption rate of ZT in Punjab and Haryana was 0.8 million hectares in 2018-2019, i.e., calculated to 5.02% of the total wheat area of the region, which is much below the 20% threshold. Hence, it confirms that ZT was not a common practice in the region before the project start date.

Since, data pertaining to DSR adoption percentage in Punjab and Haryana was not available from any of the above-mentioned sources of evidence, PP has used data from published national news articles to demonstrate the same.

As per VM0042 v1.0, pg 16, the entire project area has been divided for the purpose of the common practice demonstration to the state level (or equivalent 2nd order jurisdiction), i.e., Punjab, and Haryana in India. Our analysis collates data from news reports on DSR adoption, and it is found that in Punjab[59] and Haryana[60], DSR adoption rate is 17% and 2%, respectively, with a mean DSR adoption rate of 13.26 % in the year 2020. In terms of area, ~26,000 hectares in Haryana and ~500,000 hectares in Punjab are estimated to have adopted DSR[61] [62], of the total area of ~5 million hectares under rice cultivation in the project area. Thus, it is about 13.26% of rice cultivation through DSR in the project area.

[56] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

[57] Weblink: https://www.cimmyt.org/news/happy-seeder-can-reduce-air-pollution-and-greenhouse-gas-emissions-while-making-profits-for-farmers/. Accessed on 15th April 2024.

[58] Weblink: https://www.cgiar.org/innovations/zero-tillage-to-reduce-air-pollution-in-india/. Accessed on 15th April 2024.

[59] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[60] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[61] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[62] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

The dataset from news articles[63] [64] for DSR and publication[65] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states. Parameters for adoption rate calculation is given in table 12.

Appling Equation 1 of VM0042 v1.0

$$AR = ((EA_{ai} \times PA_{ai}) + (EA_{a2} \times PA_{a2}) + \cdots + (EA_{an} \times PA_{an}));$$

$where$

$PA_{a1} = Area_{a1} / (Area_{a1} + Area_{a2} + \cdots + Area_{an})$

$PA_{a2} = Area_{a2} / (Area_{a1} + Area_{a2} + \cdots + Area_{an})$

$PA_{an} = Area_{an} \ (Area_{a1} + Area_{a2} + \cdots + Area_{an})$

Applying equation 1, the following parameters and adoption rates were determined:

AR = weighted average adoption rate in the project area; %

EA_{a1} = existing adoption rate of Direct Seeded Rice (DSR) activity (proposed) in the project area; %

EA_{a2} = existing adoption rate of reduced Tillage (ZT) activity (proposed) in the project area; %

PA_{a1} = ratio of proposed project-level adoption of DSR relative to proposed project-level adoption of DSR + ZT in the project area; unitless

PA_{a2} = ratio of proposed project-level adoption of ZT relative to proposed project-level adoption of DSR + ZT in the project area; unitless

$Area_{an}$ = area of proposed project-level adoption of DSR in the project area; hectares

$Area_{a1}$ = area of proposed project-level adoption of ZT in the project area; hectares

Table 12: Parameters for adoption rate calculation*

Region	Area under practice change, Hectares	EA_{a1} (DSR)	EA_{a2} (ZT)	PA_{a1} (DSR)	PA_{a2} (ZT)	AR
Project area (Punjab, Haryana)	10,94,886	12.35%	9.45%	0.44	0.55	10.75~ 11%

*All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc"/24/.

Thus, it can be concluded that the DSR (12.35%) and ZT (9.45%) adoption was not a common practice in the project area (Punjab and Haryana) before the project start date.

[63] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[64] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[65] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

During the first project monitoring period, an interesting development emerged with the governments of Haryana and Punjab launching pilot schemes to promote the adoption of Direct Seeded Rice (DSR), a core regenerative practice within our project. Haryana's 2021 DSR subsidy scheme covered approximately 7,000 hectares.[66] Similarly, Punjab's 2022 cash incentive program for farmers transitioning to DSR underscores the growing recognition of regenerative agricultural practices. [67] Despite government incentives, Direct Seeded Rice (DSR) adoption remains limited in Punjab and Haryana, with the government reporting only a 2%[68] /54/uptake as of 2024 Kharif data.

Since these incentive schemes were introduced after the project's start date, they do not impact the project's additionality assessment, which was based on conditions at that time.

Importantly, any government incentives received by participating farmers go directly to them and are not linked to achieved emission reductions. This ensures there is no double counting of emission reductions, maintaining transparency and accuracy in project impact measurement. Additionally, these subsidies are separate from any carbon revenue, with no benefit or share for the Project Proponent (PP).

3.6. Methodology Deviations

No deviations observed in the project implementation and monitoring period.

4. IMPLEMENTATION STATUS

4.1. Implementation Status of the Project Activity

Training and awareness programs to promote regenerative agricultural practices in Haryana and Punjab started in 2018, led by outreach efforts from CIMMYT (the International Maize and Wheat Improvement Centre), a non-profit international organization. CIMMYT's initiatives included capacity-building sessions on Direct Seeded Rice (DSR), reduced tillage, improved machinery access conducted through village-level trainings and technical workshops. These foundational activities aimed to build farmers' knowledge and capacity to adopt regenerative agricultural practices. From December 2019, the PP initiated structured farmer outreach through in-person interaction and explanations of the carbon project, benefits associated with adoption of project practices, eligibility criteria, associated potential risks followed by baseline data collection and field geotagging. The details about these meetings are included in Table 6 of the JPDMR, with supporting evidence submitted to the VVB.

With the onset of the COVID-19 lockdown in March 2020, field activities were temporarily halted. To maintain continuity, the PP transitioned to virtual stakeholder engagement using platforms like Zoom, Microsoft Teams, and phone calls. Recognizing the digital access gap among smallholder farmers, the project designed an inclusive system where farmer representatives acted as intermediaries, relaying information to and from farmers without direct access to virtual platforms. Follow-up phone calls were used to ensure no farmer was left out. All farmers who began adopting project practices after project start date were engaged through this system and received timely, relevant guidance on regenerative practices. The mitigation measures undertaken during the

[66] Link accessed on 21st May 2024. https://www.hindustantimes.com/cities/chandigarh-news/haryana-farmers-surpass-government-target-on-direct-seeded-rice-101686327979286.html

[67] Link accessed on 21st May 2024. https://www.cgiar.org/news-events/news/agricultural-policy-in-punjab-india/#:~:text=Not%20willing%20or%20able%20to,million%20hectares%20to%20this%20practice

[68] https://ipr.punjab.gov.in/en/press-releases/hq-press-releases/dsr/, News Advertise final1 (agriharyana.gov.in)

lockdown through continuous engagement via phone calls and regular virtual sessions with farmer representatives.

In mid-2021, as restrictions eased, the PP resumed in-person field activities, conducting village-level awareness, onboarding sessions, and technical training workshops. These workshops covered topics of regenerative practices, machinery access (including cooperative and rental services), water management, nutrient and weed management. It was ensured that farmer received hands-on guidance throughout the implementation of project practices. The onboarding process was conducted in batches, based on eligibility and readiness, ensuring that every participating farmer was trained prior to adoption. To overcome technological barriers to machinery access (Section 3.5), the PP covered the training on awareness about machine rental providers and cooperatives, ensuring farmers could access the necessary equipment for DSR and reduced tillage. PP's inhouse built digital carbon management app, was developed and tested during 2020 and was fully deployed in July 2021, which enabled continuous tracking of project activities, including geo-tagged field boundaries, baseline agricultural practices, adoption of regenerative practices, and crop information. During the app's rollout, PP provided training to field staff to ensure effective data collection. All eligible farmers were monitored through the collected data, with additional verification through in-person field visits, visual checks, and remote sensing data to ensure their compliance with project eligibility.

This integrated, multi-phase strategy combining early outreach, adaptive training, technological solutions, and rigorous monitoring ensured that all enrolled farmers were properly trained, informed, and supported before and during the implementation of regenerative practices under the Grow Indigo carbon project.

During the monitoring period of the project (06-May-2019 to 31-May-2022), project activities were successfully implemented in accordance with the monitoring plan. The primary interventions—direct seeding of rice and reduced tillage in wheat were introduced to achieve reductions or removals of GHG emissions. By implementing direct seeding of rice and reduced tillage across 11,636.1 hectares, the project achieved a total net reduction and removal of 57,463.83 tCO_2e in GHG emissions during the monitoring period. There were no events that may adversely impact the GHG emission reductions or removals, and monitoring reported in this monitoring period.

No new project activities were initiated during the monitoring period. However, the previously implemented activities, such as Direct Seeding of Rice (DSR) and reduced tillage, continued throughout the monitoring period.

The project is committed to managing and monitoring the leakage and non-permanence risk factors associated with AFOLU projects as per the guidelines provided in VCS Non-Permanence Risk Report-v4.0, VCS standard v4.5, VM0042 v1.0, and VMD0053 v1.0.

The PP conducted crop cutting trials in the project area, collecting productivity data at the end of the rice and wheat growing seasons. The results indicate a decline in yields of only 3.24%, which is within the acceptable range of less than 5% as recommended by the VM0042 methodology. This decline is attributed to the adoption of regenerative practices, such as Direct Seeding of Rice and reduced tillage, promoted through our project. Since the productivity decline was less than 5%, a leakage deduction of 0% was applied in the calculation of net GHG emission reduction during the current monitoring period. For monitoring of leakage, crop cutting trials shall be conducted for rice and wheat crops at the end of every season to determine crop yield and productivity declines (leakage).

PP has prepared a non-permanence risk report in accordance with the AFOLU Non-Permanence Risk Tool which has been submitted to the VVB as a stand-alone document during validation and verification. The project shall perform the non-permanence risk analysis at every verification event to demonstrate its longevity, sustainability, and ability to mitigate risks through this analysis, to be eligible for release of buffer credits from the AFOLU pooled buffer account. The project has a longevity of 30 years and a total risk rating of 13 for the current monitoring period. Monitoring shall be conducted at least every five years, or prior to each verification event if less than five years. Representation of the project monitoring period is given in figure 24.

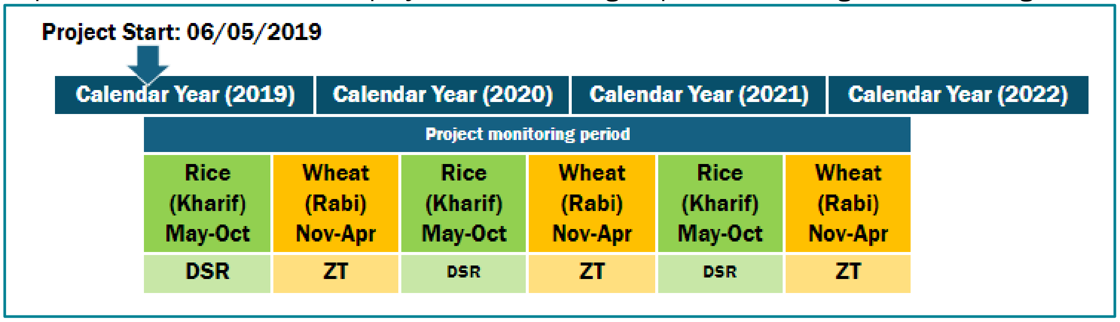


Figure 24: Representation of the project monitoring period.

The project faced significant challenges during the COVID-19 lockdown period, which impacted implementation. Specifically, the initial soil sampling campaign was delayed due to nationwide lockdowns and movement restrictions imposed during the pandemic. In summary, the project activities were implemented as planned during the monitoring period, and the project is committed to managing and monitoring the risks associated with the project activities to achieve the intended GHG reduction or removal potential.

5. ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

5.1. Baseline Emissions

Baseline GHG emission estimations (ex-ante) were calculated by using scientific publication that reported the GHG emissions from conventional agricultural practices applicable for baseline period and the mitigation potential that can be achieved by the adoption of regenerative practices.[69] /1/. The following table 13 has been built using the values mentioned in the research publication of Jat et al., 2020 that reported GHG emissions and emission mitigation potentials under conventional and regenerative practice scenarios for rice, rice-wheat and maize-wheat rotations (cropping year based) in the project area. This research publication reported the GHG emissions of conventional practices such as TPR, CT, crop residue burning conditions and high energy consumption conditions which could be applied in our project for the baseline emission calculations i.e., for a business-as-usual scenario. This table is also provided in the excel sheet as annexure (VCS2590_Estimated ERR Calculation) with clear cell links, displaying formulae applied for calculations.

As shown in the GHG ERR estimations table, in section 5.4, column two, i.e., estimated baseline emissions and removals have been calculated as a product of targeted project area of each project year (in ha) and area scaled GWP of the respective practice which includes methane, nitrous oxide as well as SOC removals that occurred during a conventional practice.

[69] Jat, H.S., Kumar, V., Datta, A. *et al.* Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. *Sci Rep* **10**, 19267 (2020). https://doi.org/10.1038/s41598-020-76035-z.

Estimated baseline emissions/removals (over a cropping year, i.e.) = targeted project area (ha) of each project year x GWP (of the GHG emissions) of entire crop rotation in a cropping year.

The baseline emission results thus obtained from a cropping year are then calculated as per vintage years (see excel sheet (VCS2590_Estimated ERR Calculation).

Table 13: Research publication of Jat et al., 2020 reported data on GHG Emissions and Mitigation Potentials in Conventional vs. Regenerative Practices in project area

Kharif	CH_4 kg (kg CO_2 eq. ha−1)	N_2O (kg CO_2eq. ha−1)	GHG emission due to residue burning (kg CO_2eq. ha−1)	GHG emission due to energy consumption (kg CO_2eq. ha−1)	Total C sequestration (kg CO_2 eq. ha−1)	Area Scaled (GWP; kg CO_2eq. ha−1)
CT TPR Rice	1818	7	278	2941	0	5044
CT Wheat	0	50	59	1299	0	1408

Category	GWP- Rice-Wheat (Kharif-Rabi) system (kg CO_2eq. ha−1)	Additionality (net of crop residue burning), (Kg CO_2e.ha-1)	GHG emissions and removals, (tCO_2e/ ha)
Baseline -TPR + CT Wheat	6452	0	6.45

For quantification of baseline emissions for the soil sampled fields using quantification approach 1, DNDC model was applied. Baseline emissions were modelled using

(a) field-specific soil data,
(b) three-year (2016 - 2018) historical records (before project start) of the actual crop management of each of the individual rice-wheat fields along with
(c) three-year (2016 - 2018) historical weather information.

The modelled results indicated SOC removals, CH_4, and N_2O emissions generated due to the conventional agricultural practices from each of the soil sampled fields in the project area. Baseline emissions and timing for each input category is given in table 14 below.

Table 14: Baseline emissions and timing for each input category.

Soil organic carbon stock and bulk density (initial)	Determined ex ante	For ex-ante estimations, literature reference[79] was used. For quantification, back-modelled values were used from the soil sampled data. (Refer parameter table for $SOC_{bsl,l,t}$ and $SOC_{bsl,l,t-1}$ for more details)
Soil properties (other than bulk density and soil organic carbon)	Determined ex ante	Measured. Accuracy of measurements is ensured through adherence to best practices (outlined in the monitoring plan in Section 6.3). Baseline soil samples that were collected from

		the project area covered 3 predominant soil types (Haplic Yermosols, Calcic Xerosols and Orthic Luvisols) (Figure 4) of project area and represented 98.01% of our enrolled farms (3819 of total 3897).
Climate variables (e.g., precipitation, temperature)	Continuously monitored ex post	Measured for each model-specific meteorological input variable at its required temporal frequency (e.g., daily) model prediction interval. Measured data was obtained from public resources (NASA Power website) wherein the data was measured at the closest continuously - monitored weather station, not exceeding 50 km of the sample field.
Agricultural management activities (as identified following procedures in VMD0053 "Model Calibration and Validation Guidance for the Methodology for Improved Agricultural Land Management", referencing categories of practices outlined in applicability condition 1)	Monitored ex post	Required model inputs related to agricultural management practices were monitored and recorded for each project year, t. Information on agricultural management practices was monitored via farmer surveys and substantiated with a signed attestations from, the farmer or landowner of the sample unit. Units for quantitative information were based on model input requirements.

Soil Organic Carbon (SOC) stocks

As defined in VM0042, SOC was quantified using Quantification Approach 1, Equation 2, VM0042 v1.0, via the DNDC 9.5 model. DNDC is a publicly available, widely published, and commonly used process-model that simulates field-scale changes in SOC and other agro-ecosystem fluxes.

$SOCbsl,i,t = ʆSOCbsl,i,t$

Where:

$SOC_{bsl,i,t}$ - Carbon stocks in the soil organic carbon pool in the baseline scenario for sample unit i at the end of period t; tCO_2e/unit area

$ʆSOC_{bsl,i,t}$ - Modeled soil organic carbon stocks in the baseline scenario for sample unit i at the end of period t; tCO_2e/unit area i Sample unit

The DNDC model simulates soil GHG fluxes over time, with respect to different ecosystems and crop/soil/land management scenarios, enabling accurate simulations using farm level data.

