VCS JOINT PROJECT DESCRIPTION & MONITORING REPORT

REGENERATING DEGRADED LANDS IN FLORIDA THROUGH PONGAMIA

Project title	Regenerating degraded lands in Florida through pongamia
Project ID	3019
Monitoring period	20-August-2018 to 09-January-2024
Crediting period	20-August-2018 to 19-August-2038
Original date of issue	
Most recent date of issue	30-June-2025
Version	3.9

VCS Standard Version	VCS v4.7 with an exemption
Prepared by	Cultivo Land PBC and Terviva

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The proposed project under the VCS-approved CDM AR-AMS0007 *A/R Small-scale Methodology: Afforestation and reforestation project activities implemented on lands other than wetlands,* version 3.1, aims to sequester carbon emissions through the implementation of sustainable agroforestry practices by planting and cultivating pongamia trees on private degraded lands in St Lucie County, and Indian River County in Florida, USA. The objective of this project is to improve the quality of degraded agricultural lands and increase farmers' income.

Land parcels in the Project Area are degrading due to past intensive agricultural production of citrus and its subsequent collapse from vector-borne disease. Huanglongbing (HLB or Citrus Greening) (USDA, 2021c) has required farmers to intensify common practices such as high pesticide and fertilizer use, as well as the removal of trees to avoid the spread of the disease. This has resulted in a decrease in citrus production yield and, in most cases, the death of trees. Consequently, farmers have ceased growing citrus in the past decade, shifting to cattle grazing or leaving the land fallow.

The Project presents an opportunity to recover the land through the reforestation of permanent, resilient crops, maintained using sustainable agroforestry practices such as reduced fertilization, pesticide use, and water use. Project activities started in 2018, through the planting of 100 to 145 pongamia trees per acre (250 to 360 trees per hectare) and have continued since. The Project Area consists of 502.8 hectares, owned by 5 landowners.

Pongamia (*Millettia pinnata*), also known as pongamia oil tree, is a non-GMO legume tree crop that produces three to four times the yield of protein and oil-rich beans per acre as soybeans. Pongamia's natural adaptations to a harsh, monsoonal climate – pest resistance, drought and salt tolerance, and nitrogen fixation – reduce the need for inputs like pesticides and fertilizers that can negatively impact water quality and biodiversity, and maximize its potential to restore the productivity of degraded agricultural lands.

The project proponents have partnered with local landowners to raise resilient, high-yielding pongamia trees on degraded land using minimal inputs and sustainable agroforestry practices. This project will also create long-term social value and benefits for all project stakeholders through shared and equitable economic returns from carbon offsets and pongamia beans and products.

It is estimated that this project will capture 38,274 tCO2e in 20 years, or an annual average capture of 1,914 tCO2e. For the monitoring period from 20 August 2018 to 09 January 2024, the project has captured a total of 4,643 tCO_2e (3,296 tCO_2e after applying the buffer pool discount).

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	*20-Aug-2018 –19-Aug-2038*	VCS	TÜV SÜD America, Inc. (formerly Ruby Canyon)	20 years
Verification	*20-Aug-2018 - -09-January-2024*	VCS	TÜV SÜD America, Inc. (formerly Ruby Canyon)	5 years and 9 days

1.3 Sectoral Scope and Project Type

Sectoral scope	Agriculture, forestry and other land use (AFOLU)
AFOLU project category[1]	Afforestation, reforestation and revegetation (ARR)
Project activity type	Restoring non-vegetative cover by planting pongamia trees

1.4 Project Eligibility

1.4.1 General eligibility

This Project is eligible under the Verified Carbon Standard (VCS). The Project falls within the scope of the VCS Program as it is in line with the VCS Standard v4.7, Section 2.1.1 Project activities supported by a methodology approved under the VCS Program through the methodology development and review process. The project has been developed in accordance with the approved methodology AR-AMS0007 and all relevant associated tools. AR-AMS0007 allows afforestation and reforestation of any land that does not fall into the category of wetland and has a broad scope of application.[2]

Compliance with Section 3.8.2 of VCS v4.7 – Pipeline listing deadline

[1] See Appendix 1 of the VCS Standard.
[2] https://cdm.unfccc.int/UserManagement/FileStorage/G7D639YWI0K1JBECMX84FH2TLNSVPO

According to Section 3.8.2 of the VCS Standard v4.7, AFOLU projects must initiate the pipeline listing process (as defined in the Registration and Issuance Process document) within three years of the project start date.

- This project, which began on 20 August 2018, initiated the pipeline listing process on 16 March 2022 under VCS Standard v4.2. It was subsequently approved for listing on the Verra Registry as "under development" in May 2022, and was made available for public comment from 21 June to 21 July 2022.

Compliance with Section 4.1.5 of VCS v4.7 – Opening meeting with the VVB

According to Section 4.1.5 of the VCS Standard, the VVB must ensure that a project is listed on the Verra project pipeline with a status of "under validation" before the opening meeting with the project proponent. This meeting marks the formal start of the validation process. Additionally, validation may only begin once the 30-day public comment period has commenced, and validation may not be completed until this period has ended.

For this project:

- The public comment period was open from 21 June 2022 to 21 July 2022 on the Verra Registry website.
- Cultivo signed the service agreement with the VVB, Ruby Canyon Engineering (now TÜV SÜD America, Inc.) on 19 July 2022, during the public comment period.
- The kick-off meeting between Cultivo and the VVB took place on 11 August 2022, after the public comment period had ended.

Compliance with Section 3.8.3 of VCS v4.7 – Validation deadline

According to Section 3.8.3 of the VCS Standard, all AFOLU projects with ex-ante emission reduction or removal estimates of 20,000 tCO_2e per year or less, and ARR, RWE, and IFM projects, regardless of size, must complete validation within eight years of the project start date.

- This ARR project remains on track to meet the eight-year validation requirement, with a final deadline of 20 August 2026, based on its start date of 20 August 2018.
- Notwithstanding the point above, this ARR project is subject to Verra's extended grace period for the AR-AMS0007 methodology, and is therefore expected to complete validation no later than 30 June 2025.

The project does not fall under the category of excluded projects from the VCS Standard v4.7 and is therefore eligible under the scope of the VCS Program.

Table 1. Excluded project activities under the VCS Program scope

Exclusions from VCS Program Scope	Exclusion
Grid-connected electricity generation activities using hydroelectric power plants	Not applicable
Grid-connected electricity generation activities using wind, geothermal, or solar photovoltaic (PV) power plants.	Not applicable
Activities recovering waste heat for combined cycle electricity generation, or to heat/cool via cogeneration or trigeneration.	Not applicable
Activities generating electricity and/or thermal energy for industrial use from the combustion of non-renewable biomass, agro-residue biomass, or forest residue biomass.	Not applicable
Activities generating electricity and/or thermal energy using fossil fuels, and activities that involve switching from a higher to a lower carbon content fossil fuel.	Not applicable
Activities replacing electric lighting with more energy-efficient electric lighting, such as the replacement of incandescent electrical bulbs with compact fluorescent lights (CFLs) or light emitting diodes (LEDs).	Not applicable
Activities installing and/or replacing electricity transmission lines and/or energy-efficient transformers.	Not applicable
Activities that reduce hydrofluorocarbon-23 (HFC-23) emissions	Not applicable

1.4.2 AFOLU project eligibility

The Project adheres to the relevant AFOLU specific matters outlined in Section 3.2 of the VCS Standard v4.7, described in the table below.

Table 2. Relevant requirements related to AFOLU-specific matters

Relevant requirements related to AFOLU-specific matters	Applicability to this Project
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.	This project is aligned with project category A1.1 (afforestation, reforestation and revegetation or ARR) described in Appendix 1 of the VCS, v4.7.
The project area shall not be cleared of native ecosystems within the 10-year period prior to the project start date, as set	Project activities consist of restoring woody vegetation by planting trees in

out in Section 3.19.28 of the VCS, v4.7.	an area that has not been cleared of native ecosystems in the 10 years previous to the Project Start Date. The Project Area is characterized by cropland formerly used for citrus production, pasture, or fallow land. Farmers participating in the Project have predominantly owned the land for decades and have previously cultivated citrus (see Section 1.14)
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.	The project is not located within a jurisdiction covered by a jurisdictional REDD+ program.
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.	Terviva, one of the two project proponents, is also acting as the implementation partner for this project.
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).	The implementation of project activities in accordance with the project design are being monitored and reported on for each verification period at the time of verification.
The following 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 grace periods for using the previous version of a methodology are 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 above and shall be validated at the same time as the subsequent verification. 3) The reassessment will capture changes in the drivers and/or behavior 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.3 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	Not applicable; this document relates to the first verification of the project after validation.

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 above are not required. 6) Sections 1.14, 3.1-3.4, Section 4 and Section 54 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.	
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.	The project activities shall not occur on wetlands. There are no wetlands in the project area (Figure 11).
Projects shall prepare a non-permanence risk report in accordance with the AFOLU NonPermanence 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.	The project proponents have prepared a non-permanence risk report using Verra's AFOLU NPRT available from the Verra Hub. The assessment is appended to this PDD.
Projects shall have a minimum of a 40-year project longevity.	The project has received an exemption from Verra for a 30-year longevity.
Buffer credits shall be deposited in the AFOLU pooled buffer account based upon the non-permanence risk report assessed by the validation/verification body. Buffer credits cannot be traded.	Buffer credits will be deposited in the AFOLU pooled buffer account based on the results of the non-permanence risk assessment.
Projects shall perform the non-permanence risk analysis at every verification event. Projects that demonstrate their longevity, sustainability, and ability to mitigate risks through this analysis may be eligible for release of buffer credits from the AFOLU pooled buffer account.	Project proponents will perform the non-permanence risk analysis at every verification event.
Validation of non-permanence risk analyses may be conducted by the same validation/verification body that is conducting validation or verification of the project and at the same time as the validation or verification of the project, as applicable.	Validation of the non-permanence risk analysis for this verification will be conducted by the same VVB that is conducting verification of the project.
Where an event occurs that is likely to qualify as a loss event (see the VCS Program Definitions for definition of loss event), the project proponent shall follow the loss event reporting requirements set out in the Registration and Issuance Process.	Not applicable; this document relates to the first verification of the project after validation.

At the verification event after the loss event, the monitoring report shall restate the loss from the loss event and calculate the net GHG benefit for the monitoring period, including the loss event, in accordance with the requirements set out in the methodology applied and the Registration and Issuance Process	Not applicable; this document relates to the first verification of the project after validation.
The permanence of carbon stocks shall be monitored for a minimum of 40 years. At its discretion, Verra may agree to monitor a project or class of project types where the crediting period is less than 40 years. Verra and the project proponent shall agree to the terms of such monitoring in advance.	This project has a 30-year longevity with an approved exemption from Verra.

1.4.3 Transfer project eligibility

Not applicable

1.5 Project Design

☐ *Single location or installation*

☒ *Multiple locations or project activity instances (but not a grouped project)*

☐ *Grouped project*

1.6 Project Proponents

Organization name	Terviva
Contact person	Nathan Chan
Title	Sustainability Manager
Address	980 Atlantic Ave., Suite 105, Alameda, CA 94501
Telephone	(+1) 510 501 3707
Email	nathan.chan@terviva.com

Organization name	Cultivo Land PBC
Contact person	Emiline Koopman
Title	Ecological Impact Senior Manager
Address	5020 Franklin Drive, Suite 100, Pleasanton, CA 94588, USA

Telephone	(+1) 415 650 9943
Email	projects@cultivo.land

1.7 Other Entities Involved in the Project

Organization name	Florida Regenerative Pongamia Fund 1
Role in the project	Owner of the project natural capital and special purpose vehicle in charge of funding the carbon capture project.
Contact person	Marc Diaz
Title	Manager
Address	980 Atlantic Ave., Suite 105, Alameda, CA 94501
Telephone	+1 202 657 2942
Email	marc.diaz@terviva.com

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1.8 Ownership

Activities are carried out by growers on privately-owned land. The project has all the required legal documentation to prove the property ownership and the lease agreement for the right of usage for restoration activities. The ownership of the land will remain with the landowners. The ownership of the Project and carbon credits are of the project proponents Terviva and FRPF1, as defined in the terms of the agreements signed with landowners, subject to renewal if agreed by all parties.

Terviva, one of the Project Proponents, has entered into a tree purchase and oilseed purchase agreement with the landowners. Under the tree purchase agreement, landowners have agreed to purchase young pongamia trees for at least 20 years, at a fair cost (mostly lower than citrus trees), grown in nurseries owned by Terviva, plant those trees, and cultivate them so they produce a crop of oilseeds. Under the oilseed purchase agreement, Terviva commits to offtake pongamia beans from farmers for 15 years at a mutually agreed price with an option to renew thereafter if agreed by all parties.

Additionally, a second Project Proponent, FRPF1, a fund created specifically with the purpose of this Project, owned and managed by Terviva, and Terviva have entered an agreement with the landowners to take ownership of environmental incentives (including carbon credits) produced on the landowners' land in exchange for financial compensation, subject to the term of the Tree Purchase agreement, which is 25 years, and subject to renewal if agreed by all parties. FRPF1 was created to facilitate the investment to the Project and provide transparency on the use of funds.

The Project Proponents, at a group level, will continue project activities for the complete project longevity of 30 years. To incentivize the continuance of project activities for at least 30 years, Project Proponents will seek to extend the current agreements, through effective relationship management and potential upside benefits from oilseed market prices and sharing of carbon offset revenues. At the conclusion of the oilseed purchase agreement (OPA) in years 15-19 of the project, Terviva and growers have an opportunity to negotiate a new OPA with favorable terms that can extend for the remainder of the 30-year project timeline. Given the current market progression for Ponova[3] food ingredients and other pongamia-based products, Terviva fully expects to re-sign these agreements with favorable terms for both parties.

1.9 Project Start Date

Project start date	20-August-2018
Justification	Date on which the first tree plantings occurred, as documented in Annex 5 Tree Inventory, and following the first contract signed between the landowners and Terviva on July 16, 2018.

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[3] Ponova is a registered brand, owned by Terviva, of food ingredients made of pongamia beans (https://www.terviva.com/foods/)

1.10 Project Crediting Period

Crediting period	☐ Seven years, twice renewable ☐ Ten years, fixed ☒ Other The initial project crediting period is 20 years. This is in line with the VCS Standard v4.7 which states that the crediting period shall be a minimum of 20 years up to a maximum of 100 years, which may be renewed at most four times, with a total project crediting period not to exceed 100 years.
Start and end date of first or fixed crediting period	20-August-2018 to 19-August-2038

1.11 Project Scale and Estimated GHG Emission Reductions or Removals

☒ < 300,000 tCO_2e/year (project)

☐ ≥ 300,000 tCO_2e/year (project)

Calendar year of crediting period	Estimated GHG emission reductions or removals (tCO_2e)
20-Aug-2018 to 31-Dec-2018	1
01-Jan-2019 to 31-Dec-2019	15
01-Jan-2020 to 31-Dec-2020	75
01-Jan-2021 to 31-Dec-2021	411
01-Jan-2022 to 31-Dec-2022	1,032
01-Jan-2023 to 31-Dec-2023	2,066
01-Jan-2024 to 31-Dec-2024	2,374
01-Jan-2025 to 31-Dec-2025	2,912
01-Jan-2026 to 31-Dec-2026	2,946
01-Jan-2027 to 31-Dec-2027	2,671
01-Jan-2028 to 31-Dec-2028	2,581
01-Jan-2029 to 31-Dec-2029	2,419
01-Jan-2030 to 31-Dec-2030	2,310
01-Jan-2031 to 31-Dec-2031	2,238
01-Jan-2032 to 31-Dec-2032	2,177
01-Jan-2033 to 31-Dec-2033	2,123
01-Jan-2034 to 31-Dec-2034	2,076
01-Jan-2035 to 31-Dec-2035	2,034
01-Jan-2036 to 31-Dec-2036	1,996
01-Jan-2037 to 31-Dec-2037	1,962

01-Jan-2038 to 19-Aug-2038	1,856
Total estimated ERRs during the first or fixed crediting period	**38274 tCO_2e**
Total number of years	**20 years**
Average annual ERRs	**3.9 tCO_2e/ha/yr across 20 years**

1.12 Description of Project Activity

The purpose of the Project is to sequester carbon, improve the quality of degraded agricultural lands and improve farmer income through the implementation of sustainable agroforestry practices and the planting and cultivation of pongamia trees on private lands in St Lucie County, and Indian River County in Florida, USA. The United States is not part of the REDD+ program.

Landowners join the project on a voluntary basis and commit to implementing the project activities through agreements with Terviva for pongamia cultivation and as buyers of produce, and with FRPF1 as the entity receiving carbon credits. Farmers participate through the implementation and promotion of good agroforestry practices, the production of pongamia beans and through securing their land.

Over the past two decades, citrus greening has caused citrus cultivation to become increasingly expensive, requiring greater use of pesticides, antibiotics, and fertilizers. In many cases, citrus production ceases to be profitable and trees are removed or abandoned altogether. The adoption of pongamia agroforestry offers farmers a more profitable and sustainable option with material decreases in the use of pesticides and fertilizers when compared to citrus production with the presence of citrus greening. These less intensive practices will decrease greenhouse gas emissions, sequester carbon in the woody biomass of pongamia trees and soils, promote greater surrounding biodiversity and increase soil moisture.

Project changes common practice to improve sustainability and restore land because pongamia trees:

- Store carbon and produce nitrogen for healthy soils;
- Require minimal fertilizer and pesticides;
- Require relatively low water usage in sub-tropical areas;
- Adapt to climate extremes, particularly annual drought and flood cycles;
- Control soil erosion by creating a dense network of lateral roots.

Preparation of the land

Depending on the state of the land being used, various land preparation activities are required before pongamia can be planted. If the land was recently used for growing citrus, stumps and dead trees are removed. Citrus beds and water furrows may need to be regraded to accommodate low-clearance pongamia harvesting equipment. Additionally, depending on site conditions, earth-moving equipment may be required to move any large rocks or boulders, bed the groves, and create water furrows. Thick sod or heavy weed cover may require a pre-tillage herbicide application four to six weeks ahead of planting, and/or mowing one to two weeks ahead of planting. The disturbance of soil represents less than 10% of the total Project Area.

If irrigation is being used, new lines need to be laid down for drip or micro-jet irrigation. In some cases, new irrigation infrastructure, such as pumps and filters, may need to be installed. Water furrows are dug to a range from 30" to 40" aid and at a slight slope to encourage drainage through a drain tile.

Prior to planting, tree rows are staked out and tree locations are marked with paint or straws. Planting pongamia in Florida is typically accomplished with hand labor crews. Immediately prior to planting, 30cm x 30cm x 30cm holes are dug by hand or using a hydraulically driven auger. Trees are then planted by hand over the course of several days.

Figure 1. Planting pongamia. Source: Terviva

Planting

Pongamia trees are planted at a density of no less than 100 trees per acre and no greater than 145 trees per plantable acre, with 25' between tree rows and a minimum of 15' between trees within the row. Growers plant at different densities depending on the exact layout of their field. The configuration of the planting area is sited to maximize the length of the tree rows to an optimum ¼ mile (1,320 feet) long. This configuration facilitates efficient harvesting, loading and hauling of the crop out of the field.

As with most orchard crops, it is typical to observe 0-5% mortality rates post-planting. In instances where pongamia trees do not survive, trees are replanted roughly 3-4 months after the initial planting event, as this allows enough time to determine with certainty that a questionable plant has not survived planting, as opposed to a plant that has dropped its leaves as a stress response and then recovers, which is also typical in pongamia.

The project activities also include the replanting of trees lost due to natural events, such as cold weather events or hurricanes. This is likely to happen within the first four years of tree growth, as trees have not yet reached maturity. This will also permit the permanence of the healthiest trees and achieve the planned tree density and carbon capture.

Harvesting

Starting in year five, pongamia trees are mechanically harvested using commercial nut crop shaking harvesting equipment that has been adapted for pongamia. Mechanical harvesting equipment requires a clear tree trunk from soil level to three inches up the trunk.

Figure 2. Harvested seeds in a pongamia orchard. Source: Terviva

Caretaking

Growers prune their trees as needed to maintain this branch-free base. In addition to pruning for clear trunks, growers deploy a variety of staking materials in their orchards to stake trees upright. Young trees are periodically shaped and balanced by cutting back excessively long branches. Hand staking, pruning and tying is necessary for approximately two years.

Hedging and topping is important for tree size containment as well as tree structure. The goal is to maximize fruiting wood with yield that can be captured with a shake and catch harvesting machine. The ability to collect harvest in the catchment frame is compromised if the trees grow too tall or wide. Hand pruning and topping through year two is often replaced with a light mechanical cut in year three to promote tree architecture. By years four and five pongamia trees grow large enough that size containment is necessary. After year five, hedging and topping is an annual occurrence.

Pongamia is very tolerant of a wide range of soil pH. Between 6.0 and 7.0 pH is optimal, with below 5.0 and above 8.5 pH potentially presenting a problem.

Figure 3. Pongamia trees planted in 2018 in the Project Area. Source: Terviva

Residue management

After planting, residues from deciduous tree litter, trimmed tree limbs and branches, and mowed weeds are left on the soil. The organic matter creates favorable microclimatic conditions that optimize decomposition and mineralization of organic matter ("surface composting") and protect soil from erosion.

Water use

Water management takes place to ensure tree growth, although water consumption is minimal due to pongamia's resilience to drought. Proper irrigation design ensures that sufficient pressure is available through irrigation lines, allowing for uniform application of irrigation water throughout the orchard. The overall capacity should provide 30 to 40 gallons of water per tree per day in order to replace evapotranspiration (ET) rates. Irrigation infrastructure from past citrus production that is still usable is kept. Drip emitters or microjets may be used. In Florida, the preferred drip option is factory installed 0.5 to 1.0 gph inline drippers every 3 ft in the poly. Microjets are generally used with a single 10 to 15 gph jet at each tree.

When planting pongamia, irrigation is critical at least three times per week during any week with less than 1" rainfall in the first two months. In the following months and years, ET loss rates are replaced in the summer months (between May 1st and September 30th) with rainfall plus irrigation. As the tree growth is slower in the fall (between October 1st and November 30th), half of the ET loss rates are replaced.

Irrigation is typically not needed in the winter months (between December 1st and April 30th), except for frost protection. Growers scout their orchards to verify that the emitter pattern is watering young trees and periodically check for emitter plugging and replacement. The point of irrigation is checked for placement and any damage to the lines is spliced with couplers and/or repaired for cuts and rips. Lines are also periodically flushed for any blockage or build-up.

Fertilizer use

Pre- and post-establishment fertilization practices will consist of some use of fertilizers to supplement pongamia trees with key macro and micronutrients to encourage maximal growth and high yields. Fertilizers will be applied through a mix of fertigation, individual tree applications and foliar sprays, depending on the nutrients being used and the equipment available to the grower.

Pre- and post-establishment practices will differ in the rate and concentration of fertilizers applied, with pre-establishment practices being more intensive. As trees mature into production, it is expected that a normal program based on crop removal replacement rates of nutrients minus soil availability will be utilized on all nutrients except nitrogen (N). The application rates of nitrogen at tree maturity will be determined by ongoing research and grower experience. Spray nutritionals are also applied at year five onwards. Micronutrient foliar crop spray (B, Zn, Mn) is applied annually at peak bloom time. For mature trees, this is approximate during the early summer months of May to July.

Due to the less intensive practices in fertilizer use that are required for pongamia growth, the GHG emissions due to fertilizer use amount to less than 7% of the total GHG benefit generated by the project for the total crediting period.

Pesticide Use

Establishment practices consist of a small amount of broadleaf and grass herbicides applied to the base of trees for the first three years to help orchard establishment. Following establishment, no other herbicides or pesticides are used. Due to the minimum use of pesticides for project activities over the complete crediting period, GHG emissions are considered *de minimis.*

Cover crops

Growers include cover crops in their orchards so that the soil will remain covered by grass and other ground cover plants. Inter-rows and furrows will be mowed throughout the year, as needed, to allow access for maintenance and caretaking. All residues from mowing will be left on the field to compost. Mechanical and/or chemical methods are used to control weeds in pongamia orchards. Growers typically mow bed top inter-rows with a tractor and 12' - 15' mower every 6 - 12 weeks, depending on grass/weed growth. When the pongamia trees are small, it often takes two passes per middle to fully mow the area. Water furrows are mowed as necessary to maintain sufficient drainage, typically an average of four times per year.

Figure 4. Young pongamia trees. Source: Terviva

In Florida, common cover crops are grass and weeds, or planting Millet and Bermuda or Bahia grass, to grow in between the tree rows. To control weeds in the planted tree row, growers maintain a weed-free buffer ~3-6' wide on either side of the pongamia trees via chemical methods.

Implementation timeline

Agreements have been signed with 5 landowners with land parcels that sum 502.8 hectares, with around 124,094 trees planted, averaging 247 trees per hectare. Areas have been added to the project according to the following timeline:

Table 3. Project timeline. Source: Terviva

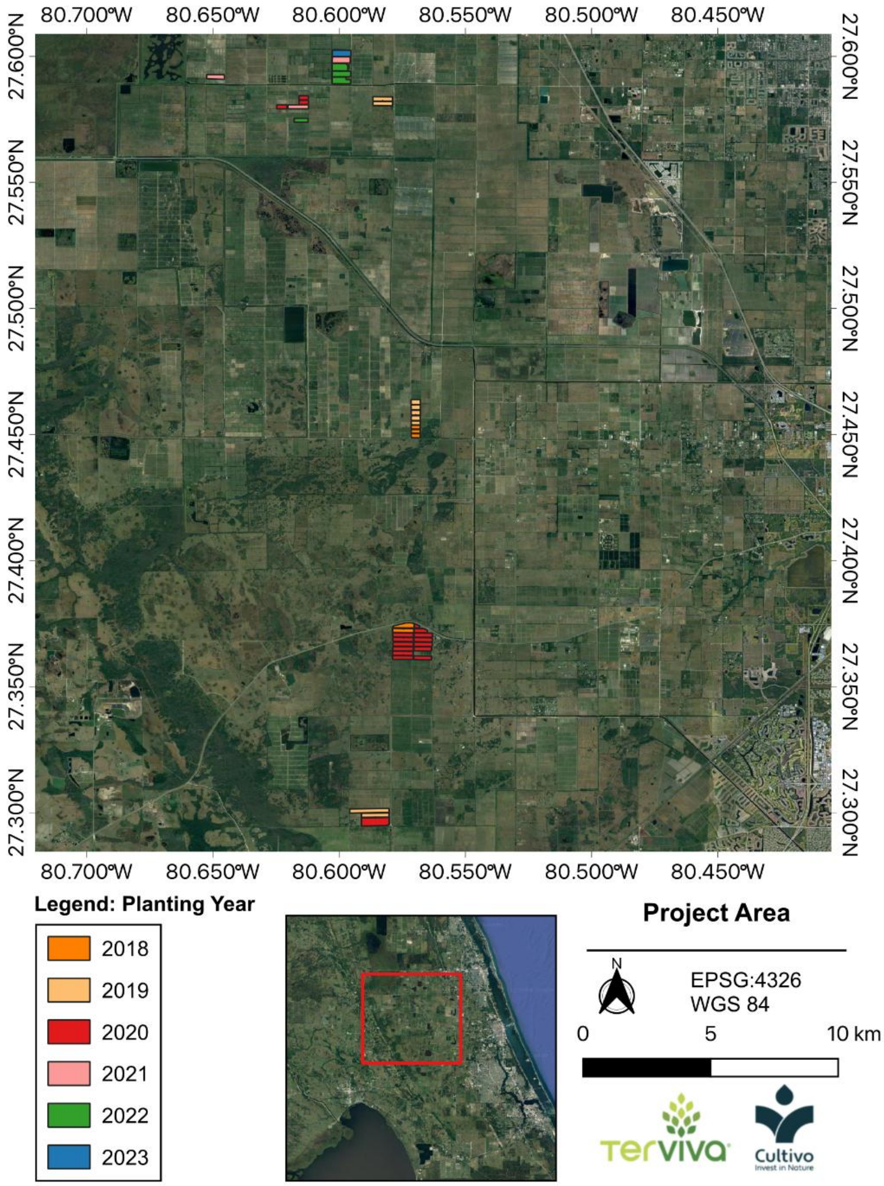
	Planting year						
	2018	2019	2020	2021	2022	2023	Total

Hectares	47.4	112.0	218.9	42.2	62.2	20.0	**502.8**
Tree count	11,987	19,006	24,501	30,982	21,331	16,289	**124,096**

1.13 Project Location

The project comprises different plots of land, owned by five different landowners, that total 502.8 hectares in St Lucie County and Indian River County, in Florida, USA. The project area is made up of multiple project activity instances (Annex 1). In this project, the Project Area is the same as the Project Zone, as there are no WRC buffer zones, leakage belts, or leakage management areas.

Figure 5. Project Area



1.14 Conditions Prior to Project Initiation

Climate

The project is in a tropical moist Climatic Zone.[4] Based on the National Weather Service data from the Fort Pierce Station (2017), located at approximately 10 km from the current Project Areas, the mean annual temperature is 74.5°F (23.6°C), the highest temperature is 95°F (35°C), and the lowest temperature 40°F (4.4°C). The mean annual precipitation is 66.03 in (1,303 mm). The

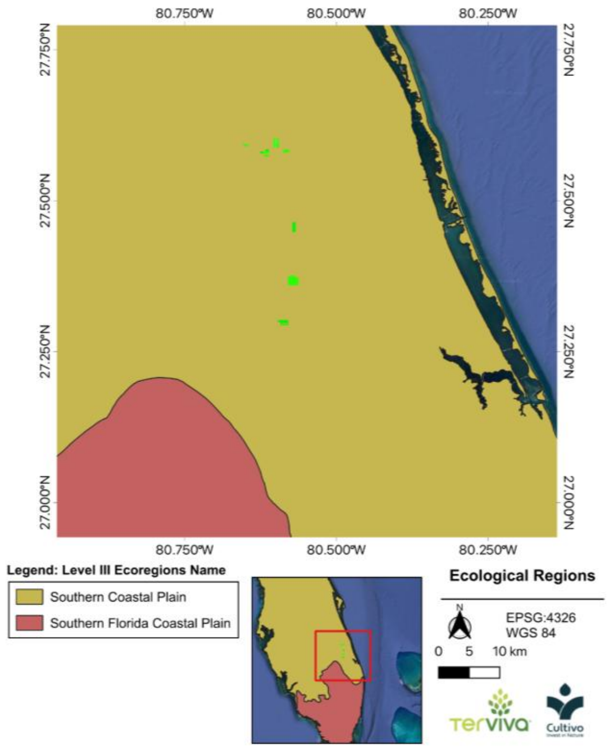
[4] Climatic Zone layer is defined based on the classification of IPCC (IPCC, 2006). Database taken from European Commission - Joint Research Centre, Institute for Environment and Sustainability (2014).

