Frequently Asked Questions

Questions about the sampling approach and analysis:

1. What is the study's sampling approach and methodology, and what is the resulting sample size?

The study's sampling approach is based on the GHG Protocol's recommended sampling methodology, with the national sample size calculated using the formula mentioned below and the standard statistical parameters:

- Confidence Interval (CI) of **95%**
- Margin of error of 5**%**, and
- Population proportion of **0.5**.

$$n = \frac{Z^2 \times p \times (1-p)}{e^2}$$

where,

n = the sample size
Z = 1.96 (Z-score, which corresponds to the desired confidence level of 95%)
p = 0.5, the estimated proportion of the population with the characteristic of interest (set to **0.5** for maximum variability and thus, the most conservative estimate for sample size).
e = ±5% (Margin of error) maximum difference allowed between the true population proportion and the sample estimate.

Based on the above values, a basic sample size calculation suggests a minimum of **370 samples** in an origin country if the farm characteristics are homogeneous. However, since the study aims to create a **national-level carbon footprint baseline** for coffee production across five Latin American countries, the variability in farming practices, farm sizes, climates, agroforestry practices, and soil types at both national and regional levels necessitates a more comprehensive sampling and analyzing approach which accounts for these variations.

Given the diverse nature of coffee farming within the target countries (Brazil, Colombia, Honduras, Mexico, and Peru), **a stratified sampling approach based on the coffee production volumes at regional and municipal levels was applied to account for regional representativeness**. With currently limited information about the variables that could significantly impact the carbon footprint, we assume their homogeneity at the regional and municipal levels to avoid introducing further invisible bias into the sampling process. Higher production volumes typically indicate regions with a denser population of farms, making it a practical proxy for ensuring that the sampling accurately represents the distribution of farms and their potential environmental impacts. This is crucial for generating an industry-accepted carbon footprint baseline that meets reporting standards.

Further, based on the recommendation from CIRAD and the third-party reviewer, the four initial farm characteristic variables were expanded to include fertilizer use, land-use change, and processing to assess how realistic the heterogeneity assumption was in each origin. Rather than assuming from the outset that each origin could be treated as a broadly uniform production system, this additional step was used to examine how much structural variation exists within each origin and whether key production conditions are concentrated around a few dominant patterns or spread across several different contexts. The purpose of the heterogeneity analysis was therefore not to replace the farm-level assessment, but to provide an added layer of validation for interpreting origin-level baselines and for understanding the extent to which a single baseline can reasonably represent a diverse coffee landscape. The review considered whether these seven characteristics showed consistent dominant patterns within an origin, since these are among the main contextual factors that can influence management practices, emission profiles, and the comparability of farms included in the sample. In practical terms, the analysis helped assess whether the sampled farms were being drawn from production systems that are broadly similar in their underlying conditions, or whether important internal differences should be more explicitly acknowledged when interpreting the results. This was especially relevant because the study was designed to generate pre-competitive, origin-level baselines for corporate and sector use, rather than highly localized sub-baselines for every production context. Following feedback from CIRAD, this explanation has been integrated more explicitly to show how the study tested the realism of the homogeneity assumption, to clarify why this assumption was used at the origin level, and to make it transparent that representativeness was not taken for granted but was examined through a structured review of agronomic, geographic, and processing-related conditions.

Keeping in view both the homogeneity analysis and the data collection logic applied in the Green Invest Asia study, three sampling scenarios were developed to translate the methodological findings into practical field options for Latin America. The purpose of defining these scenarios was not only to identify an ideal sample size under controlled assumptions, but also to examine what would be realistically achievable across diverse country contexts, supplier networks, and field conditions. In other words, the scenario approach was used to balance statistical ambition with implementation feasibility: if the most comprehensive design could not be fully realized in practice, the sampling strategy could still be refined in a transparent and methodologically grounded way to reflect on-the-ground realities without losing sight of representativeness. The three scenarios, therefore, provide a structured progression from a highly precautionary design to more operationally feasible alternatives, while making explicit the assumptions and trade-offs involved in each case. These scenarios are explained below as the Best scenario, the Better scenario, and the Good scenario.