Methane

Methane CO_2e for soil CH_4 emissions in the baseline scenario was calculated according to Equation 5, as outlined in VM0042 Section 8.2.5, using Quantification Approach 1. The modeled CH_4 flux for the baseline was determined using DNDC (as described in Modeling plan).

$$CH_4soil_{bsl,i,t} = GWPCH_4 \times ʆCH_4soil_{bsl,i,t}$$

Where:

$CH_4soil_{bsl,i,t}$ Methane emissions from soil organic carbon pool in the baseline scenario for sample unit i in year t; tCO_2e/unit area

ʆ$CH_4soil_{bsl,i,t}$ - Modeled methane emissions from the soil organic carbon pool in the baseline scenario for sample unit i in year t; tCH_4e/unit area $GWPCH_4$ -Global warming potential for CH_4 i Sample unit

Nitrous Oxide

Nitrous Oxide CO_2e for nitrogen fertilizer N_2O emissions in the baseline scenario were calculated according to Equation 10 of VM0042 v1.0, as outlined in VM0042 Section 8.2.9, using Quantification Approach 1. All parameters used in the above equations are defined in Sections 5.1 and 5.2.

$$N_2Osoilbsl,i,t = GWPN_2O \times ʆN_2Osoilbsl,i,t$$

Where:

$N_2Osoilbsl,i,t$ - Direct and indirect nitrous oxide emissions due to nitrogen inputs to soils in the baseline scenario for sample unit i in year t; t CO_2e/unit area

ʆ$N_2Osoilbsl,i,t$ - Modeled nitrous oxide emissions from soil (summed across the reporting period for sample unit i); t N_2O/unit area $GWPN_2O$ Global warming potential for N_2O i Sample unit.

5.2. Project Emissions

Ex-ante GHG emissions were estimated by using the most recent scientific publication that reported the GHG emissions from regenerative agricultural practices and the corresponding mitigation potential that can be achieved by the adoption of regenerative practices[70]

The following table has been built using the values mentioned in the research publication of Jat et al., 2020 that reported GHG emissions and emission mitigation potentials under regenerative practice scenarios for rice, rice-wheat and maize-wheat rotations (cropping year based) in the project area. This research publication reported the GHG emissions that can occur due to regenerative practices such as direct seeded rice (planting) and reduced tillage (ZT) practice during Rabi season. The emission numbers from these practices are applied in the project emission estimation calculations. This table is also provided in the excel sheet as annexure (VCS2590_Estimated ERR Calculation) with a clear cell links, displaying formulae applied for calculations.

[70] Jat, H.S., Kumar, V., Datta, A. *et al.* Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. *Sci Rep* **10**, 19267 (2020). https://doi.org/10.1038/s41598-020-76035-z.

As shown in the GHG ERR estimations table, in section 5.4, column three, i.e., estimated project emissions and removals have been calculated as a product of targeted project area of each project year (in ha) and area scaled GWP of the respective practice which includes methane, nitrous oxide emissions as well as SOC removals/sequestration during a regenerative practice adoption.

Estimated project emissions/removals (over a cropping year, i.e.) = targeted project area (ha) of each project year x GWP (of the GHG emissions) of entire crop rotation in a cropping year.

The project emission results thus obtained from a cropping year are then calculated as per vintage years (see excel sheet VCS2590_Estimated ERR Calculation).

Table 15: Research publication of Jat et al., 2020 reported data on GHG Emissions and Mitigation Potentials in Conventional vs. Regenerative Practices in project area

Kharif	CH_4 kg (kg CO2 eq. ha−1)	N_2O (kg CO2eq. ha−1)	GHG emission due to residue burning (kg CO_2eq. ha−1)	GHG emission due to energy consumption (kg CO_2eq6***. ha−1)	Total C sequestration (kg CO_2 eq. ha−1)	Area Scaled (GWP; kg CO_2eq. ha−1)
CT DSR	1103	583		2484	-428	3742
ZTFB Maize		59		1091	-866	284
ZT Wheat	0	101	0	1174	-1658	-383
ZTFB Wheat	0	72		1183	-1204	51

For quantifying field specific project emissions (i.e., actual/ex post) (SOC, CH_4, and N_2O), all DNDC input parameters in the model settings were maintained the same as in the baseline scenario, except for specific management changes (practice changes) to be undertaken by the project. For each sampled field project emissions were modelled using crop management data specific to the practice adopted (DSR/ZT). The modelled results indicated SOC removals, CH_4 and N_2O emissions generated as a result of regenerative agriculture practices adopted during the project period, The details of modeling/calculations are given in the MVR/36/. Project emissions model approach and timing for each input category. Project emissions model approach and timing for each input category is given in table 16 below.

Table 16: Project emissions model approach and timing for each input category.

Soil organic carbon stock and bulk density	Determined at project start (re-measured every 5 years or less)	For modeling, the soil sampled fields' data was used.
Soil properties (other than bulk density and soil organic carbon)	Determined ex ante	• Measured. • Estimates were derived from representative stratified random (unbiased) sampling • Accuracy of measurements is ensured through adherence to best practices (outlined in the monitoring plan in Section 5.3. • Soil samples that were collected from the project area covered 3 predominant soil types (Haplic

		Yermosols, Calcic Xerosols and Orthic Luvisols) (Figure 4) of project area and represented 98.01% of our enrolled farms (3819 of total 3897).
Climate variables (e.g., precipitation, temperature)	Continuously monitored ex post	Measured for each model-specific meteorological input variable at its required temporal frequency (e.g.,daily) model prediction interval. Measurements are taken at the closest continuously monitored weather station, not exceeding 50 km of the sample field, or from a synthetic weather station
Agricultural management activities (as identified following procedures in VMD0053 "Model Calibration and Validation Guidance for the Methodology for Improved Agricultural Land Management", referencing categories of practices outlined in applicability condition 1)	Monitored ex post	Required model inputs related to agricultural management practices were monitored and recorded for each project year, t. Information on agricultural management practices was monitored via farmer surveys and substantiated with a signed attestations from, the farmer or landowner of the sample unit. Units for quantitative information were based on model input requirements.

5.3. Leakage

The project aims to promote regenerative agricultural practices to help farmers achieve improved soil carbon and reduce GHG emissions. The project has demonstrated that adopting these practices does not result in a reduction in yield more than 5% (section. To calculate leakage from potential yield reductions, crop-cutting trials were carried out in the project area at the end of every season. The productivity data was collected for both rice and wheat crop during the respective seasons. Average historical productivity data collected from our historical data collection through farmer surveys and interviews was compared with the average productivity obtained during our crop cutting trials. This data was further used to calculate the change in productivity during historical and project period using the equation 29 from VM0042, V1.0. The results show that the change in productivity was <5% for our project area (i.e. 3.2%). We also conducted further statistical analysis, such as a t-test for verifying the statistical rigor of our results during the project and historical periods. The statistical analysis also shows that there is no statistical significance in the change in productivity. Statistical analysis data has been provided as a supporting document as evidence. Since the yield reductions observed from our productivity analysis were less than 5%, a leakage deduction of 0% was applied in the calculation of net GHG emission reductions.

5.4. Estimated Net GHG Emission Reductions and Removals

Net GHG emission reductions and removals were also estimated using scientific publication of Jat et al., 2020[71] The data for baseline emissions and project emissions was already estimated (in 5.1 and 5.2) against the targeted project area for each year. To estimate net GHG ERRs in the following table, a difference between estimated baseline emissions and project emissions was calculated. The leakage deduction applied was zero for each year. For estimating net GHG ERRs for each vintage year, cropping year calculations for the first year were halved and then the difference was carried forward for the following vintage years. An excel sheet "VCS2590_Estimated ERR Calculation" was provided for clear understanding of the calculations. Each cell is linked and displays clear formulae applied for the calculations conducted. On the other hand, quantification of soil sampled fields and for each GHG source included in the Project was conducted through biogeochemical modeling. Net GHG emission reductions were calculated after calculating the model uncertainty using the equation 46 as per VM0042 methodology. The details of net GHG emission calculations (per unit area) and model uncertainty calculations are provided in the MVR)/36/. The following table displays baseline emissions, project emissions, leakage emissions, and net emission reductions and removals. The estimated net GHG emission reductions or removals (vintage-year wise) are given in the table below:

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)
06-May-2019—31-Dec-2019	12,904	7,392	0	5,512
01-Jan-2020—31-Dec-2020	187,108	92,064	0	95,044
01-Jan-2021—31- Dec -2021	1,122,648	552,384	0	570,264
01-Jan-2022—31- Dec -2022	3,445,368	1,701,504	0	1,743,864
01- Jan-2023—31- Dec -2023	7,445,608	3,630,144	0	3,815,464
01- Jan-2024—31- Dec -2024	9,897,368	4,792,704	0	5,104,664
01- Jan-2025—31- Dec -2025	9,897,368	4,792,704	0	5,104,664
01- Jan-2026—31- Dec -2026	9,897,368	4,792,704	0	5,104,664
01- Jan-2027—31- Dec -2027	9,897,368	4,792,704	0	5,104,664
01- Jan-2028—31- Dec 2028	9,897,368	4,792,704	0	5,104,664
01- Jan-2029—31- Dec -2029	9,897,368	4,792,704	0	5,104,664
01- Jan-2030—31- Dec -2030	9,897,368	4,792,704	0	5,104,664
01- Jan-2031—31- Dec -2031	9,897,368	4,792,704	0	5,104,664
01- Jan-2032—31- Dec -2032	9,897,368	4,792,704	0	5,104,664
01- Jan-2033—31- Dec -2033	9,897,368	4,792,704	0	5,104,664

[71] Jat, H.S., Kumar, V., Datta, A. et al. Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. Sci Rep 10, 19267 (2020). https://doi.org/10.1038/s41598-020-76035-z.

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)
01- Jan-2034— 31-Dec -2034	9,897,368	4,792,704	0	5,104,664
01- Jan-2035—31- Dec -2035	9,897,368	4,792,704	0	5,104,664
01- Jan-2036—31- Dec -2036	9,897,368	4,792,704	0	5,104,664
01- Jan-2037—31- Dec -2037	9,897,368	4,792,704	0	5,104,664
01-Jan-2038—31- Dec -2038	9,897,368	4,792,704	0	5,104,664
01-Jan-2039—05-May-2039	4,948,684	2,396,352	0	2,552,332
Total	**165,622,840**	**80,270,400**	-	**8,5352,440**

Note: This table has been provided in vintage years to be consistent with the table in section 1.10 of the JPDMR. Reference for estimating baseline and projects emission data: Jat, H.S., Kumar, V., Datta, A. et al. Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. Sci Rep **10***, 19267 (2020). https://doi.org/10.1038/s41598-020-76035-z).*

6. MONITORING

6.1. Data and Parameters Available at Validation

Data sources for each parameter or model input are provided in the source columns in the following tables.

Data / Parameter	AR
Data unit	Percent
Description	Weighted average adoption rate
Source of data	The dataset from news articles[72] [73] for DSR and publication[74] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc.

[72] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[73] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[74] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

Value applied	10.75 %
Justification of choice of data or description of measurement sampling methods and procedures applied	Calculated based on VM0042 v1.0 Equation 1. As per VM0042 v1. Section 7, pg 16, evidence for DSR and ZT acreages was provided in the form of publicly available information contained in: government survey data, peer reviewed literature, and news reports. References are given in section 3.5 of JPDMR. Estimation of adoption rate was done by using the values obtained from government survey data, peer reviewed literature, and news reports, to the equation 1 of VM0042.
Purpose of Data	Common practice assessment
Comments	None

Data / Parameter	$Area_{an}$
Data unit	Hectares
Description	Area of proposed project-level adoption of each activity
Source of data	The dataset from news articles[75] [76] for DSR and publication[77] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc./24/
Value applied	Region / Practice / $Area_{an}$ Punjab and Haryana / DSR, hectares / 1,244,000 ZT, hectares / 153,400
Justification of choice of data or description of measurement methods and procedures applied	The dataset from news articles[78] [79] for DSR and publication[80] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc. /24/

[75] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[76] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[77] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

[78] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[79] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[80] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

Purpose of Data	Common practice assessment
Comments	None

Data / Parameter	EA_{an}
Data unit	Percent
Description	Adoption rate of the n largest most common proposed project activity in the region
Source of data	The dataset from news articles[81] [82] for DSR and publication[83] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc. /24/
Value applied	Punjab and Haryana: DSR= 12%, ZT= 9%
Justification of choice of data or description of measurement methods and procedures applied	Calculated based on evidence for DSR and ZT acreages provided in the form of publicly available information contained in government survey data, peer reviewed literature, and news reports. References are given in section 3.5 of JPDMR.
Purpose of Data	Common practice assessment
Comments	None

Data / Parameter	A_0
Data unit	Hectare
Description	Project area
Source of data	Field survey and remote sensing/ GIS data
Value applied	The project brought 11636.1 hectares (28,714.1 acres) of land under regenerative agriculture practice(s), such as DSR and ZT in rice-wheat cropping system.
Justification of choice of data or description of	Geotagged field boundary collected using Grow Indigo Carbon management app was overlaid on high resolution satellite data

[81] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[82] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[83] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

measurement methods and procedures applied	and correction was made related to boundary corrections and removal of non-agricultural land use classes like built up, plantation etc and the remaining area was calculated using GIS software to constitute the parameter, A_o. Following this practice change validation was conducted.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/t CH_4
Description	Global warming potential for CH_4
Source of data	IPCC Fifth Assessment Report
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	VCS Standard v4.5, Section 3.15.4 requires that CH_4 must be converted using the 100-year global warming potential derived from the IPCC Fifth Assessment Report.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

Data / Parameter	GWP_{N2O}
Data unit	t CO_2e / t N_2O
Description	Global warming potential for N_2O
Source of data	IPCC Fifth Assessment Report
Value applied	265
Justification of choice of data or description of measurement methods and procedures applied	VCS Standard v4.5, Section 3.15.4 requires that N_2O must be converted using the 100-year global warming potential derived from the IPCC Fifth Assessment Report.
Purpose of Data	Calculation of baseline and project emissions
Comments	None

6.2. Data and Parameters Monitored

Data sources for each parameter or model input are provided in the source columns in the tables.

Data / Parameter	AR
Data unit	Percent
Description	Weighted average adoption rate
Source of data	The dataset from news articles[84] [85] for DSR and publication[86] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc.
Description of measurement methods and procedures applied:	The dataset from news articles[87] [88] for DSR and publication[89] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states
Frequency of monitoring / recording	Annual
Value applied:	10.75%
Monitoring equipment	Not applicable
QA/QC procedures applied:	Evidence was provided in the form of publicly available information contained in: a.Agricultural census or other government (e.g. survey) data; b.Peer-reviewed scientific literature; c.Independent research data; or d. Reports or assessments compiled by industry associations.

[84] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[85] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[86] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

[87] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[88] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[89] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

	The dataset from news articles[90] [91] for DSR and publication[92] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states. All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc.
Purpose of Data	Common practice assessment
Calculation Method	The dataset from news articles[93] [94] for DSR and publication[95] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states:
Comments	None

Data / Parameter	$Area_{an}$
Data unit	Hectare
Description	Area of proposed project-level adoption of each activity
Source of data	The dataset from news articles[96] [97] for DSR and publication[98] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc.

[90] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[91] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[92] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

[93] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[94] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[95] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

[96] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[97] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[98] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

Description of measurement methods and procedures applied	As per VM0042 v1. Section 7, pg 16, evidence for DSR and ZT acreages is provided in the form of publicly available information contained in: government survey data, peer reviewed literature, and news reports. References are given in section 3.5 of JPDMR.
Frequency of monitoring /recording	Annual
Value applied	Region / Practice / $Area_{an}$ Punjab and Haryana / DSR, hectares / 1,244,000 ZT, hectares / 153,400
Monitoring equipment	GPS-enabled mobile device
QA/QC procedures applied	Evidence was provided in the form of publicly available information contained in: a. Agricultural census or other government (e.g. survey) data; b.Peer-reviewed scientific literature; c.Independent research data; or d. Reports or assessments compiled by Industry associations. The dataset from news articles[99] [100] for DSR and publication[101] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana states: All calculations are provided in a separate excel sheet "Adoption rate calculation" which is a part of excel workbook "CPA_ adoption rate_calc.
Purpose of data	Common practice assessment
Calculation method	N/A (measured)
Comments	None

Data / Parameter	$EAan$
Data unit	Percent

[99] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[100] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[101] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

Description	Adoption rate of the n largest most common proposed project activity in the region
Source of data	The dataset from news articles[102] [103] for DSR and publication[104] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the Adoption rate of the largest most common proposed project activity (DSR and ZT) in the region, covering Punjab, Haryana, Delhi states
Description of measurement methods and procedures to be applied	The dataset from news articles[105] [106] for DSR and publication[107] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the Adoption rate of the largest most common proposed project activity (DSR and ZT) in the region, covering Punjab and Haryana, Delhi states. References are given in section 3.5 of JPDMR.
Frequency of monitoring/ recording:	Annual
Value applied:	Punjab and Haryana: DSR= 12%, ZT=9%
Monitoring equipment	Not applicable
QA/QC procedures to be applied:	Evidence was provided in the form of publicly available information contained in: a.Agricultural census or other government (e.g. survey) data; b.Peer-reviewed scientific literature; c.Independent research data; or d. Reports or assessments compiled by industry associations.