Aridity Index for Florida is 0.90 (Humid).

Ecological region and biome

The Project Area is located in the Southern Coastal Plain Ecoregion (Level III Ecoregions of North America, United States Environmental Protection Agency, 2006) that is mostly subtropical with temperate grasslands, savannas and shrublands.

Figure 6. Ecological regions in the Project Area



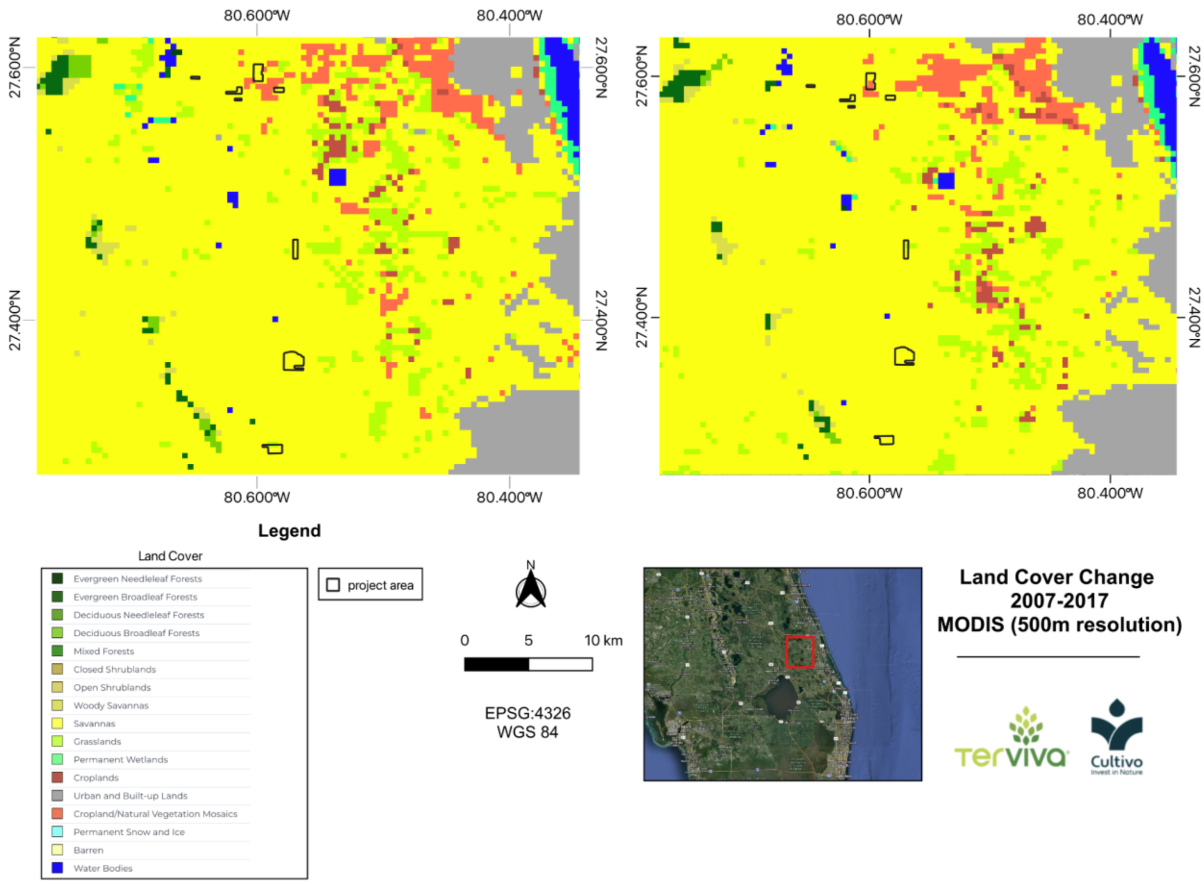
Land cover

Land currently dedicated to crops, groves and nurseries represents 7.9% of the land of the state of Florida (Volk et al., 2017). A 10-year land cover change analysis within the project area shows land cover changes between the years 2007 to 2017, prior to the start of project activities (Figure 7). In 2007, the area was dominantly classified as savannas (376 ha covering 67.5% of the project area) and cropland (44 ha covering 7.9% of the project area). In 2017, the area classified as savannas increased (421 ha covering 75.6% of the project area). This analysis uses satellite data from MODIS[5], which has the advantage of having historical land cover data since 2001. However, the 500m resolution of this data limits the analysis in small project areas such as FRPF1, making it difficult to report on the entire project area and identify fine scale changes in land cover. Despite

[5] MCD12Q1.061 MODIS Land Cover Type Yearly Global 500m.

these limitations, MODIS satellite data detects a land cover change of 44 ha from croplands to savannas in the 10 years prior to the start of the project. This is likely due to growers abandoning citrus crops which have succumbed to citrus greening disease, as described in the baseline scenario.

Figure 7. Land cover change in Project Area 2007-2017

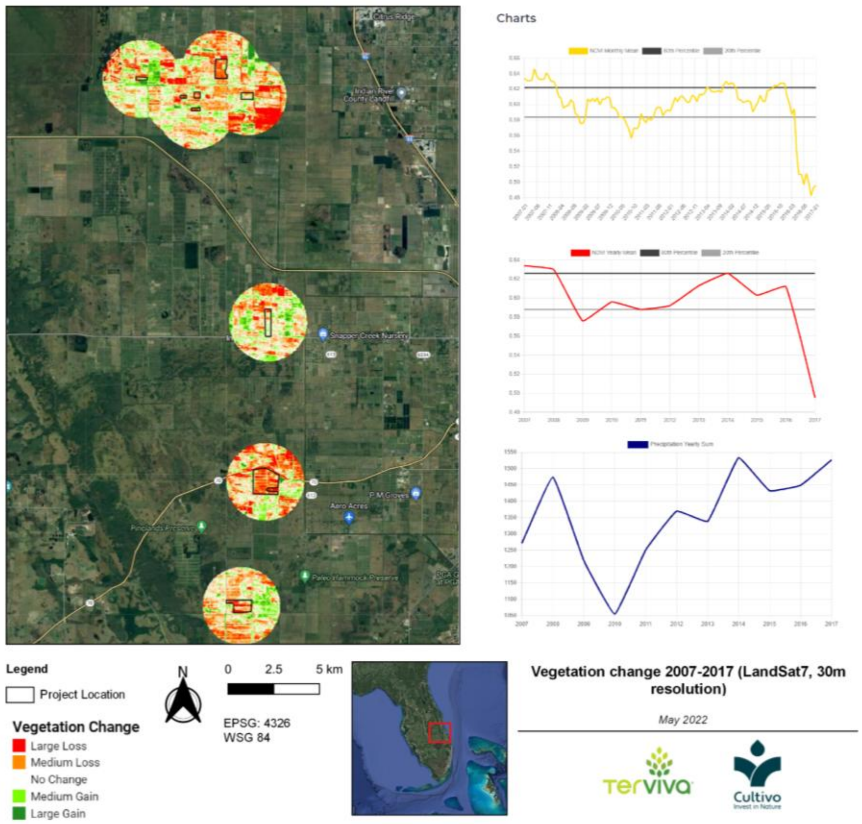


Satellite images of higher resolution show land cover in the Project Area prior to the Project Start Date was categorized as majorly shrubs, to a smaller extent by herbaceous vegetation and other forest (open) (Buchhorn *et al*. 2021).

Vegetation cover

The vegetation cover changes in the project area from 2007 to 2017 were estimated using the average Normalized Difference Vegetation Index (NDVI) for the Project Area (Funk et.al, 2015), from LandSat7 (30 m resolution). NDVI ranges from a scale of 0 (totally barren land) to 1 (densely vegetated) so that any change of NDVI between analyzed years in the order of 1.00 are considered large losses or gains of vegetation, while 0.1 changes are considered medium losses or gains. As there has been a significant loss of citrus trees in the Project Area, and a shift to cattle grazing activities and land left fallow for the past two to seven years, most plots within the Project Area show a loss in vegetation from 2007 to 2017 with a decrease in vegetation in the past 10 years unrelated to precipitation levels in the area.

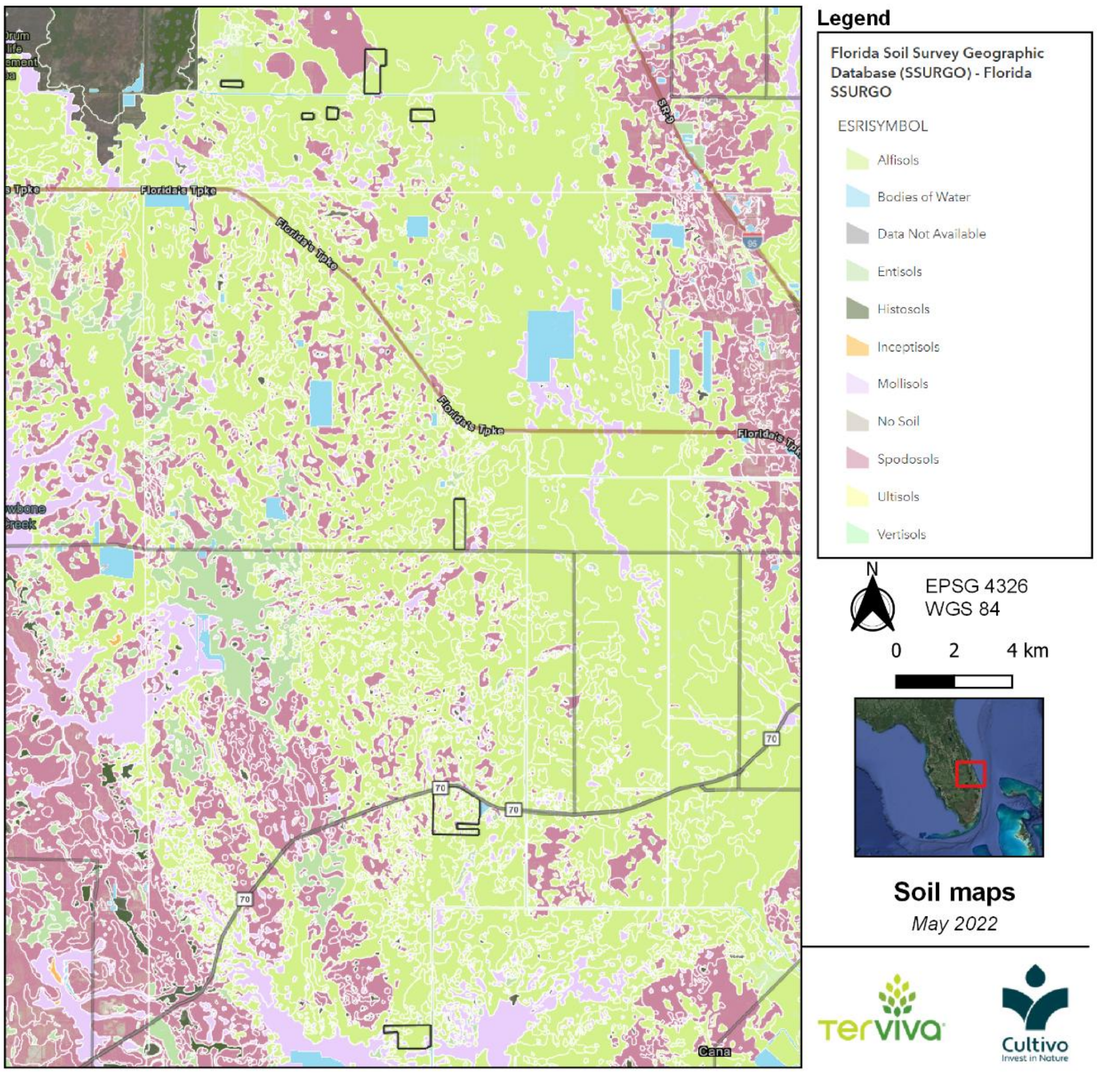
Figure 8. NDVI change 2007-2017 in Project Area



Soils

Soils in St Lucie County, and Indian River County have been extensively surveyed by the USDA - Natural Resource Natural Resources Conservation Service (2019). Soil mapping is available in the Florida Soil Survey Geographic Database (SSURGO). Soil data shows that the soils within the Project Areas are predominantly Riviera Fine Sands and Pineda Sands — Aqualf soil types within the Alfisol soil order, with low organic matter and natural fertility content (USDA, 1980). The associated soil units, Wabasso and Floridana, are both Aqualfs very similar in form to Riviera Fine Sand and make up less than 10% of the Project Area. Complete results from SSURGO are found in Annex 11.

Figure 9. Soil Survey Map of the Project Area



Hydrology

Understanding the current distribution of water bodies can be useful both in terms of water availability and discharge and from an ecological perspective (e.g., flora and fauna dependent on water bodies). There are no surface water bodies within the Project Area as shown in Figure 10.

The initial Project Area is located between the Upper St Johns and St Lucie - Loxahatchee watersheds South Florida basins. The former drains mainly into the St Johns River and the latter into the St Lucie River and forms part of the Everglades system (Florida Department of Environmental Protection, 2021; Shukla, 2004). Agricultural and urban development has increased in the region. Surface and groundwater quality varies from good to poor, although in the Upper St Johns watershed water quality has increased due to an improvement in management practices (Shukla, 2004). In the St Lucie watershed, increasing human population and agricultural activity - primarily citrus and pasture - have contributed to elevated nutrient concentrations (South Florida Water Management District, 2009). There are no wetlands within the project area (Figure 11).

Figure 10. Surface water in the Project Area (WWF HydroSHEDS, 2021; Lehner et al, 2008)

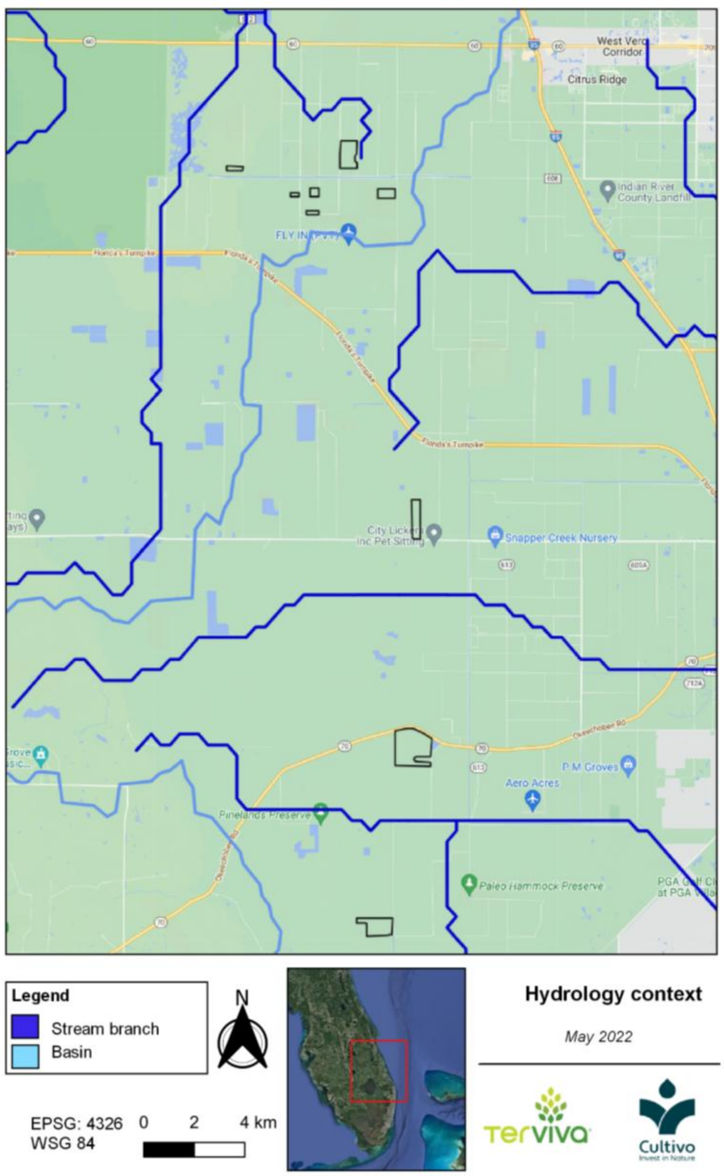
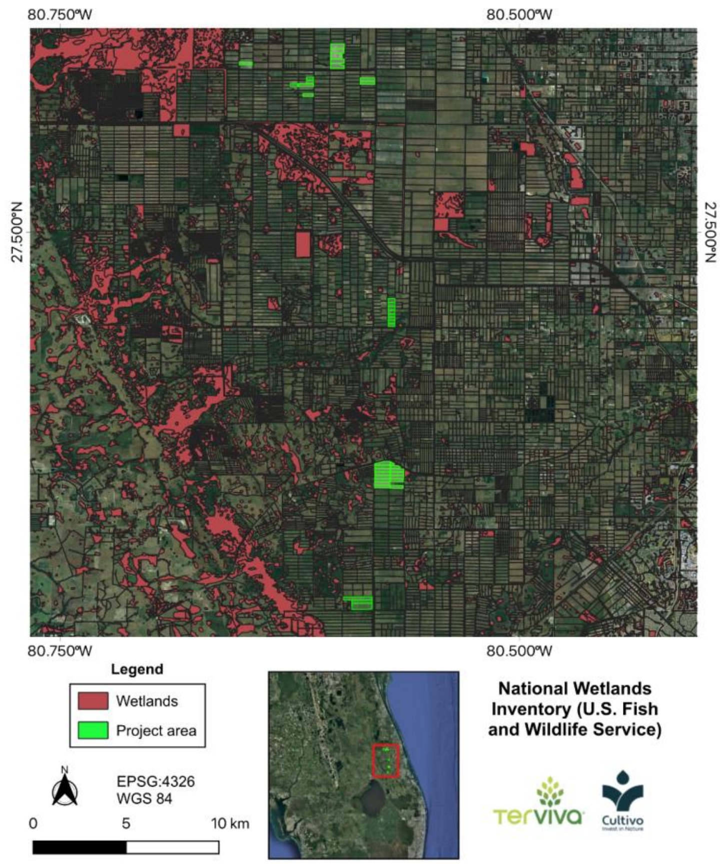


Figure 11. Wetlands in the project area (National Wetlands Inventory, U.S. Fish and Wildlife Service)



Soil moisture

Mean soil moisture in the Project Area in 2017 was approximately 71.5 mm/yr[6]. This baseline value indicates the amount of water that was stored in the soil in the project area prior to the start of project activities. By comparing the within-project soil moisture levels to the range of soil moisture from similar land units (i.e., with the same soil taxonomy and land cover) across the neighboring area in 2017, we conclude that the project activity has the potential to increase soil moisture equivalent to an average of 5 mm/year. This is approximately a 7% increase in the soil moisture baseline of 2017, which represents 25,040 m^3/yr across the whole Project Area. This is

[6] TerraClimate: Monthly Climate and Climatic Water Balance for Global Terrestrial Surfaces, University of Idaho.

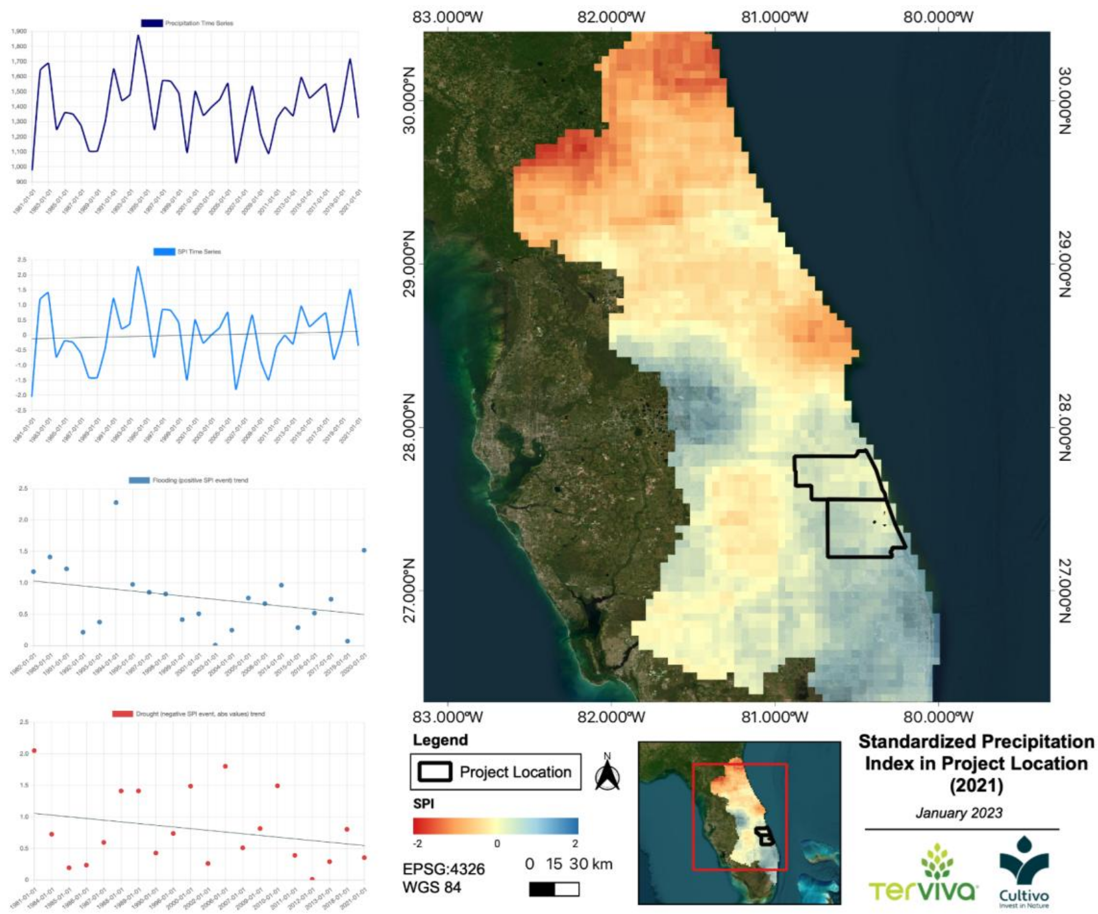
a conservative assessment since it considers only the increase in soil moisture and does not consider the complex interplay between carbon storage, soil moisture and other elements of the water balance.

Biomass and crop health rely upon an adequate supply of moisture and soil nutrients, among other things. If moisture availability declines, the normal function and growth of plants are disrupted, and yields are reduced. Moreover, levels of soil moisture have a large influence on the land's ability to store carbon. Researchers generally assume that soil response to moisture changes is linear and reversible (Patel et.al., 2021). Thus, the Project Area has the potential to increase its soil moisture and positively influence the dynamics of soil carbon.

Droughts and floods

The Standardized Precipitation Index (SPI) is a measure of the probability of precipitation for any timescale. SPI measures precipitation anomalies at a given location, based on a comparison of observed total precipitation amounts for an accumulation period of interest. The 12-month SPI time series graph for the project location shows a negligible increase in wet years, indicating there have not been any significant long term changes in precipitation (Figure 12). Further, the absolute values for both negative and positive SPI events are trending downwards, indicating that the intensity of floods and droughts are decreasing. Overall, this shows that the project area is experiencing normal yearly precipitation levels while trending towards less severe drought and flooding events, indicating minimal precipitation related risks to project activities.

Figure 12. The Standardized Precipitation Index (SPI) in the Project Location (Climate Hazards Group InfraRed Precipitation with Station Data; Funk et al, 2015)



Land activity

The initial Project Area is located within the Indian River County and St Lucie County, a commercial citrus production area in Florida. Agriculture is Florida's second-largest industry, accounting for many land cover changes since the 20th century due to population growth and development (Volk *et al*, 2017; Workman *et al.*, 2014). Land currently dedicated to crops, groves and nurseries represents 7.9% of the state's land.

According to official data from the USDA's National Agricultural Statistics Service of citrus production in Florida, in 2017, the year before the Project start date, citrus production in Florida accounted for more than 40% of the county's production (USDA, 2019b).

The Project Area is characterised by former cropland used for citrus production, which at the time of the start of this project, either contained diseased citrus trees, was used as pasture, or was unmanaged fallow land. Farmers participating in the Project have predominantly owned the land for decades and have previously cultivated citrus. Since 2010, all of the landowners ceased cultivating citrus because of lost productivity, tree mortality, and unfavorable economics caused by citrus greening, also known as Huanglongbing (HLB). Some landowners removed their citrus to prevent the spread of disease as early as 2014, while others continued unsuccessfully to try to grow citrus up until 2020. Irrespective of participation in the project, all landowners planned to cease citrus cultivation and remove trees due to citrus greening. This is consistent with best management practices published by the University of Florida, which encourage the removal of any infected trees (Dewdney *et al*., 2005). In fact, materials for citrus growers produced by the University of Florida's Institute of Food and Agricultural Sciences repeatedly state that the ultimate fate of infected trees is to succumb to citrus greening, since there is no cure or treatment (Moffis *et al*., 2016). Therefore, removing infected trees, including tree roots, is recommended to prevent the spread of the disease to other trees. Additionally, Moffis et. al. (2016) recommends disposing of infected trees through normal yard waste programs or through burning. Depending on the length of the interim period between citrus tree removal and the planting of pongamia, some growers let the land lay fallow or grazed cattle. For sites where citrus was removed after 2018, documentation has been provided in the "Other supporting documents" folder, demonstrating that citrus greening was found to be present on-site and that trees were to be removed. Some growers worked with the USDA Farm Service Agency to participate in the Tree Assistance Program (TAP) to acquire funding to plant pongamia as a replacement for their dead citrus. TAP funding is only available where orchards or nurseries have been damaged by natural disasters and therefore require rehabilitation or replanting, as was the case with these areas of the project area.[7]

Figure 13. Orange tree with the greening disease in Florida. Source: Sprague, 2019, University of Florida

[7] Tree Assistance Program (TAP) https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/tree-assistance-program/index

The table below describes the land use management for each of the plots. The past land-use practices are looking backward from the Project Start Date. For example, "20+ yrs citrus, 5 years cattle" indicates that the site had cattle grazing practices for the 5 years before pongamia was planted, and citrus trees for more than 20 years prior to the Project Start Date.

Citrus trees that were removed after the project start date were not done so because of pongamia but were deemed to be removed regardless of the project due to infection with citrus greening disease.

Table 4. Past Land Activities in the Project Area

Area ID	Past land use practices
A001, A002	20+ yrs Citrus + 5 years cattle
A003	20+ yrs Citrus + 7 years cattle
B001, B002, B003, B009, B010	20+ yrs Citrus + 1 yr fallow
B004, B005, B006, B007, B008, B011	20+ yrs Citrus + 2 yrs fallow
B012, B013	20+ yrs citrus, diseased and removed
C001, C002, C003	20+ yrs citrus, diseased and destined to be removed
D001, D002, D003, D004, D005, D006, D007, D008, D009, D010, D011, D012, D013, D014, D015	20+ yrs Citrus + 4 yrs fallow
E001, E002, E003, E004, E005	20+ yrs citrus, diseased and destined to be removed

1.15 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project proponents have conducted a review of the relevant policies and regulations, including the legislative acts listed below. It has been determined that the activities and approaches of the proposed project are in compliance with all applicable laws, statutes and other regulatory frameworks:

The Project Activity is in compliance with applicable non-native species regulations as set by the USDA, and the Florida Department of Agriculture and Consumer Services, including Chapter 5B-57 and Chapter 5B-64. Additionally, landowners that join the Project will obtain the Non-Native Species Planting Permit, according to the Florida Administrative Code (F.A.C.), with support from Terviva throughout the process.

The Project Activity is in compliance with applicable wetland laws, specifically including Section 404 of the Clean Water Act. The Project Activity is also in compliance with Florida's Coastal Zone Protection Act and Florida Unified Wetland Delineation Methodology (Chapter 62-340, F.A.C.). No local laws regulating wetlands were identified.

Additionally, the Project Proponents have, to the best of their knowledge, complied with all relevant local, state and national laws, including labor and non-discrimination laws, during project implementation. The following summary is based on the Project Proponent's review of applicable local, state and national laws.

The Project Proponents are duly organized corporations, validly existing, and in good standing under the laws of the State of Delaware and are qualified to do business in the State of Florida.

The Project Proponents maintain compliance with the following applicable anti-discrimination laws: Title VI of the Civil Rights Act of 1964 and Title VII of the Civil Rights Act of 1964, as amended by the Equal Employment Opportunity Act of 1972, Federal Executive Order 11246 as amended, the Rehabilitation Act of 1973, as amended, the Vietnam Era Veterans' Readjustment Assistance Act of 1974, Title IX of the Education Amendments of 1972, the Age Discrimination Act of 1975, the Fair Housing Act of 1968 as amended, and the Americans with Disabilities Act of 1990.

The Project Proponents are also in compliance with the Department of Labor Contract Work Hours and Safety Standards Act (40 U.S.C. 3701 et seq.), as supplemented by Department of Labor regulations (29 C.F.R. Part 5) and all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251 et seq.).

1.16 Double Counting and Participation under Other GHG Programs

1.16.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ No

1.16.2 Registration in Other GHG Programs

Is the project registered or seeking registration under any other GHG programs?

☐ Yes ☒ No

1.16.3 Projects Rejected by Other GHG Programs

Has the project been rejected by any other GHG programs?

☐ Yes ☒ No

1.17 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.17.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? *See the VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes ☒ No

1.17.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ No

1.17.3 Supply Chain (Scope 3) Emissions

Do the project activities specified in Section 1.12 affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

The products from pongamia oil or protein are not being sold as carbon neutral products and the carbon credits from the project are being sold through the voluntary carbon market and are not being used for scope 3 insetting. Carbon intensity calculations for Terviva's products are based on the supply chain emissions associated with their production and do not include any sequestration of carbon into biomass. Examples of Terviva's marketing materials can be found here.

1.18 Sustainable Development Contributions

1.18.1 Sustainable Development Contributions Activity Description

According to the Food and Agriculture Organization of the United Nations (FAO, 2017), agroforestry has the potential to restore degraded landscapes, as it can enhance physical, chemical and biological soil characteristics, thereby increasing soil fertility, controlling erosion and improving water availability. Pongamia is a permanent tree crop that has the potential to increase food and nutrition security, generate income and improve the livelihoods of farmers. Pongamia is a sustainable source of vegetable oil and plant protein. Additionally, the project addresses climate change mitigation through carbon sequestration in the trees and soil.