Best scenario: a sample size of 1500 farms in each origin

To account for the non-homogeneous characteristics of farms, an **initial national sample size of 1500 farms** was proposed. This national sample size is generated to cover the seven potentially varying characteristics mentioned earlier.

This larger sample size is justified by the need to:

- Ensure that different **farm types, climatic conditions**, **agroforestry practices**, **soil types, fertilizer usage, land use change**, and **processing** are well represented in the analysis.
- **Capture sufficient variation** in these variables, which could significantly impact overall GHG emissions calculations, and conduct an archetype analysis for the different variables.

Advantages:

- Ensures representation of diverse farm characteristics.
- Captures sufficient variability of these factors, which may significantly influence overall GHG emissions calculations.
- Rich information for archetype analysis.

Disadvantage:

- Time-intensive process.

Better scenario: a sample size of around 1000 farms in each origin

It has been essential to reduce national sample sizes due to the cultural factors in the target countries that impact access to coffee farm data. Given the ground realities shared by the supplier partners and a preview of the spatial data, a **reduced sample size of approximately 1000 farms with a focus on the high-production area** is considered sufficient to cover the diversity of the population without significantly impacting the study's statistical significance. High-production areas tend to have higher representativeness at the national level.

A national sample size of 1000 should fairly represent the varying non-homogeneous nature of coffee farms in the five countries while maintaining the robustness needed for industry-level carbon footprint reporting. The study acknowledges that farms' characteristics are not always mutually exclusive. For instance, the same farm may share several characteristics (e.g., a tropical moist small farm may practice diversified agroforestry). This overlap of characteristics should help reduce sample size, strike a balance between feasibility and reliability by optimizing resources, and ensure adequate representation across the high-production area.

This is also supported by the heterogeneity analysis, which supports moving away from a single uniform target for all origins. Instead, it indicated that differentiated sample sizes by origin are methodologically more appropriate, as some systems can be represented with fewer farms than 1000 while others still require higher coverage to capture key structural differences, provided that production-weighted stratification and randomization are maintained.

Advantages:

- Optimizes resource allocation while ensuring adequate representation of high-production areas.
- Balances feasibility and reliability by reducing the overall sample size without compromising data quality.
- Maintains regional representativeness and diversity of archetype variables.

Disadvantages:

- Potential underrepresentation of low-production areas, which may still hold unique characteristics.

Good scenario: a sample size of around 370 farms in origins with homogeneous key variables

This scenario assumes homogeneity of archetype variables within the coffee production areas of each origin country. It involves collecting 370 samples per country, with sample allocation based on municipalities, consistent with the other scenarios. This still fulfills the fundamental statistical standards applied when high heterogeneity of key influential factors or archetypes is not particularly considered.

Advantages:

- Resource Efficiency: Requires fewer samples, reducing time and resource expenditures.
- Simplicity: Streamlines the sampling process by assuming uniformity across farm characteristics.

Disadvantages:

- Potential Bias: May overlook variability in farm characteristics, potentially compromising the accuracy of the carbon footprint baseline.
- Limited Representativeness: May not adequately capture variability in key factors that influence greenhouse gas emission calculations.
- Limited archetype analysis.

Based on these methodological considerations, the feasibility assessment, and the implementation capacities of the supplier partners, the **final sample size adopted for the study was positioned between the Good and Better scenarios**. The finalized target was set at 500 farms for Brazil and 600 farms for each of the other origin countries. This calibration was made carefully in light of supplier partner capabilities, accessibility to farming areas, and additional operational constraints such as security conditions and the need to ensure the safety of personnel conducting fieldwork. In this context, external challenges had a direct influence on the final sample numbers, and the adopted sample sizes reflect a balanced compromise between methodological robustness and practical feasibility under real field conditions.

2. How was the sampling methodology chosen, and does it align with Green House Gas Protocol (GHGP) and SBTi requirements?