[102] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[103] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[104] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022 [104] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021[104] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[104] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

	The dataset from news articles[108] [109] for DSR and publication[110] for ZT, was used in Equation 1 of VM0042 v1.0 to calculate the weighted average adoption rate in the project area, covering Punjab and Haryana, NCS-Dehi states:
Purpose of Data	Common practice assessment
Calculation method	N/A
Comments	None

Data / Parameter	A_i
Data unit	Hectare
Description	Area of sample unit *i*
Source of data	Geofence fields using Grow Indigo's mobile application (https://play.google.com/store/apps/details?id=com.growindigo.farmMonitoring&pcampaignid=web_share)
Description of measurement methods and procedures applied	Field boundaries were geofenced by Kisan Advisors using Grow Indigo's mobile application (https://play.google.com/store/apps/details?id=com.growindigo.farmMonitoring&pcampaignid=web_share). Digital field boundaries obtained by mobile application were checked for quality, i.e. the boundary should not include non-agriculture area. This was done by overlaying each field boundary over high-resolution satellite imagery from Google Earth (https://earth.google.com). If the boundary was found to be incorrect, the fields were sent back for correction to the field team. Any revised boundaries again went through the field boundary quality check.

[108] Punjab brings 5.62 lakh hectares under DSR — its highest ever: Online link accessed on 30-Apr-2021

[108] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[108] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

[109] The Tribune. 2021. Government: Diversification can save 954 bn litres of water in Haryana.-accessed online on 31-Aug-2021

[110] ESTABLISHING RESIDUE SUPPLY CHAINS TO REDUCE OPEN BURNING THE CASE OF RICE STRAW AND RENEWABLE ENERGY IN PUNJAB, INDIA. Environment and Natural resources Management, Working paper 95, FAO, UN, 2022

Frequency of monitoring /recording	Conducted prior to each verification event
Value applied	0.4 hectares
Monitoring equipment	GPS-enabled mobile device
QA/QC procedures applied	Geotagged field boundary collected using Grow Indigo Carbon management app was overlaid on high resolution satellite data and correction was made related to boundary corrections and removal of non-agricultural land use classes like built up, plantation etc s and the remaining area was calculated using GIS software to constitute the parameter Ai. Following this crop and practice validation was conducted.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A (measured)
Comments	None

Data / Parameter	*I*
Data unit	Dimensionless
Description	Sample unit; defined area that is selected for measurement and monitoring, such as a field
Source of data	Sampled fields in project area
Description of measurement methods and procedures applied	The sample unit is determined prior to verification
Frequency of monitoring/recording	Conducted prior to each verification
Value applied	45 soil sampled fields
Monitoring equipment	GPS-enabled mobile device

QA/QC procedures applied	Geotagged field boundary collected using Grow Indigo Carbon management app was overlaid on high resolution satellite data and correction was made related to boundary corrections and removal of non-agricultural land use classes like built up, plantation etc s and the remaining area was calculated using GIS software to constitute the parameter i. Following this crop and practice validation was conducted.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A (measured)
Comments	None

Data / Parameter	$fSOC_{bsl,i,t}$
Data unit	t CO_2e/hectare
Description	Modelled soil organic carbon stocks in the baseline scenario for sample unit *i* at time *t*
Source of data	Modelled in the project area using farmer provided management data for each sampling unit
Description of measurement methods and procedures applied	Modeled soil organic carbon stocks in the baseline scenario are determined according to the equation 6 of VM0042 v1.0. Back- modeled to t =0 from SOC measurements collected within +/-5 years of t =0, using soil sampled data from the project area directly by PP taken in 2021
Frequency of monitoring /recording	Conducted prior to each verification event.
Value applied	$fSOC_{bsl,i,t}$ (tCO_2e/ha) **Year** / $fSOC_{bsl,i,t}$: 06-May-2019 - 31-May-2020: 105.5 01-June-2020 - 31-May-2021: 106.5 01-June-2021 - 31-May-2022: 107.9
Monitoring equipment	Modeling done with the DNDC model

QA/QC procedures applied	Grow Indigo followed the requirements of Box 1 regarding appropriate sources of qualitative and quantitative data on farmer agricultural management practices implemented each year, used to establish model input variables.
Purpose of data	Calculation of baseline emissions
Calculation method	N/A
Comments	None

Data / Parameter	$SOC_{bsl,l,t}$
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the baseline scenario for sample unit *l* in year *t*
Source of data	For quantification of baseline scenario, the SOC values were back modelled using data from soil sampled fields
Description of measurement methods and procedures applied	Soil organic carbon stocks in the baseline scenario are determined according to the equation 6 of VM0042 v1.0. Back- modeled to t =0 from SOC measurements collected within +/- 5 years of t =0, using soil sampled data from the project area directly by PP taken in 2021.
Frequency of monitoring/recording	Conducted prior to each verification event
Value applied	$SOC_{bsl,i,t}$ (tCO_2e/ha) <table><tr><td>Year</td><td>$SOC_{bsl,i,t}$</td></tr><tr><td>06-May-2019 - 31-May-2020</td><td>105.5</td></tr><tr><td>01-June-2020 - 31-May-2021</td><td>106.5</td></tr><tr><td>01-June-2021 - 31-May-2022</td><td>107.9</td></tr></table>
Monitoring equipment	N/A
QA/QC procedures applied	Grow Indigo followed the requirements of Box 1 regarding appropriate sources of qualitative and quantitative data on farmer agricultural management practices implemented each year, used to establish model input variables.

Purpose of data	Calculation of baseline emissions
Calculation method	N/A
Comments	None

Data / Parameter	$SOC_{bsl,l,t-1}$
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the baseline scenario for sample unit *l* in year *t-1*
Source of data	For quantification of baseline scenario, the SOC values were back-modeled using data from soil sampled fields.
Description of measurement methods and procedures applied	Soil organic carbon stocks in the baseline scenario are determined according to the equation 6 of VM0042 v1.0. Back- modeled to t =0 from SOC measurements collected within +/-5 years of t =0, using soil sampled data from the project area directly by PP taken in 2021.
Frequency of monitoring/ recording	Conducted prior to each verification event
Value applied	104.25
Monitoring equipment	N/A
QA/QC procedures applied	Grow Indigo followed the requirements of Box 1 regarding appropriate sources of qualitative and quantitative data on farmer agricultural management practices implemented each year, used to establish model input variables.
Purpose of data	Calculation of baseline emissions
Calculation method	Not applicable
Comments	None

Data / Parameter	$SOC_{wp,l,t}$
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the project scenario for sample unit *l* in year *t*

Source of data	Modeled in the project area
Description of measurement methods and procedures applied	Modeled soil organic carbon stocks in the project scenario are determined according to the equation 34 of VM0042.
Frequency of monitoring/ recording	Conducted prior to each verification event
Value applied	Refer excel sheet "Model inputs_ERR calculations_Sample Fields_Dataset" **Project SOC (tCO_2e/ha)** Year | $SOC_{wp,l,t}$ 06-May-2019 - 31-May-2020 | 108.53 01-June-2020 - 31-May-2021 | 108.57 01-June-2021 - 31-May-2022 | 109.61
Monitoring equipment	NA
QA/QC procedures applied	QA/QC performed by comparing modelled results with publicly available data from the project area.[111]
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	None

Data / Parameter	$SOC_{wp,l,t-1}$
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the project scenario for sample unit *l* in year *t-1*
Source of data	Modeled in the project area
Description of	Modeled soil organic carbon stocks in the project scenario are determined according to the equation 34 of VM0042.

[111] https://soilhealth.dac.gov.in/soil-health-map

measurement methods and procedures applied	
Frequency of monitoring /recording	At least every five years, or prior to each verification event if less than five years
Value applied	104.27
Monitoring equipment	NA
QA/QC procedures applied	NA
Purpose of data	Calculation of project emissions
Calculation method	NA
Comments	None

Data / Parameter	$fCH_{4soilbsl,i,t}$
Data unit	t CH_4/hectare
Description	Modeled methane emissions from the soil organic carbon pool in the baseline scenario for sample unit *i* at time *t*
Source of Data	Modeled in the project area
Value Applied	$fCH_{4soilbsl,i,t}$ was modelled using DNDC v9.5
Description of measurement methods and procedures applied	Modelled using DNDC v9.5
Frequency of monitoring/recording	Conducted prior to each verification

$fCH_{4soilbsl,i,t}$ (tCO_2e/ha)	
Year	**$fCH_{4soilbsl,i,t}$**
06-May-2019 - 31-May-2020	3.38
01-June-2020 - 31-May-2021	3.56
01-June-2021 - 31-May-2022	3.65

QA/QC procedures applied	Model error and Uncertainty were determined as per VMD0053 guidelines
Purpose of data	Calculation of baseline emissions
Calculation method	Modeled
Comments	None

Data / Parameter	$fN_2O_{soilbsl,i,t}$
Data unit	t N_2O/hectare
Description	Modelled nitrous oxide emissions from soil in the baseline scenario for sample unit i at time t
Source of Data	Modelled in the project area
Value Applied	$fN_2Osoilbsl,i,t$ was modeled using DNDC v9.5 **$fN_2O_{soilbsl,i,t}$ (tCO_2e/ha)** **Year** — **$fN_2O_{soilbsl,i,t}$** 06-May-2019 - 31-May-2020 — 0.56 01-June-2020 - 31-May-2021 — 0.69 01-June-2021 - 31-May-2022 — 0.63
Description of measurement methods and procedures applied	Modeled using DNDC v9.5
Frequency of monitoring/recording	Conducted prior to each verification
QA/QC procedures applied	Model error and Uncertainty were determined as per VMD0053 guidelines
Purpose of data	Calculation of baseline emissions
Calculation method	Modeled

Comments	None

Data / Parameter	$\bar{\Delta}$ •,t and •$\bar{t}$
Data unit	tCO_2e/ unit area
Description	Average emission reductions from pool or source •, or stock of pool •, in year t
Source of Data	Calculated from modeled or calculated values in the project area
Value Applied	$\bar{\Delta}$ •,t (tCO_2e/ha) Year / $\bar{\Delta}$ •,t (PC1): 06-May-2019 - 31-May-2020: 2.92 01-June-2020 - 31-May-2021: 2.87 01-June-2021 - 31-May-2022: 2.79
Description of measurement methods and procedures applied	Not applicable
Frequency of monitoring/recording	Monitoring must be conducted prior to each verification event
QA/QC procedures applied	N/A
Purpose of data	Calculation of emission reductions
Calculation method	The average emission reductions from pool or source •, or stock of pool •, at time t are estimated using unbiased statistical approaches, such as from: Cochran, W.G., 1977. Sampling Techniques: 3d Ed. New York: Wiley. It is understood that application of this methodology may employ sample units of unequal sizes, which would necessitate proper weighting of samples in deriving averages. A range of sample designs (e.g., simple random samples, stratified samples, variable probability samples, multi-stage samples) may be employed.
Comments	None

Value Applied table:

$\bar{\Delta}$ •,t (tCO_2e/ha)	
Year	$\bar{\Delta}$ •,t (PC1)
06-May-2019 - 31-May-2020	2.92
01-June-2020 - 31-May-2021	2.87
01-June-2021 - 31-May-2022	2.79

Data / Parameter	$LE_{,t}$
Data unit	tCO_2e
Description	Leakage in year *t*.
Source of Data	Yield analysis through crop cutting trials conducted at the end of cropping season in the project area (for rice-wheat system)
Value Applied	0
Description of measurement methods and procedures applied	Leakage is considered to be equal to zero because the yield losses due to practice change adoption were less than 5% (~3.2% for this monitoring period) as per equation 29 of VM0042 v1.0.
Frequency of monitoring/recording	Monitoring must be conducted prior to each verification event
QA/QC procedures applied	A t-Test with two-sample assuming equal variances was conducted to test whether the practices affected yields.
Purpose of data	Calculation of project emissions
Calculation method	Calculated using Equation 29 of VM0042 v1.0
Comments	None

Data / Parameter	ΔP
Data unit	Percent
Description	Change in productivity.
Source of Data	Calculated using equation 29 of VM0042 v1
Value applied	3.24% (see Table no. 25)

Description of measurement methods and procedures applied	Yield analysis through crop cutting experiments conducted at the end of cropping season in the project area (for rice-wheat system)
Frequency of monitoring/recording	Conducted at the end of every cropping season.
QA/QC procedures applied	A t-Test with two-sample assuming equal variances was conducted to test whether the practices affected productivity.
Purpose of data	Determination of change in crop productivity for leakage analysis
Calculation method	Calculated using Equation 29 of VM0042 v1.0
Comments	None

Data / Parameter	Pwp,p
Data unit	Productivity (e.g., kg per hectare)
Description	Average productivity for product p during the project period
Source of Data	Crop cutting trials for yield measurement
Value applied	4.23 (Table no. 25)
Description of measurement methods and procedures applied	Yield analysis through crop cutting experiments conducted at the end of cropping season in the project area (for rice-wheat system). Statistical significance for difference of mean in yields was checked using a t-test.
Frequency of monitoring/recording	Conducted at the end of every cropping season
QA/QC procedures applied	Quality of data checked by checking for outliers.
Purpose of data	Determination of project productivity for market leakage analysis

Calculation method	Measured from crop cutting trials conducted in the project area
Comments	None

Data / Parameter	ΔP R
Data unit	Percent
Description	Change in productivity ratio
Source of Data	Crop cutting trials for yield measurement
Value applied	3.24
Description of measurement methods and procedures applied	Yield analysis through crop cutting experiments conducted at the end of cropping season in the project area (for rice-wheat system)
Frequency of monitoring/recording	Conducted at the end of every cropping season
QA/QC procedures applied	N/A
Purpose of data	Determination of change in crop productivity for leakage analysis
Calculation method	Measured from crop cutting trials conducted in the project area
Comments	None

Data / Parameter	$Buffer_{,t}$
Data unit	tCO_2e
Description	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t
Source of Data	The number of buffer credits to be contributed to the AFOLU pooled buffer account were determined by applying the latest version of the VCS AFOLU Non-Permanence Risk Tool v4.0

Value applied	*13%* Provided in the VCS AFOLU Non-Permanence Risk Report/3/ and section 7.5 of JPDMR (ERR Table: Buffer pool allocation)
Description of measurement methods and procedures applied	N/A
Frequency of monitoring/recording	Monitoring is conducted prior to each verification event
QA/QC procedures applied	The number of buffer credits to be contributed to the AFOLU pooled buffer account was determined by applying the latest version of the VCS AFOLU Non-Permanence Risk Tool v4.0
Purpose of data	Calculation of project emissions
Calculation method	The number of buffer credits were determined by applying the *VCS AFOLU Non-Permanence Risk Tool v4.0*
Comments	None

6.3. Monitoring Plan

The Project monitoring plan is pivotal in determining the final Verified Carbon Units (VCUs) of the project, rigorously pursued by the project owner during implementation and monitoring phases. This Joint Project Design and Monitoring Report (JPDMR) outlines the monitoring plan, establishing a framework that ensures compliance with the VM0042 method and quantification guidelines set forth in VMD0053. This plan facilitates the accurate measurement, recording, and reporting of the project's greenhouse gas (GHG) emission reductions/removals (ERRs) over the long term.

The monitoring plan encompasses detailed project implementation specifics, quality assurance guidelines, risk mitigation strategies, monitoring protocols, advanced technology or standard methods, efficient equipment, and the involvement of skilled personnel. It will be regularly re-evaluated and updated as necessary to maintain its effectiveness in capturing precise data required for quantifying ERRs. This comprehensive approach is crucial for maintaining the transparency, reliability, and integrity of the project's emission reductions, ensuring the quality and validity of the VCUs.