Sustainable Development Contributions

The United States is aligned to the United Nations Sustainable Development Goals (SDG), and officially tracks US statistics for Sustainable Development Goal global indicators to measure its national contributions (US SDG, 2022). Within this framework, the project activities contribute to three of the SDGs, described as follows:

- SDG 2, Zero Hunger - Project activities will ensure sustainable food production systems, producing healthy and nutritious foods through regenerative agroforestry practices. Pongamia is a tree crop that produces oil-rich beans, which can be processed into feedstock for biofuel as well as sustainable food ingredients. As a nitrogen-fixing legume species with a dense network of lateral roots, pongamia restores soil health by increasing nitrogen and preventing erosion. Pongamia also requires less fertilizer, pesticide, and water use compared to alternative agricultural land use practices in the region.

- SDG 13, Climate Action - The project contributes to GHG reductions and carbon capture. The cultivation of pongamia with sustainable agroforestry practices can produce a more sustainable and less carbon-intensive source of food. As pongamia trees grow, they contribute to climate change mitigation through the sequestration of carbon intro tree biomass and into the soil.

- SDG 15, Life on Land - The project will increase vegetation cover and reverse degradation in the project area, contributing to a land degradation-neutral world. Project activities will halt soil degradation caused by intensive land management practices and ecological imbalances due to HLB disease. Furthermore, research has shown that pongamia has the potential to restore degraded lands and improve soil properties (Leksono B. et al, 2021). Planting pongamia in the project area will increase vegetation cover, while also improving soil quality and reducing erosion (see Section 2.3 for further details on pongamia).

1.18.2 Sustainable Development Contributions Activity Monitoring

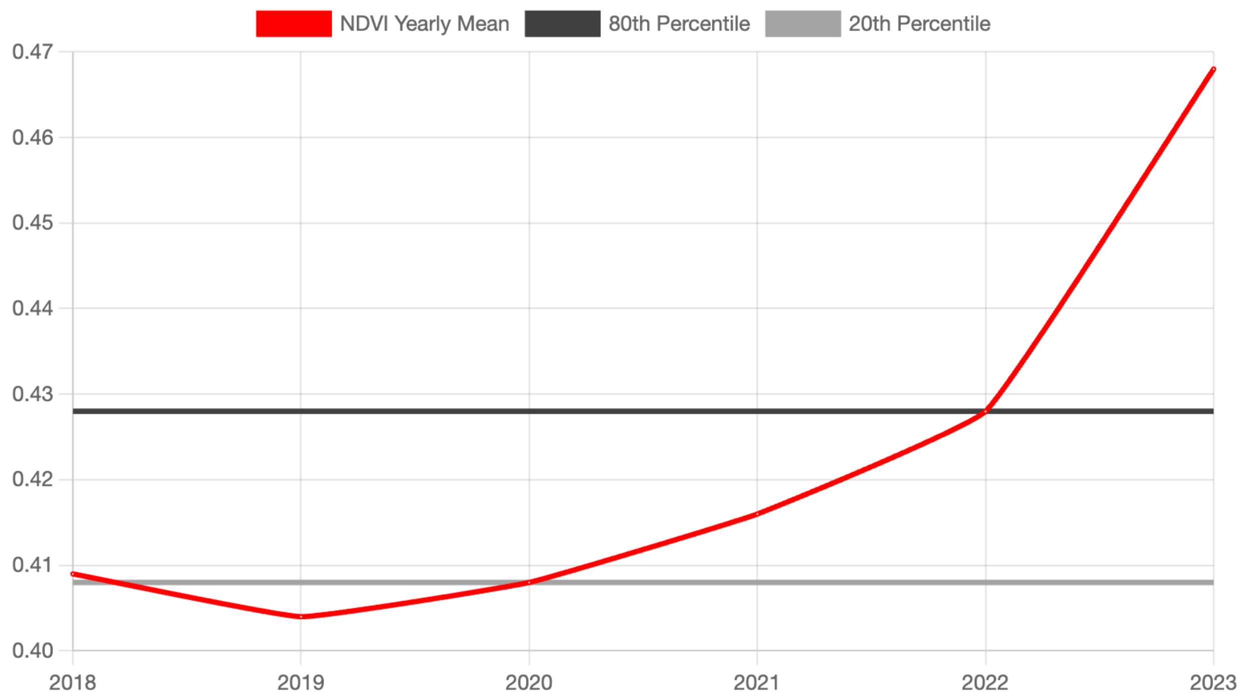
Sustainable Development monitored indicators are defined according to the project's impacts and aligned to SDGs targets. The indicators of the Sustainable Development contributions of the project activities to these SDGs will be included in the Monitoring Plan and monitored before every verification. In addition to monitored SDG indicators, an online survey has been completed by the landowners with the objective to understand how land management activities have changed, and how the project has impacted the way they work, their productivity, and overall livelihoods. Landowners will be asked to respond to this survey during each verification.

Table 5. Sustainable Development Contributions

Row number	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
1)	2.4.1	Proportion of agricultural area under productive and sustainable agriculture	Project activities have increased the use of sustainable practices and the proportion of agricultural area under sustainable agriculture. Sustainable agroforestry practices are implemented in all Project Areas.	100% of the Project Area, a total of 502.8 hectares, is currently under sustainable agroforestry practices that was previously managed unsustainably. Please refer to sections 1.12 and 1.14 for more information on past and current agricultural practices.	Since this is the first monitoring report, there are no previously approved VCS monitoring reports or Sustainable Development Contribution Reports, and therefore current project contributions are the same as contributions over the project lifetime. However, we expect that 100% of the 502.8 ha will continue to be cultivated using sustainable agroforestry practices throughout the lifetime of the project.
2)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Trees have been planted at a density of approximately 247 trees per hectare, increasing carbon capture through aboveground and belowground biomass, and soil organic carbon. Therefore, the project is increasing the number of tonnes of greenhouse gas emissions removed from the atmosphere.	Planting pongamia trees in the 502.8 ha project area has resulted in a net removal of 3,296 tCO2e for this monitoring period. Please refer to Annex 3. GHG Monitoring Report for detailed calculations of GHG removals.	Since this is the first monitoring report, there are no previously approved VCS monitoring reports or Sustainable Development Contribution Reports and therefore current project contributions are the same as contributions over project lifetime. However, we anticipate net removals of 27,175 tCO2e in 20 years. Please refer to Annex 15. Ex Ante GHG Emissions and Reductions.

3)	15.3.1	Increase of vegetation cover in the Project Area.	The project activities have increased vegetation cover and reversed the degradation of lands in the Project Area. The project contributes to achieving a land degradation-neutral world.	The yearly average Normalized Difference Vegetation Index (NDVI) increased from 0.41 in 2018 to 0.47 in 2023, representing a 14.6% increase in the Project Area (Figure 14). NDVI uses satellite data to measure the reflection of visible and near-infrared (NIR) light by vegetation. NDVI values can be used as a proxy for vegetation quantity, with higher values indicating that more vegetation is present.	Since this is the first monitoring report, there are no previously approved VCS monitoring reports or Sustainable Development Contribution Reports and therefore current project contributions are the same as contributions over project lifetime. However, we anticipate a 50% increase of NDVI in the Project Area by 2038.

Figure 14. Change in NDVI between 2018 and 2023 in the project area. Graph generated by Cultivo's proprietary Vegetation Change tool using Sentinel-2 MSI: MultiSpectral Instrument, Level-1C at 10m resolution.



1.19 Additional Information Relevant to the Project

1.19.1 Leakage Management

Leakage is considered for each pre-existing land use: pasture land, long-term cultivated, and fallow land.

Within the project area, only planting blocks A001, A002, and A003 were previously used for grazing. These blocks are owned by a single landowner, who provided first-hand information on the displacement of cattle from the project area. Per the landowner, 80 head of cattle (cow-calf) were grazed across the property, including the portions of the project area starting five to seven years before the implementation of project activities. After implementation, the herd size was reduced to 60 head of cattle, with 20 unproductive cattle sent for slaughter. The grazing area for the 60 heads of cattle was reduced to approximately 250 acres, utilizing the remaining pasture on the property. This portion of the property has been used as grazing pasture for the past 50 years and the current population is well below the carrying capacity. In Florida, carrying capacities for cattle grazing are typically 1.5-3 head per acre, which would be 375-750 total head in 250 acres.

Based on this information, the animals displaced in blocks A001, A002, and A003 were displaced to existing grazing lands and the total number of animals in the receiving grazing land did not exceed the carrying capacity of the grazing land. The small area and low stocking rates make GHG emissions due to cattle grazing that could be displaced *de minimis* for the project scenario and with minimum impact to the regional production of cattle. Therefore, there is no displacement of pre-project agricultural activities in the pasture areas.

The areas where the previous land use is long-term cultivated were defined by diseased citrus trees destined to be removed, and there is no logical incentive to displace this agricultural activity to another area. In addition, there is a large amount of fallow agricultural land in Florida due to the decline of the citrus industry over the past 20 years. Between 2004 and 2022, citrus acreage decreased from 679,000 acres to 340,000 acres in the state of Florida[8]. There is more than enough existing agricultural land that can be used for long-term cultivated agriculture. Therefore, there is no displacement of pre-project agricultural activities in the long-term land use areas.

For fallow areas, unmanaged land isn't defined as an agricultural activity according to tool 15, and thus there can be no displacement of pre-project agricultural activities from areas that were previously fallow (e.g. areas that are defined as short-term cultivated (< 20 yrs) or set aside (< 5 years)).

As per the A/R Methodological tool *Estimation of the increase in GHG emissions attributable to the displacement of pre-project agricultural activities in A/R CDM project activity*, the applicable scenario for leakage caused by the proposed project activities can be accounted as zero. Thus, no leakage management plan is included.

1.19.2 Commercially Sensitive Information

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

1.19.3 Further Information

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

[8] https://citrusindustry.net/2023/10/18/citrus-acreage-attrition-by-county-in-florida/

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Table 6. Stakeholder Identification

Stakeholder Identification	Stakeholders were identified through in-person meetings, presentations, and small-scale trails with members of the Florida agriculture industry (farmers, researchers, extension agents, etc.) Stakeholders Identified Primary stakeholders: *Landowners directly or indirectly affected by the project and their representatives* (landowners and growers)
Legal or customary tenure/access rights	The primary stakeholders, the landowners, demonstrated legal tenure to the land through public records for deeded land. All project participants are owners of the land where project activities are occurring. There are no conflicting rights or unresolved conflicts regarding land tenure or property rights in the project area. All land holding rights were reviewed prior to the signing of any legal agreements.
Stakeholder diversity and changes over time	The Florida citrus industry as a whole has faced a significant downturn over the past twenty-plus years due to a combination of increased disease pressures and economic factors. Many of the landowners in the area have seen a sharp decrease in the profitability and productivity of their citrus farming operations and have largely ceased citrus operations almost entirely leaving their land fallow while they look for alternate land uses such as pasture, water conservation projects, or selling land for future development. All of the landowners participating in the project previously grew citrus, but have moved away from it in the last 10-plus years and are cultivating pongamia as a more sustainable and economically viable

	alternative. Some landowners still cultivate small amounts of citrus, but at a small fraction of their previous acreage. Overall, there are not expected to be any significant changes in the makeup of stakeholders over time.
Expected changes in well-being	The project activities are expected to demonstrate improved quality of the existing agricultural lands that stakeholders are operating on, which will increase their income compared to baseline practices and potentially allow the agricultural communities of St. Lucie and Indian River counties to maintain their livelihoods. Pongamia cultivation is expected to increase soil health through large reductions in the use of fertilizers and pesticides, as well as the ability for pongamia to fix nitrogen. At a larger scale, this project is expected to demonstrate the biological and economic feasibility of cultivating a new tree crop allowing for the potential expansion of pongamia onto fallow agricultural lands in the area.
Location of stakeholders	All stakeholders are located in the state of Florida within Indian River and St. Lucie counties.
Location of resources	All project sites are located on legally owned land.

The following stakeholder map and consultation process was defined, based on the Inter-American Development Bank's "Meaningful Stakeholder Consultation" (IDB, 2017), Forest Trends' "Social Impact Guidance" and the International Association for Impact Assessment's "Social Impact Assessment: Guidance for assessing and managing social impacts of projects" (IAIA, 2015).

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively (IFC, 2007). The table below includes a brief description of each stakeholder group identified, whether they are being directly or indirectly impacted by the project and their respective level of influence and interest in the project.

Stakeholder	Description

Landowners	Landowners with proof of ownership of the land within the Project Area. They are directly impacted by the project activities as they are responsible to implement a change to agroforestry practices. They will receive direct benefit from pongamia produce and carbon offsets for a minimum of a 20-year long-term impact, and provide a sustainable and permanent crop. Their level of interest and influence is high, as the Project will directly depend on them to successfully perform the necessary activities.

2.1.2 Stakeholder Consultation and Ongoing Communication

Table 7. Stakeholder consultation and ongoing communication

Date of stakeholder consultation	Stakeholder consultation has been ongoing since 2015.
Stakeholder engagement process	The primary stakeholder in this project, growers and landowners, have been in a long-term engagement to assess the commercial viability of pongamia since 2015. This has consisted of a number of trial and pilot plantings, regular individual and group meetings, and participation in various research and development activities and studies. Since 2015, growers and landowners (including those that are not project participants) have participated in four pongamia grower meetings hosted by Terviva that bring all of the current and prospective growers of pongamia together to review the latest advances in pongamia cultivation and market developments, including updates on carbon project participation and registration. These meetings also provide an opportunity for growers and landowners to ask questions and voice any comments or concerns in a more formal setting. Additionally, Terviva spent time with growers and landowners reviewing caretaking activities and anticipated project activity costs. In addition to these large gatherings, individual meetings between Terviva and growers regularly occur to discuss the status of the project activities.
Consultation outcome	This consultation process covered all relevant information to the carbon project and made clear the potential agricultural and market risk that came with adopting a novel crop like pongamia. This culminated in the signing of agreements between Terviva and growers between 2018-2022 for a) the purchase of pongamia trees from Terviva by the grower, and b)

	the purchase of pongamia beans from the grower by Terviva. The pongamia bean purchase agreements help to reduce downstream risk for growers on markets. To reduce risk on farming practices, Terviva has heavily involved growers in the process of project design. In particular, growers have been key to developing many of the aspects of project design such as site selection, planting density, and caretaking practices. Some principles from citrus cultivation, such as drainage and irrigation infrastructure have been directly integrated into project design. This process is ongoing as Terviva's field staff is in regular communication with landowners and their field staff to advise on management and updating best practices.
Ongoing communication	Terviva has a dedicated customer success manager that landowners and field staff have direct contact with via phone and email. In addition to this, they also have contact with Terviva's agricultural operations and research and development teams. Landowners were provided notice regarding the VCS validation and verification process and visits by the VVB.
Stakeholder input	Stakeholder input was incorporated into project design in a number of ways. Growers provided significant input on the planting layout and design of fields to best accommodate the specific features and infrastructure of their sites. Caretaking practices were developed over a number of years of trial projects with some growers. Grower input was also taken into account when writing the contract terms for carbon offset transference and payment terms.

Stakeholder group	Engagement strategy	Communication strategy
Landowners	Regularly engage and monitor closely	• Clearly explaining to landowners how project activities, including carbon credits, will work in ways that are compatible with local practices. • Ensure full and realistic understanding of the project risks and benefits when including landowners and signing legal agreements. • Providing access to project documentation in the public comment

		stage. ● Monitoring impacts on a yearly basis through surveys.

All landowners were provided with all information regarding pongamia trees, terms of engagement and required agroforestry practices before signing the tree purchase agreement, oilseed purchase agreement and environmental benefits agreement. During the information sharing and consultation process, Terviva spent significant time communicating and agreeing with stakeholders on costs related to their participation. This included through the sharing and co-development of financial models and presentations summarizing expected costs with landowners. The landowners have decades of experience in agriculture in the area and provided direct input into the activities and their associated costs to develop an anticipated set of project activities and associated costs. These costs and activities were exhaustive and included land preparation, irrigation installation and operation, mechanical equipment rentals and operation, chemicals, labor, and fuel. These costs were communicated extensively in meetings throughout this process and collaboratively calculated with landowners, who demonstrated their agreement with these costs through the signing of the agreements, which were signed on different dates, the earliest being on March 29, 2018.

Relevant laws and regulations covering workers' rights in the USA were discussed during the consultation process in accordance with local business and cultural norms. To respect local cultural practices, the conversation around labor laws and regulations was made explicit and documented in the tree purchase agreement, where landowners certified that they were "in good standing under the laws of the State of Florida", which includes laws and regulations covering workers' rights.

All five landowners responded to a monitoring survey prepared by the Project Developer and Project Coordinator. Surveys were completed from May to August 2022 for the current monitoring period. Questions of the survey were focused on understanding past land activities, current land activities, motivations behind implementing project activities, as well as impacts to livelihoods, job creation, income and production levels. A copy of the survey and answers can be found on Annex 13.

Additionally, project proponents have initiated a research project with the University of Florida to understand the relationship between different pongamia production practices and their effects on water quality issues in surrounding water bodies. Project proponents are pursuing additional projects with researchers in Florida to better understand how different practices can increase yield. These partnerships can help inform future project activities to improve the caretaking practices that landowners use to improve water quality, and increase their tree yields, thus improving income and livelihoods.

2.1.3 Free Prior and Informed Consent

Obtaining consent	In the legal structure of property rights in the USA, FPIC is not mandated in the case of private property. However, Terviva's approach to land access, project design, project implementation and ongoing monitoring is performed with full consent of the landowners.
Outcome of FPIC	Not applicable

2.1.4 Grievance Redress Procedure

Development process	Terviva has developed a global grievance redress mechanism that applies to all its operations, including this project, and can be found in Annex 16. Terviva's global grievance redressal mechanism was developed over the past 10+ years of experience working directly with its partners, customers, and suppliers across a global operating footprint and adheres to best practices for grievance redressal. Terviva has been in direct contact throughout the project development and implementation process, responding directly to stakeholder feedback, challenges, and complaints. Feedback on specific issues and the process for addressing them from project stakeholders has been incorporated into the development of the grievance process. This grievance redress mechanism has been communicated to landowners, and the mechanism itself is continuously monitored for any grievances that may arise.
Grievance redress procedure	The Terviva Grievance Redressal Mechanism (Annex 16) , T-Samadhan, aligns with Section 3.18 of the VCS v4.7 by providing an accessible, inclusive, and transparent process for stakeholders to raise concerns related to the pongamia supply chain. The mechanism features multiple culturally appropriate grievance channels—including verbal submissions, SMS, social media, and community intermediaries—to ensure accessibility for all affected parties, especially marginalized groups. It follows a structured, time-bound process that includes investigation, stakeholder

	communication, resolution development, and action plan implementation, as illustrated in the process flow diagram on page 12 of the mechanism document. Importantly, Terviva commits to protecting complainants from retaliation and ensures confidentiality, impartiality, and timely redress (within 14 days of grievance logging), fulfilling the VCS requirements under Section 3.18.4. The mechanism also enables escalation through neutral mediation and legal recourse via recommended parties like the American Arbitration Association (AAA) or the United States Council for International Business (USCIB), satisfying the three-tier structure stipulated by Verra for effective dispute resolution.

Grievances received	**Resolution and outcome**
None. The grievance mechanism and communication channels have been continuously monitored, and no grievances have been received.	Not applicable

2.1.5 Public Comments

No comments were received during the 30-day public comment period.

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

Terviva and Cultivo have extensive management experience implementing agricultural and natural capital projects.

Terviva brings extensive experience engaging and working with agricultural stakeholders in Florida, having worked with them since 2012. Between 2012 and 2015, Terviva and its citrus partners planted ~50 hectares of commercial pongamia trials across Central Florida on former citrus fields to co-develop experience managing pongamia in Florida. Terviva employs staff that previously worked in the Florida citrus industry and provide specific expertise in agricultural management. In addition to Florida, Terviva operates agriculture projects in Hawai'i and Queensland, Australia.

In turn, Cultivo began originating natural capital projects in 2019 and now has the first of these nearing credit issuance. We have a pipeline of projects at various stages of development, including:

United States

- Montana Sustainable Grazing Project (ID 5129)
- Western US Sustainable Grazing Project

Mexico

- Nature Generator 1 - Northern Mexico Sustainable Grazing Carbon Capture Project (ID 2996)
- Nature Generator 2 & 3 - Coahuila Sustainable Grazing Project (ID 5130)
- Sustainable Forest Management of Communal Lands in Michoacan (CARC1918)

Uruguay

- Grasslands Regeneration through Holistic Management in Uruguay (ID 5289)

Namibia

- Regeneration of the Kunene Highlands Elephant Landscape (ID 5128)

India

- Community-based Agroforestry in Central & South India

2.2.2 Risk Assessment

Table 8. Risks to Stakeholders and the Environment

	Risks identified	Mitigation or preventative measure taken
Natural and human-induced risks to stakeholders' wellbeing	No risks identified	The project poses no natural or human-induced risks to the wellbeing of stakeholders.
Risks to stakeholder participation	Economic risk from adoption of a novel crop	10-year plus forward offtake agreements for all growers.
Working conditions	Minimal risk s related to potential injury during land preparation, harvesting, pruning, or other field-based agricultural activities.	Local and federal regulations on occupational health and safety are followed by landowners, their staff, and project proponents. Workplace health and safety trainings have been held over the years for harvesters, grove workers,

		and other relevant stakeholders to ensure they follow protocols to prevent and minimize identified risks.
Safety of women and girls	No risks identified	There are no safety risks associated with the project that are specific to women and girls.
Safety of minority and marginalized groups, including children	No risks identified	There are no safety risks associated with the project that are specific to minority and marginalized groups, including children
Pollutants (air, noise, discharges to water, generation of waste, release of hazardous materials)	Minimal risk from use of herbicides or chemical fertilizers.	All chemicals and/or hazardous materials used in project activities are used in accordance with federal and state laws regarding occupational health and safety, and environmental regulations. Chemical safety practices and procedures are in place and have been reviewed to ensure they adequately address identified risks. These practices include annual pesticide safety trainings as well as chemical inventory and storage protocols.
Potential Invasive Risk	Minimal risk	Compliance with Non-Native Species Planting Permits, among other management practices.

Although no specific environmental impact assessments have been carried out for this project, there is available research on the effects of pongamia around the world. Research summarized below demonstrates environmental benefits of pongamia for agroforestry use to restore degraded land and reduce the risk of abandoned citrus fields, its benefits in nitrogen fixation, and oil-rich seeds. This section also includes a research review of potential environmental impacts from pongamia as a non-native species in Florida.

Land restoration

Pongamia (Millettia pinnata) has multiple properties for agroforestry use to restore degraded land and biodiversity by improving soil quality, controlling erosion and increasing vegetation cover. It is a fast-growing leguminous tree that can grow to a height of 15-20 meters, live up to 100 years and thrive in a range of harsh environmental conditions (Leksono et.al, 2021; Scott et.al, 2008). It can survive temperatures ranging 5 to 50°C and elevations up to 1,200 m; it can grow in most soil types from stony through sandy to clay (Agus et.al., 2017; Leksono et.al, 2021). Studies have found pongamia to have potential for growing as a restoration species in highly degraded forest areas in India (Ramachandran and Radhapriya, 2016), on land which has been degraded due to mining operations in Indonesia (Agus et.al., 2017), and withstand drought stress or low water input as shown in a trial of pongamia plantation in Bali (Arpiwi et.al., 2018). These studies highlight the properties of pongamia to restore soil organic content, soil pH, and overall soil nutrients and soil health. Studies also show the advantages of pongamia growth over similar trees in height, stem diameter, as well as yields, resistance to disease and oil content of the seeds.

Another distinctive advantage of pongamia is that it is a nitrogen-fixing species, meaning that it can produce its own nitrogen. Nitrogen is one of the most important nutrients required by plants which control and enable their growth and reproduction (Calica, 2017). This characteristic reduces the cost of production and improves carbon efficiency.

Benefits of oil-rich seeds

Pongamia produces high yields of oil and protein-rich seeds, making it a source for food and biofuel production. Pongamia produces seeds which contain 40% oil which have historically been used for biofuel in many parts of the world (Scott et.al., 2008). Terviva's proprietary processes create pongamia oil that can be used as a cooking oil or in other formulated foods as well as high-protein flour and protein isolate. (Terviva, 2021). Pongamia oil has been calculated to be three times less carbon-intensive than soybean oil (Wylie et al, 2021).

Pongamia production yields increase as trees grow older and can range from 9 to more than 90 kg of seeds annually per adult tree (yields differ according to location), equivalent to a potential yield of between 900 kg and 9,000 kg per hectare (Leksono et al, 2021).

Revitalizing fallow land

Agricultural lands that have gone out of production are highly vulnerable to infestation by invasive plants, diseases and pests, as seen in Florida's fallow citrus fields. Limited private and public funding to manage these invasive species make fallow lands potential seed sources for invasive plants and breeding grounds for pests and diseases. Fallow or unused agricultural lands ultimately put nearby public and private lands at risk.

Environmental stewardship has gained recognition as a positive aspect of Florida's agricultural sector, as exemplified by the Agricultural-Environmental Leadership Award (FDACS, 2021) and This Farm CARES (This Farm CARES, 2021). Farmers have been shown to be active stewards of the environment by buffering against the spread of invasive species between urban and natural areas through their daily land management activities.

Maintaining farmland in profitable agriculture ensures landowners can effectively manage agricultural land as well as Florida's natural resources.

Working conditions

The risks from working conditions associated with project activities are minimal and typical for agricultural activities in Florida. Typical risks include potential physical injury from operating mechanical equipment or dehydration/heat stroke when working in hot and humid conditions. These risks are mitigated through proper safety training and ensuring safe operating practices, including reducing working hours in the hottest part of the day, taking rest breaks, and providing adequate water and shade. Worker safety is ensured through regular training, including annual WPS training on chemical safety, heavy equipment usage, and standard agricultural health and sanitation SOPs.

Pollutants

Minimal to moderate amounts of herbicides and chemical fertilizers are used in the cultivation of pongamia. Herbicides are necessary during tree establishment to suppress weed pressure from fast growing grasses. As trees grow larger, they shade out grasses reducing their growth and competition for water and nutrients. Fertilizers are necessary to encourage faster growth in early years and then are applied at a moderate rate to optimize annual crop yield.

Risk of pollution from chemical usage is managed through policies ensuring that a chemical inventory list is maintained, proper storage of chemicals is maintained according to product labels, including storage in dedicated facilities where necessary or required, disposal according to label directions and in accordance with local regulations, and chemical applications are done according to label requirements. Chemcial applications of pesticides are done only by workers who have completed WPS Pesticide Handler training.

Potential invasive risk

Available research was gathered to identify potential environmental impacts from pongamia as a non-native species in Florida. Although several predictive assessments have labeled pongamia as an invasive species, no empirical evidence of invasion risk was found in this review. Pongamia's native origins are uncertain, but research indicates a broad distribution from India, through central and south-eastern Asia, Indonesia and into northern Australia, in humid, tropical and subtropical areas, and in a wide range of soils (State of Queensland, 2016). It has been used for various purposes all around the world including indigenous medicine, biofuel and others. It was introduced to Florida in the 1960s as an ornamental tree and is currently recognized by the USDA as an "introduced" species in the state, native status L48[9] (USDA, 2021b). Currently, pongamia has not been listed by the IUCN in the Global Invasive Species Database (IUCN, 2021).

As a legume tree with biofuel and food production potential, several studies have been conducted to assess threats of human-assisted proliferation of pongamia. These studies have informed the environmental impact and the risk of invasiveness of pongamia in different locations in the world. Although predictive assessments have classified pongamia as an invasive risk due to its expansion beyond its native range and its biological characteristics, empirical studies in similar conditions for pongamia plantations in Hawaii have not been able to demonstrate these predictions. An invasive risk assessment conducted by the State of Queensland in 2016 stated that, although pongamia had been considered a 'weed' in Florida and other parts of the world, they were "unable to find evidence that pongamia has significant negative impacts as a weed anywhere in the world" (State of Queensland, 2016: 12). However, recommendations were drawn regarding preventing pongamia plantings to occur close to environmentally sensitive areas. Similarly, an observational study of seven pongamia sites in Oahu, Hawaii concluded that pongamia is not invasive or established outside of cultivation (Daehler, 2018). "Based on its current behavior in the field, pongamia is not invasive or established outside of cultivation" (Daehler, 2018 p.30).

As a non-native species, to prevent and minimize any risk of proliferation, management and monitoring measures are relevant when planting pongamia. Through a Monitoring Plan, environmental and social impacts will be monitored and evaluated for this project (refer to Section 5 on the monitoring of GHG emissions and reductions). Also, in addition to the compliance with all federal, state and local laws and regulations, landowners that have joined the Project have obtained a Non-Native Species Planting Permit, according to the Florida Administrative Code (F.A.C.). To comply with this permit, landowners must assert the following:

- A viable system to prevent plants and plant parts from spreading into ditches, natural waterways and any onsite drainage by maintaining a 20–25-foot buffer from site boundaries.
- Adequate measures to mitigate the spread of the permitted plant species from dispersal via seed such as eradicating any propagative material that occurs in buffer areas and natural areas.
- Adequate safeguarding measures are applied to the border of the planting to prevent plant spread.
- Containment procedure for cleaning equipment used onsite.
- Adequate measures for wildfire mitigation.

[9] Native Status L48 means the species is introduced in the lower 48 states of the US (USDA, 2021).

- Maintaining a surety bond for 150% to the cost eradicating the planting for the duration of the project.

Additionally, the Project has applied mitigation measures, such as properly cleaning equipment and vehicles that may carry pongamia seeds, properly covering harvesting bins and containers, and developing mitigation plans for any escaped seeds due to an inclement weather event to minimize any risk of uncontrolled spread of seedlings outside the Project Area.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

	Risks identified	Mitigation or preventative measure(s) taken
Discrimination	No risk identified	No discrimination has been reported, and protections against potential future cases involve the emphasis on providing a safe and trusting work environment for all involved in planting activities.
Sexual harassment	No risk identified	No sexual harassment has been reported, and protections against potential future cases involve the emphasis on providing a safe and trusting work environment for all involved in planting activities.
Equal pay for work	No risk identified	Equal employment opportunities and pay equity are provided with respect to gender and are core to Terviva and Cultivo's work.
Gender equity in labor and work	No risk identified	Gender equity is a core value of both Terviva and Cultivo. The project ensures that all employment practices support equitable participation regardless of gender.
Forced labor	No risk identified	This project does not and will not use forced labor in its operations.
Child labor	No risk identified	This project does not and will not use child labor in its operations.
Human trafficking	No risk identified	This project does not and will not use human trafficking in its operations.