The sampling methodology for this study was chosen based on the GHG Protocol's stratified sampling approach**,** ensuring consistency with established best practices for creating reliable national baselines. This method guarantees that the study's approach remains aligned with both industry standards and reporting requirements, facilitating accurate carbon footprint assessments. The methodology also ensures continuity with the previous **USAID projects in Asia**, enabling comparability across different studies and ensuring methodological consistency.

The heterogeneity analysis further reinforced this choice of methodology by showing that key emission-relevant variables do not vary equally across origins. This supports the use of a stratified, origin-specific sampling design rather than a single one-size-fits-all sample across all countries.

In terms of **GHG Protocol (GHGP)** and **Science-Based Targets Initiative (SBTi)** requirements, the sampling approach adheres to their established guidelines. The study covers all relevant topics necessary for **Scope 3** reporting, providing robust data on emissions associated with coffee farming practices. Additionally, this alignment ensures that the study meets **SBTi's Scope 3** reporting needs, which are critical for companies aiming to improve their supply chain sustainability.

However, the study does not focus on **Scope 1** (direct emissions) or **Scope 2** (indirect emissions), as these are subject to the assumption that the participating supplier partner has no ownership of the studied farms. Nevertheless, the results from this study will provide a strong foundation for companies to disclose **Scope 3 emissions** in alignment with **GHGP** and **SBTi** standards, supporting industry requirements for comprehensive carbon footprint reporting.

3. How does the sampling methodology ensure statistical significance and avoid bias?

In this study, avoiding **sampling** and **selection bias** was particularly important because coffee production systems are highly diverse, with substantial variation in farm characteristics, management practices, and regional conditions across and within countries.

Sampling bias can occur when some groups within the target population are overrepresented or underrepresented in the sample, which can distort the results. For example, if high-production areas are undersampled while lower-production areas receive a disproportionate share of the sample, the resulting dataset may no longer reflect the actual structure of coffee production in that origin. **Selection bias**, by contrast, can arise when the process used to choose farms is not sufficiently random, for instance, if farms with similar profiles are repeatedly selected because they are easier to access or already known to local partners. This can reduce the variability captured in the sample and limit the representativeness of the results.

To address these risks, the study applied a stratified sampling approach combined with a defined **randomization protocol**. The sample was first distributed proportionally across relevant strata, such as production regions and municipalities, using coffee production volumes as a practical basis for ensuring representativeness. This proportional allocation helps ensure that the sample reflects the structure of the underlying population, while still giving smaller strata an appropriate level of representation.

Within these strata, farms were selected using a randomization procedure to reduce the risk of subjective or convenience-based selection. In practice, although farms accessible through supplier partners formed the operational sampling frame, partners were asked to support a randomized selection within those accessible farmer groups rather than selecting farms purposively. This was intended to preserve as much randomness as possible under real field conditions and to avoid overrepresentation of farms with similar characteristics.

Statistical significance was further supported through the use of standard sampling parameters: a 95% confidence interval, a 5% margin of error, and a population proportion of 0.5. These are widely accepted assumptions for calculating robust sample sizes in cases where maximum variability must be assumed. Although the final sample sizes were adjusted from the initial idealized scenarios to reflect field feasibility, the sampling design retained a statistically grounded structure through proportional stratification, randomization, and origin-level calibration informed by heterogeneity and implementation realities.

Taken together, these measures, namely stratified sampling, proportional allocation, and a dedicated randomization protocol, were designed to reduce both sampling and selection bias as far as practically possible and to support findings that are robust, credible, and representative of the diversity of coffee production systems included in the study.

4. Can we conduct a baseline study using only 370 samples?

According to the GHG Protocol sampling recommendation, a sample size of 370 farms can be sufficient for national-level reporting where the underlying farm population is reasonably homogeneous. In such cases, a smaller sample can still provide statistically robust results because the main production conditions and emission-relevant characteristics do not vary substantially across the population.