1. **Process for obtaining monitored data.**

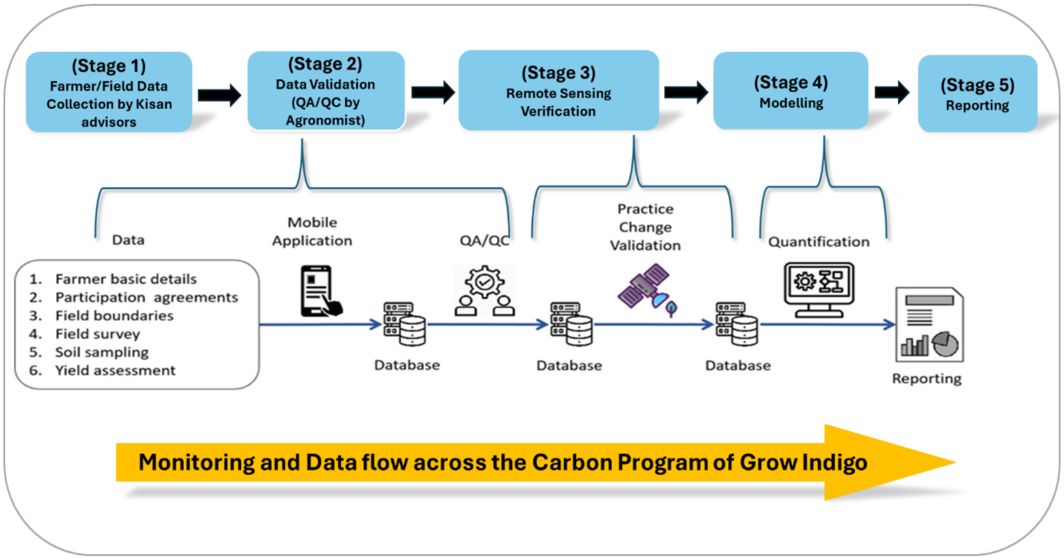


Figure 25: Monitoring process flow chart

Farmers are visited by Grow Indigo staff to collect both baseline and project survey data, such as tillage events, planting and harvest dates, crop selection, fertilizer and irrigation schedules, grazing activities if any, crop management etc. as specified in the table 4 of VM0042 (Table 4: Minimum specifications on agricultural management practices for the baseline scenario) using a mobile application. In addition to data collection, these visits are a means to further train farmers on Grow Indigo Carbon program and activities,

The process for collecting farmer and field data for quantification typically involved a questionnaire survey using a mobile application, that captures a combination of farmer basic details, signed agreements, geo-fenced field data, and field survey data. Other field activities include on-site soil sampling, ground-truthing activities, and crop cutting experiments for productivity and leakage assessment. Data collected through the mobile application assisted by field agents can be categorized as:

a. Farmer and field information: This includes the basic details of the farmer such as name, father's name, age, address, total number of fields, and geo-coordinates of the field, legal land information, signed agreement, etc.

b. Agriculture land management data/ survey data: This includes field information, season data, survey details including the agricultural practices such as crop management, tillage, fertilizer application, irrigation, residue management, crop variety, farm equipment used, practice information etc.

Farmer details were collected through in-person interactions and questionnaire surveys by field agents and validated by the regional agronomist. Followed by the registration process (collection of basic details and agreement signing) the farmer's field is geo-fenced, and the co-ordinates are stored in the database. Data collected through the Grow Indigo proprietary mobile survey application is stored in the database.

Remote sensing verification of farmer-reported practices for DSR and ZT:

Data is validated using remote sensing analysis of crop sowing (DSR) and tillage (ZT) practice change information (from TPR to DSR, and CT to ZT) using the satellite imagery data/6/.

This project aimed to assess the adoption of regenerative practices like DSR and ZT by farmers. However, national datasets on these practices using remote sensing weren't available. Additionally, analysing small fields with satellite imagery proved challenging.

To address this, an internal remote sensing methodology was developed to analyse the regenerative practice adoption at a field level. Ground-truth data (actual field conditions) was collected from some fields in our project area to train the model to determine the accuracy of the methodology. Finally, farmer-reported practices were classified using the in-house developed remote sensing methodology. See Table 17 for details on the qualification process.

- Conventional Practices (TPR or CT): Fields reported with these practices were disqualified.
- Regenerative Practices (DSR or ZT): Only fields matching with the remote sensing predicted results for DSR or ZT were considered eligible as project fields.

Table 17: Qualification of farmer reported practices with remote sensing analysis

Farmer reported	Remote sensing predicted	Final practice considered
TPR	TPR	TPR
TPR	DSR	TPR
DSR	TPR	TPR
DSR	DSR	DSR
CT	CT	CT
CT	ZT	CT
ZT	CT	CT
ZT	ZT	ZT

This approach was conservative, leading to some farmer-reported adoptions being disqualified.

The RS-GIS scientists of the GI team follow 3 levels of QA which is given below:

1st level QA: farmer reported geotagged polygons/ fields are visually interpreted by the agronomist and errors are reported and corrected by the field team.

2nd level QA: Topological errors like polygon overlaps with other field boundaries and non-eligible agricultural lands are corrected by the remote sensing team.

3rd level QA: Farmer reported crop sowing (DSR) and tillage (ZT) practice changes are validated using Sentinel-1 (SAR) & Sentinel-2 MSI (optical) satellite data. Detailed methodology is provided in the RS report.

Once the data is validated, it is analysed and processed to estimate the GHG emissions and carbon sequestration using biogeochemical modelling. Overall, the science team (RS team and Quant team) perform the QA/QC of the data collected before quantification of emissions. Quant team uses process-based models and methods approved in VM0042 and VMD0053 to analyse the survey data scientifically and quantify GHG emission reductions and carbon SOC stocks.

2. The organizational structure

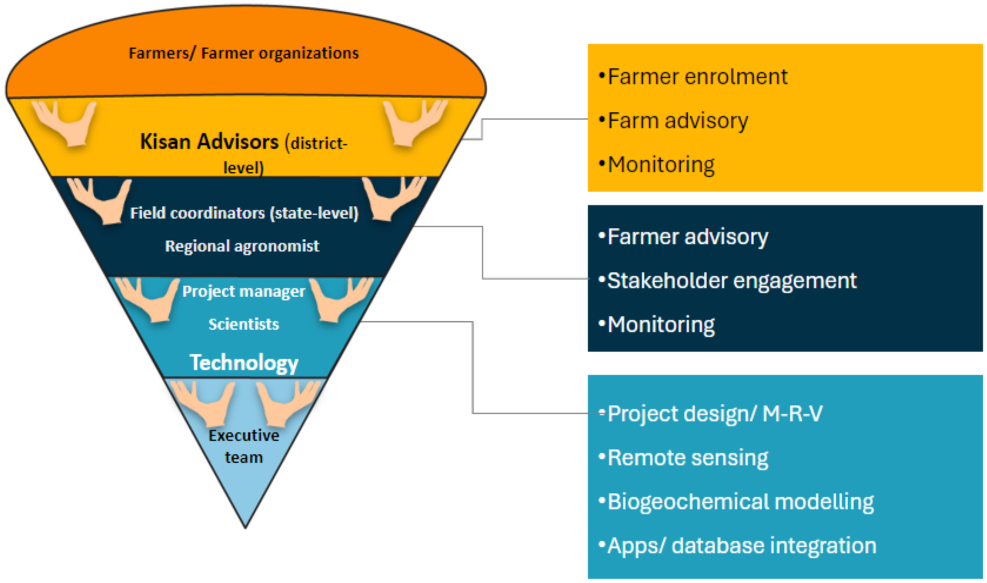


Figure 26: Organizational structure of Grow Indigo

Table 18 Responsibilities and competencies of the personnel that carried out monitoring activities.

S. NO.	Personnel	Responsibilities
1	Field agents and field coordinators	Collection of farmer data including field polygons, agriculture land management data, signing of agreements, farmer awareness and training
2	Agronomist	Stakeholder consultations, Farmer training/ events, QA/ QC of field data, Soil sampling, Ground truthing, Crop-cutting trials for yield estimations, baseline, and project survey data collection
3	Project manager	Project documentation, Supervision of processes for monitoring, check eligibility of fields based on methodology guidance
4	Scientists and technologists	Mobile application development and maintenance, data management and analysis, validation of data using remote sensing, biogeochemical modelling, baseline and project ERRs calculation, documentation and reporting

The policies used for oversight and accountability of monitoring activities.

The policies used for oversight and accountability of agriculture land management carbon monitoring activities are designed to ensure the reliable and accurate measurement of GHG ERRs and carbon sequestration and encourage the participation of farmers and land managers in carbon sequestration activities.

The policies include:

Data management

PP has established a strong process of data collection and monitoring system crucial for the VCS credits quantification and validation. To ensure the quality of data collection, a set of clear guidelines and protocols for data collection, analysis, and reporting were followed. PP has conducted levels of on-field training activities and provided the training manual to the field team to use as reference.

The efficiency and capacity of the field team are reviewed by the Project Manager at regular intervals, while the science team sets the standards for the scientific accuracy and consistency of data collection. Database holds information of the farmers participating in this project activity.

Training stakeholders

The proponent provided all stakeholders, teams, and associated members with the necessary training, including both VCS project requirements and technical aspects of the project, as well as a basic understanding of the VCS Standard and climate change impacts of adopting the regenerative agricultural practices. Providing training and resources to farmers supports accurate reporting and tracking of their field activities. PP conducts multilevel stakeholders' sensitization and training programs. Refer section.2.2. stakeholders Consultation in the JPDMR.

Training to project staff

In order to meet the project objectives and ensure compliance with VM0042 methodologies, team capacity building training for all monitoring staff is very crucial. This training Increases the team's capacity, and ability to identify and mitigate potential risks, improving the overall project quality, enhances the collaboration and communication among the team members, which can lead to better performance and more effective and efficient project management.

Monitoring frequency

The monitoring of the project implementation takes place every season, i.e., twice a year. The monitoring frequency is determined according to the methodological requirements for each parameter in the project after the project registration to ensure the continuity of the benefits. Monitoring of the field is very crucial as the farmers shouldn't deviate from the defined project cultivation practice, and not to represent any other GHG programs.

The procedures used for internal auditing and QA/QC.

Internal auditing and QA/QC procedures are conducted stringently by the proponent at 3 levels to ensure the accuracy and integrity of the project implemented and data collected at the ground level for the project including survey data, remote sensing, and soil sampling data. These procedures involve systematic review of plans, documentation, and records, as well as the use of QA parameters such as farmer field location, sample size, location, sample design, soil sample preparation, sample collection, packing and shipment, soil laboratory analysis, and quality control of samples.

It also includes the implementation of standard operating procedures and staff training on those procedures. The project manager ensures that project staff is adhering to these procedures ensuring that the data collected meets quality standards set out by the science team.

The 3 levels of QA auditing include:

1. Level 1 - Agronomist: Check the completeness and sanity of field data.
2. Level 2 - Project management: Completeness of signed agreements, survey and soil testing data, eligibility check of the farmers as per VM0042, based on the reported practice changes.
3. Level 3 - Science Team: Validation of survey data and field boundary, evaluates the technical correctness of data for eventual input for biogeochemical modeling.

The procedures used for handling any internal auditing performed and any non-conformances identified.

The procedures for handling internal audits and identifying non-conformances are included in monitoring of the project. These procedures ensure that any issues or discrepancies identified during the internal audit process are properly addressed and resolved in a timely manner. The internal audit involves reviewing process activities, supervision, documentation, online and offline meetings, conferences with project staff, meetings with agricultural experts and consultants, and regular site inspections to ensure compliance with VM0042 and VMD0053 guidelines.

Data Quality control and assurance procedures:

A quality management system guarantees that both qualitative and quantitative data are collected as per defined standards and process of regularly monitoring at 3 levels of QA auditing of data to ensure compliance and accuracy (see **Figure 25**). As shown in the diagram, QA assurance is conducted at 3 levels to ensure the accuracy, consistency, and overall quality of the collected and measured data. The final audit by the science/Data science team certifies data collected is qualified for VCS carbon credit quantification.

The Grow Indigo Kisan Advisor (field agent) conducts on-site visits to farmers' fields. The farmer survey is documented using Grow Indigo's proprietary application. This application includes crop-season-year-specific agronomy surveys, covering questions related to agricultural management practices. Additionally, it facilitates the recording of farmers' personal contact information and field details such as land ownership. Leveraging the Google Maps API, the Kisan (farmer) Advisor can geofence the farmer's fields directly within the app. Moreover, the app allows for the capture of field photographs.

The workflow typically involves the Kisan Advisor first gathering the farmer's personal details, followed by geofencing each field and subsequently collecting crop-season and year-specific (baseline period: 2016-2017, 2017-2018, and 2018-2019; project period: 2019-2020, 2020-2021, and 2021-2022), which marks the first monitoring period) agronomy survey data for each field (PAI). The application operates on Android devices, functioning both online and offline for Kisan Advisors. The collected data is stored in an MS SQL database. Personal information is masked and remains confidential, with access limited to the IT team responsible for managing incoming database entries. No data is deleted, and a historical record of all data since inception is maintained. When needed by cross-functional teams like Remote Sensing, Modelling, Projects, or Business, the data is shared without revealing any personally identifiable information.

This is followed by polygon QA/QC where, field boundaries, geotagged via the Kisan advisor's carbon management application, were overlaid on a high-resolution satellite image. The boundaries were adjusted based on the satellite data, and non-agricultural land use classes such as built-up areas, scrublands, roads, brick kilns, etc., were identified and excluded. Additionally, agricultural plantations were also omitted from the field boundaries during this process.

The accounting boundary for the project is geographical project boundary. All fields included in the project are clearly delineated, and the area within a field is continuous (excepting minor breaks) as established through the field boundary QA/ QC. All the initial PAIs are in the states of Haryana and Punjab only. Same quantification approach (QA1, Measure and Model, VM0042, V1.0) was applied for the accounting/project boundary and no deviations of methodologies were required.

QA/QC procedure for remote sensing:

Field boundaries were geofenced by Kisan Advisors using Grow Indigo's mobile application (https://play.google.com/store/apps/details?id=com.growindigo.farmMonitoring&pcampaignid=web_share). Digital field boundaries obtained by mobile application were checked for quality, i.e. the boundary should not include non-agriculture area. This was done by overlaying each field boundary over high-resolution satellite imagery from Google Earth (https://earth.google.com). If the boundary was found to be incorrect, the fields were sent back for correction to the field team.

Any revised boundaries again went through the field boundary quality check. Baseline and project fields were analysed for tillage (CT or ZT) and rice planting method (TPR or DSR) using the multi-date satellite images of each field during the crop growing season, using data from the Sentinel-1 and Sentinel-2 satellites (accessed via https://dataspace.copernicus.eu/). All methods for remote sensing analysis were developed in partnership with the Indian Agriculture Research Institute, New Delhi. Detailed documentation including data sources, methodology, and results is provided as supplementary information/6/.

Operations Process Control and Policy Implementation

Operations process control is maintained at zero tolerance for violation of set processes, policies, and operational standards. It involves the monitoring and operations of hiring, supervision, data governance, reporting processes, and project implementation activities. The goal of operations process control is to ensure that the project is running smoothly and efficiently while also meeting all safety and regulatory requirements. These policies outline the specific procedures and protocols that must be followed to ensure compliance with VM0042 and VMD0053. Any deviations or issues that may arise during the project are identified and handled to avoid inconsistency in the project.

Any non-conformances identified during the audit process are documented in the form of email or written format, further evaluated, and addressed through corrective measures as per the code of conduct in the same mode of communication. This leads to incorporating or upgrading new procedures and technology, retraining staff, or making changes to the procedure used in the project if the proponent deems it important. The main objective of the auditing procedures is to ensure that the project is meeting VM0042 and VMD0053 objectives and achieving the desired carbon credit outcomes while adhering to the best practices and standards.

Project area Stratification and Soil sample collection

Soil sample collection in the project area was performed using stratified random sampling method. Stratification of project area was done by dividing the project area into four smaller, homogeneous sub-areas (strata) to increase the precision of the sampling results. The four strata of the project area are based on the four predominant soil types (Haplic Yermosols, Calcic Xerosols, Orthic Luvisols and Cambic Arenosols (Figure 4). Soil samples collected from our project area fall into one agro-ecological zone (number Z-4.1) and agro-climatic zone (number 6).

This zone is also called as 'Trans Gangetic Plain' and has been historically reported (references above) to represent homogeneity with respect to climate, crop growing periods and soil textures, which covers all features of abiotic crop environment (that can influence soil GHG emissions). Within the project area (Haryana and Punjab), the Rice-Wheat cropping system was prominent with a large number of enrolled farmers geographically scattered, and thus stratified random sampling enabled to collect the samples that best represented the entire project area. We have covered 3 predominant soil types (out of four) (Haplic Yermosols, Calcic Xerosols and Orthic Luvisols) since 97.35% of our enrolled farms (3236 of total 3324) are present in these three soils (Figure 4).

A stratified random sampling approach was used, with strata defined by Practice Categories (e.g., TPR/DSR and CT/ZT), since management practices are the main factors influencing variations in modeled ERRs. For aggregation, each Practice Category was treated as a separate stratum, and the average ERR (tCO_2e/ha) was calculated for sampled fields within each category. This average ERR was then multiplied by the total enrolled area under that category, and the results from all categories were summed to obtain the total project ERR. This approach applies area-based weights (each stratum's share of total project area) to ensure that the aggregation accurately represents the full project area, consistent with the methodology's areal-average aggregation requirements.

To estimate the desired sample size for our study, as per equation 46 (according to the VM0042 v1.0), we selected the desired confidence level as 95% and a 5% margin of error. In order to estimate the desired sample size, we also needed an estimate of the variance for emission reduction value from the practices. Equation 46 gives an allowance of 15% in the final uncertainty.