2.3.2 Human Rights

The project recognizes, respects, and promotes the protection of the rights for all in line with all international human rights law. In relation to working conditions, the project aligns with the UN International Covenant on Economic, Social and Cultural Rights (1976), such as the right to work in just and favourable conditions. This commitment is codified in Terviva's Supplier Code of Conduct and its Human Rights Principles.

Risks identified	Mitigation or preventative measure(s) taken

No risk identified	The project area is private property, and therefore there are no risks related to the rights of IPs, LCs, or customary rights holders.

2.3.3 Indigenous Peoples and Cultural Heritage

Risks identified	Mitigation or preventative measure(s) taken
No risk identified	The project area is private property, and therefore there are no risks related to the rights of IPs, LCs, or customary rights holders.

2.3.4 Property Rights

Risks identified	Mitigation or preventative measure(s) taken
Rights to territories and resources	The primary stakeholders, the landowners, demonstrated legal tenure to the land through public records for deeded land. All project participants are owners of the land where project activities are occurring. There are no conflicting rights or unresolved conflicts regarding land tenure or property rights in the project area.
Rights to territories and resources	All land holding rights were reviewed prior to the signing of any legal agreements.

2.3.5 Benefit Sharing

No property rights are impacted by the project.

2.4 Ecosystem Health

	Risks identified	Mitigation or preventative measure taken
Impacts on biodiversity and ecosystems	No risk identified	Available research was gathered to identify potential environmental impacts from pongamia as a non-native species in Florida. Although several predictive assessments have labeled pongamia as an invasive species, no empirical evidence of invasion risk was found in this review.

		It was introduced to Florida in the 1960s as an ornamental tree and is currently recognized by the USDA as an "introduced" species in the state, native status L48 (USDA, 2021b). Currently, pongamia has not been listed by the IUCN in the Global Invasive Species Database (IUCN, 2021). As a non-native species, to prevent and minimize any risk of proliferation, management and monitoring measures are relevant when planting pongamia. Through a Monitoring Plan, environmental and social impacts will be monitored and evaluated for this project (refer to Section 5 on the monitoring of GHG emissions and reductions). Also, in addition to the compliance with all federal, state and local laws and regulations, landowners that have joined the Project have obtained a Non-Native Species Planting Permit, according to the Florida Administrative Code (F.A.C.).
Soil degradation and soil erosion	No risk identified	Pongamia (Millettia pinnata) has multiple properties for agroforestry use to restore degraded land and biodiversity by improving soil quality, controlling erosion and increasing vegetation cover. It is a fast-growing leguminous tree that can grow to a height of 15-20 meters, live up to 100 years and thrive in a range of harsh environmental conditions (Leksono et.al, 2021; Scott et.al, 2008). It can survive temperatures ranging 5 to 50°C and elevations up to 1,200 m; it can grow in most soil types from stony through sandy to clay (Agus et.al., 2017; Leksono et.al,

		2021). Studies have found pongamia to have potential for growing as a restoration species in highly degraded forest areas in India (Ramachandran and Radhapriya, 2016), on land which has been degraded due to mining operations in Indonesia (Agus et.al., 2017), and withstand drought stress or low water input as shown in a trial of pongamia plantation in Bali (Arpiwi et.al., 2018). These studies highlight the properties of pongamia to restore soil organic content, soil pH, and overall soil nutrients and soil health. Another distinctive advantage of pongamia is that it is a nitrogen-fixing species, meaning that it is capable of producing its own nitrogen. Nitrogen is one of the most important nutrients required by plants which control and enable their growth and reproduction (Calica, 2017). This characteristic reduces the cost of production and improves carbon efficiency.
Water consumption and stress	No risk identified	Pongamia can withstand drought stress or low water input (Arpiwi et.al., 2018). After tree establishment, irrigation is used seasonally and is 73% less than the incumbent land use of citrus cultivation.
Usage of fertilizers	No risk identified	Pongamia is a nitrogen-fixing species, meaning that it can produce its own nitrogen. Some fertilizer is applied to pongamia but it is significantly less (50+ %) than other land uses, such as citrus cultivation.

2.4.1 Rare, Threatened, and Endangered species

Is the project located in or adjacent to habitats for rare, threatened, or endangered species?

☐ Yes ☒ No

2.4.2 Introduction of species

The Project complies with Section 3.19.27 of the VCS Standard v4.7, as it does not introduce invasive species or allow an invasive species to thrive through project implementation. Pongamia (*Millettia pinnata*), formerly known as *Pongamia pinnata*, is a non-native species, permitted under the Florida Administrative Code (FAC). Landowners have obtained the Non-Native Species Planting Permit, according to the FAC. In compliance with regulations, the Project has applied environmental mitigation measures to prevent plants and plant parts from spreading, as explained further in Section 2.2.

Species introduced	Classification	Justification for use	Adverse effects and mitigations
Millettia pinnata	non-native monoculture	Pongamia is a highly productive legume tree that yields significantly more protein and oil-rich beans per acre than soybeans. Its natural resilience to harsh climates, including pest resistance, drought and salt tolerance, and nitrogen fixation, reduces the need for harmful agricultural inputs. Additionally, pongamia's dense network of lateral roots helps control soil erosion, making it an ideal crop for restoring degraded lands, storing carbon, and improving soil health.	Pongamia's non-native status in Florida necessitates careful management. The project employs a comprehensive monitoring plan and requires landowners to obtain a Non-Native Species Planting Permit. This permit mandates measures such as maintaining buffers, eradicating propagative material, safeguarding planting borders, and implementing equipment cleaning procedures. Furthermore, the project includes additional mitigation efforts like cleaning

			vehicles and harvesting equipment, covering containers, and developing plans for escaped seeds to minimize any adverse environmental impacts.

Existing invasive species	Mitigation measures to prevent spread or continued existence of invasive species
Brazilian Pepper (*Schinus terebinthifolius*)	All invasive plant species listed have a historical presence in agricultural areas in Florida. Their spread is prevented through mowing and targeted use of herbicides.
Camphor (*Cinnamomum camphora*)	
Tropical Soda Apple (*Solanum viarum* Dunal)	

	Risks identified	Mitigation or preventative measure(s) taken
Invasive species	Low risk of existing invasive species spread.	While invasive species are ubiquitous throughout Florida, agricultural management can mitigate the presence and spread of invasive species. In the project area, existing invasive species are managed through activities such as mowing and targeted use of herbicides.

2.4.3 Ecosystem conversion

No clearing of native ecosystems occurred within the project area as demonstrated in this map. This area was historically agricultural land and was actively in use as such within the last 10+ years.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

AR-AMS0007 *A/R Small-scale Methodology Afforestation and reforestation project activities implemented on lands other than wetlands*, version 3.1.

Table 9. Methodologies and tools applied to the Project

Type (methodology, tool or module)	Reference ID, if applicable	Title	Version
Methodology	AR-AMS0007	A/R Small-scale Methodology Afforestation and reforestation project activities implemented on lands other than wetlands	3.1
Methodological Tool	AR-TOOL16	Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities	1.1.0
Methodological Tool	AR-TOOL14	Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities	4.2
Methodological Tool	AR-TOOL12	Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities	3.1
Methodological Tool	AR-TOOL	Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities	1.0.1
Methodological Tool	AR-TOOL19	Demonstration of Eligibility of Lands for A/R CDM Project Activities	2.0
Methodological Tool	AR-TOOL15	Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity	2.0
Methodological Tool	AR-TOOL03	Calculation of the number of sample plots for measurements within A/R CDM project activities	02.1.0
Tool	VT0001	Tool for the Demonstration and Assessment of Additionality in VCS	3.0

		Agriculture, Forestry and Other Land Use (AFOLU) Project Activities	

3.2 Applicability of Methodology

The Project activity meets the applicability conditions of the AR-AMS0007 methodology and other relevant tools used by the project as outlined below.

Table 10. Methodology applicability conditions

Methodology ID	Applicability condition	Justification of compliance
AR-AMS0007	a) The land subject to the project activity does not fall in wetland category	According to the definitions for terms used in the VCS Program document, a wetland is a "land that is inundated or saturated by water for all or part of the year (e.g., peatland), at such frequency and duration that under natural conditions they support organisms adapted to poorly aerated and/or saturated soil…". The Project Area does not fall into this category. As described in Section 1.13, the Project Area is located in St Lucie, and Indian River counties, a commercial citrus production area in Florida. Current Project Area plots are characterized by cropland and grasslands formerly used for citrus production that turned to cattle grazing or land left fallow.
AR-AMS0007	b) Soil disturbance attributable to the project activity does not cover more than 10% of area in each of the following types of land, when these lands are included within the project boundary:	b) Management actions in the project scenario do not impact more than 10% of the project area. Immediately prior to planting, 30cm x 30cm x 30cm holes are dug by hand or using a hydraulically-driven auger. Trees are then planted by hand over the course of several days. Pongamia trees are planted at a density of no less than 100 trees per acre and no greater than 145 trees per plantable acre. Thus, soil disturbance in the Project Area will only cover a small fraction of the project area (0.13% of each hectare planted). Depending on the state of the land being used, a number of practical land preparation activities are required before pongamia can be planted but will cause

		minimal disturbance of the land. If the land only recently stopped growing citrus, stumps and dead trees may need to be removed. Citrus beds and water furrows may need to be regraded to accommodate low-clearance pongamia harvesting equipment.. Additionally, earth-moving equipment may be required to move any large rocks or boulders. If irrigation is being used, new lines need to be laid down for drip or micro-jet irrigation. In some cases, new irrigation infrastructure such as pumps and filters may need to be installed.
AR-AMS0007	i) Land containing organic soils	i) There are no organic soils in the project area (see subsection on soil data and Annex 11). The soils within the Project Area are predominantly Riviera Fine Sands and Pineda Sands — Aqualf soil types within the Alfisol soil order, with low organic matter and natural fertility content (USDA, 1980).
AR-AMS0007	ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 2 and 3 to this methodology	ii)The project area is not subject to any of the land management practices and application inputs as listed in Appendix 2. The baseline land use conditions are not long-term cultivated cropland with high manure inputs (the project area is classified by a warm, moist, temperature/moisture regime). Additionally, the baseline land use conditions are not short-term or set aside cropland with full or reduced tillage with high manure inputs nor no-till with high manure or high without manure inputs. Regarding Appendix 3, baseline grassland management is not improved or non-degraded, nor moderately degraded with high inputs. Therefore, the project is not subject to the baseline land management practices outlined in appendices 2 and 3 of the methodology.
AR-AMS0007	A project activity applying this methodology shall also comply with the	The project activity complies with the applicability conditions of the tools contained within the methodology as per this table.

	applicability conditions of the tools contained within the methodology and applied by the project activity.	
AR-TOOL16	(a) The areas of land to which this tool is applied: (i) Do not fall into wetland category; or (ii) Do not contain organic soils as defined in Annex A: glossary of the IPCC GPG LULUCF 2003; (iii) Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2.	The project activity complies with the applicability conditions of AR-TOOL16. See justifications provided above: i) The project area does not fall into the wetland category. ii) The project area does not contain organic soils. iii) The project area is not subject to any of the land management practices and application inputs as listed in Tables 1 and 2. The project falls within the tropical moist moisture/temperature regime. From Table 1 of the tool, the baseline land use conditions are not long-term cultivated cropland with high manure inputs. Additionally, the baseline land use conditions are not short-term or set aside cropland with full or reduced tillage with high manure inputs nor no-till with high manure or high without manure inputs. Instead, baseline cropland management can be defined as either (1) long-term cultivated with reduced tillage and medium inputs or (2) short-term cultivated or set aside with reduced tillage and medium inputs. Long-term cultivated land use areas were areas in citrus production for more than 20 consecutive years directly prior to the project start date. These areas were considered to have reduced tillage based on the fact that previous citrus crops represent permanent trees with limited tillage. Areas that were fallow before the start of the project activities (e.g. categorised as short-term cultivated or set-aside land use areas), where not undergoing any active management and therefore were not tilled. For both land use areas, medium inputs were selected since previous citrus

		crops did require fertilisers, however, there was no production of high residue yielding crops, no use of green manures, no cover crops, no improved vegetated fallows, limited irrigation, and no use of perennial grasses. Regarding Table 2 of the tool, baseline grassland management is not improved or non-degraded, nor moderately degraded with high inputs. Instead, baseline grassland management practices can be defined as moderately degraded grasslands with low/medium inputs. Grassland land use was considered where cattle grazing was the land use prior to the start of the project. These are considered moderately degraded grasslands since there was no active management of cattle. No fertilisers were applied to grasslands. Therefore, the project is not subject to any of the baseline land management practices outlined in Tables 1 and 2 of the tool. See Table 21, Table 22, and Table 23 for more information.
AR-TOOL16	(b) The A/R CDM project activity meets the following conditions: (i) Litter remains on site and is not removed in the A/R CDM project activity; and (ii) Soil disturbance attributable to the A/R CDM project activity, if any, is: • In accordance with appropriate soil conservation practices, e.g. follows the land contours. • Limited to soil disturbance for site preparation before planting and such	 i) Litter will remain on site. ii) Any soil disturbance will be in accordance with appropriate soil conservation practices and soil disturbance is limited to site preparation before planting.

	disturbance is not repeated in less than twenty years.	
AFOLU Non-Permanence Risk Tool V4.2	This tool has no internal applicability conditions.	The scope of this tool is AFOLU projects with GHG removals or avoided emissions through carbon sinks.
AR-TOOL14	This tool has no internal applicability conditions.	Not applicable
AR-TOOL12	This tool has no internal applicability conditions.	Not applicable
AR-TOOL17	This tool has no internal applicability conditions.	Not applicable
AR-TOOL19	This tool has no internal applicability conditions.	Not applicable
AR-TOOL15	The tool applies to all types of A/R CDM project activities and programmes of activities.	This tool applies to this project, which is restoring non-vegetative cover by planting pongamia trees.
AR-TOOL03	This tool has no internal applicability conditions.	Not applicable
VT0001	The tool is applicable under the following conditions: a) AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced; b) The use of this tool to determine additionality requires the baseline methodology to provide for a stepwise approach justifying the determination of the most plausible baseline scenario. Project proponent(s) proposing new baseline	All the applicability conditions are met for this tool. The AFOLU activities of this project will not lead to the violation of any laws, and this document outlines the most plausible baseline scenario.

	methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity.	

3.3 Project Boundary

The project is defined as the specification of GHG sources, sinks, and reservoirs associated with the project and baseline scenarios. In the case of this project, the project boundary is the same as the project location. Due to the estimated changes in practices derived from the Project activities and according to the AR-AMS0007 methodology, the following carbon pools and GHG sources are included in the baseline and project scenarios.

Table 11. Project Boundary - Carbon Pools

Source		Gas	Included?	Justification/Explanation
Baseline	Above-ground biomass	CO_2	Yes	The baseline scenario assumes that past citrus trees would decline and die due to citrus greening disease. Therefore, this carbon pool is conservatively assumed to be equal to zero for the life of the project. Any biomass not related to citrus is either non-existent or would remain in a steady state under the baseline cattle grazing scenario.
		CH_4	N/A	Not applicable to this carbon pool.
		N_2O	N/A	Not applicable to this carbon pool.
		Other	N/A	Not applicable to this carbon pool.
	Below-ground biomass	CO_2	Yes	The baseline scenario assumes that past citrus trees would decline and die due to citrus greening disease. Therefore, this carbon pool is conservatively assumed to be equal to zero for the life of the project. Any biomass not related to citrus is either non-existent or would remain in a steady state under the baseline cattle grazing scenario.
		CH_4	N/A	Not applicable to this carbon pool.
		N_2O	N/A	Not applicable to this carbon pool.

Source		Gas	Included?	Justification/Explanation
		Other	N/A	Not applicable to this carbon pool.
	Deadwood and litter	CO_2	No	This pool is optional under AR-AMS0007. Past practices for citrus orchards consisted of removing dead or decaying trees. For the baseline scenario of cattle grazing, it is assumed that deadwood and litter carbon pools would likely decline. Therefore, this pool is conservatively omitted in the baseline scenario.
		CH_4	N/A	Not applicable to this carbon pool.
		N_2O	N/A	Not applicable to this carbon pool.
		Other	N/A	Not applicable to this carbon pool.
	Soil organic carbon	CO_2	Yes	This pool is optional under AR-AMS0007. In the baseline scenario of cattle grazing, soil organic carbon stocks are expected to remain either at a steady state or decrease due to recurring soil disturbance from livestock. Thus, this pool is conservatively assumed to be equal to zero.
		CH_4	N/A	N/A
		N_2O	N/A	N/A
		Other	N/A	N/A
	Burning of woody biomass	CO_2	No	CO2 emissions due to burning of biomass are accounted as a change in carbon stock.
		CH_4	Yes	This pool is required under AR-AMS0007. While burning of woody biomass likely occurred as part of past citrus orchard practices, and could occur as part of the baseline practice of livestock grazing, this pool will conservatively be counted as 0 in the calculations.
		N_2O	Yes	This pool is required under AR-AMS0007. While burning of woody biomass likely occurred as part of past citrus orchard practices, and could occur as part of the baseline practice of livestock grazing, this pool will conservatively be counted as 0 in the calculations.
		Other	N/A	Not applicable to this carbon pool.

Source		Gas	Included?	Justification/Explanation
Project	Above-ground biomass	CO_2	Yes	This is the principal carbon pool subject to the project activity.
		CH_4	N/A	Not applicable to this carbon pool.
		N_2O	N/A	Not applicable to this carbon pool.
		Other	N/A	Not applicable to this carbon pool.
	Below-ground biomass	CO_2	Yes	Carbon stocks in this pool are expected to increase due to the implementation of the project activities.
		CH_4	N/A	Not applicable to this carbon pool.
		N_2O	N/A	Not applicable to this carbon pool.
		Other	N/A	Not applicable to this carbon pool.
	Deadwood and litter	CO_2	No	This pool is optional under AR-AMS0007. Therefore, this pool is omitted in the project scenario.
		CH_4	N/A	Not applicable to this carbon pool.
		N_2O	N/A	Not applicable to this carbon pool.
		Other	N/A	Not applicable to this carbon pool.
	Soil organic carbon	CO_2	Yes	This pool is optional under AR-AMS0007. However, this pool is expected to increase under the project activities.
		CH_4	N/A	N/A
		N_2O	N/A	N/A
		Other	N/A	N/A
	Burning of woody biomass	CO_2	No	CO2 emissions due to burning of biomass are accounted as a change in carbon stock.
		CH_4	Yes	This pool is required under AR-AMS0007. However, there will be no burning of biomass as part of project activities and it is counted as 0 in the calculations.
		N_2O	Yes	This pool is required under AR-AMS0007. However, there will be no burning of biomass as part of project activities and it is counted as 0 in the calculations
		Other	N/A	Not applicable to this carbon pool.

3.4 Baseline Scenario

According to the CDM AR-AMS0007 Methodology, the baseline scenario of a small-scale A/R CDM project activity implemented under this methodology is the continuation of the pre-project land use: former cropland with diseased citrus trees, pasture, or fallow land (see section 1.14 subsection Land Activity and section 3.6 for more details). Although the long-term historical land use of the entire project area is citrus cultivation, these three baseline scenarios reflect the land use in the year prior to project initiation.

3.5 Additionality

3.5.1 Regulatory Surplus

Is the project registered or seeking registration in an UNFCCC Annex 1 or Non-Annex 1 country?

☒ Annex 1 country ☐ Non-Annex 1 country

Are the project activities mandated by any law, statute, or other regulatory framework?

☐ Yes ☒ No

If the project is located inside a Non-Annex 1 country and the project activities are mandated by a law, statute, or other regulatory framework, are such laws, statutes, or regulatory frameworks systematically enforced?

☐ Yes ☐ No ☒ Not applicable

3.5.2 Additionality Methods

According to the VCS Standard v4.7, Section 3.14, the simplified procedure to prove additionality is only applicable in a developing country context. Since this project is taking place in Florida in the United States, the additionality demonstration is based on the approved VCS *Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities* version 3.0 that requires greater detail from available information.

Step 1. Identification of alternative land-use scenarios to the proposed VCS AFOLU project activity

a) **Sub-step 1a. Identify credible alternative land-use scenarios to the proposed AFOLU project activity.**

Based on the specific context of the Project Location and economic activities in the region and pre-project land-use, four alternative land use scenarios are proposed: i) citrus orchards ii) land used for cattle ranching iii) abandoned and fallow land and iv) agroforestry with pongamia performed without being registered as the A/R CDM project activity[10].

i) Citrus orchards

Lands within the Project Area have been used for citrus production for over two decades. Due to the increasing loss of citrus trees from HLB disease, growers have ceased citrus production and most land now lays fallow or has been converted to cattle grazing, though in some cases diseases citrus trees were left standing in the field. Additionally, citrus production remains common practice in the Project Location. The Project Area is located within the Indian River District, a commercial citrus production area in Florida. According to official data of the USDA's National Agricultural Statistics Service of citrus production in Florida in 2017-2018 (the year prior to the project start date), citrus production in Florida accounted for more than 40% of the country's production (USDA, 2019b).

ii) Lands used for cattle grazing

Past land activities in some areas within the project boundaries consisted of cattle grazing as an alternative to keep the land under production after the loss of citrus orchards to widespread disease. Cattle ranching is one of the most common agricultural activities in the region. In 2017, nearly half of Florida's agricultural land was involved in cattle production with half of all farms registering a cattle inventory (USDA, 2017c). Cattle production is considered a vital activity for the state's food security, so much so that Florida's Right to Farm Act, established in 1979, as well as the Rural and Family Lands Protection Act of December 2001, were designed to protect valuable agricultural lands and ranches to ensure sustainable land management practices and reasonable protection of the environment (FDACS, 2001).

iii) Abandoned and fallow land

Many citrus groves that have died or become economically unfeasible to maintain due to HLB are abandoned. Abandoned groves are a threat to the citrus industry in Florida because they are a source of the bacterium that causes HLB disease. St. Lucie County has the largest amount of abandoned citrus at 32,605 acres, followed by Indian River County which had the largest gain, bringing its total to 16,599 acres (USDA, 2016).

iv) Agroforestry of pongamia performed without being registered as the A/R CDM project activity.

The establishment of a pongamia agroforestry operation within the project boundary performed without being registered as the A/R CDM project activity is the least likely alternative land use scenario considered. As discussed in detail below (Step 3a, Investment and financial barriers), the

[10] Reforestation of natural forests without registration of the A/R CDM project activity was also considered as a fifth alternative land use scenario, but was deemed unfeasible.

upfront costs associated with establishing a pongamia plantation are prohibitive to small landowners with or without the ability to access Tree Assistance Program (TAP) funding. Additionally, the conversion of healthy citrus groves to pongamia plantations is financially unattractive and thus unlikely to occur. For example, when considering the costs and revenues associated with farming and offtake of raw materials, pongamia produces ~$519/acre of cash flow, or 15% less than a conservative estimate for healthy citrus.

Moreover, unlike traditional crops, pongamia also involves added market and technical barriers (discussed in detail below), including access to planting stock, agronomic knowledge, and market infrastructure, all of which are made viable through the support of the VCS AFOLU project. Therefore, the scenario of pongamia establishment with TAP funding but without the carbon project is not a financially or practically feasible alternative, nor is the scenario of pongamia replacing healthy citrus groves.

b) **Sub-step 1b. Consistency of credible alternative land-use scenarios with enforced mandatory applicable laws and regulations**

All four scenarios described above are consistent with enforced mandatory state and federal laws and regulations.

c) **Sub-step 1c. Selection of the baseline scenario.**

According to the CDM AR-AMS0007 Methodology, the baseline scenario of a small-scale A/R CDM project activity implemented under this methodology is the continuation of the pre-project land use: former cropland with diseased citrus trees, pasture, or fallow land. However, the most economically viable alternative land use without carbon finance is identified as pasture or cattle grazing.

Step 3. Barrier analysis

The barrier analysis is performed to identify barriers that a) Prevent the implementation of this type of proposed project activity without the revenue from the sale of GHG credits; and b) Do not prevent the implementation of at least one of the alternative land-use scenarios.

a) **Sub-step 3a. Identify barriers that would prevent the implementation of the type of proposed project activity**

i) Technological barriers

Significant technological barriers exist for the activity of establishing pongamia agroforestry operations (scenario iv). Farmers and landowners in Florida face many challenges as they seek to make their farms and forestlands profitable, productive, and environmentally sustainable. Current and emerging agroforestry practices in the Southeast states in the USA, together with an increase in policy directed towards agricultural sustainability and alternative production systems focus on increasing food security while maintaining sufficient yields in sustainable production systems (Workman et al 2014). Despite these initiatives, competition between crops, trees and animals as the greatest constraint to use of agroforestry, lack of information and lack of markets, the expense of additional management and lack of familiarity with the practices, lack of technical assistance, water scarcity and lack of demonstrations are recorded constraints that prevent uptake (Workman et al 2014).

Specialty crops are considered high-risk, high reward, as growers face differing and larger risk exposure when compared to traditional row crops. The type of crops that can be grown in Florida are limited due to the climate and soil. This together with technology (including the efficiency of that technology), training to ensure proper field use of equipment, ability and capacity for on-farm storage/processing, produce form (fresh vs. frozen), timing and geography of harvest, etc., play interrelated roles in impacting the economic profitability of specialty crop growers (Neil and Morgan, 2021).

Pongamia is considered novel in the agroforestry sector. There is limited information around modern pongamia cultivation, long-term orchard management, and various other added-value plantation options that the Project activities entail. Pongamia has very limited use in the United States and there is limited evidence of pongamia supply chains and markets existing outside of the ones Terviva has created. Overall, there is no evidence that landowners would be able to access the knowledge, technical experience, plant genetics and cultivation expertise in pongamia elsewhere.

Therefore, the successful establishment of pongamia agroforestry systems faces significant technological barriers, particularly regarding access to planting materials and, specifically, pongamia cultivars. Terviva has developed proprietary pongamia cultivars through more than a decade of targeted research and development. These cultivars have been selectively bred and clonally propagated to ensure uniformity in performance, superior yields, and resilience under commercial-scale production. In contrast, generic pongamia seed sources exhibit wide genetic variability, resulting in suboptimal yields that undermine the economic viability of standalone pongamia agroforestry systems. Terviva's high-performing cultivars are protected under intellectual property rights, with 25 patent applications filed globally and five granted specifically for unique pongamia cultivars. Access to these cultivars is made possible only through participation in the project. Without access to Terviva's proprietary planting material, independent landowners would be unable to establish commercially feasible pongamia operations. A summary of Terviva's relevant patents is provided as evidence to demonstrate the proprietary nature of this enabling technology.

Direct collaboration with Terviva through the project helps landowners overcome these technological barriers by providing the necessary cultivars, along with technical expertise and access to adapted machinery. Terviva partners with growers to develop and refine best management practices to promote growth and high yields. The economic viability of the project is also reliant on harvesting using adapted mechanical harvesting equipment from the tree nut industry (almonds, pistachios, pecans). Terviva provides technical support and partners with growers and equipment manufacturers to adapt and develop existing nut harvesting machinery for pongamia and for Florida soils (i.e. sandy, bermed soils). Without the development of this harvesting technology, growers would be required to use hand labor which would be far less efficient and more expensive.

ii) Prevailing practices

Significant barriers due to prevailing practices exist for the activity of establishing pongamia agroforestry operations (scenario iv). Agricultural activities (including citrus production) and the cattle industry have persisted in North and Central Florida for over 100 years (Volk et al, 2017). Currently, citrus production in Florida accounts for more than 40% of the country's production (USDA, 2019b). Specifically, the lands under the Project Area have been under citrus production for over 20 years. Sustainable agroforestry practices as well as the adoption of a new crop represent a substantial change in the ways of working of owners who are familiar and specialized with the common practices of citrus production in the region.

Specialty crops that can be grown in Florida tend to have small and relatively mature markets that don't allow farmers to reach the same scale of operations that they once did with citrus. In Florida, the market for citrus produce is one of the biggest in the country. Considering Florida as one of the largest state producers of citrus in the US with over 80 thousand jobs (National Research Council, 2010), and that citrus fruit ranks first internationally in trade value among all fruits (ibid), the citrus markets remain one of the largest in the region. Entering new unknown crop markets represents a very high risk for farmers.

iii) Ecological barriers

The largest barrier for landowners to continue growing citrus trees (scenario i) is the ecological conditions that allow for the spread of HLB disease, which results in increasing costs, and the decline of citrus production. Citrus production has suffered under the stresses brought on by these changing ecological and climatic conditions, thus jeopardizing its long-term future.

Florida's citrus production has declined around 80% from 2003-2004 to 2017-2018 (USDA, 2019a). This decline is mainly due to three factors: first, many trees and groves were culled in an effort by the State to eradicate citrus canker (*Xanthomonas axonopodis* pv. *citri*), followed by catastrophic hurricanes in 2004, 2005, and 2017, and by the devastating citrus greening disease or huanglongbing (HLB) (Ferrarezi et al., 2019).

Official data shows a constant decrease of yearly citrus production from almost 14 million tons in 1999-2000 to around 2 million tons in 2017-2018 (USDA, 2019a). While the economic data for the state's 2018-2019 citrus season improved from the prior season that was impacted by Hurricane Irma in 2017, the improvement lagged behind expectations. The state's citrus acreage has declined 4% since 2018 to 430,601 acres, according to the Commercial Citrus Inventory by the U.S. Department of Agriculture (2019a). This is the lowest total yearly acreage dedicated to citrus production since the USDA began the current inventory in 1966 (ibid). This trend has occurred across the whole state: the 2021/22 season is expected to reach a record low harvest and California's orange harvest is expected to be larger than Florida's for the first time ever (Buccholz, 2022).