However, the heterogeneity analysis carried out for this study showed that this assumption did not hold across the assessed coffee origins. The results indicated meaningful variation in key characteristics relevant to greenhouse gas emissions, including farm size, geographic and climatic conditions, agroforestry practices, fertilizer use, land use change, and processing systems. As a result, limiting the study to 370 samples per origin would have increased the risk of not adequately capturing this internal diversity and could have reduced the representativeness and reliability of the resulting baseline.

For this reason, the sample size was expanded beyond the minimum 370-farm threshold. The final numbers were determined by balancing methodological robustness with the practical level of resources that could realistically be deployed by supplier partners in each country. This included consideration of their operational capacity, accessibility to farms, and field-level implementation constraints. On this basis, the study adopted sample sizes of approximately 500 farms for Brazil and 600 farms for Colombia, Honduras, Mexico, and Peru.

In this way, the final sample sizes reflect an intermediate approach: they go beyond the minimum sample size that would only be suitable under conditions of homogeneity, while remaining feasible within the real-world resource and access limitations of the study. This helped ensure that the baseline remained both scientifically credible and practically achievable.

5. What would happen if we compared the results of a larger dataset to a smaller subset of 370 farms?

An analysis comparing a larger dataset (e.g., 1000 farms) to a smaller subset of 370 farms would reveal how the reduced sample size impacts reporting outcomes. By randomly selecting subsets of 370 farms from the larger dataset and comparing these subsets to the entire dataset, one could evaluate the variability and biases introduced by the smaller sample size. Smaller samples may not fully represent the diversity of practices and emissions profiles in heterogeneous farming systems, leading to less precise results and increased outcome variability. This variability is especially relevant in sectors like coffee, where farm-level factors significantly influence GHG emissions.

The homogeneity analysis provides the conceptual basis for such a comparison, because the effect of reducing the dataset would be expected to differ between more homogeneous and more heterogeneous systems. In principle, a reduction to 370 farms would likely have a smaller effect in relatively homogeneous systems such as Brazil, and a larger effect in systems such as Colombia, Honduras, Peru, and Mexico, where the analysis indicated greater structural variability.

6. Could we use this comparison to show the impact of smaller datasets on baseline accuracy?

Yes, comparing a larger dataset to smaller subsets can effectively highlight the impact of reduced sample sizes on baseline accuracy and reveal important trends. Such an analysis would allow us to:

Understand Representation: Smaller subsets may not fully capture the diversity of farm characteristics present in the entire dataset, leading to potential under- or overestimation of average GHG emissions. This comparison can quantify how well smaller samples reflect the overall population.

Analyze Variability and Precision: By comparing multiple subsets, we can measure how much smaller datasets deviate from the entire dataset in terms of mean emissions and variability. This helps assess the reliability of results obtained from smaller samples.

Identify Biases and Extremes: Subsets may over-represent or under-represent certain farm types or practices due to random sampling or unbalanced representation. The comparison can reveal patterns of bias, especially in critical impact categories like fertilizer use, energy consumption, or land-use changes.

Detect Trends in Impact Categories: This analysis allows us to examine whether the core contributors to GHG emissions, such as fertilizer application, fuel use, or irrigation practices, are consistently identified across subsets and the entire dataset. Any discrepancies in the ranking or contribution of these categories can inform us about the adequacy of smaller samples for identifying key drivers of emissions.

Visualize Data Patterns: Density plots or similar visualizations can illustrate differences in the distribution of emissions between the entire dataset and subsets, showing whether smaller datasets maintain similar trends or diverge significantly.

Guide Sample Size Decisions: By analyzing statistical metrics (e.g., mean, standard deviation, confidence intervals), the comparison can inform decisions on the minimum sample size needed to achieve acceptable accuracy while balancing resource constraints.

This type of analysis will assess the reliability of smaller datasets but also help pinpoint the most impactful areas for intervention in GHG mitigation. For instance, if fertilizer use emerges as a key contributor in the entire dataset and subsets, it reinforces its importance as a core impact category. However, if discrepancies arise, it may indicate that the smaller sample size is insufficient to capture the complete picture. This understanding can ultimately lead to more targeted and effective GHG reduction strategies.