We used this as the baseline value to compute the desired sample size for our soil sample collection study as follows:

Sample size = (z * stdev / ME)^2
where:
z = 1.96 (critical score for 95% confidence level)
stdev = 0.15 (i.e. baseline 15% allowed in equation 46)
ME = 0.05 (i.e. 5% as expected in equation 46)

This results in:
Sample size = (1.96 * 0.15 / 0.05)^2 = 35 samples

Given that sampling is a resource intensive, time sensitive and time-consuming process, we opted for a conservative approach. 50 samples (about 143% of desired size) were collected during the year 2021 covering an area of 50 acres from the project area and the samples were sent for laboratory analyses for characterization of soil chemistry. Out of 50 samples, the PC-wise and year-wise distribution of usable samples is provided in Table 19. Note that 16 samples were from fields with no practice changes, 4 fields were research sites, 1 field exited the program. Therefore, Table 19 has 29 fields in the PC-by-year matrix.

Table 19: PC-wise and year-wise distribution of soil sampled fields

Practice Categories	2019	2020	2021
PC0	7	0	0
PC1	3	7	7
PC2	19	22	22

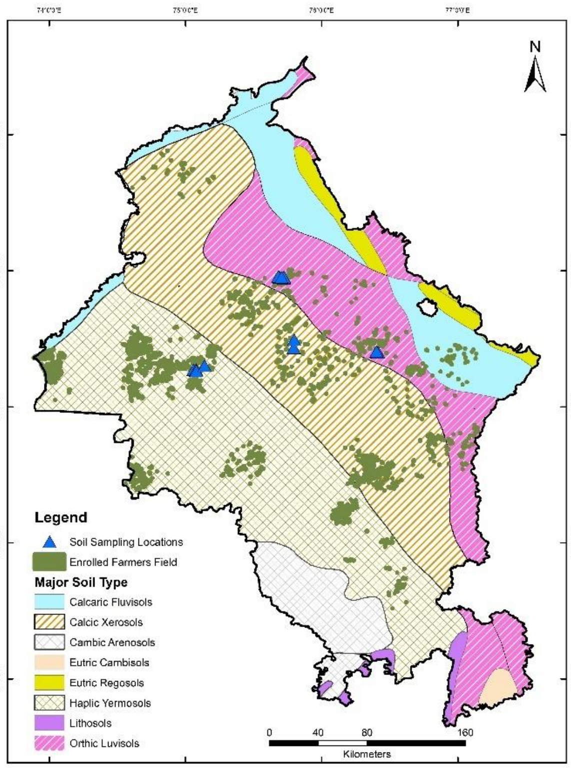


Figure 27: Soil Map showing enrolled farmers' fields and the soil sampling area along with project boundary covering predominant soil types. (Source of soil layer is https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/446ed430-8383-11db-b9b2-000d939bc5d8)

Measurement of soil organic carbon

Soil organic carbon (SOC) is measured at two depths in each field: 0-15 cm and 15-30 cm. At each depth, three samples are collected using an auger, and then pooled into a single sample for analysis. Bulk density (BD) measurements are made simultaneously at the two depths at the location of SOC sampling. The dry combustion method is used in the lab to determine the SOC content of the sample. This method heats the sample to a high temperature, converting the organic carbon to carbon dioxide gas. The amount of carbon dioxide released is then measured to determine the SOC content of the soil. Each field's SOC and BD results are used as input parameters as per quantification approach 1. Detailed sampling procedure, lab analysis methods, and results are provided as supplementary information/38//39/.

The measurement frequency is determined based on project objectives and regulations. QA/QC procedures should be established to ensure the accuracy and integrity of the soil sampling results.

Emergency procedure

Continuous field monitoring is essential to identify and mitigate potential risks in a timely manner. By keeping a close eye on the project activities, the proponent can take proactive steps to address any issues that may arise, thereby reducing the likelihood of negative consequences. Furthermore, continuous monitoring enables proponents to make real-time adjustments to their operations, which can help optimize performance and improve overall outcomes.

Some issues that may arise in the field are.

1. **Risk:** Farmers may deviate from the defined project cultivation practice and may represent any other GHG programs.

Mitigation: A periodical visit of our field officer and interaction with farmers ensures no deviation; if found, we will educate farmers to stick with regenerative farming.

2. **Risk:** Unaddressed challenges faced by the farmers during the project may lead to the risk of low crop yield and farmers signing out of the program.

Mitigation: A contact number of the associated field officer is always with the enrolled farmers. The farmers are encouraged to call if any unaddressed challenges are faced. The field officer also visits the farms/farmers to do the risk preventive methods

3. **Risk:** If ground truthing is not done, it may lead to inaccurate identification of the information gathered by remote sensing methods. These inaccuracies can have significant consequences, such as poorly distinguish practice change, and may be underestimated or overestimated.

Mitigation: Ground truthing is carried out by the Science team with visits to the field and ensures correct and accurate analysis of the practice-changes is done with a corelation.

4. **Risk:** Prevent the loss of data or any future reference /verification by Verra.

Mitigation: Data is stored in a database that is regularly backed up. The data access is also restricted based on need. Records are never deleted; any deletion is only on a logical level by way of a status flag. All data collected as part of the monitoring plan and process is saved with at least one retrievable backup copy for at least two years after the end of the total project crediting period. The data and technology department of the project proponent manage and governs the data for the project as per processes that have been defined.

Baseline revaluation after 10-year period:

In accordance with VM0042 v1.0 and VCS standard 4.5, the project sets the baseline using historical management data specific to the project area. This baseline undergoes comparison with published information regarding current common practices within the project region. Agricultural production data and procedures will be reviewed and revised in five years in accordance with the baseline schedule of activities. This periodic evaluation ensures that the project remains aligned with evolving agricultural practices and regional dynamics, thereby enhancing its effectiveness and relevance over time.

Baseline re-evaluation will occur every 10 years in accordance with Section 6 in the VM0042 methodology. At the end of each baseline period, production of the commercial crop(s) in the baseline scenario will be re-evaluated. Published state-wise agricultural production data from within the five years immediately preceding the end of the current baseline period will be consulted. Where there is evidence of continued production of the relevant commercial crop(s) using the same ALM practices in the region, the baseline scenario will be valid as is, continuing with the previous schedule of activities.

Where there is no evidence of continued production of the relevant commercial crop(s), a new schedule of ALM activities (evaluated against common practices in the region) will be developed based on written recommendations for the sample field provided by independent professional agronomists, agricultural experts such as soil scientists and government agricultural extension agents. Recommendations would provide sufficient detail to produce the minimum specifications on ALM practices for the baseline scenario as outlined in Table 4 of VM0042. Common practice assessment and regulatory surplus will also be re-evaluated at the time of baseline re-assessment following the VCS standard and VM0042 methodology.

Fields that have not adopted regenerative practices and are still using conventional practices will be targeted by PP to identify potential locations within the project area covering the states of Punjab and Haryana. Project practices will be introduced through influential farmers/farmer organizations. Further, PP will also approach the local authorities for strategizing the regenerative agricultural practice implementation in the potential fields in the project area. This approach will be used by PP to identify future areas for project implementation.

Modeling plan

Model Selection and Model Version

As per VMD0053 Model Requirements, the biogeochemical model selected for calibration, validation and quantification of GHGs in the project is the Denitrification-Decomposition (DNDC) model, version DNDC 9.5 (http://www.dndc.sr.unh.edu/model/DNDC95.zip). Grow Indigo also has a legal right to use the model exclusively for commercial application in the project area.

DNDC Model Description

DNDC is a process-oriented computer simulation model of carbon and nitrogen biogeochemistry in agroecosystems. The DNDC model incorporates the driving factors of the ecological environment and aims to simulate the carbon and nitrogen cycle in the terrestrial ecosystem. The entire model forms a bridge between the C and N biogeochemical cycles and the primary ecological drivers.

DNDC model has been shown to be highly valid across a wide range of management practices and geographic area and needs to be explicitly calibrated with empirical data. DNDC has also been widely tested against several field observations regarding trace gas emissions and SOC dynamics and in agroecosystems worldwide. The empirical data requirement is necessary because the quantification of uncertainty around modelled results can only be done with local and specific data.

Our project employs the DNDC 9.5 model for accurate quantification of SOC, methanogenesis process (causing CH_4 emissions) and nitrification and denitrification processes (causing N_2O emissions). This model is publicly accessible via the University of New Hampshire's website for research purposes. Additionally, we hold exclusive commercial rights to utilize the DNDC model within the project area. The model has been validated by the IME (Independent Modeling Expert) specifically for our geographical scope.

The model consists of two components. The first component, consisting of the soil climate, crop growth and decomposition sub-models, predicts soil temperature, moisture, pH, redox potential (Eh) and substrate concentration profiles driven by ecological drivers (e.g., climate, soil, vegetation and anthropogenic activity). The second component, consisting of the nitrification, denitrification and fermentation sub-models, predicts emissions of carbon dioxide (CO_2), methane (CH_4), ammonia (NH_3), nitric oxide (NO), nitrous oxide (N_2O) and di-nitrogen (N_2) from the plant-soil systems.

The DNDC model accommodates six sub-models and describes soil C and N cycles in agricultural systems (Li et al., 1992, 2000). DNDC9.5 was calibrated to simulate Rice-wheat cropping system, and the sensitivity of the model to different input parameters was investigated as described in Pathak et al., 2005. Region specific climate, soil and crop input parameters were adopted to simulate Kharif Rice-Rabi Wheat cropping systems in this project. In the current project, baseline practices (TPR and CT) and project practices (DSR/ZT) were modeled and quantified;

i. TPR/DSR for CH_4 and N_2O emissions quantification
ii. CT/ZT for SOC quantification

DSR practice has been promoted in the project as it allows: (1) avoidance of the flooding or inundated conditions for cultivation of rice paddies and thus reducing CH_4 emissions whereas (2) ZT practice involves reduced number of tillage operations before planting and thus enables retaining/incorporation of crop residues in the field.

Datasets

Research papers and the corresponding datasets selected for the calibration and validation of the model were mainly from IGP region and were focused on field-scale GHG measurements during

DSR and ZT practice implementation (treatments) against conventional practices i.e., transplanted rice (TPR) and conventional tillage (CT) before wheat crop cultivation. The datasets of the selected research papers comprised of key parameters such as of soil texture, crop management crop establishment and water management rice-wheat cropping system that were specific for simulating the corresponding emission fluxes, from DSR and ZT practices. These studies also reported emission fluxes and SOC changes and thus enable validating our sampled fields that adopted these regenerative practices. The research papers applied, and the datasets of these research papers applied for calibration and validation were documented and were evaluated by IME/36/.

Documentation Of Model Parameter Sets

Input Parameters

As per the Model Requirements and Guidance in VMD0053, parameter set was defined as “the set of mathematical values and constants contained in a model that characterize the biophysical and biogeochemical system being represented”. Crop management practices implemented before project start, form the “baseline” scenario, and is thus unambiguously defined by fixing the key input parameters ex-ante, in the project document. Modeling is conducted across a cropping year, i.e., agricultural seasons, both Kharif and Rabi. For both seasons, farmer reported date of sowing and date of harvesting is applied as model inputs.

Table 20: Crop management parameters input for modeling baseline scenario

Baseline activity	Key input parameters
Transplanted rice (TPR)	Sowing date Harvesting date Fertilization schedule Irrigation schedule
Conventional tillage (CT)	Tillage events Sowing date Harvesting date Fertilization schedule Irrigation schedule

Climate parameters

The weather parameters were obtained on site-by-site basis from NASA POWER that provides high resolution precipitation data derived from NASA's Global Precipitation Measurement (GPM) mission's Integrated Multi-satellite Retrievals for GPM (IMERG). (https://power.larc.nasa.gov/docs/methodology/) (Table 21).

Table 21: Input parameters specific to climate conditions

Input parameter	Unit
J day (julian day)	Day of the year
MaxT (maximum temperature)	°C
MinT (minimum temperature)	°C
Precipitation	mm day^{-1}

Soil parameters applied

a. Soil input parameters are collated in Table 22
b. Land-use type - rice paddy field
c. Soil Texture: Soil type was based on area of the experimental studies or field site. The soil textures applied for calibration included (1) loam (2) loamy sand and (3) silty clay loam specific to project area. For GHG quantification amongst the sample fields, the soil textures applied were based on

soil measurements/analyses (from each of the sampled field areas). These soils are very commonly found in Haryana and Punjab.

d. Bulk density (g/cm^3):Bulk density of topsoil (0-10 cm) for calibration and validation was used as reported in the published literature (BD measured and reported in the experimental studies). BD used for sample quantification was from measured soil samples.
e. Soil pH: For Calibration and Validation soil pH parameters were from literature whereas for quantification, data from soil sampling measurements were applied.
f. Clay fraction of soil by weight: default clay content was applied.
g. Field Capacity (0-1): Water-filled porosity (WFPS) at soil field capacity. The default values of DNDC obtained after the selection of soil texture were applied.
h. Wilting Point (0-1): Water-filled porosity (WFPS) at soil wilting point. The default values of DNDC obtained after the selection of soil texture were applied.
i. Hydro-conductivity (m/hr): Hydrological saturation conductivity in m/hr, was default value. The default values of DNDC obtained after the selection of soil texture were applied.
j. Porosity (0-1): a default porosity value was used. The default values of DNDC obtained after the selection of soil texture were applied.
k. SOC at surface soil (0-10 cm) (kg C/kg): for Calibration and validation, literature values were applied and for quantification, the SOC values from soil sampled (by PP to 30 cm depth) data was used.
l. Initial NO_3(-) concentration at surface soil (mg N/kg)]: Fixed values of 10 and 12 were used for loam soils and silty loam soils whereas in soils with clay content (silty clay loam or sandy clay loams) a higher initial NO_3- concentration value of 18 was applied. This is because NO_3- leaching is higher in loamy or silty loam soils and lower in soils with clay content.
m. Initial NH_4(+) concentration at surface soil (mg N/kg): a fixed value of 2 was used for Calibration, Validation and Quantification.

Table 22: Input parameters specific to soil characteristics

Input parameter	Unit
Bulk Density	g/cm^3
pH	-
Porosity	
Organic Carbon Content	Kg C/kg soil
Texture	-
Nitrate	mg N/kg
Ammonium	Mg N/kg

Crop Management parameters

a. Total years: For calibration and validation, 1–3-year simulations were performed (as per the experimental duration) and for the quantification, the number of total simulation years is 7yrs. Three baseline years and three project years. The seventh year is the harvest year of the 2nd crop (wheat), during 6th year.
b. Number of cropping systems applied during the total simulated years: 1 cropping system for calibration, validation and quantification exercises.
c. Duration of this cropping system (yrs): 7.

Crop parameters applied

a. Crop type: Annual
b. Seeding procedures: Transplanting (TPR), DSR.
c. Tillage information (no of applications): Varied from 3-10 tills for TPR-CT and 0-1 for Reduced/ZT
d. [Tilling #]: Sequential number of each application.
e. Month/Day: Date of the tilling application.

f. Tilling method: Defined tilling depths by selecting the model options as shown in model interface (1) no-till (2) ploughing slightly (5 cm), (3) ploughing with disk or chisel (10 cm), (4) ploughing with moldboard (20 cm), or (5) deep ploughing (30 cm).
g. Fertilization information: options for fertilization: Manual application of fertilizers was opted with only surface application (typically broadcasting method of fertilizer application).
h. Number of applications in the year was added as per the research data (for calibration and validation) and surveyed data of the sample fields (for quantification of GHG emissions/SOC from sampled fields).
i. Fertilizer applications: Sequential numbers of fertilizer applications were provided for each application.
j. Application date: month/Day: Dates of each application were applied.
k. Application depth: Surface or injection applications was specified.
l. Applied amount of fertilizers (kg N/ha): actual amount of fertilizers applied.
m. Flooding: Flooding practice applied for paddy rice.
n. Number of flooding applications in the year was provided.
o. Flooding number: Sequential number of each application. Frequency and duration of flooding for the rice crop (if any) was provided.
p. Start on month/day: Starting date of each flooding application was applied.
q. End on month/day: End date of each flooding application was applied.

Key Input Parameters

All parameters that are related to the project activities were named "key management parameters" (Table 23) and were fixed ex-ante. In other words, values of key management parameters must be identical ex-ante and ex- post as per VMD0053 and the same guideline was followed in this project. Specific parameters representing DSR/ZT practices were input into the model as shown in Table 21, and Table 23.

Table 23: Key crop management parameters input for modeling project scenario

Project activity	Key input parameters
Dry seeding (DSR)	Sowing date Harvesting date Fertilization schedule Irrigation schedule
Reduced tillage (ZT)	Tillage events Sowing date Harvesting date Fertilization schedule Irrigation schedule

Quantification of sampled fields from project area

After model calibration and validation, the quantification analysis was carried out using the DNDC95 biogeochemical model representing the two regenerative practice changes (PCs) implemented (adoption of ZT and DSR). The model was executed separately for each soil-sampled rice–wheat field within the project area to estimate GHG emissions and SOC sequestration. The quantification procedure followed a series of steps aligned with the model input requirements and the guidelines outlined in VM0042 v1. Climate data was collected from various resources like Indian Agricultural Research Institute, Krishi Vigyan Kendra Jalandhar, Punjab Agricultural University and NASA POWER for the years 2016-2021. Crop management data for the farmers' fields were surveyed with the help of a Grow Indigo digital application for the years 2016-2021. Soil textural data was specific to IGP region. Historical SOC was back- modeled to t =0 from SOC measurements collected within +/-5 years of t =0, using soil sampled data from the project area directly by PP collected in 2021 (Figure 28).