Citrus greening or HLB is the most serious and devastating disease affecting citrus (FAO, 2013). The estimated damage of the disease from 2015 to 2020 amounts to over $1 billion per year, with nearly 5,000 jobs lost annually (Li et al, 2020). This has led growers to change and intensify their management practices, with a very high economic impact to production costs (ibid). The citrus greening disease impacts the health of citrus trees, as well as the quantity and quality of yields, and eventually kills trees. Trees affected by HLB can become unproductive in the first five years and their lifespan can be reduced significantly to only 7–10 years (ibid). Growers have turned to practices to prevent and control the spread and effect of citrus greening that include the increased use of pesticides, insecticides, fertilizers, as well as continuous monitoring and testing for the spread of the disease.

b) **Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternative land-use scenarios (except the proposed project activity):**

None of the identified barriers would prevent landowners continuing to operate pasture and cattle ranching activities. Additionally, none of the identified barriers prevent the continuation of fallow land.

The cattle grazing scenario assumes annual revenue of approximately USD $35/acre (obtained from similar rental rates in the region), from leasing the land for cattle grazing purposes. This alternative land-use scenario does not entail significant upfront costs from the landowner, relative to other land-use scenarios (specifically afforestation and reforestation), and operational costs are considered minimal. For example, establishing pastures requires a relatively low capital investment, ranging from $150-$424 per acre (Harrison et. al., 2018; Justesen, 2020)

The identified barriers in the previous sub-step of this analysis, such as climate threats, together with implementation constraints, have pushed landowners to convert their land to other land-use activities such as pasture or ranching activities (Humphries, 2019; Workman et. al., 2014). Some landowners have also left their land fallow, which has no upfront costs but also produces no income.

c) Sub-step 3c. Conclusion of barrier analysis

As a result of the barrier analysis, scenario ii - Cattle grazing and fallow land are identified as the land-use scenarios not prevented by barriers, while only cattle grazing presents an accessible alternative revenue stream for landowners.

Step 4. Common Practice Analysis

The project activities consist of a series of sustainable agroforestry practices that are not common practice within the Project Location, located in a commercial citrus production area in Florida. This section explains the essential distinctions between common agroforestry practices in the region and the project activity.

a) Similar activities in the geographical area of the proposed VCS AFOLU project.

Agroforestry practices are common in the Project Location and Project Area. However, as mentioned in sub-step 3a, the adoption of pongamia as a new permanent crop for farmers represents a shift away from common intensive practices while improving yields. Citrus production practices in the region have increased their use of pesticide- and fertilizer-intensive farming practices to combat environmental and market pressures. Project activities for pongamia cultivation differ significantly from these.

b) Essential distinctions between common agroforestry practices and project activities.

Pongamia can thrive in a range of harsh environmental conditions: it can grow in a variety of soil types, withstand drought stress, grow on saline soils and needs little topsoil. It is also tolerant of soil sodicity, pH imbalances, high temperatures, heavy metal contamination, and poorly drained soils. Due to these properties, pongamia requires a moderate amount of maintenance, low use of chemicals, and reduced water input (Leksono et al, 2021). Nodulation and nitrogen fixation are also characteristic of pongamia trees. Biological Nitrogen Fixation (BNF) offers an economic and ecological significance by reducing the use of external nitrogen, such as fertilizers with high nitrogen content (Calica, 2017). Main distinctions to common agroforestry practices in the region are mentioned below.

c) Reduction of pesticides

The use of pesticides is widespread in citrus production for pre- and post-harvest protection and chemical substances are often applied to control undesirable molds or insects. In the Florida region specifically, Huanglongbing (HLB or Citrus Greening) (USDA, 2021c) has required farmers to intensify common practices of high-pesticide use in order to avoid the spread of the disease. In Florida, 90% of citrus acreage is affected by greening, requiring the use of pesticides such as Glyphosate, paraquat, atrazine, and FOS as a part of agricultural management to control the spread of nematodes. Without intense practices and human intervention, citrus trees are likely to die and have a negative environmental impact on the region (Dala-Paula et al., 2019).

Based on the USDA chemical use survey (USDA, 2019e), the average use of chemicals for orange groves, including fungicide, herbicide, insecticide and other in 2019 was 1.85, 2.68, 3.79, and 6.31 lbs per acre per year, respectively. By assuming a mix of all chemicals is used for the production of citrus, the total use equals 14.63 lbs/acre/year (16.40 kg/ha/year). Project activities therefore represent a reduction of around 67% in total chemical use for the first three years and a complete elimination of pesticides from year 4 onwards.

d) Reduction of fertilizer use

Fertilizer use is considered common practice in the region. The 2017 Census of Agriculture in the US reported that the percentage of acres treated with commercial fertilizer, lime, and soil conditioners in St Lucie County was between 70% and 79% (USDA, 2019b), whereas in Florida the adoption rate is 85% in cropland areas (ibid).

Fertilizer use is an important component of citrus production and is considered common practice in the region to maintain tree productivity. Fertilizer programs and methods of delivery determine citrus tree growth, health, fruit production, and fruit quality (Boman et al., 2021). Additionally, in the past decade farmers have adopted more intense management practices such as high fertilizer use to grow and maintain citrus due to HLB. The nutrient uptake efficiency of trees that are affected by greening is lower than that of healthy trees, so larger and more frequent doses of fertilizer are needed to grow and maintain the trees (Ferrarezi et al., 2021).

Studies of the relationship between nutrient uptake, tree growth, and yield production rates of citrus trees in central Florida have shown that minimum Nitrogen (N) rates required to reach optimal canopy volumes range from 182, 198 and 199 kg ha^{-1} for fertigation (30 times annually), control release fertilizer and fertigation (4 times annually), respectively (Kadyampakeni et.al, 2015). Other research suggests that a common rule between citrus growers in the past decades has been 0.4 lb (0.18 kg) of N 200 lb/acre (224 kg·ha–1) of N fertilizer annually, split into three applications (Litvany and Ozores-Hampton, 2002). Project activities result in lower fertilizer use by at least 76% for years one and two, 67% in years three and four, and 64% in years five onwards.

e) Reduction of water use

Pongamia's resilience to drought and a variety of harsh climate conditions make it a suitable crop for reduced or no irrigation. Plantings of pongamia in hot, dry areas, with different soil conditions and water availability, showed high survivability (Leksono et.al., 2021). This represents a positive opportunity to reforest degraded lands as well as a change of water management in the Project Area, which is not considered common practice in the region.

Irrigation is an important component of citrus management and is common practice in the region. Citrus are subtropical plants and their optimal growth conditions are warm temperatures and high humidity. Citrus roots are shallow and are unable to mine deeper layers of soil, and thus irrigation is a critical component of citrus management. Due to low rainfall levels from February to May, additional irrigation is necessary to reduce the negative effects of water stress and promote growth. Citrus greening has led to the increased frequency of irrigation, because water stress can negatively affect tree growth and crop production, and make trees more susceptible to infection (Ferrarezi et al., 2021b).

The implementation of project activities will impact water use significantly. The water needs for a citrus grove with 140 trees per acre are between 14 and 39 gallons per tree per day for the winter and summer months, respectively (Parsons and Morgan, 2017). For pongamia, irrigation is typically not needed in the winter months (except for frost protection). Therefore, the water use for pongamia plantations represents a reduction of 100% for winter months, and about 73% annually.

f) Cover crops

Cover crops are only included on a small portion of cropland in both the US and the region. According to the USDA, cover crops were used on just 1.7% of total farmland (USDA, 2019b). In Eastern Florida, specifically in the Indian River District, an adoption rate of cover crops is less than 5% of the total cropland acres (USDA, 2017a). While adoption of cover crops has increased for annual crops, there is less research on their impact on soil health and root growth for perennial crops such as citrus. The possibility of cover crops competing with citrus for nutrients or soil moisture has also not been well-examined and has possibly contributed to the low adoption rates of cover crops in the region (Strauss et al., 2019).

Project activity includes cover crops such as grass and weeds, or Millet and Bermuda or Bahia grass, to grow in between the tree rows.

g) Change in circumstances

One of the main essential distinctions between similar activities in the region and the project activities is the presence of Terviva and the Project Proponents in the region. Driven by a desire to combat climate change while helping farmers, Terviva aims to produce low-carbon-intensity food products from pongamia (Terviva, 2021). Carbon finance has allowed Terviva to reach this objective by being able to couple a new financial vehicle with trusted technical support to invest and partner with landowners in transitioning to sustainable agroforestry practices in their farms.

Terviva breaks the knowledge and technological barrier to access pongamia crops and sustainable agroforestry practices due to its decade-plus of agricultural technology and experience in the production of pongamia trees and pongamia production. The company provides patented high-yielding trees to growers and offers proprietary bean processing to create sustainable food ingredients. They are dedicated to training and supporting growers in adopting sustainable agroforestry practices and providing access to a new market through the purchase of pongamia produce.

3.6 Methodology Deviations

We request a methodology deviation regarding A/R Tool 14, section 5, "Conditions under which carbon stock and change in carbon stock may be estimated as zero". We assert that the carbon stock in trees and change in carbon stock in trees in the baseline scenario should be accounted for as zero, and that the conditions listed do not accurately reflect the specific baseline scenario of this project.

The removal of citrus trees prior to the implementation of the project was not incentivized by carbon finance. Instead, it was a direct response to the economic and agronomic devastation wrought by citrus greening disease (Huanglongbing or HLB). The project's baseline scenario reasonably assumes that, in the absence of the carbon project, citrus trees would have been cleared due to disease, and the land would be mostly likely converted to pasture rather than replanted with citrus or other tree crops.

Citrus greening, caused by the bacterium Candidatus Liberibacter asiaticus and transmitted by the Asian citrus psyllid, has devastated Florida's citrus industry since its discovery in 2005. By 2016, an average of 90% of citrus acreage and 80% of trees were infected, leading to an average yield loss of 41% and a drop in orange production from 242 million boxes in 2004 to 104.6 million in 2014 (Singerman and Useche 2016). This systemic disease has no known cure, and best management practices recommend the removal of symptomatic and dead trees to reduce inoculum and prevent further transmission (Dewdney et al. 2024). Other mitigation practices like pruning, antibiotics, and insecticides have proven either ineffective or economically burdensome, with one study concluding that such interventions offer neutral to negative returns on farm profitability (Li et al. 2020). Consequently, the removal of infected trees is the only economically viable long-term strategy.

In all five cases within the project area, citrus production had ceased prior to project implementation due to these pressures. Within the project area, the presence of citrus greening is evidenced by two or more of the following:

1. Tree Assistance Program (TAP) documentation, which pre-dates pongamia planting, and which is only awarded to qualifying orchardists and nursery tree growers for the replanting

or rehabilitation of eligible trees, bushes, and vines damaged by natural disasters, in this case, disease infection.[11]

2. Satellite imagery showing the decline and removal of citrus orchards prior to the planting of Pongamia.
3. Written attestation from landowners confirming that their crops were infected with citrus greening.
4. Receipts for infrastructure associated with non-citrus cultivation (e.g., fencing), indicating that citrus production was no longer viable.

This body of evidence shows that the clearing of citrus trees was a necessary response to disease, not a decision influenced by carbon incentives. Along with this evidence, we also demonstrate that transitioning from a healthy, non-infected citrus orchard to a pongamia agroforesty operation is not financially attractive and therefore extremely unlikely to occur. In this scenario, landowners wouldn't be eligible for Tree Assistance Program (TAP) funding, and would be responsible for all upfront costs associated with establishing a pongamia orchards. Along with upfront costs, an analysis of farmgate economics (i.e. only considering costs/revenues associated with farming and offtake of raw materials) shows that a healthy citrus orchard in Indian River and St. Lucie counties would be more economically attractive than pongamia. Data from the University of Florida and USDA indicate that typical grapefruit cultivation costs are $2,479 per acre and average mature (Year 6+) yields are ~195 boxes per acre[12]. Using the 5-year historical average price of grapefruit ($15.84/box) and these yields and costs, the average cash flow per acre of an acre of healthy grapefruit is $610/acre[13]. The yield estimate of 195 boxes/acre is a conservative estimate. A 25% increase in yield–which would be reasonable for a healthy, productive orchard–results in a net annual cash flow of $1,481 per acre. Pongamia provides less cash flow to growers. Using Terviva's internal estimates of caretaking costs ($981/acre), offtake price ($500/metric ton), and yield (3 met. ton/acre), pongamia produces ~$519/acre of cash flow, or 15% less than a conservative estimate for healthy citrus. Therefore, there is no logical incentive for landowners to remove healthy, mature, citrus trees and replace them with pogamia seedlings. We can therefore attribute the large-scale removal of citrus trees in the project area to infection by citrus greening, not to the project activities.

Additionally, replanting of trees after citrus tree removal—whether citrus or other crops—would not have occurred due to severe industry decline and high financial barriers. Between 2003–04 and 2021–22, Florida's citrus-bearing acreage declined from 679,000 to 340,200 acres (Singerman, 2023). Orange production dropped by over 50% from 2004 to 2014, and average

[11] https://www.fsa.usda.gov/resources/disaster-assistance-program/tree-assistance-program

[12] https://edis.ifas.ufl.edu/publication/FE984

[13] https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Statistics/2022-23/FCS2023.pdf

grapefruit yields fell from 490 to 136 boxes per acre from 2003 to 2023 (Singerman 2023). Between 2013 and 2023, St. Lucie and Indian River counties, where the project is located, experienced citrus production declines of 75.3% and 89.4%, respectively (USDA NASS 2014, 2024). These declines rendered citrus cultivation unprofitable, forcing many growers out of the industry. This is further evidenced by Alico, Inc., one of Florida's largest citrus producers, announcing that it would “wind down” all citrus production, shifting instead to land management (Zimmerman, 2025).

Evidence from the growers participating in the project further support the claim that citrus tree planting would not occur in the absence of the project. Documentation in the Previous Land Use Documentation folder includes records of fencing purchases and installation to facilitate livestock grazing, media interviews with landowners discussing citrus divestment, sales of other infected citrus groves for dispersed water management, and land appraisals revealing degraded, unproductive citrus land that couldn't cover production costs. These factors, combined with economic pressures such as significant yield declines and increased production costs, make replanting citrus an economically unviable option and demonstrate an industry exit from citrus at the project level which mirrors the state and county-wide trends.

Other orchard crops also proved unviable, with urbanization and land competition applying significant pressure to develop unproductive agricultural land use. Florida gained 3.4 million residents from 2010 to 2022, with around 1,100 people moving to the state daily(Singerman 2023). Urban sprawl and solar energy developments have increasingly replaced citrus groves (Singerman 2023).

Financial barriers are also significant. Establishing new orchards is capital-intensive: pongamia costs $4,618 per acre, peach $6,457, and citrus $9,708 (Terviva's internal data; Singerman et al. 2021; IFAS 2021). Even with TAP support—which covers up to 65% of replanting and 50% of rehabilitation—growers face steep out-of-pocket costs. For a hypothetical 179-acre property, pongamia, one of the cheaper tree crops to establish, would require over $289,000 in upfront investment after TAP reimbursement, not including maintenance. TAP also does not cover lost income or annual operational costs, which are estimated at $800–$1,000 per acre for pongamia, and these expenses are likely even higher for other orchard crops requiring more agricultural inputs.

Given these factors, pastureland for cattle grazing is the most likely alternative land use. It is common (nearly half of Florida's agricultural land in 2017 was for cattle) and significantly less expensive to establish—between $150–$424 per acre (Harrison et al. 2018; Justesen 2020). This makes pasture a much more accessible and economically viable option than orchard replanting.

The removal of citrus trees in the project was an unavoidable consequence of an economically devastating and incurable disease. This action was neither triggered nor incentivized by carbon finance but aligned with best management practices. Due to ongoing citrus industry decline, high costs of establishing orchards, and increasing development pressure, replanting citrus or other tree crops is not a feasible scenario. Consequently, the removal of citrus trees should not be treated as land-preparation for pongamia, but rather as a baseline activity. While not addressed in the conditions listed in A/R Tool 14 section 5, we contend that it is more accurate to account for the carbon stocks of citrus trees as zero. Please refer to section 1.14 Conditions Prior to Project Initiation subsection “land activity” for more information.

4 Implementation Status

4.1 Implementation Status of the Project Activity

During the monitoring period 2018-2024, trees were planted across 502.8 hectares with five different landowners. Project activities across all sites consisted of land preparation, tree planting, and caretaking including the use of some fertilisers and pesticide use and irrigation. Two extreme weather events occurred, resulting in tree loss and the subsequent replanting of trees as described below. No changes to project proponents or other entities occurred.

Tree loss due to extreme weather events

Data on trees lost due to extreme weather events was collected through survey responses from landowners and verified by the Tree Operations Coordinator. In summary, two low-temperature events occurred within the first monitoring period 2018-2024. The dates of these events were February 1 to 7, 2021 and February 14 to 20, 2022. The number of trees lost corresponds to roughly 200 ha considering current planting density. These events consisted of slight breezes at times, but mostly radiational freezes, that caused low temperatures of around 28°F (-2°C) for approximately eight hours in several areas. The two counties within the Geographical Area of the project were impacted by the freezes.

These freezes were different from most historical freeze events in the South Florida region. Note that average temperatures are reported for 6 feet elevation, and temperatures can be 1-3°F colder at ground level. Furthermore, internal tree tissue temperature can be 4°F colder than air temperature. It is not only geographical areas and microclimates that matter; variations in soils within the same block or even tree row can have a profound influence on freeze susceptibility by changing the internal physiological status of the tree.

Table 12. Number of trees lost per stratum and year of loss event

Year of Loss	2018	2019	2020	2021	2022	2023	2024	Grand Total
Vintage (year planted)								
2018	0	0	0	691	0	0	0	691
2019	0	0	0	8,389	443	0	0	8,832
2020	0	0	0	32,766	476	0	0	33,242
2021	0	0	0	141	7,353	0	0	7,494
2022	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**41,987**	**8,272**			**50,259**

The loss of carbon stocks (Annex 10) is estimated for aboveground and belowground biomass through a tree-by-tree inventory of mortality. The standing age of trees is used to proxy DBH at the time of the loss event. DBH is modelled using a logarithmic equation based on measurements of pongamia trees in Florida covering a range of ages from 4 to 49-year-old trees (Eaton and McFarland, 2019, Annex 12). The DBH is then calculated per stand age from 0- to 20-year-old trees. The modelled DBH is input into the Chave *et al.* 2005 allometric equation to determine the above ground biomass of deceased trees, and ultimately, the total carbon losses.

$C_{TREE_{Loss}} = \sum \quad C_{TREE_{Loss}i,t}$; tCO2e

$C_{TREE_{Loss},i,t} = B_{TREE_{Loss},i,t} * 44/12 * 0.47$; tCO2e

$B_{TREE_{Loss},i,t} = AGB_{TREE_{Loss},i,t} * R_j$

Where:

$C_{TREE_{Loss}}$ = Total loss of carbon stocks in monitoring period; tCO_2e

$C_{TREE_{Loss}i,t}$ = Total loss of carbon stocks of stratum *i* in year *t*; tCO_2e

$B_{TREE_{Loss},i,t}$ = Loss stocks of tree biomass of stratum *i* in year *t*; tCO_2e

$AGB_{TREE_{Loss},i,t}$ = Loss stocks of aboveground biomass of stratum *i* in year *t*; tCO_2e

$44/12$ = Biomass carbon is converted to CO_2 using 44/12, the molecular weight ratio of CO_2/C.

0.47 = Dry biomass estimates were converted to carbon using the default carbon fraction of 0.47 t C/t dry matter

R_j = The value of R_j is estimated as $R_j = e\,(-1.085 + 0.9256 \times ln\,(b)) \div (b)$, where *b* is the above-ground tree biomass per hectare (in t d.m. ha-1)

$AGB_{TREE_{Loss},i,t} = p * [exp(-0.667 + 1.784In(dbh_t) + 0.207In(dbh_t)^2 - 0.0281In(dbh_t)^3] * N_{TREE_{Loss,i,t}} * 1000$; kg/tree

Where:

$AGB_{TREE_{Loss},i,t}$ = Loss stocks of aboveground biomass of stratum *i* in year *t*; tCO_2e

p = 0.595; Wood specific gravity of pongamia trees obtained from *Zanne et al.* (2009); g/cm[3]

dbh_t = Diameter at breast height at year t; cm

$N_{TREE_{Loss},i,t}$ = Number of trees that suffered mortality of stratum *i* in year *t*

$1/1000$ = Conversion from kg of C to tons of C

In summary, both loss events impacted less than 4% of total carbon stocks for the Monitoring Period 2018-2024. Since there was not a cumulative loss of more than five percent of previously verified emission reductions and removals, no loss event occurred. Furthermore, the net GHG benefit of the project is positive and no reversals have occurred.

Table 13. Summary loss of carbon stocks

Stratum (planting year)	Carbon loss in year 3 (2020) (tCO_2eq)	Carbon loss in year 4 (2021) (tCO_2eq)	Total carbon loss (tCO_2eq)
2018	35.93	0.00	35.93
2019	101.16	23.04	124.2
2020	0.00	5.74	5.74
2021	0.00	0.00	0.00
2022	0.00	0.00	0.00
2023	0.00	0.00	0.00
Total	**137.09**	**28.78**	**165.87**

Remediation measures

Project Proponents and landowners have taken immediate action to compensate for the losses by replanting trees since the loss events. Orchard economics necessitate that dead trees are promptly re-set. Fields are monitored in accordance to tree age:

- **Planting (0 - 90 days)**: New plantings are observed for mortality throughout the first 90 days post-planting. Non-viable trees are mapped, the cultivars are tallied, and replacement trees are ordered from the nursery. Resets are similarly monitored for 90 days following planting.
- **Establishment (Yrs 1-3):** Pongamia requires tree training (pruning, staking, tying) for its first three years to create strong scaffolding branches and canopy structure. Skilled hand crews visit each block 3-4 times annually, throughout the spring, summer and fall, to perform tasks at each tree. These crews monitor each block for mortality. During winter months each block is mapped for nonviable trees, which are re-set in the spring.
- **Bearing (Yrs 4-30)**: Trees are observed twice annually: at flowering and pod set (to assess potential yield and calculate a crop estimate) and at harvest (to assess performance and field economics). Orchards are evaluated for mortality during each

observation period. All blocks are mapped, and nonviable trees are marked to be re-set in the early spring.

Actions also include strengthening landowners' prevention measures such as the use of irrigation to increase the level of heat around plant tissues and prevent large-scale die-off. The tree replanting plan is defined below:

Table 14. Remediation plan

Total tree losses 2021	Total tree losses 2022	Trees replanted 2021	Trees replanted 2022	Trees replanted 2023
41,987	8,272	27,854	4,762	11,065

5 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

According to the AR-AMS0007 methodology, the baseline net GHG removals by sinks are calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$$

Where:

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks in year *t*; tCO_2e

$\Delta C_{TREE\_BSL,t}$ = Change in carbon stock in baseline tree biomass within the project boundary in year *t*; tCO_2e

$\Delta C_{SHRUB\_BSL,t}$ =Change in carbon stock in baseline shrub biomass within the project boundary in year *t*; tCO_2e

$\Delta C_{DW\_BSL,t}$ = Change in carbon stock in baseline deadwood biomass within the project boundary in year *t*; tCO_2e

$\Delta C_{LI\_BSL,t}$ = Change in carbon stock in baseline litter biomass within the project boundary in year *t*; tCO_2e

For the three baseline scenarios identified (disease and dying citrus, cattle grazing, and fallow land) zero carbon stocks can be assumed at baseline because the removal of pre-project trees was a direct, unavoidable consequence of citrus greening disease (HLB), not an action incentivized by carbon finance. HLB has devastated Florida's citrus industry, leading to widespread infection, significant yield losses, and unprofitability, making tree removal the only economically viable long-term strategy. Furthermore, changes in carbon stocks in trees in the baseline may be accounted as zero because replanting citrus or other tree crops would not have occurred in the baseline, as evidenced by severe industry decline, high financial barriers for new orchards, and increasing pressure from urbanization and land competition. Instead, cattle grazing is the most plausible without-project counterfactual scenario (as detailed in Section 3.5.2). See section Methodology Deviation for more information.

In regards to Tool 14 (v4.2), carbon stock in trees in the baseline can be accounted as zero and changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero if the following conditions are met:

(a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity;

While some tree removal did occur during the crediting period of the project activity, it was solely due to infection with citrus greening disease (HLB) and was not incentivized by project activities. All project areas had ceased citrus production prior to project implementation due to the incurable nature and economic devastation of HLB. Best management practices for HLB recommend removing symptomatic and dead trees to prevent disease spread. Therefore, any remaining citrus trees would have naturally declined and been removed in the baseline scenario, independent of the carbon project. For this reason, we have requested a methodology deviation.

(b) The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;

Pre-project trees were already dying or dead due to HBL, or were removed for disease management, before competition from pongamia trees could be a factor. The baseline scenario defines these areas as containing "infected dead or dying citrus trees destined to be removed." Therefore, any damage or mortality suffered by pre-project trees is attributable to the disease, not to project activities or competition from newly planted pongamia.

(c) The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

The pre-project trees were all removed due to citrus greening disease, following best management practices. Therefore, monitoring their continued existence is not possible nor applicable to this project.

Therefore, in all three baseline scenarios, tree biomass will decline as any remaining citrus trees die and are removed, thus aboveground and belowground biomass carbon pools are conservatively assumed to be equal to zero ($\Delta C_{TREE\_BSL,t} = 0$; $\Delta C_{SHRUB\_BSL,t} = 0$). Similarly, deadwood and litter carbon pools will decline as any remaining citrus trees are removed and thus are conservatively omitted ($\Delta C_{LI\_BSL,t} = 0$; $\Delta C_{DW\_BSL,t} = 0$).

As a result, for $for\ 0 < t < 20\ year$ in the baseline scenario: $\Delta C_{BSL,t} = 0$

Regarding baseline GHG emissions, while some biomass burning possibly occurred as part of baseline practices, the burning of biomass is conservatively omitted.

5.2 Project Emissions

According to the AR-AMS0007 methodology, the actual net GHG removals by sinks are calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year *t*; tCO_2e

$\Delta C_{P,t}$ = Change in the carbon stocks in the project, in the selected carbon pools, in year *t*; tCO_2e

$GHG_{E,t}$ = Increase in non-CO2 GHG emissions within the project boundary in year *t*; tCO_2e

According to the AR-AMS0007 methodology, GHG emissions resulting from removal of herbaceous vegetation, combustion of fossil fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activity shall be considered insignificant and therefore accounted as zero. As there will be no biomass burning as part of project activities, GHG emissions are considered zero.

$$GHG_{E,t} = 0; for\ 0 < t < \ 20$$

Change in carbon stocks in the project, occurring in the selected carbon pools, in year *t* is calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t}$ = Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; tCO_2e

$\Delta C_{TREE\_PROJ,t}$ = Change in carbon stock in project tree biomass within the project boundary in year *t as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities";* tCO_2e

$\Delta SOC_{Al,t}$ = Change in carbon stock in SOC in project, in year *t*, as estimated in the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities"; tCO_2e

Above-ground and below-ground biomass

Ex-ante estimates of carbon sequestered in aboveground and belowground live tree biomass over the life of the project were calculated using the CDM tool *"Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.1)* by modeling of tree growth and stand development.

$\Delta C_{TREE_{PROJ}} = \frac{44}{12} * CF_{TREE} * \Delta B_{TREE}$; tCO2e;

Where:

$\Delta C_{TREE_{PROJ}}$ = Change in carbon stock in trees between two successive measurements; tCO2e;

ΔB_{TREE} = Change in tree biomass within the biomass estimation strata; t d.m.

CF_{TREE} = 0.47, the default value for carbon fraction of tree biomass; tC/t d.m.

$44/12$ = Biomass carbon is converted to CO_2 using 44/12, the molecular weight ratio of CO_2/C.

The Bohre et al., 2014 volume equation was selected to model tree growth for this project as it was specifically developed for *Pongamia pinnata* trees growing in a plantation setting. It is based on a sample of 103 trees and achieved a high coefficient of determination (R^2 = 0.940). The equation estimates volume over bark (VOB) for individual trees using two input variables: diameter at breast height (DBH) and tree height. Although developed in India, the equation reflects edapho-climatic conditions similar to those in our project area in Florida, USA. Therefore, the equation meets all the requirements of the CDM A/R Methodological Tool "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities" (Version 01.0.1). Refer to Annex 4 for more details.

Below is the formula and application of *Bohre et al. 2014*:

$$VTREEj\ (x_{1l}, x_{2l}, x_{3l} \ldots) = -\mathbf{0.007} + \mathbf{0.002}D_t + \mathbf{2.638\ x\ 10^{-5}}D_t\ ^2H_t - \mathbf{3.863\ x\ 10^{-10}}(D_t\ ^2H_t)^2$$

$$B_{\mathrm{TREE},l,j,p,i} = V_{\mathrm{TREE},j}(x_{1,l}, x_{2,l}, x_{3,l}, \ldots) \times D_j \times BEF_{2,j} \times (1 + R_j)$$

Where:

$VTREEj\ (x_{1l}, x_{2l}, x_{3l} \ldots)$ = Stem volume (volume over bark) of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a volume table or volume equation, in this case, *Bohre et al. 2014*; m^3

D_t = diameter at breast height at year *t*; cm
H_t = height of tree at year *t*; *meter*

$B_{\mathrm{TREE},l,j,p,i}$ = Biomass of tree l of species j in sample plot p of stratum i; t d.m.