Questions about the survey content:

7. What is the survey based on, and how does it align with GHGP and SBTi requirements?

The survey is based on the Cool Farm Platform (CFP), which is the foundation for collecting data on greenhouse gas (GHG) emissions across different farm activities. The CFP is designed to cover crop details, fertilizer, pesticide application, energy use, agroforestry systems and waste management, aligning with the GHG Protocol and Science-Based Targets Initiative (SBTi) requirements. The platform's methodology is grounded in widely accepted standards for assessing carbon footprints within agricultural systems.

The GHG Protocol focuses on Scope 1 (direct emissions from owned or controlled sources) and Scope 3 (indirect emissions, primarily from the supply chain), which the CFP covers by including farm-level data that accounts for both direct and indirect emissions. By following the activities outlined in the CFP, the survey gathers all the necessary data points required to assess emissions related to coffee production, including agroforestry systems, energy consumption, fertilizer usage, and more.

The CFP's methodology also ensures compliance with the SBTi's focus on providing a framework to meet carbon reduction goals. While the SBTi emphasizes both Scope 1 and Scope 2 emissions, which are related to direct operations and energy consumption, the current survey's focus aligns more directly with Scope 3 assessments, which are critical for companies setting science-based targets, especially in the agricultural supply chain. The survey captures all the relevant variables needed for a comprehensive Scope 3 GHG emissions assessment, ensuring that it can support sustainability reporting and decision-making in line with the GHG Protocol and SBTi.

By leveraging the Cool Farm Platform, the survey ensures that the data collected adheres to global best practices and recognized frameworks for GHG accounting. This alignment guarantees that the study not only meets industry standards but also provides actionable insights that can be used for future reporting and compliance with both the GHG Protocol and SBTi guidelines.

8. Is the survey collecting removals data and data related to soil organic carbon and carbon stock?

The survey includes several key questions to collect data on removals, soil organic carbon, and carbon stock, particularly through sections on agroforestry and land use change. These sections gather information on tree planting, species types, deforestation, and land conversion, all of which directly impact carbon sequestration and emissions. Here's how the survey captures this data:

Agroforestry Data Collection:

The survey asks detailed questions about planting **intercrop trees, shade trees**, and **hedges**. These questions include information on the **planting density**, percentage of the **growing area**, and the **species** types planted. Such information is crucial for estimating carbon sequestration in biomass and soil organic carbon improvements through agroforestry practices.

Specific questions include:

- Have you planted any new intercrops or shade trees in the current crop cycle?
- What is the planting density of these trees per hectare?
- What is the average age of these trees?

Land Use Change:

The section on land use change requests data on any deforestation or land use change that occurred within the plantation bounds, focusing on forest type removed, area deforested, and the age of the forest. These questions are essential for calculating carbon emissions or removals related to land use change.

Key questions include:

- Has there been any deforestation within the coffee growing area during the plantation lifecycle?
- What was the age of the forest, and how much area was deforested?
- Details of land conversion, such as tillage practices and input changes

Additionally, the survey records crucial data on soil organic carbon (SOC), particularly related to management inputs like tillage and carbon inputs. However, it's essential to acknowledge that the Cool Farm Platform (CFP), which we are using as the primary tool for GHG assessments, is currently updating its methodology to include soil organic carbon evaluations. Therefore, while the survey collects this data, SOC assessment will not be part of the CFP outputs for this study, as the updated methodology has not yet been integrated.

The survey is structured to gather all the necessary data for participants to conduct IPCC Tier 1 assessments of soil organic carbon. The Tier 1 approach utilizes default values and basic activity data, and the survey's collection of land-use change, crop management, and tillage practice data allows for this analysis. While the CFP update is pending, participants will still have the means to perform SOC assessments using IPCC guidelines, ensuring they are not left without tools for understanding soil carbon dynamics.

In conclusion, while the survey comprehensively covers removals and carbon stock data, soil organic carbon assessment will need to rely on external assessment based on methods like IPCC Tier 1 until the CFP methodology is updated.