The first monitoring period spans three years. Therefore, each field-year was assigned a provisional PC. This is the initial category inferred directly from field records/monitoring for that year (PC0, PC1, PC2, or PC3). Then provisional PCs were converted to final PCs using the rules defined by the PP for practice continuity checks, stacked-practice (PC3) handling. Detailed PC categorization logic is provided as supplementary information (07_PC_Assignment_logic). This two-step (provisional→final) process keeps categories mutually exclusive, prevents double counting, and ensures only well-supported, conservative cases are credited.

The following illustration shows the structure of DNDC model simulations performed both for baseline and project scenarios. Each simulation (for one sampled field) is a 7-year long simulation including the baseline (2016-2018) and project (2019-2021) scenarios as shown in Figure 28. The details are further provided in the MVR and the specific “dnd” input files used and the “output” files generated are also validated by the IME. The same are also provided in MVR/36/ annexed to this document.

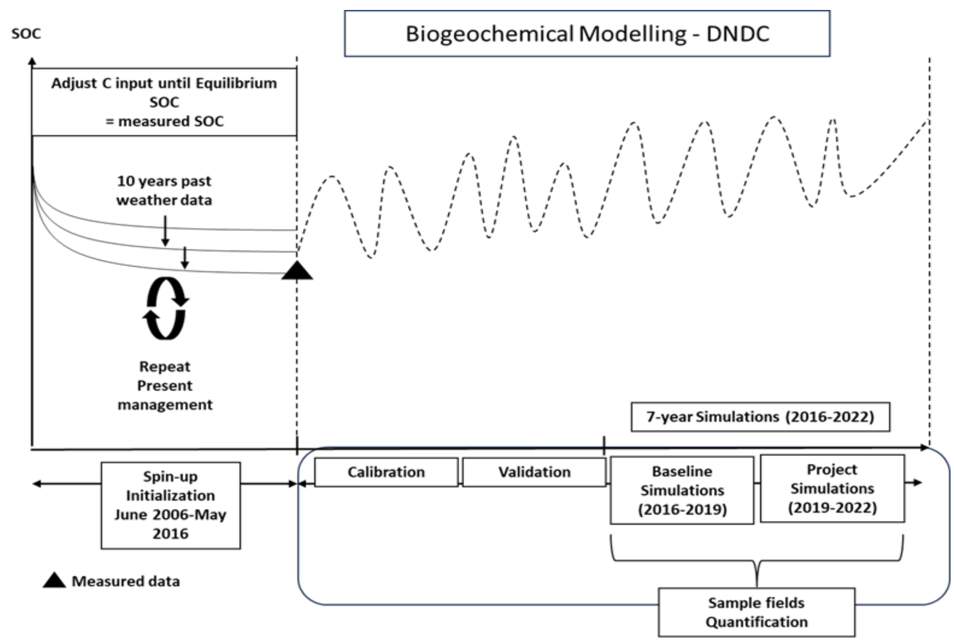


Figure 28: Structure of the biogeochemical modeling conducted for the project.

(Figure adapted from Rie Nemoto, 2014)

7. QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

7.1. Data and Parameters Monitored

Data and parameters monitored during the monitoring period is given below.

Data / Parameter	AR

Data unit	Percent
Description	Weighted average adoption rate
Value applied	11 %
Comments	Mentioned in section 3.5 of JPDMR

Data / Parameter	$Area_{an}$
Data unit	Hectares
Description	Area of proposed project-level adoption of each activity
Value applied	<table><tr><td>Region</td><td>Practice</td><td>Area_{an}</td></tr><tr><td rowspan="2">Punjab and Haryana</td><td>DSR, hectares</td><td>1,244,000</td></tr><tr><td>ZT, hectares</td><td>153,400</td></tr></table>
Comments	None

Data / Parameter	EA_{an}
Data unit	Percent
Description	Adoption rate of the n largest most common proposed project activity in the region
Value applied	Mentioned in section 3.5 of JPDMR (DSR = 12%, ZT = 9%)
Comments	None

Data / Parameter	A_0
Data unit	Hectare
Description	Project area
Value applied	13518.7 ha
Comments	None

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/t CH_4
Description	Global warming potential for CH_4

Value applied	28
Comments	None

Data / Parameter	GWP_{N2O}
Data unit	$t\ CO_2e$ / $t\ N_2O$
Description	Global warming potential for N_2O
Value applied	265
Comments	None

Data / Parameter	A_i
Data unit	Hectare
Description	Area of sample unit *i*
Value applied	0.4 ha each field.
Comments	None

Data / Parameter	i
Data unit	dimensionless
Description	Sample unit; a field
Value applied	45
Comments	None

Data / Parameter	$fSOC\ bsl,i,t$
Data unit	$t\ CO_2e$/hectare

Description	Modeled soil organic carbon stocks in the baseline scenario for sample unit *i* at time *t*
Value applied	SOC stock values vary with field/practice/crop history **Baseline Modeled SOC (tCO_2e/ha)** **Year** | $fSOC\ bsl,i,t$ 06-May-2019 - 31-May-2020 | 105.5 01-June-2020 - 31-May-2021 | 106.5 01-June-2021 - 31-May-2022 | 107.9
Comments	None

Data / Parameter	$SOC\ bsl,i,t$
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the baseline scenario for sample unit *i* in year *t*
Value applied	$SOC_{\ bsl,i,t}$ (tCO_2e/ha) **Year** | $SOC_{\ bsl,i,t}$ 06-May-2019 - 31-May-2020 | 105.5 01-June-2020 - 31-May-2021 | 106.5 01-June-2021 - 31-May-2022 | 107.9
Comments	None

Data / Parameter	SOC *bsl*,i,t-previous
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the baseline scenario for sample unit *i* in year *t-1*
Value applied	104.25
Comments	None

Data / Parameter	SOCwp,i,t
Data unit	t CO_2e/hectare

<table>
<tr><td>Description</td><td>Areal-average soil organic carbon stocks in the project scenario for sample unit i in year t</td></tr>
<tr><td>Value applied</td><td>Refer excel sheet “Model inputs_ERR calculations_Sample Fields_Dataset”
<table>
<tr><th colspan="2">Project SOC (tCO_2e/ha)</th></tr>
<tr><th>Year</th><th>$SOC_{wp,I,t}$</th></tr>
<tr><td>06-May-2019 - 31-May-2020</td><td>108.53</td></tr>
<tr><td>01-June-2020 - 31-May-2021</td><td>108.57</td></tr>
<tr><td>01-June-2021 - 31-May-2022</td><td>109.61</td></tr>
</table></td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	SOCwp,i,t-1
Data unit	t CO_2e/hectare
Description	Areal-average soil organic carbon stocks in the project scenario for sample unit *i* in year *t-1*
Value applied	104.27
Comments	Modeled using DNDC 9.5

<table>
<tr><td>Data / Parameter</td><td>$\overline{\Delta}\bullet$,t and $\overline{\bullet}$t</td></tr>
<tr><td>Data unit</td><td>t CO_2e/hectare</td></tr>
<tr><td>Description</td><td>Average emission reductions from pool or source ●, or stock of pool ●, in year t</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th colspan="2">$\overline{\Delta}\bullet,t$ (tCO_2e/ha)</th></tr>
<tr><th>Year</th><th>$\overline{\Delta}\bullet,t$ (PC1)</th></tr>
<tr><td>06-May-2019 - 31-May-2020</td><td>2.92</td></tr>
<tr><td>01-June-2020 - 31-May-2021</td><td>2.87</td></tr>
<tr><td>01-June-2021 - 31-May-2022</td><td>2.79</td></tr>
</table></td></tr>
<tr><td>Comments</td><td>None</td></tr>
</table>

Data / Parameter	$ƒCH_4$soilbsl,i,t
Data unit	t CH_4/hectare

Description	Modelled methane emissions from the soil organic carbon pool in the baseline scenario for sample unit *i* at time *t*
Value Applied	$fCH_{4soilbsl,i,t}$ was modelled using DNDC v9.5 $fCH_{4soilbsl,i,t}$ (tCO2e/ha) Year / $fCH_{soilbsl,i,t}$ 06-May-2019 - 31-May-2020: 3.38 01-June-2020 - 31-May-2021: 3.56 01-June-2021 - 31-May-2022: 3.65
Comments	None

$fCH_{4soilbsl,i,t}$ (tCO2e/ha)	
Year	$fCH_{soilbsl,i,t}$
06-May-2019 - 31-May-2020	3.38
01-June-2020 - 31-May-2021	3.56
01-June-2021 - 31-May-2022	3.65

Data / Parameter	$fN_2Osoilbsl,i,t$
Data unit	t N_2O/hectare
Description	Gas or pool
Value Applied	$fN_2Osoilbsl,i,t$ was modelled using DNDC v9.5
Comments	None

$fN2O_{soilbsl,i,t}$ (tCO_2e/ha)	
Year	$fN_2O_{soilbsl,i,t}$
06-May-2019 - 31-May-2020	0.56
01-June-2020 - 31-May-2021	0.69
01-June-2021 - 31-May-2022	0.63

Data / Parameter	$LE_{,t}$
Data unit	tCO_2e
Description	Leakage in year *t*.
Value Applied	0
Comments	None

Data / Parameter	ΔP
Data unit	Percent
Description	Change in productivity.
Value applied	3.24% (see Table no. 25)
Comments	Evidence provided to VVB as supporting document named "Farm productivity analysis"

Data / Parameter	Pwp,p
Data unit	Kg per hectare
Purpose of data	Determination of project productivity for market leakage analysis
Value applied	4.22 (Table no. 25)
Comments	Evidence provided to VVB as supporting document named "Farm productivity analysis"

Data / Parameter	ΔP R
Data unit	Percent
Purpose of data	Determination of change in crop productivity for leakage analysis
Value applied	3.24
Comments	Evidence provided to VVB as supporting document named "Farm productivity analysis"

Data / Parameter	$Buffer_{,t}$
Data unit	tCO_2e
Description	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t
Value applied	13% Provided in the VCS AFOLU Non-Permanence Risk Report/6/and section 7.5 of JPDMR (ERR Table: Buffer pool allocation)
Comments	None

7.2. Baseline Emissions

Baseline GHG emission estimations (ex-ante) were made by using scientific publication that reported the GHG emissions from conventional agricultural practices applicable for baseline scenario and the mitigation potential that can be achieved by the adoption of regenerative practices.[112] Baseline emissions in the project were modeled using (a) field-specific soil data, (b) three-year (2016-2018) historical records (before project start) of the actual crop management of each of the individual rice-wheat fields along with (c) three-year historical (2016-2018) weather information collected from NASA power website. The modeled results indicated SOC removals, CH_4, and N_2O emissions generated due to the conventional agricultural practices from each of the soil sampled fields in the project area. The following illustration enables to understand the cropping pattern of rice-wheat rotation in the project area and the timelines of modeling performed.

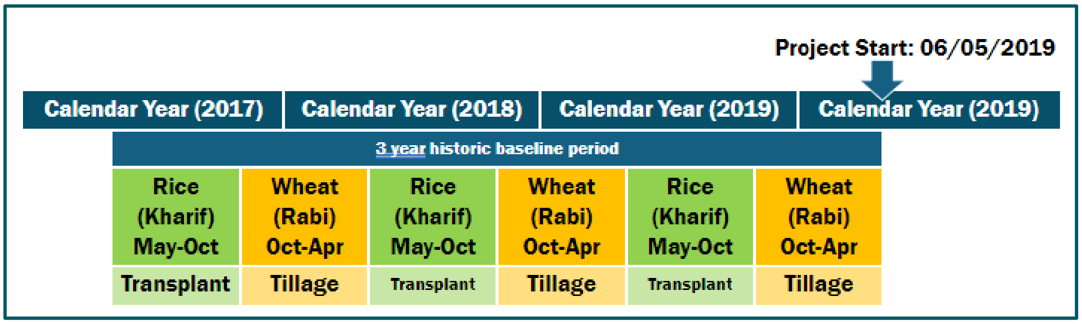
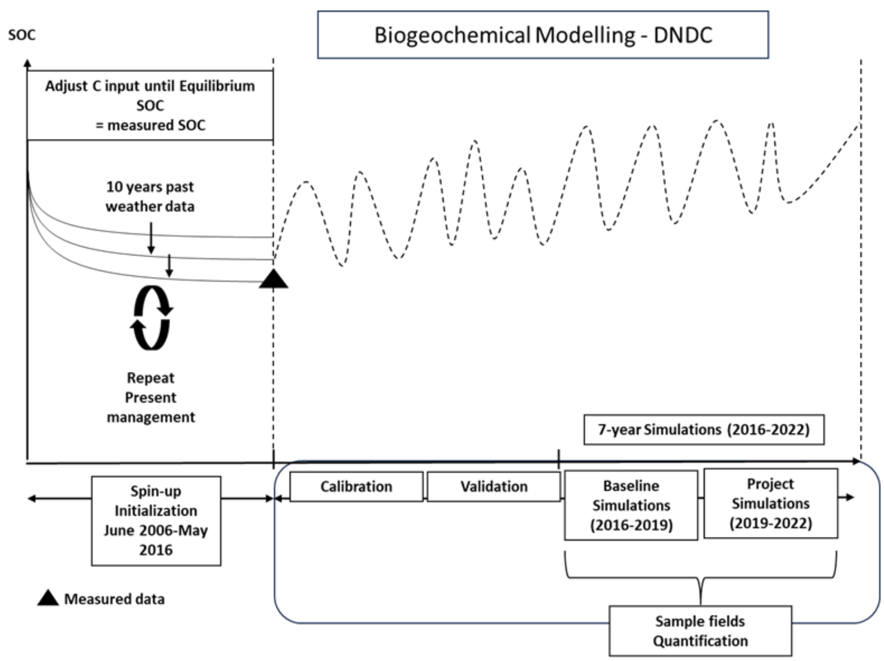


Figure 29: Representation of the Baseline period

For quantification exercise, the values of the key input parameters unambiguously define the baseline scenario, they are fixed ex-ante and are not allowed to change until a baseline update.



[112] Jat, H.S., Kumar, V., Datta, A. *et al.* Designing profitable, resource use efficient and environmentally sound cereal-based systems for the Western Indo-Gangetic plains. *Sci Rep* **10**, 19267 (2020). https://doi.org/10.1038/s41598-020-76035-z.

Figure 30: Biogeochemical modeling conducted for the project to calculate baseline emissions (Figure adapted from Rie Nemoto, 2014)

To initiate the quantification of baseline emissions for sampled fields, a simulation file was developed comprising three years of historical data representing the baseline scenario (2016-2018). Modeling was conducted at a fixed soil depth of 0–30 cm using measured SOC data. Annual estimates of CH_4, N_2O emissions, and SOC stock were generated year-by-year for the baseline scenario.
The DNDC simulation outputs provided detailed annual SOC stock and GHG emission values for baseline scenario. Further details can be found in the MVR)/36/.

7.3. Project Emissions

For estimation of project emissions (SOC, CH_4, and N_2O) all DNDC input parameters in the model settings were maintained same as in the baseline scenario, except for key/specific management changes (practice changes) to be undertaken by the project (DSR/ZT). For each sampled field project emissions were modelled using crop management data specific to the practice adopted (DSR/ZT). The modelled results indicated SOC removals, CH_4, and N_2O emissions generated as a result of regenerative agriculture practices adopted during the project period. Subsequent to modeling the project emissions emission reduction and removal calculations were performed using the results generated by modeling baseline emissions. The details of baseline emissions, project emissions calculations are provided in ERR calculation spreadsheet.

Table 24: Baseline and project parameters applied for quantifying baseline and project emissions

Scenario	Condition variations
Baseline	• Rice-Wheat rotation (R-W), • Continuous flooding (CF), • Conventional tillage (tilling twice to depth 20 cm) • Rice optimum yield 6500 kg dry grain/ha, • Fertilizer 80-250 kg urea-N/ha per year; • Annual average temperature 17.2°C, • Annual precipitation 1000 mm, N concentration in rainfall 2 ppm,
Management Alternatives	
Crop rotation, Tillage, Fertilizers	• Rice-wheat crop (R-W) • Reduced Tillage (depth 10 cm) (CST), and no-till (No Tillage - ZT) • Fertilizer types- Urea, DAP, nitrate, ammonium bicarbonate (AB)
Soil Factor	
Soil textures SOC content	Loam, Loamy sand, sandy loam, clay loam, silty clay and clay SOC content (kg c/kg soil)

7.4. Leakage

Leakage from Productivity Declines

The project aims to promote regenerative agricultural practices to help farmers achieve improved soil carbon and reduce GHG emissions. The project has demonstrated that adopting these practices does not result in a reduction in yield.