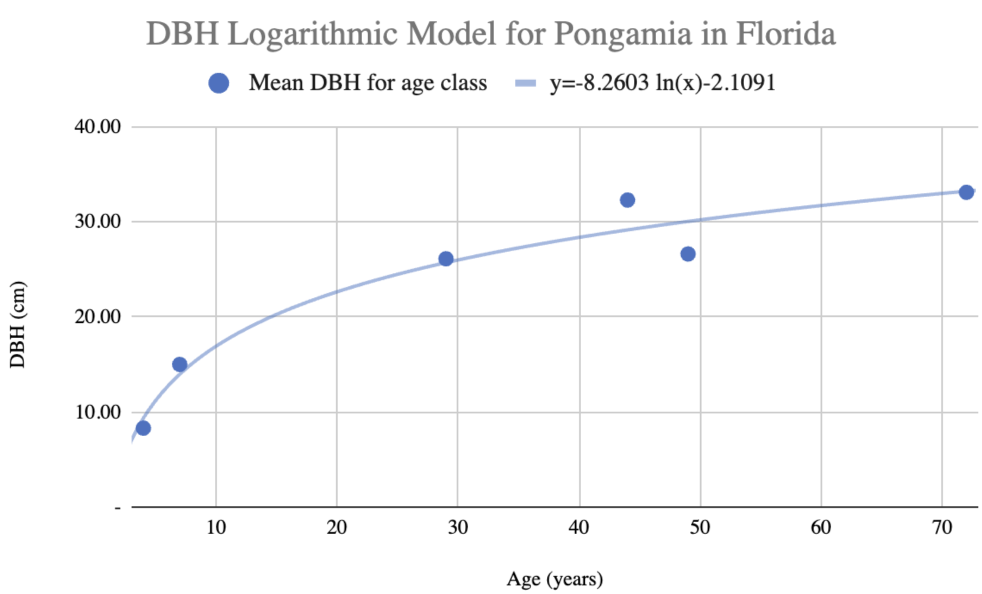
D_j =Density (over-bark) of tree species j; t d.m. m^{-3}

$BEF_{2,j}$ =Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j; dimensionless

$(1 + R_j)$ = Root-shoot ratio for tree species j; dimensionless

For ex-ante calculations (Annex 15), estimates of tree growth by its diameter at breast height (DBH) were modelled using a logarithmic equation of measurements of pongamia trees in Florida covering a range of ages from 4 to 49-year-old trees (Figure 15). The DBH was then calculated per stand age from 0- to 20-year-old trees. Estimates of tree growth by its height are taken as an average across individual trees using current field data for tree ages 3 to 5 years. As per management plans, trees will be annually pruned to maintain height at 5 meters starting at year six. Once biomass was estimated for individual trees ages 0-20, biomass values were multiplied by the current planting density (247 trees/ha), and converted to CO_2 to calculate estimated GHG removals on a ton/ha/year basis.

Figure 15. Logarithmic equation used for estimating tree growth (DBH) in ex-ante carbon calculations. Taken from Eaton and McFarland 2019 (Annex 12), encompassing measurements of 88 pongamia trees within Florida.



Soil Organic Carbon

Ex-ante estimates of soil carbon stocks (ΔSOC_AL,t) were generated using the *"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0).*

Soil data shows that the soils within the Project Area are predominantly Riviera Fine Sands and Pineda Sands — Aqualf soil types within the Alfisol soil order, with low organic matter and natural fertility content (USDA, 1980). Thus, the soil type selected for the entire project area was sandy soils and there was no need to stratify by soil type.

Additionally, the entire project area falls within the IPCC climate zone of tropical moist and therefore there was no need to stratify across climate zones.

Stratification was required across baseline land use in the following three categories: (1) grassland, (2) short-term cultivated (< 20 yrs) or set aside (< 5 years), and (3) long-term cultivated. Although the long-term historical land use of the entire project area is citrus cultivation (e.g. long-term cultivated), these land use factors were selected to conservatively account for any land use change that happened in the 1-7 years prior to project initiation.

$$\Delta SOC_{AL,t} = \frac{44}{12} * \sum_i \quad A_i * dSOC_{t,i} * 1year$$

Where:

$\Delta SOC_{AL,t}$ = Change in SOC stock in the Project Area, in year *t*; tCO_2e

A_i = The area of stratum i of the Project Area; ha

$dSOC_{t,i}$ = The rate of change in SOC stocks in stratum i of the areas of land; $t\ C\ ha^{-1}\ yr^{-1}$

i =1, 2, 3, … strata of areas of land; dimensionless

The area of land for the Project Area (A) is 502.8 ha.

The change in SOC stocks is calculated as follows:

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years}\ for\ t_{PREP,i} < t < t_{PREP,i} + 20$$

Where:

$dSOC_{t,i}$ =The rate of change in SOC stock in stratum *i* of the areas of land, in year *t*; $t\ C\ ha^{-1}\ yr^{-1}$

$SOC_{REF,i}$ = Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation- normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

$SOC_{INITIAL,i}$ = SOC stock at the beginning of the A/R CDM project activity in in stratum *i* of the Project Area; t C ha^{-1}

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable the A/R CDM project activity in in stratum *i* of the Project Area; t C ha^{-1}

$t_{PREP,i}$ = 1; the year in which the first soil disturbance takes place in stratum *i* of the Project Area.

i =1, 2, 3, … strata of areas of land; dimensionless

t = 1, 2, 3, … years elapsed since the start of the A/R CDM project activity

The approximate loss of soil organic carbon during site preparation is considered zero, as the proportion of soil disturbed as a result of these activities is less than 10%.

$SOC_{LOSS,i} = 0$

Where:

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable the A/R CDM project activity, in stratum *i* of the areas of land; t C ha^{-1}

i =1, 2, 3, … strata of areas of land; dimensionless

The initial SOC stock at the start of the project is estimated as follows:

$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i}$

Where:

$SOC_{INITIAL,i}$ = 37.83 (grasslands); 36.78 (short-term cultivated or set aside); 21.53 (long-term cultivated); SOC stock at the beginning of the A/R CDM project activity in stratum *i* of the areas of land; t C ha^{-1}

$SOC_{REF,i}$=39.0 for all strata; Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation -normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

$f_{LU,i}$ = 1 (grasslands); 0.82 (short-term cultivated or set aside); 0.48 (long-term cultivated); stock change factor for 'tropical moist' areas; dimensionless

$f_{MG,i}$ = 0.97 (grasslands); 1.15 (short-term cultivated and set aside and long-term cultivated); Relative stock change factor for moderately degraded grasslands and reduced tillage in baseline management regime in the Project Area; dimensionless

$f_{IN,i}$ = 1.00 (grasslands, short-term cultivated and set aside and long-term cultivated); relative stock change factor for low/medium or medium input regime, in a 'tropical moist area; dimensionless

i =1, 2, 3, … strata of areas of land; dimensionless

Using the results of this equation, the estimated annual rate of change per hectare in SOC stocks due to the Project Activity are:

$dSOC_{t,i}$ = *0.0585* for the grassland land use strata

$dSOC_{t,i}$ = *0.11115* for the short-term cultivated (< 20 yrs) or set aside (< 5 years) land use strata

$dSOC_{t,i}$ = *0.8736* for the long-term cultivated land use strata

According to *"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0)* the value of the rate of change of SOC stock cannot be greater than 0.8 tC ha^{-1}. Therefore, for the long-term cultivated land use strata the following equation applies:

$$If\ dSOC_{t,i} > .8\ t\ C\ ha^{-1}, then\ dSOC_{t,i} = .8\ t\ C\ ha^{-1}$$

Using the results of the equations above, the following ex-ante estimations were obtained:

Table 15. Pongamia growth projection and carbon sinks per year

Stand age (years)	Avg. dbh (cm)	Avg. height (m)	Biomass Carbon (tC/ha)	SOC (tC/Ha)	Total Carbon Stock (tC/ha)	Total Carbon Dioxide stocks (tCO_2/ha)	Annual capture (tCO_2/ha/yr)
0	0.00	0	0.00	0.00	0.00	0.01	0.01
1	0.00	0	0.00	0.08	0.08	0.29	0.28
2	3.62	0	0.05	0.29	0.32	1.16	0.86
3	6.97	3	2.37	0.65	1.77	6.48	5.33
4	9.34	3	4.10	1.18	3.11	11.40	4.91
5	11.19	4	6.28	1.86	4.81	17.63	6.23
6	12.69	5	8.69	2.54	6.63	24.30	6.67

7	13.96	5	10.21	3.23	8.03	29.45	5.15
8	15.07	5	11.60	3.92	9.37	34.37	4.92
9	16.04	5	12.88	4.61	10.66	39.10	4.73
10	16.91	5	14.07	5.30	11.91	43.67	4.57
11	17.70	5	15.17	5.99	13.12	48.10	4.43
12	18.42	5	16.21	6.68	14.30	52.42	4.31
13	19.08	5	17.18	7.37	15.44	56.63	4.21
14	19.69	5	18.11	8.06	16.57	60.74	4.12
15	20.26	5	18.98	8.75	17.67	64.78	4.03
16	20.79	5	19.81	9.43	18.75	68.74	3.96
17	21.29	5	20.61	10.12	19.81	72.63	3.90
18	21.77	5	21.37	10.81	20.86	76.47	3.84
19	22.21	5	22.10	11.50	21.89	80.25	3.78
20	22.48	5	22.54	11.87	22.47	82.38	2.13

5.3 Leakage Emissions

As leakage is *de minimis* for the project scenario, as detailed in Section 1.19, leakage is estimated as zero for the project scenario.

5.4 Estimated GHG Emission Reductions and Carbon Dioxide Removals

Following Section 5.7 paragraph 22 of AR-AMS0007, the ex-ante net anthropogenic GHG removals by sinks is estimated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$ = Net anthropogenic GHG removals by sinks, in year *t*; tCO_2e

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year *t*; tCO_2e

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks, in year *t*; tCO_2e

LK_t = GHG emissions due to leakage, in year *t*; tCO_2e

Considering the implementation timeline of the project, the annual changes in carbon sinks were calculated as follows:

Ex-Ante Estimate of Verified Carbon Units

For the ex-ante estimate of Verified Carbon Units (VCUs), it is assumed that the first verification will take place in 2025 with subsequent verification every year, concluding at the end of year 20 of the crediting period, in 2038.

Consistent with Section 5 of the Registration and Issuance Process, the non-permanence risk rating of the project (Annex 14) has been used to estimate the number of Verified Carbon Units (VCUs) that will be reserved in the buffer account at each verification.

For the ex-ante estimation of VCUs, the risk rating is assumed to be 15% and remains unchanged during the life of the project. The results of the estimation of buffer credits and VCUs are presented in the table below.

Table 16. Ex-Ante Estimate of VCUs including buffer pool allocation

Vintage period	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated buffer pool allocation (tCO_2e)	Estimated reduction VCUs (tCO_2e)	Estimated removal VCUs (tCO_2e)	Estimated total VCU issuance (tCO_2e)
20-Aug-2018 to 31-Dec-2018	0	1	0	0	0	0	0
01-Jan-2019 to 31-Dec-2019	0	15	0	4	0	11	11
01-Jan-2020 to 31-Dec-2020	0	75	0	22	0	54	54
01-Jan-2021 to 31-Dec-2021	0	411	0	119	0	292	292
01-Jan-2022 to 31-Dec-2022	0	1032	0	299	0	732	732
01-Jan-2023 to 31-Dec-2023	0	2066	0	599	0	1467	1467
01-Jan-2024 to 31-Dec-2024	0	2374	0	688	0	1685	1685
01-Jan-2025 to 31-Dec-2025	0	2912	0	845	0	2068	2068
01-Jan-2026 to 31-Dec-2026	0	2946	0	854	0	2092	2092

01-Jan-2027 to 31-Dec-2027	0	2671	0	775	0	1896	1896
01-Jan-2028 to 31-Dec-2028	0	2581	0	749	0	1833	1833
01-Jan-2029 to 31-Dec-2029	0	2419	0	702	0	1718	1718
01-Jan-2030 to 31-Dec-2030	0	2310	0	670	0	1640	1640
01-Jan-2031 to 31-Dec-2031	0	2238	0	649	0	1589	1589
01-Jan-2032 to 31-Dec-2032	0	2177	0	631	0	1545	1545
01-Jan-2033 to 31-Dec-2033	0	2123	0	616	0	1507	1507
01-Jan-2034 to 31-Dec-2034	0	2076	0	602	0	1474	1474
01-Jan-2035 to 31-Dec-2035	0	2034	0	590	0	1444	1444
01-Jan-2036 to 31-Dec-2036	0	1996	0	579	0	1417	1417
01-Jan-2037 to 31-Dec-2037	0	1962	0	569	0	1393	1393
01-Jan-2038 to 19-Aug-2038	0	1856	0	538	0	1318	1318
Total	**0**	**38,274**	**0**	**11,099**	**0**	**27,175**	**27,175**

6 MONITORING

6.1 Data and Parameters Available at Validation

The below tables contain all data and parameters that are determined and available at validation and remain fixed throughout the project crediting period.

Data / Parameter	D_j
Data unit	g/cm^3
Description	wood density (Density over-bar of tree species j)
Source of data	*Jothivel et al* 2016; *Zanne et al* 2009
Value applied:	0.595
Justification of choice of data or description of measurement methods and procedures applied	A/R Tool 14 states "Values are taken from Table 3A.1.9 of IPCC GPGLULUCF 2003 unless transparent and verifiable information can be provided to justify different values." As this source does not include Pongamia wood density values, we instead conducted a literature review to determine an appropriate wood density value. Pongamia wood density values vary depending on the literature source. For example, *Jothivel et al. 2016* estimate wood density at 0.83 g/cm^3; however, others such as *Zanne et al. 2009*,[14] estimate an average wood density of pongamia species of 0 .595 g/cm^3. We use the more conservative value of 0.595 g/cm^3 when calculating biomass.
Purpose of data	Calculation of project emissions
Comments	-

Data / Parameter	$BEF_{2,j}$
Data unit	dimensionless
Description	Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j

[14] Zanne, Amy E. et al. (2009). Data from: Towards a worldwide wood economics spectrum [Dataset]. Dryad. https://doi.org/10.5061/dryad.234

Source of data	A/R Tool 14
Value applied:	1.15
Justification of choice of data or description of measurement methods and procedures applied	A/R Tool 14 states "For ex-post estimation the conservative default value of 1.15 is used, unless transparent and verifiable information can be provided to justify a different value."
Purpose of data	Calculation of project emissions
Comments	-

Data / Parameter	Plot width
Data unit	meter
Description	Sample plot width is half the distance between the tree rows (average tree bole to tree bole)
Source of data	measured in Google Earth
Value applied:	8m
Justification of choice of data or description of measurement methods and procedures applied	The inter row planting distance is consistent across the project area because the project is planted on former citrus land with established drainage infrastructure (beds and furrows). The bed width was measured in Google Earth to be 50 feet, in line with University of Florida's recommended drainage infrastructure for citrus[15]. Two rows of pongamia trees are planted on each 50 foot bed, with an inter row distance of 25 feet, or 8m. Exact measurements may differ slightly from row to row or bed to bed, but across an entire field the average row width is 25ft or 8m.
Purpose of data	Calculation of ex-ante project emissions and reductions
Comments	-

[15] https://irrigationtoolbox.com/ReferenceDocuments/BasicWaterManagement/f23_florida_citrus_drainage_systems.pdf

Data / Parameter	CF_{TREE}
Data unit	t C/t d.m.
Description	Carbon fraction of tree biomass
Source of data	IPCC Guidelines for National Greenhouse Gas Inventories.
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	IPCC reference value used to estimate carbon in dry matter.
Purpose of Data	Calculation of baseline emissions and ex-ante project emissions and reductions
Comments	-

Data / Parameter	Molecular weight ratio of CO_2/C.
Data unit	CO_2/C
Description	Ratio of CO_2/C
Source of data	IPCC Guidelines for National Greenhouse Gas Inventories
Value applied	44/12
Justification of choice of data or description of measurement methods and procedures applied	IPCC reference value used to calculate the amount of CO_2 in biomass carbon
Purpose of Data	Calculation of baseline emissions and ex-ante project emissions and reductions
Comments	-

Data / Parameter	$SOC_{REF,i}$
Data unit	t C ha-1
Description	Default reference SOC stock in strata *i*

Source of data	*"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0)*
Value applied	39.0
Justification of choice of data or description of measurement methods and procedures applied	Default reference SOC stock for tropical, moist climate region in sandy soils, applicable to the Project Area; t C ha-1
Purpose of Data	Calculation of ex-ante project emissions and reductions and ex-post project emissions and reductions
Comments	-

Data / Parameter	$f_{LU,i}$
Data unit	Dimensionless
Description	Relative stock change factor for baseline land-use in strata *i*
Source of data	*"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0)*
Value applied	1.0; 0.82; 0.48
Justification of choice of data or description of measurement methods and procedures applied	Tropical moist stock change factor, for grassland, short term cultivated or set aside, and long-term cultivated areas, respectively.
Purpose of Data	Calculation of ex-ante project emissions and reductions and ex-post project emissions and reductions
Comments	-

Data / Parameter	$f_{MG,i}$
Data unit	Dimensionless
Description	Relative stock change factor for baseline management regime in strata *i*

Source of data	*"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0)*
Value applied	0.97; 1.15
Justification of choice of data or description of measurement methods and procedures applied	Relative stock change factor for moderately degraded grassland and reduced tillage, respectively, in baseline management regime in the Project Area.
Purpose of Data	Calculation of ex-ante project emissions and reductions and ex-post project emissions and reductions
Comments	-

Data / Parameter	$f_{IN,i}$
Data unit	Dimensionless
Description	Relative stock change factor for baseline input regime in strata *i*
Source of data	*"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0)*
Value applied	1.00
Justification of choice of data or description of measurement methods and procedures applied	Relative stock change factor for low/medium and medium baseline input regime in tropical moist grassland and cropland areas, respectively.
Purpose of Data	Calculation of ex-ante project emissions and reductions and ex-post project emissions and reductions
Comments	-

Data / Parameter	$\Delta C_{BSL,t}$
Data unit	tCO_2e
Description	Baseline net GHG removals by sinks in year *t*
Source of data	Landowners, land management records, site inspections.

Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	The parameter is calculated using equation 1 from AR-AMS0007 methodology: $\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$ Where: $\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks in year *t*; tCO_2e $\Delta C_{TREE\_BSL,t}$ = Change in carbon stock in baseline tree biomass within the project boundary in year t; tCO_2e $\Delta C_{SHRUB\_BSL,t}$ = Change in carbon stock in baseline shrub biomass within the project boundary in year t; tCO_2e $\Delta C_{DW\_BSL,t}$ = Change in carbon stock in baseline deadwood biomass within the project boundary in year t; tCO_2e $\Delta C_{LI\_BSL,t}$ = Change in carbon stock in baseline litter biomass within the project boundary in year t; tCO_2e As detailed in Section 3.5.2, cattle grazing is the most plausible scenario for the initial instances in the Project Area. Assuming that past citrus trees would decline and die, aboveground and belowground biomass carbon pools decline are non-existent or are in a steady-state under a cattle grazing scenario, thus conservatively assumed to be equal to zero for the baseline scenario ($\Delta C_{TREE\_BSL,t} = 0$; $\Delta C_{SHRUB\_BSL,t} = 0$). Past practices for citrus orchards consisted of removing dead or decaying trees. For the baseline scenario, it is assumed that deadwood and litter carbon pools are likely to result in a decline and thus are conservatively omitted ($\Delta C_{LI\_BSL,t} = 0$; $\Delta C_{DW\_BSL,t} = 0$). As a result, for $for\ 0 < t < 20\ year$ in the baseline scenario: $\Delta C_{BSL,t} = 0$
Purpose of data	Calculation of baseline emissions
Comments	-

6.2 Data and Parameters Monitored

The tables below contain all data and parameters that will be monitored during the project crediting period.

Data / Parameter	AL, t

Data unit	Hectares
Description	Surface used for SOC estimations.
Source of data	GIS tools
Description of measurement methods and procedures to be applied	Project Area monitored remotely with GIS technology, using property limits as physical boundaries.
Frequency of monitoring/recording	Annually, before each verification.
Value applied	The Project Area is measured at 502.8 ha at the time of verification. This number is expected to stay the same, but will be verified annually via satellite imagery. The SOC calculations are stratified based on previous land use, following the requirements of *A/R Methodological Tool 16: Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities* Version 1.10.
Monitoring equipment	QGIS software package
QA/QC procedures to be applied	Values will be cross-checked with the project landowners' property records, and satellite imagery.
Purpose of data	Calculation of change in SOC stock.
Calculation method	Recorded in the Tree Inventory database (Annex 5).
Comments	-

Land Use Stratum (*i*)	Hectares planted (*AL_t*)
Grassland	86.0
Short-term cultivated (< 20 yrs) or set aside (< 5 years)	264.4
Long-term cultivated	152.4

Data / Parameter	A_i
Data unit	Hectares
Description	Project area per stratum

Source of data	GIS tools
Description of measurement methods and procedures to be applied	Project Area monitored remotely with GIS technology, using property limits as physical boundaries.
Frequency of monitoring/recording	Before validation, every year
Value applied	The Project Area (A) is measured at 502.8 ha. However, as only the biomass of trees planted in 2018, 2019, and 2020 are included within this monitoring period, A is equal to 378.4 ha for biomass calculations. Stratum (*i*) / Hectares planted (*Ai*): 2018: 47.43 2019: 112.02 2020: 218.92 2021: 42.17 2022: 62.24 2023: 20.00
Monitoring equipment	QGIS software package
QA/QC procedures to be applied	Values will be cross-checked with the project landowners' property records and satellite imagery.
Purpose of data	Calculation of baseline and project GHG emissions and reductions.
Calculation method	Recorded in the Tree Inventory Database (Annex 5).
Comments	-

Stratum (*i*)	Hectares planted (*Ai*)
2018	47.43
2019	112.02
2020	218.92
2021	42.17
2022	62.24
2023	20.00

Data / Parameter	R_j
Data unit	dimensionless
Description	Root-shoot ratio
Source of data	A/R Tool 14 — Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2
Description of measurement methods and procedures to be applied	Above-ground biomass of trees will be calculated from a volume equation based on tree dimensions measured within the field. Total project area will be monitored remotely with GIS technology, using property limits as physical boundaries.

Frequency of monitoring/recording	Before verification, every year
Value applied	See Annex 3 GHG Monitoring Report
Monitoring equipment	N/A
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of Data	Calculation of ex-post project emissions and reductions
Calculation method	In accordance with A/R Tool 14, the value of R_j is estimated as: $R_j = e\ (-1.085 + 0.9256 \times ln\ (b)) \div (b)$ Where: *b* = the above-ground tree biomass per hectare (in t d.m. ha-1)
Comments	-

Data / Parameter	ΔC_{TREE}
Data unit	*tCO2e*
Description	Change in carbon stock in trees between two successive measurements
Source of data	Annex 3. GHG Monitoring Report
Description of measurement methods and procedures to be applied	The calculation of this parameter follows the *Direct estimation of change by re-measurement of sample plots method* provided in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* This method is applicable in ex-post estimation of change in carbon stock. Under this method, the same sample plots are measured on two successive occasions and the plot-level

	change in biomass is obtained by subtracting the plot biomass on the first occasion from the plot biomass on the second occasion. Plot biomass is obtained through field measurements of the DBH and height of trees above 5 cm DBH by Terviva's Tree Operations Team. Field measurements are input into an volume equation to determine the above-ground volume of each tree in a sample plot, which is then used to calculate average biomass per hectare for each sample plot. Sample plots are selected using stratified random sampling.
Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	3126.07
Monitoring equipment	N/A
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$$\Delta C_{TREE} = \frac{44}{12} * CF_{TREE} * \Delta B_{TREE}$$ Where: ΔC_{TREE} = Change in carbon stock in trees in the tree biomass estimation strata; tCO2e CF_{TREE} = Carbon fraction of tree biomass; tC/t d.m.; a default value of 0.47 is used ΔB_{TREE} = Change in tree biomass in the tree biomass estimation strata; t d.m.
Comments	-

Data / Parameter	ΔB_{TREE}
iData unit	*t d.m.*

Description	Change in tree biomass within the biomass estimation strata
Source of data	Annex 3. GHG Monitoring Report
Description of measurement methods and procedures to be applied	The calculation of this parameter follows the Direct estimation of change by re-measurement of sample plots method provided in AR-TOOL14 A/R *Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*, v4.2. This method is applicable in ex-post estimation of change in carbon stock. Under this method, the same sample plots are measured on two successive occasions and the plot-level change in biomass is obtained by subtracting the plot biomass on the first occasion from the plot biomass on the second occasion. Plot biomass is obtained through field measurements of the DBH and height of trees above 5 cm DBH by Terviva's Tree Operations Team. Field measurements are input into an volume equation to determine the above-ground volume of each tree in a sample plot, which is then used to calculate average biomass per hectare for each sample plot. Sample plots are selected using stratified random sampling.
Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	*1813.97*
Monitoring equipment	*N/A*
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$$\Delta B_{TREE} = A * \Delta b_{TREE}$$ Where: ΔB_{TREE} = Change in tree biomass in the tree biomass estimation strata; t d.m. A = Sum of areas of the tree biomass estimation strata; ha

	b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha^{-1}
Comments	-

Data / Parameter	Δb_{TREE}
Data unit	t d.m. ha^{-1}
Description	Mean change in tree biomass per hectare within the biomass estimation strata
Source of data	Annex 3. GHG Monitoring Report
Description of measurement methods and procedures to be applied	The calculation of this parameter follows the Direct estimation of change by re-measurement of sample plots method provided in AR-TOOL14 A/R *Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*, v4.2. This method is applicable in ex-post estimation of change in carbon stock. Under this method, the same sample plots are measured on two successive occasions and the plot-level change in biomass is obtained by subtracting the plot biomass on the first occasion from the plot biomass on the second occasion. Plot biomass is obtained through field measurements of the DBH and height of trees above 5 cm DBH by Terviva's Tree Operations Team. Field measurements are input into an volume equation to determine the above-ground volume of each tree in a sample plot, which is then used to calculate average biomass per hectare for each sample plot. Sample plots are selected using stratified random sampling.
Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	*5.98*
Monitoring equipment	*N/A*
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions

Calculation method	$$\Delta b_{TREE} = \sum_{i=1}^{M} w_i * \Delta b_{TREE,i}$$ Where: b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha^{-1} w_i = Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; dimensionless $\Delta b_{TREE,i}$ = Mean change in tree biomass per hectare in stratum *i*; t d.m. ha^{-1}
Comments	-

Data / Parameter	$u_{\Delta c}$
Data unit	t d.m ha-1
Description	Uncertainty in ΔC_{TREE}
Source of data	Annex 3. GHG Monitoring Report
Description of measurement methods and procedures to be applied	The calculation of this parameter follows the *Direct estimation of change by re-measurement of sample plots method* provided in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* This method is applicable in ex-post estimation of change in carbon stock. Under this method, the same sample plots are measured on two successive occasions and the plot-level change in biomass is obtained by subtracting the plot biomass on the first occasion from the plot biomass on the second occasion. Plot biomass is obtained through field measurements of the DBH and height of trees above 5 cm DBH by Terviva's Tree Operations Team. Field measurements are input into an volume equation to determine the above-ground volume of each tree in a sample plot, which is then used to calculate average biomass per hectare for each sample plot. Sample plots are selected using stratified random sampling.

Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	Uncertainty: 1.57
Monitoring equipment	*N/A*
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$$u_{\Delta c} = \frac{t_{val} * \sqrt{\sum_{i=1}^{M} w_i^2 \frac{s_{\Delta i}^2}{n_i}}}{\lvert \Delta b_{TREE} \rvert}$$ Where: $u_{\Delta c}$ = Uncertainty in ΔC_{TREE} t_{val} = Two-sided Student's t-value for a confidence level of 90 percent and degrees of freedom equal to n – M, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata w_i = Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; dimensionless b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha^{-1}
Comments	-

Data / Parameter	$\Delta b_{TREE,i}$
Data unit	t d.m. ha^{-1}

Description	Mean change in tree biomass per hectare in stratum *i*
Source of data	Annex 3. GHG Monitoring Report
Description of measurement methods and procedures to be applied	The calculation of this parameter follows the *Direct estimation of change by re-measurement of sample plots method* provided in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* This method is applicable in ex-post estimation of change in carbon stock. Under this method, the same sample plots are measured on two successive occasions and the plot-level change in biomass is obtained by subtracting the plot biomass on the first occasion from the plot biomass on the second occasion. Plot biomass is obtained through field measurements of the DBH and height of trees above 5 cm DBH by Terviva's Tree Operations Team. Field measurements are input into a volume equation to determine the above-ground volume of each tree in a sample plot, which is then used to calculate average biomass per hectare for each sample plot. Sample plots are selected using stratified random sampling.
Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	<table><tr><th>Stratum (year planted)</th><th>$\Delta b_{TREE,i}$ (tdm/ha)</th></tr><tr><td>2018</td><td>9.03</td></tr><tr><td>2019</td><td>7.55</td></tr><tr><td>2020</td><td>4.51</td></tr></table>
Monitoring equipment	*N/A*
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$$\Delta b_{TREE,i} = \frac{\sum_{p=1}^{n_i} b_{TREE,p,i}}{n_i}$$ Where:

	$\Delta b_{TREE,i}$ = Mean change in tree biomass per hectare in stratum i; t d.m. ha-1. $\Delta b_{TREE,p,i}$ = Tree biomass per hectare in sample plot *p* of stratum *i*; t d.m. ha-1 n_i = Number of sample plots in stratum *i*
Comments	-

Data / Parameter	$s^2_{\Delta i}$
Data unit	(t d.m. ha^{-1}) ^{2}
Description	Variance of mean change in tree biomass per hectare across all sample plots in stratum *i*
Source of data	Annex 3. GHG Monitoring Report
Description of measurement methods and procedures to be applied	The calculation of this parameter follows the *Direct estimation of change by re-measurement of sample plots method* provided in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* This method is applicable in ex-post estimation of change in carbon stock. Under this method, the same sample plots are measured on two successive occasions and the plot-level change in biomass is obtained by subtracting the plot biomass on the first occasion from the plot biomass on the second occasion. Plot biomass is obtained through field measurements of the DBH and height of trees above 5 cm DBH by Terviva's Tree Operations Team. Field measurements are input into an volume equation to determine the above-ground volume of each tree in a sample plot, which is then used to calculate average biomass per hectare for each sample plot. Sample plots are selected using stratified random sampling.
Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	<table><tr><th>Stratum (year planted)</th><th>n_i</th><th>$s^2_{\Delta i}$</th></tr></table>

	2018 | 12 | 8.23 2019 | 10 | 26.54 2020 | 10 | 18.38
Monitoring equipment	*N/A*
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$$s\Delta_i^2 = \frac{n_i * \sum_{p=1}^{n_i} b_{TREE,p,i}^2 - (\sum_{p=1}^{n_i} b_{TREE,p,i})^2}{n_i * (n_i - 1)}$$ Where: $s_{\Delta i}^2$ = Variance of mean change in tree biomass per hectare across all sample plots in stratum *i*; (t d.m. $ha^{-1})^2$ $\Delta b_{TREE,p,i}$ = Tree biomass per hectare in sample plot *p* of stratum *i*; t d.m. ha-1 n_i = Number of sample plots in stratum *i*
Comments	If $s_{\Delta i}^2$ is greater than 10 per cent, ΔC_{TREE} is made conservative by applying an uncertainty discount.