This has been confirmed by comparing the productivities (t/ha of rice/wheat crops) obtained during our project period with the productivity data collected (farmer reported data) during the historical look-back period. We also collected multiple reports published in peer-reviewed journals, government, and industry reports, as well as a farmer yield report, which further reinforced our results. To calculate leakage from potential yield reductions, crop-cutting trials were carried out in the project area.

Equation 29 (VM0042 v1.0

$$\Delta P = \left(\frac{P_{wp,p} - P_{bsl,p}}{P_{bsl,p}}\right) \times 100$$

Where:

ΔP	Change in productivity; percent
$P_{wp,p}$	Average productivity for product p during the project period; productivity per hectare or acre
$P_{bsl,p}$	Average productivity for product p during the historical baseline period; productivity per hectare or acre
p	crop/livestock product

The productivity data was collected for both rice and wheat crop during the respective seasons. Average historical productivity data collected from our historical data collection was compared with the average productivity obtained during our crop cutting trials. This data was further used to calculate the change in productivity during historical and project period using the equation 29 from VM0042, V1.0. The following table 25 shows the data collected and the change in productivity calculated. The results show that the change in productivity was <5% for our project area.

Table 25: Change in productivity calculations for leakage analysis:

Practice	Productivity (t/ha)		ΔP (%)
	Historical look-back period (2016-2018) Source: Grow Indigo Farmer reported data	Project period (2019-2022) Data Source: Crop cutting trials	
	(Pbsl, p)	**(Pwp, p)**	
Rice (TPR)	3.8	4.20	3.20
Rice (DSR)		4.26	3.26
Wheat (CT)	3.05	4.26	3.26
Wheat (ZT)		4.22	3.22
Average change in productivity, %		**4.23**	**3.24**
Change in productivity is <5%; therefore Leakage = 0			

The details of our productivity analysis indicates that there is no yield reduction as a result of adoption of regenerative practices promoted (DSR/ZT) in the project area. We also conducted further statistical analysis, such as a t-test for verifying the statistical rigor of our results during the project and historical periods.

Table 26: Yield data from crop cutting trials conducted for estimating productivity in 2021 (Kharif and Rabi) across project area

Crop cutting trials conducted for estimating productivity in 2021 (Kharif and Rabi) across project area				
	Rabi		Kharif	
Field no.	CT Wheat (t/ha)	ZT Wheat (t/ha)	TPR (t/ha)	DSR (t/ha)
1	3.20	3.57	3.12	4.50
2	3.90	3.85	3.50	4.30
3	4.00	3.95	3.92	4.45
4	4.05	4.05	3.95	4.32
5	4.12	4.30	4.00	4.25
6	4.25	4.40	4.05	4.42
7	4.32	4.45	4.45	3.85
8	4.42	4.50	4.65	4.50
9	5.15	4.50	5.15	4.05
10	5.27	4.65	5.27	4.12
t-Test: Paired Two Sample for Means				
	CT Wheat	*ZT Wheat*	*TPR*	*DSR*
Mean	4.26	4.22	4.20	4.27
Variance	0.358	0.121	0.463	0.045
Observations	10	10	10	10
Pooled Variance	0.239		0.254	
Hypothesized Mean Difference	0		0	
df	18		18	
t Stat	0.209		-0.310	
P(T<=t) one-tail	0.418		0.379	
t Critical one-tail	1.734		1.734	
P(T<=t) two-tail	0.836		0.759	
t Critical two-tail	2.100		2.100	

The statistical tests above show p value greater 0.05 indicating there was no significant effect on the yields due to practice changes in the project area. Since the yield reductions observed from our productivity analysis were less than 5%, a leakage deduction of 0% was applied in the calculation of net GHG emission reductions (as per VM0042 V1.0).

Leakage from New Application of Manure from Outside the Project Area

Application of manure was not quantified during this monitoring period.

Leakage from Livestock Displacement

Livestock data is not quantified in the project activity.

7.5. Net GHG Emission Reductions and Removals

Net GHG emissions reductions and removals are calculated based on actual farmer field areas and practices. Each field enrolled in the carbon program is assigned a particular practice category (PC) for a given year based on the cultivation methods for rice and wheat in that year.

With two possible practice changes, DSR and ZT, there are three possible PCs in the project. PC1 = DSR-only, PC2 = ZT-only, and PC3 = DSR+ZT together.

The first monitoring period spans three years (2019-2021). Therefore, each field-year was assigned a provisional PC. This is the initial category inferred directly from field records/monitoring for that year (PC0, PC1, PC2, or PC3). Then provisional PCs were converted to final PCs using the framework defined by PP, for practice continuity checks, stacked practice (PC3) handling. Detailed PC categorization logic is provided as supplementary information (07_PC_Assignment_logic). This two-step (provisional→final) process keeps categories mutually exclusive, prevents double counting, and ensures only well-supported, conservative cases are credited.

The **total area** of all the fields enrolled in the carbon program is 11,636.1 ha till end of first monitoring period (06 May 2019 - 31 May 2022). This has been referred to as the unique area. The total eligible area (cumulative of PC1 and PC2 areas over three years) for the complete monitoring period is 11,636.1 ha.

In order to explain, how the enrolled area is accurately accounted under each practice change (PC) category data is shown in a Sankey diagram (Figure 31). The Sankey diagram provides a visual summary of the flow and transformation of the enrolled area across the two-practice change (PC) categories (PC1 and PC2) across three project years (2019-2021).

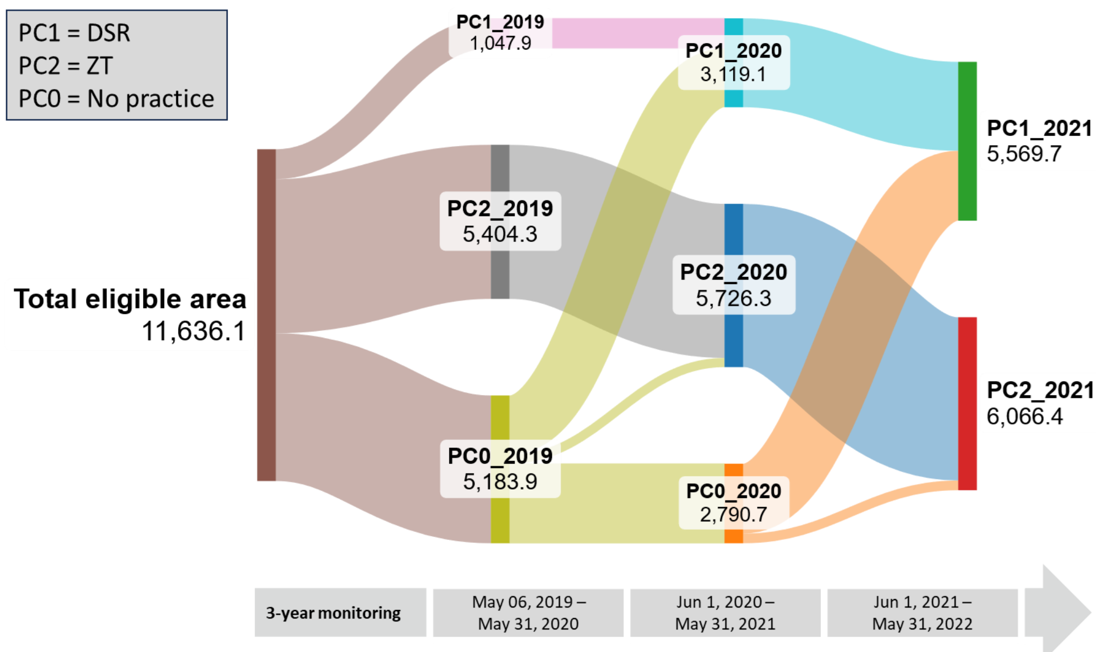


Figure 31: Sankey diagram illustrating the distribution of area into the practice categories and the exact area accounted under PC category for accounting GHG emissions reductions and removals for a specific year.

The quantification analysis was carried out using the DNDC9.5 biogeochemical model. The model was executed separately for each soil-sampled rice–wheat field within the project area to estimate GHG emissions and SOC sequestration. The quantification procedure followed a series of steps aligned with the model input requirements and the guidelines outlined in VM0042 v1.0

To initiate the quantification of sampled fields, a simulation file was developed comprising three years of historical data representing the baseline scenario (2016-2018), followed by three years of data reflecting the project scenario (2019-2021). This file serves as the basis for project quantification. Modeling was conducted at a fixed soil depth of 0–30 cm using measured SOC data. Annual estimates of CH_4, N_2O emissions, and SOC stock were generated year-by-year for both scenarios.

The DNDC simulation outputs provided detailed annual SOC stock and GHG emission values for each scenario. Based on these results, annual emission reduction and removal factors (expressed in tCO_2e/ha) were calculated using Equation [34,39,44] from the VM0042 methodology. These factors quantify the net difference in CH_4, N_2O emissions and SOC stock between the baseline and project scenarios, enabling robust assessment of climate benefits.

The SOC removals, CH_4 and N_2O emissions and emission reductions were quantified using the DNDC 9.5 model (modeling details in MVR)/36/. The results of the net GHG emission reductions are provided in the tables 29 below. The details of ERR calculations have also been provided in an excel sheet as a supporting document /1//2/. Validation for the emission sources was carried out according to VMD0053 v1.0, using PMU and bias evaluation methods as outlined in the MVR section 6.

As a result, the Net GHG emission reduction estimates include only CH_4 and N_2O reductions in PC1 fields and SOC stock changes in PC2 fields (Table 29). These reductions are scaled to the project area based on the type of practice adopted (PC1 or PC2), year-specific uncertainties, and leakage factors.

Table 27: Practice categorization of enrolled farmers in the project and their emission sources.

Practice categories	Baseline Practice	Improved Practice	Emission Source
PC_1 (T→D)	Transplanted Rice (TPR)	Direct Seeded Rice (DSR)	CH_4+N_2O SOC
PC_2 (T→Z)	Transplanted Rice-Conventional Tillage (TPR-CT)	Transplanted Rice-Reduced Tillage (TPR-ZT)	SOC

This modeled increase in SOC under DSR aligns with published studies. Research shows that DSR practice does not reduce SOC compared to TPR practice; in fact, when combined with practices like reduced tillage, it can improve SOC levels. For example, Jat et al. (2020, *Nature Scientific Reports*)[113] reported carbon sequestration of 428 kg CO_2e/ha under DSR (Table 3, Scenario 2). Moreover, unlike TPR, DSR avoids soil puddling, which helps preserve soil macro and micro-aggregates, key to maintaining or increasing SOC as shown in studies by Gathala et al. (2011b, 2013)[114,115] and Sapkota et al. (2017)[116].In doing so, we have followed a conservative

[113] Jat, H.S., Kumar, V., Datta, A. *et al.* Designing profitable, resource use efficient and environmentally sound cereal based systems for the Western Indo-Gangetic plains. *Sci Rep* **10**, 19267 (2020). https://doi.org/10.1038/s41598-020-76035-z

[114] Gathala, M.K., Ladha, J.K., Saharawat, Y.S., Kumar, V., Kumar, V. & Sharma, P.K. 2011b. Effect of tillage and crop establishment methods on physical properties of a medium-textured soil under a seven-year rice–wheat rotation. *Soil Science Society of America Journal*, 75, 1851–1862.

[115] Gathala, M.K., Kumar, V., Sharma, P.C., Saharawat, Y.S., Jat, H.S., Singh, M., Kumar, A., Jat, M.L., Humphreys, E., Sharma, D.K., Sharma, S. & Ladha, J.K. 2013. Optimizing intensive cereal-based cropping systems addressing current and future drivers of agricultural change in the northwestern Indo-Gangetic Plains of India. *Agriculture, Ecosystems and Environment*, 177, 85–97.

[116] Sapkota, T.B., Jat, R.K., Singh, R.G., Jat, M.L., Stirling, C.M., Jat, M.K., Bijarniya, D., Kumar, M., Saharawat, Y.S. and Gupta, R.K., 2017. Soil organic carbon changes after seven years of conservation agriculture in a rice–wheat system of the eastern Indo-Gangetic Plains. *Soil Use and Management*, *33*(1), pp.81-89. https://doi.org/10.1111

approach by not claiming ERRs without validated model support (as per guidelines of VMD0053), even though there is strong evidence that SOC is likely to increase with DSR.

Although existing literature indicates that SOC does not decline when fields shift from TPR to DSR, no evidence was found to demonstrate any change in SOC stock when transitioning from DSR back to TPR. To address the data gap arising from the absence of direct SOC measurements for fields transitioning from DSR back to TPR, DSR has been designated as a continuous-practice requirement for PC1—similar to the existing continuity requirement for ZT under VM0042. Accordingly, if a farmer discontinues DSR at any point, no credits are awarded for that practice for all affected years. This conservative approach effectively mitigates the uncertainty associated with PC1, ensuring that no claims are made for years in which reverting to TPR could potentially reduce SOC levels.

Equation 31 of VM0042 V1.0

$$ER_t = (A_0 \times (\overline{\Delta CO2_t} + \overline{\Delta CH4_t} + \overline{\Delta N2O_t}) - LE_t) \times (1 - UNC_t)$$

Where:

ER_t	Estimated net GHG emissions reductions and removals in year t; t CO_2e
A_0	Project area; unit area
$\overline{\Delta CO2_t}$	Areal average carbon dioxide emission reductions in year t; t CO_2e /unit area
$\overline{\Delta CH4_t}$	Areal average methane emission reductions in year t; t CO_2e /unit area
$\overline{\Delta N2O_t}$	Areal average nitrous oxide emission reductions in year t; t CO_2e /unit area
LE_t	Leakage in year t, equal to zero; t CO_2e
UNC_t	Uncertainty deduction in year t; fraction between 0 and 1

Carbon Dioxide Emission Reductions and Removals

Carbon dioxide emission removals by enhancing the SOC pool for sample unit i in year t are quantified using Equation (40).

Equation 34

$$\Delta CO2\_soil_{i,t} = (SOC_{wp,i,t} - SOC_{wp,i,t\_previous}) - (SOC_{bsl,i,t} - SOC_{bsl,i,t\_previous})$$

Where:

$\Delta CO2\_soil_{i,t}$	Estimated carbon dioxide emission reductions from soil organic carbon pool for sample unit i at the end of year t; t CO_2e/unit area
$SOC_{wp,i,t}$	Estimated carbon stocks in the soil organic carbon pool in the project scenario for sample field i at the end of year t; t CO_2e/unit area
$SOC_{wp,i,t\_previous}$	Estimated carbon stocks in the soil organic carbon pool in the project scenario for sample field i at the previous measurement year, t_previous; t CO_2e/unit area
$SOC_{bsl,i,t}$	Estimated carbon stocks in the soil organic carbon pool in the baseline scenario for sample field i at the end of year t; t CO_2e/unit area
$SOC_{bsl,i,t\_previous}$	Estimated carbon stocks in the soil organic carbon pool in the baseline scenario for sample field i at the previous measurement year, t_previous; t CO_2e/unit area
i	Sample unit

Correction for Spatial Autocorrelation

As detailed in section 3.4 under the sub-heading "Impact of COVID-19 Lockdown," our soil sampling activities were significantly hindered by COVID-19 restrictions, resulting in samples being concentrated in fewer zones rather than widely distributed. Consequently, to address the incomplete representation of the project area, it was recommended by the IME to conduct spatial auto-correlation analysis and adjust the number of sampled fields accordingly to account for uncertainty deductions.

Physical proximity of sample locations results in dependence among observations, and as a result residuals of these sampling points are not independent. This phenomenon is known as spatial autocorrelation and needs to be corrected for (Bivand et al, 2013). Moran's I test was used to statistically ascertain residual spatial autocorrelation (Bivand et al, 2015). In five of the six cases significant spatial autocorrelation was found (i.e., p-value < 0.1). We calculated the effective sample size (neff) using the formula (Grace, 2019):

$$n_{eff} = n \cdot \frac{1 - |Moran's\, I|}{1 + |Moran's\, I|}$$

where the n is the original sample size which is being corrected for spatial autocorrelation using the absolute value of Moran's I statistic estimate. For the analysis we used the pysal library (version 23.7) in python (version 3.8.2). We used four nearest neighbours (k=4) to assess the spatial autocorrelation among sample sites (Grace, 2019). For PC 2019 we had only 4 samples, so we had to use three nearest neighbours (k=3) for this specific case. We used 2000 permutations for computing significance. Five out of the six cases were found to have significant spatial autocorrelation. For these five cases effective sample size were computed using the approach mentioned above and explained in detail in MVR)/36/.

There is another less conservative version of this formula (Cahoon et al, 2019) which was NOT used:

$$n_{eff} = n \cdot \frac{1}{1 + |Moran's\, I|}$$

PP has used the conservative approach as per Verra's guidelines. Another reason for adopting the conservative approach is the relatively smaller sample size, which was partly out of PP's control, due to Covid-19 related traveling restrictions in place during this first round of sampling (2020-21).

Uncertainty Analyses

Model uncertainty of the GHG emissions and SOC between the practice changes and the baseline category was estimated according to VMD0053. Uncertainty deductions have been estimated separately for each GHG source within the project. Deductions are based on an estimate of the total error of the project's calculated GHG emission reductions or removals for that source over a given verification period.

Structural uncertainty was quantified by comparing modelled gas fluxes with empirical gas fluxes. The structural uncertainty around the size of the emission reductions of a project that combines multiple individual rice fields will decrease with increasing number of individual rice fields included. In our current project, we conducted uncertainty assessments by an initial classification of validation dataset into two practice change categories (PC1 and PC2). This classification was further applied to the sample fields data and further also to the larger dataset of enrolled farmer's fields.

Uncertainty calculations flow chart

We have calculated uncertainty as per the equation's guideline in VM0042. The prerequisite parameters for calculating uncertainty can be obtained from equations 47, 49, 50, and 51. The flow of equations is depicted in Figure 32. We have provided separate spreadsheets of uncertainty calculations for PC1 and PC2 as annexures to this document (/45/).

Equation 47

$$s_{\text{struct},\Delta\bullet,t} = s_{\bullet}\sqrt{2(1-\rho_{\bullet})}$$

Equation 49

$$\overline{\Delta\bullet_t} = \frac{1}{n}\sum_{i=1}^{n}\overline{\Delta\bullet_{i,t}} = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{m_i}\sum_{k=1}^{m_i}\Delta\bullet_{i,k,t}$$

Equation 51

$$s^2_{\Delta\bullet,t} = s^2_{\text{sample \& meas.},\Delta\bullet,t} + \frac{s^2_{\text{struct},\Delta\bullet,t}}{n \times m}$$

Equation 50

$$s^2_{\text{sample \& meas.},\Delta\bullet,t} = \frac{\sum_{i=1}^{n}\left(\overline{\Delta\bullet_{i,t}} - \overline{\Delta\bullet_t}\right)^2}{n(n-1)}$$

Total uncertainty deduction, UNC_t, is quantified as:

Equation 46

$$UNC_t = MIN\left(100\%, MAX\left(0, \frac{T\sqrt{\sum_{\bullet} s^2_{\Delta\bullet,t}}}{\overline{\Delta CO2_t} + \overline{\Delta CH4_t} + \overline{\Delta N2O_t}} - 15\%\right)\right)$$

Figure 32: Flow-chart of equations for calculating model uncertainty for sampled fields

Uncertainty equation 46 requires that we calculate standard error of the emission reductions including the model prediction error at time t using equation 47 to 51. Figure 32 gives a outline of these calculations., The summary of the flow is:

Areal average of emission reductions can be calculated from equation 49 while standard error of sample and measurement can be calculated using equation 50. Subsequently, Variance of the sample and measurement errors of emission reductions is calculated using equation no 51. To calculate this variance Equation 47 was used compute approximate standard error for emission reductions (for each emission source) due to model prediction error at time t. Finally, uncertainty can be calculated from equation 46 for all the sample fields quantified using the DNDC model.

Statistical error for sample/measurement was propagated further to calculate combined sample and model error which is further used estimating uncertainty (%) across each PC (refer folder "Uncertainty including spatial error adjusted no of sampled fields_2024"). The flow chart of equations (Figure 32) indicate how statistical errors are propagated for estimating project wide uncertainty (across practices and across project).

In Equation 46, VM0042

UNC_t= Uncertainty deduction in year t (expressed as the extent to which the half width of the 95% confidence interval, as a percentage of the mean, exceeds the threshold of 15%); unitless number between 0 and 1

$\sum$ = Sum over pools and gases CO_2_soil, CTREE, CSHRUB, 24 CH_4_SOC, CH_4_ent, CH_4_md, and N_2O_soil, where Quantification Approaches 1 or 2 were employed.

$S^2_{\Delta=t}$ = Variance of the estimate of Δ • t. (Δ • t = mean emission reductions from gas and pool • at time t) (see); (t CO_2e/unit area)2

$\overline{\Delta CO_{2_2}}$= Areal average carbon dioxide emission reductions in year t; t CO_2e/unit are

$\Delta\overline{CH_{4_t}}$= Areal average methane emission reductions in year t; t CO_2e/unit area

$\Delta\overline{N_2O_t}$=Areal average nitrous oxide emission reductions in year t; t CO_2e/unit area

T = Critical value of a student's t-distribution for significance level α = 0.05 (i.e., a $1 - \alpha$ = 95% confidence interval) and the degrees of freedom df appropriate for the design used (e.g., df = n − 1 for a simple random sample of n sample units)

15% = Threshold beyond which there is an uncertainty deduction

• = Gas or pool

GHG quantification of sample fields was conducted by quantification approach 1, and emission reductions and removals were calculated as a difference of baseline and practice change emissions. Uncertainty calculations were done over different PC groups for each of the monitoring years. A spatial auto correlation analysis was conducted (on advice of the IME) for sample size correction due to limited number of sampling locations available in the first monitoring period. Detailed description is further provided in MVR)/36/.

Table 28: Baseline and project emissions and SOC stocks, tCO_2e

SOC Stock Changes across project area	Baseline emissions (tCO_2e) (a)	Project emissions (tCO_2e) (b)	Reductions (tCO_2e) (a-b)	Baseline SOC stock (tCO_2e) (c)	Project SOC stock (tCO_2e) (d)	Removal (tCO_2e) (d-c)
06-May-2019 –– 31-December -2019	22,923.07	21,393.06	1,119.81	6,13,802.89	6,21,990.34	8,040.89
01-January-2020–31-December -2020	47,707.90	41,702.01	5,595.70	12,33,249.28	12,47,449.30	13,284.46
01-January-2021–31-December -2021	49,686.04	37,440.37	12,245.67	12,47,212.57	12,58,411.86	9,621.68
01-January-2022–31-May-2022	24,901.20	17,131.42	7,769.78	6,27,766.18	6,32,952.90	4,378.11
Total	**1,45,218.20**	**1,17,666.85**	**26,730.96**	**37,22,030.93**	**37,60,804.41**	**35,325.14**

Calculation of Verified Carbon Units

The number of buffer credits which must be deposited in the AFOLU pooled buffer account is based on the net change in carbon stocks.

The number of VCUs that may be issued in year t was calculated as:

Equation 53 (VM0042 V1.0)

$$VCU_t = ER_t - Buffer_t$$

VCU	Number of VCU in year t; t CO_2e
ER_t	Estimated net GHG emissions reductions and removals in year t; t CO_2e
$Buffer_t$	Number of buffer credits to be contributed to the AFOLU pooled buffer account in year t; t CO_2e

GHG Emission reductions and removals generated in the project:

Year	Reductions (tCO_2e)	Removals (tCO_2e)	Leakage emissions (tCO_2e)	Uncertainty deductions (tCO_2e)	Net GHG emission reductions and removals (tCO_2e)	Buffer pool allocation (tCO_2e)	VCUs eligible for Issuance* (tCO_2e)
06-May-2019 --- 31-December-2019	1,119.81	8,040.89	0.00	556.75	9,160.70	1,045.32	8,115.39
01-January-2020–31-December-2020	5,595.70	13,284.46	0.00	1,325.76	18,880.16	1,726.98	17,153.18
01-January-2021–31-December-2021	12,245.67	9,621.68	0.00	1,577.62	21,867.34	1,250.82	20,616.53
01-January-2022–31-May-2022	7,769.78	4,378.11	0.00	808.61	12,147.89	569.15	11,578.73
Total	**26,730.96**	**35,325.14**	**0.00**	**4,268.74**	**62,056.09**	**4,592.27**	**57,463.83**

*Calculated as per equation 53 of VM0042 v1.

Ex-ante emission reductions/removals	Achieved emission reductions/removals	Percent Difference	Justifications for difference
5,512	9,161	-66.20%	Lower difference due to successful penetration into the project area and effective promotion and adoption rate achieved in the first year
95,044	18,880	80.14%	High difference is because of lower achieved project area; project implementation affected due to covid19 restrictions

Ex-ante emission reductions/removals	Achieved emission reductions/removals	Percent Difference	Justifications for difference
5,70,264	21,867	96.17%	High difference is because of lower achieved project area; project implementation affected due to covid19 restrictions
4,80,732	12,148	97.47%	High difference is because of lower achieved project area; project implementation affected due to covid19 restrictions

APPENDIX 1: PROJECT VALIDATION AND CATEGORIZATION DETAILS

Practice Categories

The project intends to credit Two practices falling into two Practice Categories (PCs):

a. “Crop establishment (TPR/DSR)”,

b. “Soil disturbance and/or residue management” (TILLAGE),

Crop Functional Groups

The project includes two crop functional groups (CFGs): “Rice-Group”, and “Wheat-group”.

Land resource regions (LRR)

The project includes fields in 2 LRRs:

UGP: Upper Gangetic Plains

TGP: Trans Gangetic Plains

These sites span over two IPCC climate zones: Warm semi-arid climate (BSh), Humid subtropical climate (Cwa).

Emissions Sources (ES)

The model was validated for changes in emissions of methane (CH_4), nitrous oxide (N_2O) and soil organic carbon (SOC) stock changes.

Domain covered by this validation.

The domain validated in this report includes a total of 5 combinations of CFG, PC, and emissions sources, as summarized in Table A1, A2 and A3 below.

Table A1: Combinations of CFG and PC that are validated for CH_4 in this project.

	RICE	WHEAT
CROP	✓	x
TILLAGE	x	x

Table A2 : Combinations of CFG and PC that are validated for N_2O in this project.

	RICE	WHEAT
CROP	✓	x
TILLAGE	x	✓

Table A3 : Combinations of CFG and PC that are validated for SOC in this project.

	RICE-WHEAT
CROP - TILLAGE	✓

Soil Textural classes

The project area includes 6 soil textures in the USDA soil texture classification, listed below along with the clay contents at the midpoint of each textural class definition.

Sandy loam (15%)

Loamy sand (10%)

Loam (20%)

Silt loam (20%)

Sandy clay loam (20%)

Silty clay loam (40%)

APPENDIX 2: LIST OF ABBREVIATIONS

ALM	Agriculture Land Management
AFOLU	Agriculture Forestry and other land use
AR	Adoption rate
BISA	Borlaug Institute for South Asia
CEEW	Council on Energy, Environment and Water
CO_2	Carbon Dioxide
tCO_2e	Tonne Carbon Dioxide Equivalent
CH_4	Methane
CT	Conventional Tillage
CIMMYT	International Maize and Wheat Improvement Centre
DNDC	Denitrification-Decomposition
DSR	Direct Seeded Rice
ERR	Emission Reduction and Removal
EUE	Energy Use Efficiency
ZT/RT	Reduced Tillage
JPDMR	Joint Project Description Monitoring report
GHG	Greenhouse gases
GI	Grow Indigo Pvt Ltd
GIS	Geographic Information System
GT	Ground Truthing
GWP	Global Warming Potential
GPS	Global Positioning System
Ha	Hectare
IME	Independent Modeling Expert
INM	Integrated Nutrient Management
IGP	Indo Gangetic Plan
IPCC	Intergovernmental Panel on Climate Change
ICAR/IARI	Indian Agricultural Research Institute
KVK	Krishi Vigyan Kendra
LLL	Laser Land Levelling
LULC	Land Use and Land Cover
ODS	Ozone Depleting Substance
MVR	Model validation report
NBSS	National Bureau of soil survey and land-use planning
NPK	Nitrogen Phosphorus Potassium
NPRR	Non-Permanence Risk Report
NPRT	Non-Permanence Risk Tool
N_2O	Nitrogen Dioxide
PC	Practice Change
PP	Project Proponent
PAI	Project Activity Instances
RS	Remote Sensing
SSNM	Site specific nutrient management
SOC	Soil Organic Carbon
SOP	Standard Operating Practice
TGP	Trans Gangetic Plan

TPR	Transplanted Rice
UPG	Upper Gangetic Plain
UN SDGs	United Nations' Sustainable Development Goals
VVB	Validation Verification Body
ZT	Reduced tillage

APPENDIX 3: LIST OF DOCUMENTS REFERRED IN JPDMR

/1/ VCS2590_Estimated ERR Calculation_Nov2024
/2/ VCS2590_Net GHG ERRs_14 Feb 2025
/3/ VCS_Non-Permanence-Risk-Report_v1.3(NPRR)
/4/ VCS_Non-Permanence-Risk-Tool_v1.3(NPRT)
/5/ Evidence for risk ratings
/6/ Remote_sensing_report
/7/ Final_Baseline_Fields
/8/ Final_Project_Fields
/9/ 01_Project area
/10/ Project_Database
/11/ Baseline_Database_20240424_VCS2590
/12/ GI - Farmers_Agreements
/13/ Farmer's Agreement Amendment
/14/ MoU_Signed_other_entities_involved
/15/ IARI_GI_Signed MoU
/16/ CIMMYT_GI_Signed MoU
/17/ Undertaking on REED+ Jursidiction_02-03-2023
/18/ Undertaking letter_v2.0
/19/ Proof_of_SDG_outcomes
/20/ Stakeholder Engagement SOP
/21/ Stakeholder consultation
/22/ Stakeholder_Engagement
/23/ Field_overlaps_justification
/24/ VCS2590_CPA_Adoption_Rate_Calulation
/25/ Common Practice supporting literature data analysis
/26/ Evidence of Unique ID & field area shared with farmer
/27/ Grievance Redressal Mechanism
/28/ Evidence for Project start date
/29/ Field_details_DSR_TPR_of_Graph_for_project_start_date
/30/ GHG mitigation potential calculation
/31/ GI_Regulatory Surplus Analysis for Sustainable Agriculture in Punjab and Haryana
/32/ Draining of hydrological function
/33/ Evidence regarding Invasive species
/34/ LULC_Proof_LANDSAT_Data_Overlay
/35/ Screenshot of app_230302
/36/ Model validation report (MVR)
/37/ Soil Sample Size Calculation_Feb03
/38/ Soil Sampling proof_230302
/39/ Soil parameter analysis lab result_230302
/40/ Yield effects with practice changes
/41/ PMU_Bias_ER_Scatterplot_PI_Histograms

/42/ Research papers used for Calibration and Validation
/43/ Calibration Excelsheets_Before and After_Stats
/44/ dnd files_Cal Val
/45/ Uncertainty calculations_Including Spatial error
/46/ Quantification of Sampled Fields
/47/ Land_Records_VVB_20240424_VCS2590
/48/ PoSH Policy and awareness training evidence
/49/ DSR_TPR_50_Fields_result_VVB samples (Remote Sensing)
/50/ CL04_Field_details_DSR_TPR_of_Graph_for_project_start_date
/51/ Letter_IARI_VVB_Carbon_GrowIndigo dated 10/07/2024
/52/ Adoption rate DSR Punjab Haryana -2024
/53/ VCS 2590_Opportunity Cost NPV calculations evidence
/54/ Stakeholder engagement meeting records
/55/ VCS2590_DSR SOC Increase demonstration
/56/ VCS2590_PC Assignment
/57/ Letter Soil Lab KVK Baramati

APPENDIX 4: PROCESS FOR CHECKING FIELD BOUNDARY OVERLAPS

The process for checking field boundary overlaps with other ALM programs on VCS registry is given below:

A search was conducted on VCS registry for all AFOLU projects in India. A total of 108 projects were found, dated 30th June 2023. These projects were further filtered based on AFOLU activities (ALM), state/province (Haryana and Punjab), and availability of individual field boundaries in the provided KML files. These filters resulted in only one project (VCS 3093) with which 45 fields overlapped with our project area. The field boundary (kml file) was downloaded and overlaid on our field boundary using QGIS software. Topological errors check (to avoid overlaps) was done to identify the overlapping fields. Error reports were evaluated and later on we excluded these fields from our project boundary, database, and ERR calculations.

We plan to follow the same procedure to check for field boundary overlaps in each subsequent verification. Detailed justification provided in the 'Field_overlaps_justification.xlsx excel document in the supporting document.

APPENDIX 5: PROCESS FOR CHECKING FIELD BOUNDARY OVERLAPS WITH WETLANDS OR WATER BODIES.

A remote sensing analysis was conducted to demonstrate that the project activity does not occur in wetlands. To check for intersection in wetland areas or water bodies, all the field boundaries were overlaid on satellite data (NRSC, Hyderabad, developed decadal LULC maps). A list of wetlands was collected from the web. The Ramsar tagged wetlands in Punjab are Harike, Kanjli, and Ropar and in Haryana are Sultanpur National Park in Gurugram and Bhinda was Wildlife Sanctuary in Jhajjar. Wetlands and water bodies overlaps were cross-checked on google earth engine with the above-mentioned list and found to be lying only on agricultural croplands. The analysis has been submitted as a separate document. The LULC maps show that none of the fields intersect with any wetlands or water bodies. Thus, there is neither any conversion of land nor leading to drainage of any hydrological function in the project area and the project activity occurs on the agricultural cropland only.