Data / Parameter	$\Delta C_{TREE,t}$
Data unit	*tCO2e*
Description	Change in carbon stock in trees within the project boundary in year *t*
Source of data	Annex 3. GHG Monitoring Report

Description of measurement methods and procedures to be applied	The calculation of this parameter follows the *Estimating change in carbon stock in trees in a year* method provided in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* Change in carbon stock in trees in a year (annual change) is estimated on the assumption of linear change.
Frequency of monitoring/recording	Annually, prior to each verification.
Value applied	Annex 3. GHG Monitoring Report, Tab '*ΔC_P,t*'
Monitoring equipment	N/A
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$\Delta C_{TREE,t} = (C_{TREE,t1} - C_{TREE,t2}) \div T \ * \ 1\ year)$ Where: $\Delta C_{TREE,t}$ = Change in carbon stock in trees within the project boundary in year *t*; t CO2e $C_{TREE,t2}$ = Carbon stock in trees within the project boundary at time t_2; t CO2e. $C_{TREE,t1}$= Carbon stock in trees within the project boundary at time t_1; t CO2e. T = Time elapsed between two successive estimations (T=t_2 – t_1); yr.
Comments	The value of T does not have to be a whole number and can represent a fraction of a year.

Data / Parameter	$b_{TREE,p,i}$

Data unit	t d.m. ha-1
Description	Tree biomass per hectare in sample plot *p* of stratum *i.*
Source of data	Annex 3. GHG Monitoring Report and Annex 5. FRPF1 Tree Inventory Database.
Description of measurement methods and procedures to be applied	The calculation of this parameter follows *Appendix 1. Methods of plot biomass measurement* in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* Tree biomass per hectare in a sample plot is estimated from direct measurements conducted on trees in fixed area sample plots. Individual tree dimensions (i.e. diameter at breast height, tree height) are converted into tree biomass using an volume equation.
Frequency of monitoring/recording	Annually, before every verification.
Value applied	Annex 3. GHG Monitoring Report, Tab '*ΔCTREE_PROJ*'
Monitoring equipment	N/A
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of data	Calculation of project emissions
Calculation method	$$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}}$$ $$B_{TREE,p,i} = \sum_{i} B_{TREE,j,p,i}$$ $$B_{TREE,j,p,i} = \sum_{l} B_{TREE,l,j,p,i}$$ Where:

	$b_{TREE,p,i}$ = Tree biomass per hectare in sample plot *p* of stratum *i*; t d.m. ha-1 $B_{TREE,p,i}$ = Tree biomass in sample plot *p* of stratum *i*; t d.m. $B_{TREE,j,p,i}$ = Biomass of tree *l* in sample plot p of stratum *i*; t d.m. $B_{TREE,l,j,p,i}$= Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*; t d.m. $A_{PLOT,i}$ = Size of sample plot in stratum *i*; ha
Comments	This project only includes one species of tree; therefore, species *j* will always be *Pongamia pinnata.*

i.

Data / Parameter	$B_{TREE,l,j,p,i}$
Data unit	t d.m.
Description	Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*
Source of data	Annex 3. GHG Monitoring Report and Annex 5. FRPF1 Tree Inventory Database.
Description of measurement methods and procedures to be applied	The calculation of this parameter follows *Appendix 1. Methods of plot biomass measurement* in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* Tree biomass per hectare in a sample plot is estimated from direct measurements conducted on trees in fixed area sample plots. Individual tree dimensions (i.e. diameter at breast height, tree height) are converted into tree biomass using an volume equation.
Frequency of monitoring/recording	Annually, before every verification.
Value applied	Annex 3. GHG Monitoring Report, Tab 'Individual Tree Biomass'.
Monitoring equipment	N/A
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.

Purpose of data	Calculation of project emissions
Calculation method	$B_{\mathrm{TREE},l,j,p,i} = V_{\mathrm{TREE},j}(x_{1,l}, x_{2,l}, x_{3,l}, \ldots) \times D_j \times BEF_{2,j} \times (1 + R_j)$ Where: $B_{TREE,l,j,p,i}$ = Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*; t d.m $V_{\mathrm{TREE},j}(x_{1,l},\ x_{2,l},\ x_{3,l}, \ldots) =$ Stem volume of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a volume table or volume equation; m^3 $BEF_{2,j} =$ Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j; dimensionless $D_j =$ Density (over-bark) of tree species j; t d.m. m^{-3} R_j = Root-shoot ratio for tree species *j*; dimensionless
Comments	-

ii.

Data / Parameter	$V_{\mathrm{TREE},j}(x_{1,l},\ x_{2,l},\ x_{3,l}, \ldots)$
Data unit	m^3

Description	Stem volume of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a volume table or volume equation
Source of data	*Bohre et al. 2014*
Description of measurement methods and procedures to be applied	The calculation of this parameter follows *Appendix 1. Methods of plot biomass measurement* in *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* Tree biomass per hectare in a sample plot is estimated from direct measurements conducted on trees in fixed area sample plots. Individual tree dimensions (i.e. diameter at breast height, tree height) are converted into tree biomass using the *Bohre et al. 2014* volume equation.
Frequency of monitoring/recording	Annually, before every verification.
Value applied	Annex 3. GHG Monitoring Report, Tab 'Individual *Tree Biomass*'.
Monitoring equipment	N/A
QA/QC procedures to be applied	See Annex 4.
Purpose of data	Calculation of project emissions.
Calculation method	$VTREEj\ (x_{1l}, x_{2l}, x_{3l} \ldots) = \mathbf{-0.007} + \mathbf{0.002} D_{l,j,p,i} + \mathbf{2.638}\ ^{\mathbf{2}}\ \mathbf{x}\ \mathbf{10^{-5}} D_{l,j,p,i}\ ^{\mathbf{2}} H_{l,j,p,i} - \mathbf{3.863}\ \mathbf{x}\ \mathbf{10^{-10}} (D_{l,j,p,i}\ ^{\mathbf{2}} H_{l,j,p,i})^{\mathbf{2}}$ Where: $VTREEj\ (x_{1l}, x_{2l}, x_{3l} \ldots)$ = Stem volume (volume over bark) of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a

	volume table or volume equation, in this case, *Bohre et al. 2014*; m^3 $D_{l,j,p,i}$ = diameter at breast height of tree *l* of species *j* in sample plot *p* of stratum *i*; cm $H_{l,j,p,i}$ = height of tree *l* of species *j* in sample plot *p* of stratum *i*; *meter*
Comments	According to A/R Tool "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities", the *Bohre et al* (2014) equation is appropriate for volume calculations, as it derived from trees, growing in edapho-climatic conditions similar to those in the project area, the equation was derived from a data set of at least 30 sample trees, and the value of the coefficient of determination (R^2) obtained was not less than 0.85. A detailed description of the methods followed to select this volume equation can be found in Annex 4.

Data / Parameter	$D_{l,j,p,i}$
Data unit	*cm*
Description	Diameter at Breast Height (DBH) of tree *l* of species *j* in sample plot *p* of stratum *i*
Source of data	Magarik et al. 2020
Description of measurement methods and procedures applied	The Diameter at Breast Height (DBH) measurement method involves locating the point at 1.3 m above the ground using a meter stick. For single-stem trees, a standard measuring tape with a designated DBH side is wrapped around the trunk, ensuring level and perpendicular placement. In the case of multi-stemmed trees, the DBH tape is used to measure branches with a diameter greater than 2.5 cm at a 45-degree angle. These techniques follow *Magarik et al. 2020* methods and their equation are applied for DBH calculation (square root of

	the sum of each branch DBH squared). Adherence to these methods serves as the standard protocol, ensuring consistency. More detailed information can be found in Annex 9.
Frequency of monitoring/recording	Annually, before every verification.
Value applied:	See Annex 3. GHG Monitoring Report, Tab 'Individual Tree Biomass'.
Monitoring equipment	Meter stick and DBH tape
QA/QC procedures applied	Members of the tree operations team underwent training on proper field procedures for data collection. Furthermore, the use of pre-marked sticks at 1.3 meters aids in DBH measurement precision, contributing to reliable results. All data was collected in an electronic app called *Appsheet*. Electronic data capture reduces the risk of data entry errors and ensures that all required data is collected (e.g. through required fields). In addition, field data was checked for mistakes and inconsistencies. For example, accidental duplications and/or incorrect measurements are removed.
Purpose of data	Calculation of project emissions
Calculation method	For multi-stemmed trees: *DBH*= $\sqrt{((branch\ 1)^2 + (branch\ 2)^2 + (branch\ 3)^2 + \cdots)}$ *Where:* *branch 1, 2, 3… = diameter at 1.3 m, if diameter greater than 2.5 cm at a 45-degree angle* For single-stemmed trees: *DBH = diameter at 1.3 m*
Comments	-

Data / Parameter	$H_{l,j,p,i}$
Data unit	*meter*
Description	height of tree *l* of species *j* in sample plot *p* of stratum *i*

Source of data	*Terviva Field Team*
Description of measurement methods and procedures applied	The height of each individual tree (from ground to top of highest leaf) was measured using a meter stick. One field personnel would hold a meter stick, and another would stand away from the tree to get an accurate height read. More detailed information can be found in Annex 9.
Frequency of monitoring/recording	Annually, before every verification.
Value applied:	See Annex 3. GHG Monitoring Report, Tab 'Individual Tree Biomass'.
Monitoring equipment	A tall meter stick was marked using a ruler to measure height.
QA/QC procedures applied	Members of the tree operations team underwent training on proper field procedures for data collection. All data was collected in an electronic app called *Appsheet*. Electronic data capture reduces the risk of data entry errors and ensures that all required data is collected (e.g. through required fields). This data was also checked for mistakes and inconsistencies by project proponents. More detailed information can be found in Annex 9.
Purpose of data	Calculation of project emissions
Calculation method	*N/A*
Comments	-

○

6.3 Monitoring Plan

The purpose of the Monitoring Plan is to describe the process and schedule for obtaining, recording, compiling, and analyzing the monitored data and parameters set out in Section 5.2 (Data and Parameters Monitored) above. The data collected will:

- Verify that the applicability conditions of the methodology have been met; and
- Verify the changes in carbon stocks in the pools selected.

Organization of monitoring activity and responsibilities

Terviva

Terviva organizes and monitors each field planting to ensure that the clonal integrity of the elite cultivar planting map is maintained. Following planting, Terviva provides growers with recommendations on best management practices given the growth rate of trees in each field, such as tree nutrition, training, pruning, and mechanical canopy maintenance, irrigation, and pollination.

Prior to harvest, Terviva monitors the fields and trees to ensure harvest access by mechanical equipment and/or hand harvest crews. Terviva operationalizes harvest activities and maintains the integrity of the product during and post-harvest.

Terviva's Tree Operations team works closely with landowners from the onset of the project. During the contracting stage, the Tree Operations team conducts site feasibility assessments of potential project sites that the landowner is considering. These assessments consider agro-climatic conditions (e.g. soil type, annual weather patterns, water availability, etc.) and existing agriculture infrastructure (drainage, irrigation, roads, etc.). After the tree and oilseed purchase agreements have been signed the Tree Operations team works in conjunction with the landowner to make any infrastructure improvements necessary for pongamia, such as decreasing the slope of water furrows and elongating drainage tiles in order to accommodate future use of mechanical harvesting equipment.

Terviva's management team has significant experience in all skills necessary to successfully undertake all project activities. With successful operations in India, Hawaii and Australia, Terviva offers an alternative to local smallholder farmers of a product that is economically valuable and sustainable. In Florida, landowners have existing agroforestry experience managing citrus groves and have received substantial pongamia - specific support and training from TerViva's team. TerViva has full access to the areas planted with pongamia and they work with the landowners to ensure that all land activities are meeting the project's standards. This support will continue throughout the entire project period.

Cultivo

Cultivo Land PBC is the entity in charge of coordinating all monitoring efforts during the whole crediting period. This includes yearly geographic information analysis of the land and neighboring areas using remote sensing data, proprietary algorithms, as well as on-the-ground fieldwork every year to complete the Monitoring Report in compliance with VCS Standard and AR-AMS0007 methodology.

On-the-ground fieldwork to assess carbon stocks, as well as the project's social impact, will be supported by the Project Proponents, landowners, and an AppSheet template for data capture.

Additionally, Cultivo has developed an integrated internal Project Management and Operations process to keep track of the project's KPIs, timeline, and deliverables. Throughout the implementation and monitoring of the project, Cultivo will provide full transparency and update investors, partners, and off-takers through the Cultivo Platform on the performance and progress of the project.

Cultivo's operations team has significant experience with nature-based solutions, project management, science technology, operations, and investment. Cultivo is a global company with teams located in the United States, Mexico, and Europe. Cultivo uniquely combines technology, operations, and investments to restore nature at scale. The project management team consists of the following roles:

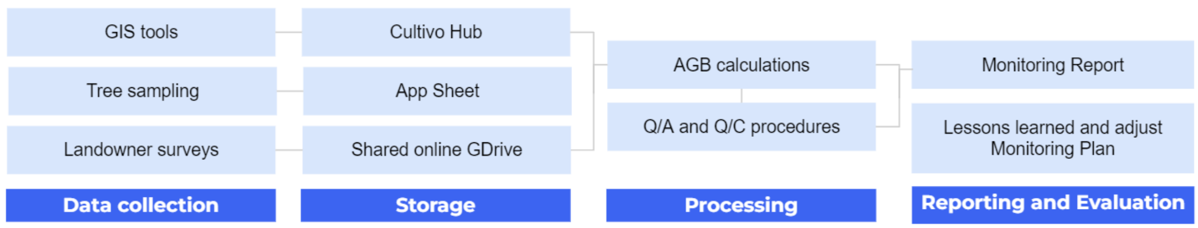
Table 17. Project management team roles

Role	Entity	Description
Project Director	Terviva	Has overall responsibility for the successful development and implementation of the projects. The project director oversees the project coordinator, who coordinates teams to ensure that work is completed on time and within budget, to a high standard.
Project Coordinator	FRPF1	Is responsible for planning and overseeing all project activities within the Project Area, from the initial ideation throughout the lifetime of the project. In charge of coordinating people and processes to deliver the project on time, within budget, and with the desired outcomes aligned to objectives.
Project Developer	Cultivo	Is responsible for drafting the Project Description (PD) as well as Project Design Document and Monitoring Reports, and delivery of necessary documentation to the Validation/Verification body according to VCS guidelines and procedures. Responsible for developing and implementing the necessary training to perform monitoring activities.
Tree Operations Coordinator	Terviva/ FRPF1	Supervises the Tree Operations team and reports to the Project Coordinator. Communicates with landowners and supervises ongoing project activities.
Tree Operations Team	Terviva/ FRPF1	Supports the necessary on-the-ground monitoring activities.

Monitoring sequence

Monitoring activities involve tree inventory, tree allometry data, data storage, processing, reporting, and evaluation from field data collection and remote sensing of permanent sampling plots across multiple strata.

Figure 16. Sequence of monitoring activities



I. Data collection

Project boundary

Physical project boundaries are verified remotely with GIS tools by the Project Coordinator and Project Developer.

Planting establishment

Before planting, Terviva's Tree Operations team produces a detailed planting map that depicts the entire site by individual tree. Each tree is identified in the map by a tree row and position. Multiple varieties of pongamia are required in each planting to ensure there is enough cross-pollination between varieties to produce sufficient yield. The planting map accurately determines the total number of trees needed and the placement of specific varieties within the field.

Terviva's Tree Operations team plants the trees for the landowner or will supervise a planting crew that the landowner hires to ensure that trees are planted in the correct position and that all trees are planted. Careful inventory and accounting follows each planting in order to maintain accurate nursery inventories, invoice growers for purchased and planted trees, update Terviva's R&D map library, etc.

Following the planting of trees, Terviva will make routine visits to the field to ensure that the trees are acclimating and healthy, and make any recommendations to the landowner on care. It is expected that some 3% of trees will die in the first 6 months and Terviva replaces dead trees at no cost to the grower.

Soil disturbance

Prior to planting and during the orchard's lifetime, Terviva makes routine field visits to oversee field preparation, planting work, and routine field maintenance. During land preparation, some soil disturbance is required to remove debris and obstacles to allow access to machinery and equipment required for planting and harvesting. During the planting of trees, a 30 cm x 30 cm x 30 cm hole is dug by hand or a mechanically driven augur in which trees are planted.

Following planting, no soil disturbance is expected, except for cases where a tree has died and needs to be replanted. In those cases, the diseased tree will be removed and a new 30 cm x 30m x 30 cm hole is dug for a new tree. The soil between tree rows remains covered by grasses, which are occasionally mowed in order to allow vehicle access. Plant residues from mowing or activities are left on the ground to promote increases in soil organic matter.

Carbon stock change

Project monitoring will measure and quantify carbon stocks in the carbon pools of the project boundaries in aboveground biomass, and then estimate the according belowground biomass and soil organic carbon. Change in soil carbon stocks will be determined following the approved CDM *"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities".*

All planted trees will be monitored regularly by the team of technicians from the Project Proponent and landowners, in order to record the number of surviving trees, assess good agroforestry practices, the quality of plantation, weed control, and the presence of pests and diseases.

To monitor the change in biomass carbon stock, a sampling design will be drafted to determine the number and location of sample plots.

a) Sampling design for biomass monitoring

Sample plots in the project are rectangular given trees in the project scenario are planted in rows. Sample plot width is half the distance between the tree rows (average tree bole to tree bole) and plot length is the complete row length, varying according to the grove boundaries. The inter-row planting distance is consistent across the project area because the project is planted on former citrus land with established drainage infrastructure (beds and furrows). The bed width was measured in Google Earth to be 50 feet, in line with University of Florida's recommended drainage infrastructure for citrus[16]. Two rows of pongamia trees are planted on each 50 foot bed, with an inter row distance of 25 feet, or 8m. Exact measurements may differ slightly from row to row or bed to bed, but across an entire field the average row width is 25ft or 8m.

These sample plots are readily defined in the field and specific locations and coordinates are identified and stored. These sample plots are defined as permanent, and marked remotely and with individual tree tags.

[16] https://irrigationtoolbox.com/ReferenceDocuments/BasicWaterManagement/f23_florida_citrus_drainage_systems.pdf

Figure 17. Image shows an example of a sample plot

As provided by "*A/R Tool 14 — Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2*", an analysis may be conducted to aid in understanding the level of confidence in the total number of sample plots used for project monitoring. Although not compulsory by methodology, we are using this tool as a guide to help us determine the total sample size needed to capture population variance. Using this tool analysis titled: "*A/R Methodological Tool Calculation of the number of sample plots for measurements within A/R CDM project activities" (Version 02.1.0)*, we aimed to calculate a confidence level above 90% using equation two (for dataset <5% of population) from the A/R tool.

This analysis approximates the population variance of biomass stocks in each stratum and estimates the total number of rows or plots that could be sampled in each strata for 90% Confidence interval. Sampling occurred in October 2023, and then continued between October 2023-January 2024. Sampling data was entered into the analysis at the end of October. After October sampling, according to this analysis, we only needed 8 total rows to be sampled for a 90% CI. Even though this satisfied the 90% CI, we did not feel this sample size was large enough to satisfy a t-test; therefore, we continued to add sampling plots. The output of this analysis changed each time new data was input, which required periodic re-evaluation to maintain alignment with the results. While initially planning to sample based on the power analysis recommendation for a 90% confidence interval, the continuously evolving total sample size due to additional data led us to pragmatically settle for an 88% confidence interval to maintain methodological consistency and continue to move the project forward.

Each row is considered a sample plot (see image below). According to the A/R tool on the calculation of the number of sample plots needed, a total of 32 sample plots (88% CI) were needed across all 2018, 2019 and 2020 strata (planting year), as indicated in Table 2. in Annex 9. Specifically, 12 rows from the 2018 stratum and 10 rows from the 2019 and 2020 strata. We sampled 32 rows/plots (12 in 2018, 10 in 2019, 10 in 2020). More detailed information on these steps, including the Python script (Annex 6) created to perform these calculations, can be found in Annex 9.

b) Stratification

Stratification is based on the age class of trees (i.e. year of planting). However, stratification will be evaluated at each monitoring event, and changes in stratification will be reported at each verification process. Although plots are stratified by planting year, sampling was randomly selected across each grove to ensure a balanced spread of sampling plots across the entire project (i.e. not all plots located in one grove). More detailed information on the number and location of sampling can be found in Annex 9. For future monitoring events, replanted trees will have the same strata as the original planting block. This ensures that each strata takes into account any influence of mortality on the average size or growth rate of trees in any given year. This is also a practical approach in terms of monitoring, since, once they have reached the appropriate size, replated trees will be monitored in the same manner as the other trees within the planting block.

This stratified random sampling occurred from October 2023 and January 2024. Random rows (i.e. plots) were selected for monitoring in each planting block using a RStudio script (version 2023.06.1) (Annex 7) while stratifying by strata (year of planting) across each grove owner. The R script outputs a data frame (Table 2 in Annex 9) with randomly selected rows from the total available rows for each stratum (2018-2020) across each landowner block.

c) Tree monitoring

Trees will be measured by Terviva's Tree Operations team. All trees in a row are measured and registered at each monitoring event.

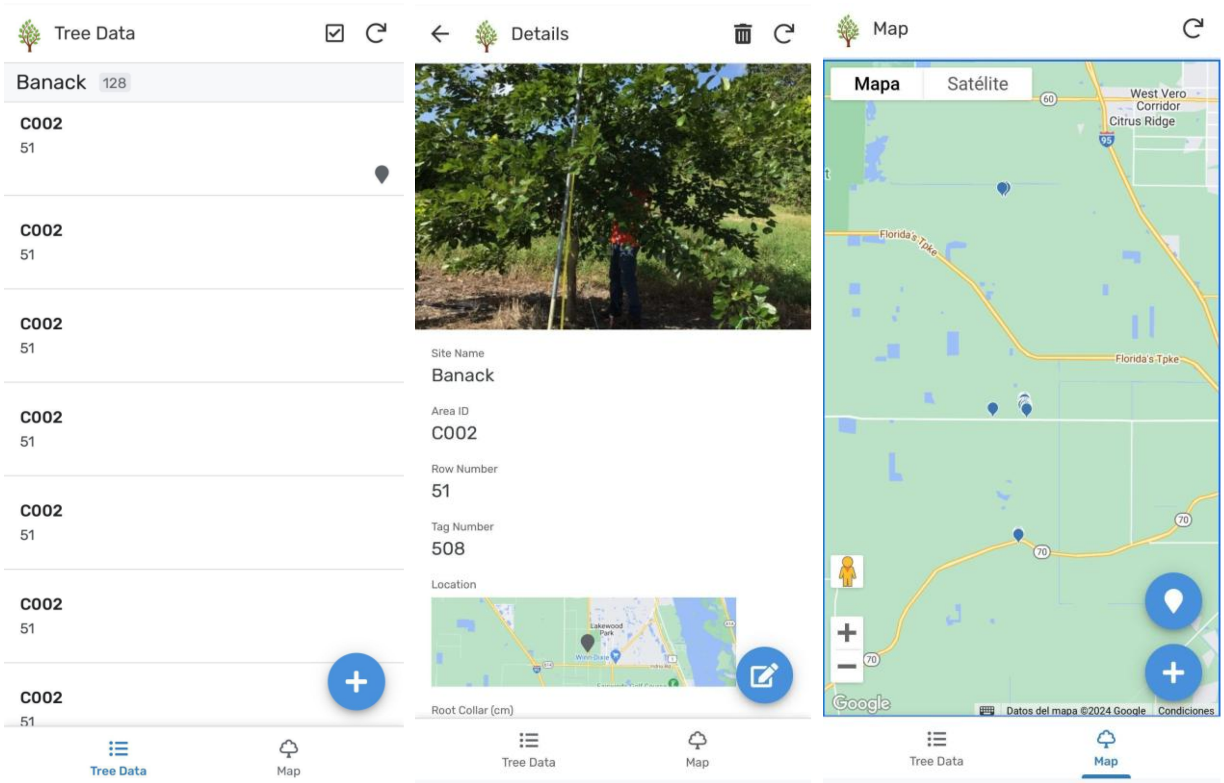
Training materials and sessions will be provided by Cultivo to ensure capacities are built and strengthened for field teams on the ground. To ensure consistent measurement of DBH at the standard height of 1.30 meters, Cultivo and Terviva will conduct additional training for all field team members prior to the next round of measurements. Revised training materials, aligned with the updated Tree Monitoring Manual (Annex 9), will be used to reinforce the correct measurement protocol. Documentation of the training will be provided, serving as proof of implementation and commitment to data accuracy.

Tree data will be collected through a customizable AppSheet template.[17] The following information is collected (raw data can be found in Annex 8):

- Row number
- Date of data collection
- Person collecting the data
- Site name
- Area ID
- Row number (counted from West to East)
- Tree tag number
- Geotag (coordinates with the location of the measured tree)
- If the tree branches above 130 cm (yes/no)
- Diameter of trunk or branches in centimetres
- Height of measurement in centimetres
- Tree height in metres
- Root collar
- Notes

Figure 18. Views of AppSheet

[17] AppSheet is an application that provides a no-code development platform for application software, which allows users to create mobile, tablet, and web applications using data sources like Google Drive, DropBox, Office 365, and other cloud-based spreadsheets and database platforms.



d) Handling non-conformities or deviations from the monitoring plan

In the event that a deviation from the validated monitoring plan occurs, Cultivo and Terviva will follow the procedures for project description deviations as outlined in Section 3.21 of the VCS Standard v4.7. Specifically, Cultivo and Terviva will assess whether the deviation results in changes to the monitoring methodology, the monitoring frequency, or the procedures for data collection, aggregation, or calculation that could materially impact the estimation of GHG emission reductions or removals.

Should such a non-conformance be identified, the deviation will be documented in the monitoring report and submitted to the validation/verification body (VVB) for evaluation and approval during the verification process. The VVB will assess whether the deviation compromises the applicability of the methodology, the integrity of the GHG quantification, or the eligibility of the project. If necessary, the deviation will be subject to validation.

All deviations will be transparently recorded and justified, including an explanation of the reason for the deviation, the time period affected, the impact on data quality or completeness, and corrective measures taken to realign monitoring with the validated plan. Where the deviation is material and affects the quantification of GHG reductions/removals, the project will apply conservative assumptions and follow procedures to ensure that emissions are not underestimated.

Where deviations are anticipated or recurring, Cultivo and Terviva may opt to revise and revalidate the monitoring plan as part of the project documentation. This ensures continuous alignment with the VCS Program's requirements and allows for operational flexibility without compromising environmental integrity.

Sustainable Development Goal Contributions and Social Impact

The project contributes to the United Nations Sustainable Development Goals (SDG): SDG 2 Zero Hunger, SDG 13 Climate Action, SDG 13 Climate Action, and SDG 15 Life on Land through its work producing healthy and nutritious foods through regenerative agriculture practices.

The SDG contributions of the project activities to these SDGs are monitored before every verification. In addition, an online survey will be sent out to the landowners with the objective to understand how land management activities have changed, and how the project has impacted the way they work, their productivity, and overall livelihoods. Monitored indicators are defined according to the project's impacts and aligned to SDGs targets.

Risk Management

In addition to the above monitoring plans, the project proponents will carry out comprehensive risk management strategies on the land to mitigate potential risks to the project, such as disease, extreme weather, and tree damage from animals. While disease and citrus greening has been prevalent in the project area, pest and disease outbreaks pose an insignificant risk to pongamia cultivation in Florida. Nevertheless, Terviva will keep a full-time integrated pest management (IPM) specialist on staff to make routine field visits and monitor nursery operations for any signs of pest or disease. Additionally, Terviva maintains a diverse set of cultivars and rootstocks in the field to reduce the likelihood of a pest or disease negatively impacting all trees in a planting.

Frost damage and hurricanes present risks to pongamia cultivation in Florida, especially in the first three to four years of an orchard's life. Frost risk is mitigated largely using irrigation to increase the level of heat around plant tissues and prevent large-scaled die-offs. Impacts from hurricane-force winds are highest when trees are smaller and have not fully developed a larger root mass to anchor the tree in the ground. To mitigate the potential for damage, young trees are specifically pruned so that their canopies do not catch too much wind during hurricanes and cause the tree to be ripped out of the ground. Mitigation measures are also in place, as landowners replant lost young trees in a span of one to two years after the loss. The replanting plan is listed in the table below.

In some locations, animals such as deer and hogs can kill young trees by digging up roots or destroying aboveground biomass through rubbing. This risk is mitigated using fencing around orchards.

II. Data storage

Tree measurements are stored in the AppSheet system, which syncs automatically to a Google Sheet file, stored electronically in a shared GDrive between the data collectors and all Project Proponents.

Surveys are implemented through Google Forms and answers are synced automatically to a Google Sheets file, stored electronically in a shared GDrive between the data collectors and all Project Proponents. Electronic storage of the data will avoid any loss of information.

III. Processing and QA/QC procedures

Processing

Data collected will be gathered by Field Technicians and automatically stored. The Project Developer will verify the quality of data collected first. For tree measurements, a filtering of the data collected will be performed to make sure that the DBH falls within the limits defined by the selected volume equation (DBH above 5 cm).

The Project Developer will conduct the necessary calculations to determine GHG emissions and reductions during the monitoring period, and draft the Monitoring Report. The processed data will be available in a Google Sheets document, accessible to authorized stakeholders.

Quality assurance

Quality assurance (QA) is the set of activities aimed at assuring that the data collected, stored, processed, and reported during monitoring activities will meet the AR methodology and VCS requirements, as well as the desired data quality objectives. Throughout the monitoring process, quality assurance will be completed by the Local Field Coordinator and then externally by the Project Developer. QA procedures ensure that operations and procedures involved in conducting tree sampling design, tree measurements, and data processing are well identified and that appropriate control procedures are defined, documented, and communicated to relevant project stakeholders.

The QA process begins with the documentation of protocols used for monitoring activities, followed by training sessions for the Tree Operations team. All Tree Operations team members will participate in a training session for every new Tree Monitoring guide version released. The Tree Monitoring Manual standardizes definitions, procedures, and field methods for field monitoring activities. This manual was drafted by Cultivo and verified by Terviva, followed by in-person training sessions.

Communication between the Tree Operations team, the Tree Operations Coordinator, and the Project Coordinator is continuous, addressing issues and questions as needed.

Blind checks will be conducted by the Tree Operations Coordinator to identify measurement errors (location of trees sampled, number of trees sampled, measurement errors).

The Project Coordinator will assess the following indicators to identify errors in the process and data collected and processed:

- Number of rows sampled vs planned number of rows to be sampled
- Number of trees sampled vs the number of trees estimated

IV. Reporting and Evaluation

Reports will be made available upon request to all authorized stakeholders.

After monitoring activities, and obtaining the Monitoring Report, a lessons-learned session will be conducted with the Project's management team to evaluate the results and required adjustments to the monitoring activities in the following monitoring period.

7 Quantification of GHG Emission Reductions and Removals

7.1 Data and Parameters Monitored

The tables below describe all data and parameters monitored during the monitoring period. The values provided are used to quantify actual GHG emissions and removals achieved for the monitoring period. Data and parameters determined or available at validation which will remain fixed throughout the project crediting period are included in Section 6.1 above.

Data / Parameter	AL, t
Data unit	Hectares
Description	Surface used for SOC estimations.
Value applied:	The Project Area is measured at 502.8 ha at the time of verification. This number is expected to stay the same but will be verified annually via satellite imagery. The SOC calculations are stratified based on previous land use, following the requirements of *A/R Methodological Tool 16: Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities* Version 1.10. Land Use Stratum (*i*) / Hectares planted (*AL_t*): Grassland: 86.0 Short-term cultivated (< 20 yrs) or set aside (< 5 years): 264.4 Long-term cultivated: 152.4
Comments	-

Land Use Stratum (*i*)	Hectares planted (*AL_t*)
Grassland	86.0
Short-term cultivated (< 20 yrs) or set aside (< 5 years)	264.4
Long-term cultivated	152.4

Data / Parameter	A_i
Data unit	Hectares
Description	Project area per stratum

Value applied:	The Project Area (A) is measured at 502.8 ha. However, as only the biomass of trees planted in 2018, 2019, and 2020 are included within this monitoring period, A is equal to 378.4 ha for biomass calculations. Stratum (*i*) / Hectares planted (A_i): 2018: 47.43 2019: 112.02 2020: 218.92 2021: 42.17 2022: 62.24 2023: 20.00
Comments	-

Stratum (*i*)	Hectares planted (A_i)
2018	47.43
2019	112.02
2020	218.92
2021	42.17
2022	62.24
2023	20.00

Data / Parameter	R_j
Data unit	dimensionless
Description	Root-shoot ratio
Source of data	A/R Tool 14 — Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2
Description of measurement methods and procedures to be applied	Above-ground biomass of trees will be calculated using an volume equation based on tree dimensions measured within the field. Total project area will be monitored remotely with GIS technology, using property limits as physical boundaries.
Frequency of monitoring/recording	Before verification, every year
Value applied	See Annex 3 GHG Monitoring Report
Monitoring equipment	N/A
QA/QC procedures to be applied	All calculations are reviewed by project proponents and verified by 3rd party auditors.
Purpose of Data	Calculation of ex-post project emissions and reductions.
Calculation method	In accordance with A/R Tool 14, the value of

	R_j is estimated as: $R_j = \frac{e^{-1.085+0.9256 \times ln\,(b)}}{b}$ Where: *b* = the above-ground tree biomass per hectare (in t d.m. ha-1)
Comments	-

Data / Parameter	ΔC_{TREE}
Data unit	*t CO2e*
Description	Change in carbon stock in trees between two successive measurements
Value applied:	3126.07
Comments	-

Data / Parameter	ΔB_{TREE}
Data unit	*t d.m.*
Description	Change in tree biomass within the biomass estimation strata
Value applied:	*1813.97*
Comments	-

Data / Parameter	Δb_{TREE}
Data unit	t d.m. ha^{-1}
Description	Mean change in tree biomass per hectare within the biomass estimation strata
Value applied:	*5.98*
Comments	-

Data / Parameter	$u_{\Delta c}$
Data unit	t d.m ha-1
Description	Uncertainty in ΔC_{TREE}
Value applied:	Uncertainty: 1.57
Comments	-

Data / Parameter	$\Delta b_{TREE,i}$
Data unit	t d.m. ha^{-1}
Description	Mean change in tree biomass per hectare in stratum *i*
Value applied	(see table below)
Comments	-

Stratum (year planted)	$\Delta b_{TREE,i}$ (tdm/ha)
2018	9.03
2019	7.55
2020	4.51

Data / Parameter	$s_{\Delta i}^2$
Data unit	(t d.m. $ha^{-1})^2$
Description	Variance of mean change in tree biomass per hectare across all sample plots in stratum *i*

Value applied	<table><tr><th>Stratum (year planted)</th><th>n_i</th><th>$s^2_{\Delta i}$</th></tr><tr><td>2018</td><td>12</td><td>8.23</td></tr><tr><td>2019</td><td>10</td><td>26.54</td></tr><tr><td>2020</td><td>10</td><td>18.38</td></tr></table>
Comments	If $s^2_{\Delta i}$ is greater than 10 per cent, ΔC_{TREE} is made conservative by applying an uncertainty discount, as detailed in Tool 14, Appendix 2.

Data / Parameter	$\Delta C_{TREE,t}$
Data unit	tCO_2e
Description	Change in carbon stock in trees within the project boundary in year *t*
Value applied	Annex 3. GHG Monitoring Report, Tab '*ΔC_P,t*'
Comments	The value of *t* does not have to be a whole number and can represent a fraction of a year.

Data / Parameter	$b_{TREE,p,i}$
Data unit	t d.m. ha^{-1}
Description	Tree biomass per hectare in sample plot *p* of stratum *i*
Value applied	Annex 3. GHG Monitoring Report, Tab '*ΔCTREE_PROJ*'
Comments	This project only includes one species of tree; therefore, species *j* will always be *Pongamia pinnata.*

iii.

Data / Parameter	$B_{TREE,l,j,p,i}$

Data unit	t d.m.
Description	Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*
Value applied	Annex 3. GHG Monitoring Report, Tab 'Individual Tree Biomass'.
Comments	-

■

Data / Parameter	$V_{\mathrm{TREE},j}(x_{1,l},\ x_{2,l},\ x_{3,l},\ldots)$
Data unit	m^3
Description	Stem volume of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a volume table or volume equation
Value applied:	Annex 3. GHG Monitoring Report, Tab 'Individual *Tree Biomass*'.
Comments	According to A/R Tool "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities", the *Bohre et al* (2014) equation is appropriate for volume calculations, as it derived from trees, growing in edapho-climatic conditions similar to those in the project area, the equation was derived from a data set of at least 30 sample trees, and the value of the coefficient of determination (R^2) obtained was not less than 0.85. A detailed description of the methods followed to select this equation can be found in Annex 4.

Data / Parameter	$D_{l,j,p,i}$
Data unit	*cm*
Description	Diameter at Breast Height (DBH) of tree *l* of species *j* in sample plot *p* of stratum *i*
Value applied:	See Annex 3. GHG Monitoring Report, Tab 'Individual Tree Biomass'.
Comments	-

Data / Parameter	$H_{l,j,p,i}$
Data unit	*meter*
Description	Height of tree *l* of species *j* in sample plot *p* of stratum *i*
Value applied:	See Annex 3. GHG Monitoring Report, Tab 'Individual Tree Biomass'.
Comments	-

7.2 Baseline Emissions

According to the AR-AMS0007 methodology, the baseline net GHG removals by sinks are calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$$

Where:

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks in year *t*; tCO_2e

$\Delta C_{TREE\_BSL,t}$ = Change in carbon stock in baseline tree biomass within the project boundary in year *t*; tCO_2e

$\Delta C_{SHRUB\_BSL,t}$ = Change in carbon stock in baseline shrub biomass within the project boundary in year *t*; tCO_2e

$\Delta C_{DW\_BSL,t}$ = Change in carbon stock in baseline deadwood biomass within the project boundary in year *t*; tCO_2e

$\Delta C_{LI\_BSL,t}$ = Change in carbon stock in baseline litter biomass within the project boundary in year *t*; tCO_2e

In all three baseline scenarios (disease and dying citrus, cattle grazing, and fallow land), tree biomass will decline as any remaining citrus trees die and are removed, thus aboveground and belowground biomass carbon pools are conservatively assumed to be equal to zero ($\Delta C_{TREE\_BSL,t} = 0$; $\Delta C_{SHRUB\_BSL,t} = 0$). Similarly, deadwood and litter carbon pools will decline as any remaining citrus trees are removed and thus are conservatively omitted ($\Delta C_{LI\_BSL,t} = 0$; $\Delta C_{DW\_BSL,t} = 0$). See Baseline Emissions for more information.

As a result, for $for\ 0 < t < 20\ year$ in the baseline scenario: $\Delta C_{BSL,t} = 0$

Regarding baseline GHG emissions, while some biomass burning possibly occurred as part of baseline practices, the burning of biomass is conservatively omitted.

7.3 Project Emissions

According to the AR-AMS0007 methodology, and project boundaries the actual net GHG removals by sinks are calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year *t*; tCO_2e

$\Delta C_{P,t}$ = Change in the carbon stocks in the project, in the selected carbon pools, in year *t*; tCO_2e

$GHG_{E,t}$ = Increase in non-CO2 GHG emissions within the project boundary in year *t*; tCO_2e

According to the AR-AMS0007 methodology, GHG emissions resulting from removal of herbaceous vegetation, combustion of fossil fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activity shall be considered insignificant and therefore accounted as zero. As there will be no biomass burning as part of project activities, GHG emissions are considered zero.

$$GHG_{E,t} = 0; for\ 0 < t < 20$$

Change in carbon stocks in the project, occurring in the selected carbon pools, in year t is calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t}$ = Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; tCO_2e

$\Delta C_{TREE\_PROJ,t}$ = Change in carbon stock in project tree biomass within the project boundary in year *t as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"*; tCO_2e

$\Delta SOC_{AL,t}$ = Change in carbon stock in SOC in project, in year t, as estimated in the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities"; tCO_2e

Stratification and number of sample plots

According to the preliminary sampling protocol (applied on groves where Pongamia trees are established), an adequate number of sample plots required for project monitoring is estimated, using an approximate value of the variance of biomass stocks in each stratum.

Sample plots are appropriate for the project as there is:

- Homogenous tree density.
- Likely homogenous biomass in each age class of trees across sites.
- Plot sampling is practical to allow for reliable repeat sampling in the project scenario.

Stratification was defined according to the age class of a tree, thus identifying the year when trees were planted.

The details of the results of the sampling of trees and the estimation of the number of sample plots can be found in Annexes 6, 7 and 9. With guidance from these calculations, a total number of 32 sample plots were measured. More specifically, we sampled 12 rows for 2018 stratum, 10 rows for 2019 stratum, and 10 rows for 2020 stratum. This translates to approximately 947 trees.

Data collection and QA/QC processes

Tree data was collected in a span of 2 weeks, from May 9th to May 20th. An online webinar session was carried out previously on April 23rd to train the Tree Operations team on the monitoring activities, as well as all requirements for data collection (see Annex 9. Tree Monitoring Manual). In total, 6 people participated in the webinar and monitoring activities, of which 4 were women.

The Operations team was supervised and accompanied by the Operations Team Coordinator, who reported all activities to the Project Developer.

Calculation of carbon stocks in trees

Carbon stocks from standing trees

After collecting the tree data from each sample plot, the calculation of carbon stocks in trees was carried out using the *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" v4.2.*

The method and design selected were "estimation by re-measurement of sample plots". All standing trees in a sample plot above 5 cm of *DBH* were considered for the calculation of biomass, according to the parameters set by the used volume equation by *Bohre et al* (2014).

The mean carbon stock in trees within the tree biomass estimation strata and the associated uncertainty were estimated using the following equations:

$$\Delta C_{TREE} = \frac{44}{12} * CF_{TREE} * \Delta B_{TREE}$$

$$\Delta B_{TREE} = A * \Delta b_{TREE}$$

$$\Delta b_{TREE} = \sum_{i=1}^{M} \quad w_i * \Delta b_{TREE,i}$$

$$u_{\Delta c} = \frac{t_{val} * \sqrt{\sum_{i=1}^{M} \quad w_i^2 \frac{s_{\Delta i}^2}{n_i}}}{|b_{TREE}|}$$

$$\Delta b_{TREE,i} = \frac{\sum_{p=1}^{n_i} \quad \Delta b_{TREE,p,i}}{n_i}$$

$$s_{\Delta i}^2 = \frac{n_i * \sum_{p=1}^{n_i} \quad b_{TREE,p,i}^2 - (\sum_{p=1}^{n_i} \quad b_{TREE,p,i})^2}{n_i * (n_i - 1)}$$

Where:

ΔC_{TREE} = Change in carbon stock in trees between two successive measurements; tCO2e
CF_{TREE} = Carbon fraction of tree biomass; tC/t d.m.; a default value of 0.47 is used

ΔB_{TREE} = Change in tree biomass within the tree biomass estimation strata; t d.m.

A = Sum of areas of the tree biomass estimation strata; ha

Δb_{TREE} = Mean change in tree biomass per hectare in the tree biomass estimation strata; t d.m. ha^{-1}

w_i = Ratio of the area of stratum *i* to the sum of areas of tree biomass estimation strata; dimensionless

$\Delta b_{TREE,i}$ = Mean change in tree biomass per hectare in stratum *i*; t d.m. ha^{-1}

$u_{\Delta c}$ = Uncertainty in ΔC_{TREE}

t_{val} = Two-sided Student's t-value for a confidence level of 90 percent and degrees of freedom equal to n – M, where n is the total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata

$s_{\Delta i}^2$ = Variance of change in tree biomass per hectare across all sample plots in stratum *i*; (t d.m. $ha^{-1})^2$

n_i = Number of sample plots in stratum *i*

The biomass of the individual trees is added and the sum is divided by the area of the sample plot to obtain the plot biomass value.

The plot biomass value (i.e. per-hectare tree biomass) is estimated as follows (all time-dependent variables relate to the time of measurement):

$b_{TREE,p,i} = \frac{B_{TREE,p,i}}{A_{PLOT,i}}$

$B_{TREE,p,i} = \sum_j \quad B_{TREE,j,p,i}$

$B_{TREE,j,p,i} = \sum_l \quad B_{TREE,l,j,p,i}$

Where:

$b_{TREE,p,i}$ =Tree biomass per hectare in sample plot *p* of stratum *i*; t d.m. ha-1
$B_{TREE,p,i}$ = Tree biomass in sample plot *p* of stratum *i*; t d.m.

$B_{TREE,j,p,i}$ = Biomass of tree *l* in sample plot p of stratum *i*; t d.m.

$B_{TREE,l,j,p,i}$= Biomass of tree *l* of species *j* in sample plot *p* of stratum *i*; t d.m.

$A_{PLOT,i}$ = Size of sample plot in stratum *i*; ha

Following Appendix 2 of AR-TOOL14 A/R Methodological tool: "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities*" v4.2, the uncertainty discount was applied. First, the uncertainty percentage is calculated by dividing the uncertainty value by the estimated mean. This percentage is then used to find the appropriate discount factor from Appendix 2, which specifies the discount required for different ranges of uncertainty. The discount amount is then determined by multiplying this discount factor by the original uncertainty value. Finally, this calculated discount amount is subtracted from the original estimated mean to yield the final, discounted conservative mean for the project scenario.

Volume of a tree in a sample plot is estimated by using the following equation by *Bohre et al.* (2014):

$$VTREEj\ (x_{1l}, x_{2l}, x_{3l} \ldots) = \mathbf{-0.007 + 0.002}D_t + \mathbf{2.638\ x\ 10^{-5}}D_t{}^2H_t - \mathbf{3.863\ x\ 10^{-10}}(D_t{}^2H_t)^2$$

Where:

$VTREEj\ (x_{1l}, x_{2l}, x_{3l} \ldots)$ = Stem volume (volume over bark) of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a volume table or volume equation; m^3

D_t = diameter at breast height at year *t*; cm
H_t = height of tree at year *t*; *meter*

Volume is converted to biomass for each tree using the following equation:

$$B_{\mathrm{TREE},l,j,p,i} = V_{\mathrm{TREE},j}(x_{1,l}, x_{2,l}, x_{3,l}, \ldots) \times D_j \times BEF_{2,j} \times (1 + R_j)$$

Where:

$VTREEj\ (x_{1l}, x_{2l}, x_{3l}...)$ = Stem volume (volume over bark) of tree l of species j in sample plot p of stratum i, estimated from the tree dimension(s) as entry data into a volume table or volume equation, in this case, *Bohre et al. 2014*; m^3

$B_{\text{TREE},l,j,p,i}$ = Biomass of tree l of species j in sample plot p of stratum i; t d.m.

D_j = Density (over-bark) of tree species j; t d.m. m^{-3}

$BEF_{2,j}$ = Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j; dimensionless

$(1 + R_j)$ = Root-shoot ratio for tree species j; dimensionless

Results of the carbon stocks in trees are found in detail in Annex 5.

The Bohre et al., 2014 volume equation was selected for this project as it was specifically designed for *Pongamia pinnata* trees growing in a plantation setting. It is based on a sample of 103 trees and achieved a high coefficient of determination (R^2 = 0.940). The equation estimates volume over bark (VOB) for individual trees using two input variables: diameter at breast height (DBH) and tree height. Although developed in India, the equation reflects edapho-climatic conditions similar to those in our project area in Florida, USA. Therefore, the equation meets all the requirements of the CDM A/R Methodological Tool "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities" (Version 01.0.1), and can be used for ex-post estimations of tree stem volume. Refer to Annex 4 for more details.

Table 18. Carbon stocks in each stratum for the monitoring period.

Stratum (year planted)	ΔbTREEi (tdm/ha)	Ai (ha)
2018	9.026	47.43
2019	7.555	112.02
2020	4.506	218.92
2021	0	42.17
2022	0	62.24
2023	0	20

Estimates with high uncertainty can be used in methodologies only if such estimates are conservative. In accordance with Appendix 2 of AR-TOOL14 A/R Methodological tool: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" v4.2, an uncertainty discount was applied in order to make the mean estimated values of parameters conservative. First, the uncertainty percentage was calculated by dividing the uncertainty value by the estimated mean. This percentage was then used to find the appropriate discount factor from Appendix 2, which specifies the discount required for different ranges of uncertainty. The discount amount is then determined by multiplying this discount factor by the original uncertainty value. Finally, this calculated discount amount is subtracted from the original estimated mean to yield the final, discounted conservative mean for the project scenario.

In the case of this monitoring period, an uncertainty of 1.57 led to an uncertainty percentage of 26.35%. Therefore, according to Tool 14, a 75% discount was applied which led to a total uncertainty discount of 1.18. This was subtracted from the mean biomass carbon of 5.98 t.dm/ha, resulting in a conservative mean of 4.79 t.dm/ha. Since the baseline carbon mean is zero, the uncertainty in the baseline is also zero.

Table 19. Mean carbon stock adjusted with uncertainty discount

bTREE (t.dm/ha)	Uncertainty discount	Conservative bTREE (t.dm/ha)
5.98	1.18	4.79

The number of GHG emission reductions or carbon dioxide removals generated in each calendar year are specified below. Change in carbon stock in trees in a year (annual change) is estimated on the assumption of linear change, according to *AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (version 4.2).* Therefore, the following equation was used to calculate the number of VCUs per vintage:

$$\Delta C_{TREE,t} = (C_{TREE,t1} - C_{TREE,t2}) \div T * 1\ year)$$

Where:

$\Delta C_{TREE,t}$ = Change in carbon stock in trees within the project boundary in year *t*; tCO2e

$C_{TREE,t2}$ = Carbon stock in trees within the project boundary at time t_2; t CO2e.

$C_{TREE,t1}$= Carbon stock in trees within the project boundary at time t_1; t CO2e.

T = Time elapsed between two successive estimations (T=t_2 – t_1); yr.

Table 20. Change in carbon stock in trees within the project boundary within each calendar year

Vintage	ΔCTREE,t (tCO_2)
2018	18.06
2019	226.81
2020	548.61
2021	771.81
2022	771.81
2023	771.81
2024	17.15

Soil Organic Carbon

Ex-post estimates of soil carbon stocks (ΔCSOC_AL,t) were generated using the *"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0).*

Soil data (Figure 7) shows that the soils within the Project Areas are predominantly Riviera Fine Sands and Pineda Sands — Aqualf soil types within the Alfisol soil order, with low organic matter and natural fertility content (USDA, 1980). Thus, the soil type selected for the entire project area was sandy soils and there was no need to stratify by soil type.

Additionally, the entire project area falls within the IPCC climate zone of tropical moist and therefore there was no need to stratify across climate zones.

Stratification was required across baseline land use in the following three categories: (1) grassland, (2) short-term cultivated (< 20 yrs) or set aside (< 5 years), and (3) long-term cultivated. Although the long-term historical land use of the entire project area is citrus cultivation (e.g. long-term cultivated), these land use factors were selected to conservatively account for any land use change that happened in the 1-7 years prior to project initiation.

Table 21. Land use strata for SOC calculations

Area ID	Past land use practices	Land Use Strata	Rational
A001, A002	20+ yrs Citrus + 5 years cattle	Grassland	Most recent previous land use was pasture (cattle grazing).
A003	20+ yrs Citrus + 7 years cattle	Grassland	Most recent previous land use was pasture (cattle grazing).
B001, B002, B003, B009, B010	20+ yrs Citrus + 1 yr fallow	Short-term cultivated (< 20 yrs) or set aside (< 5 years)	Most recent previous land use was fallow for < 5 years.
B004, B005, B006, B007, B008, B011	20+ yrs Citrus + 2 yrs fallow	Short-term cultivated (< 20 yrs) or set aside (< 5 years)	Most recent previous land use was fallow for < 5 years.
B012, B013	20+ yrs citrus, diseased and destined to be removed	Long-term cultivated	Long-term previous land use was citrus cultivation.
C001,C002, C003	20+ yrs citrus, diseased and destined to be removed	Long-term cultivated	Long-term previous land use was citrus cultivation.
D001,D002, D003,D004, D005,D006, D007,D008, D009,D010, D011,D012, D013,D014, D015	20+ yrs Citrus + 4 yrs fallow	Short-term cultivated (< 20 yrs) or set aside (< 5 years)	Most recent previous land use was fallow for < 5 years.
E001,E002, E003,E004, E005	20+ yrs citrus, diseased and destined to be removed	Long-term cultivated	Long-term previous land use was citrus cultivation.

Table 22. Management Activity for each Land Use Strata

Land Use Strata	Management Activity	Rational
Grassland	Moderately degraded grassland	Cattle grazing with very minimal livestock management.

Short-term cultivated (< 20 yrs) or set aside (< 5 years)	Reduced tillage	Tillage occurred but was not intensive since citrus is a permanent tree crop.
Long-term cultivated	Reduced tillage	Tillage occurred but was not intensive since citrus is a permanent tree crop.

Table 23. Input Category for each Land Use Strata

Land Use Strata	Input Category	Rational
Grassland	Low/Medium	No fertilizers were applied to pasture.
Short-term cultivated (< 20 yrs) or set aside (< 5 years)	Medium	Only input was synthetic fertilizers. There was no production of high residue yielding crops, no use of green manures, no cover crops, no improved vegetated fallows, limited irrigation, and no use of perennial grasses
Long-term cultivated	Medium	Only input was synthetic fertilizers. There was no production of high residue yielding crops, no use of green manures, no cover crops, no improved vegetated fallows, limited irrigation, and no use of perennial grasses

$$\Delta SOC_{AL,t} = \frac{44}{12} * \sum_i \quad A_i * dSOC_{t,i} * 1year$$

Where:

$\Delta SOC_{AL,t}$ = Change in SOC stock in the Project Area, in year t; tCO_2e

A_i =The area of stratum i of the Project Area; ha

$dSOC_{t,i}$ = The rate of change in SOC stock in stratum i of the areas of land, in year t; $t\ C\ ha^{-1}\ yr^{-1}$

i =1, 2, 3, … strata of areas of land; dimensionless

The area of land for the Project Area was taken from the initial project instances of 502.8 ha.

The change in SOC stocks is calculated as follows:

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years}\ for\ t_{PREP,i} < t < t_{PREP,i} + 20$$

Where:

$dSOC_{t,i}$ =The rate of change in SOC stock in stratum i of the Project Area, in year t; tC ha^{-1} yr^{-1}

$SOC_{REF,i}$ = Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation-normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

$SOC_{INITIAL,i}$ = SOC stock at the beginning of the A/R CDM project activity in the Project Area; t C ha^{-1}

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable the A/R CDM project activity in the Project Area; t C ha^{-1}

$t_{PREP,i}$ = 1; the year in which the first soil disturbance takes place in the Project Area.

i =1, 2, 3... strata of areas of land; dimensionless

t = 1, 2, 3... years elapsed since the start of the A/R CDM project activity

The approximate loss of soil organic carbon during site preparation is considered zero, as the proportion of soil disturbed as a result of these activities is less than 10%.

$$SOC_{LOSS,i} = 0$$

Where:

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable the A/R CDM project activity, in stratum i of the areas of land; t C ha^{-1}

i = 1, 2, 3... strata of areas of land; dimensionless

The initial SOC stock at the start of the project is estimated as follows:

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i}$$

Where:

$SOC_{INITIAL,i}$ = 37.83 (grasslands); 36.78 (short-term cultivated or set aside); 21.53 (long-term cultivated); SOC stock at the beginning of the A/R CDM project activity in stratum *i* of the areas of land; t C ha^{-1}

$SOC_{REF,i}$ =39.0 for all strata; reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation -- normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

$f_{LU,i}$ = 1 (grasslands); 0.82 (short-term cultivated or set aside); 0.48 (long-term cultivated); stock change factor for 'tropical moist' areas; dimensionless

$f_{MG,i}$ = 0.97 (grasslands); 1.15 (short-term cultivated and set aside and long-term cultivated); Relative stock change factor for moderately degraded grasslands and reduced tillage in baseline management regime in the Project Area; dimensionless

$f_{IN,i}$ = 1.00 (grasslands, short-term cultivated and set aside and long-term cultivated); relative stock change factor for low/medium or medium input regime, in a 'tropical moist area; dimensionless

i =1, 2, 3, … strata of areas of land; dimensionless

Using the results of this equation, the annual rate of change per hectare in SOC stocks due to the Project Activity are:

$dSOC_{t,i}$ = *0.0585* for the grassland land use strata

$dSOC_{t,i}$ = *0.11115* for the short-term cultivated (< 20 yrs) or set aside (< 5 years) land use strata

$dSOC_{t,i}$ = *0.8736* for the long-term cultivated land use strata

According to *"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (version 1.1.0)* the value of the rate of change of SOC stock cannot be greater than 0.8 t C ha^{-1}. Therefore, for the long-term cultivated land use strata the following equation applies:

$$If\ dSOC_{t,i} > 0.8\ t\ C\ ha^{-1}, then\ dSOC_{t,i} = 0.8\ t\ C\ ha^{-1}$$

The results for the change in SOC stock in the Project Area, for this monitoring period are found in the following table.

Table 24. Change in SOC for monitoring period by vintage

Vintage	ΔSOC_P,t (tCO_2)
2018	3.61
2019	68.84
2020	167.95
2021	275.64
2022	429.47
2023	558.25
2024	12.7

Change in the carbon stocks in the project, occurring in the selected carbon pools is calculated according to this equation.

Table 25. Change in the carbon stocks in the Project Area

Monitoring period	ΔCTREE_PROJ,t (tCO_2)	ΔSOC_AL,t (tCO_2)	ΔC_PROJ,t (tCO_2)
20/Aug/2018 to 9/Jan/2024	3,126.07	1,516.50	4,642.57

7.4 Leakage Emissions

No leakage is considered for the project emissions.

7.5 GHG Emission Reductions and Carbon Dioxide Removals

Table 26. Additional Information

State the non-permanence risk rating (%)	29%
Has the non-permanence risk report been attached as either an appendix or a separate document?	X Yes ☐ No
For ARR and IFM projects with harvesting, state, in tCO_2e the Long-term Average (LTA).	N/A
Has the LTA been updated based on monitored data, if applicable?	☐ Yes ☐ No N/A
State, in tCO_2e, the expected total GHG benefit to date	3,296 tCO2e
If a loss occurred (including a loss event or reversal), state the amount of tCO_2e lost:	N/A

Table 27. Total VCU Issuance per Vintage Period

Vintage period	Baseline emissions and removals (tCO_2e)	Project removals (tCO_2e)	Leakage emissions (tCO_2e)	Buffer pool allocation (tCO_2e)	Reductions VCUs (tCO_2e)	Removals VCUs (tCO2e)	Total VCU Issuance (tCO_2e)
20-Aug-2018 to 31-Dec-2018	0	22	0	6	0	16	16
01-Jan-2019 to 31-Dec-2019	0	296	0	86	0	210	210
01-Jan-2020 to 31-Dec-2020	0	717	0	208	0	509	509
01-Jan-2021 to 31-Dec-	0	1047	0	304	0	743	743

2021							
01-Jan-2022 to 31-Dec-2022	0	1201	0	348	0	853	853
01-Jan-2023 to 31-Dec-2023	0	1330	0	386	0	944	944
01-Jan-2024 to 09-Jan-2024	0	30	0	9	0	21	21
Total	**0**	**4,643**	**0**	**1,347**	**0**	**3,296**	**3,296**

Table 28. Comparison of Ex-Ante and Achieved Reductions and Removals

Vintage period	Ex-ante estimated reductions/ removals	Achieved reductions/ removals	Percent difference	Explanation for the difference
20-Aug-2018 to 31-Dec-2018	0	16	188%	Ex-ante projections are based on modelled data, including from unmanaged trees outside the project area. This represents a distinct environment from the trees growing inside the project area, which can lead to differences in growth rates and patterns.
01-Jan-2019 to 31-Dec-2019	11	210	180%	Ex-ante projections are based on modelled data, including from unmanaged trees outside the project area. This represents a distinct environment from the trees growing inside the project area, which can lead to differences in growth rates and patterns.
01-Jan-2020 to 31-Dec-2020	54	509	162%	Ex-ante projections are based on modelled data, including from unmanaged trees outside the project area. This represents a

				distinct environment from the trees growing inside the project area, which can lead to differences in growth rates and patterns.
01-Jan-2021 to 31-Dec-2021	292	743	87%	Ex-ante projections are based on modelled data, including from unmanaged trees outside the project area. This represents a distinct environment from the trees growing inside the project area, which can lead to differences in growth rates and patterns.
01-Jan-2022 to 31-Dec-2022	737	853	15%	No difference.
01-Jan-2023 to 31-Dec-2023	1,467	944	43%	Ex-ante projections are based on modelled data, including from unmanaged trees outside the project area. This represents a distinct environment from the trees growing inside the project area, which can lead to differences in growth rates and patterns.
01-Jan-2024 to 09-Jan-2024	1,685	21	195%	Monitoring period only covers 9 days of 2024.
Total	**4,241**	**3,296**	**25%**	Ex-ante projections are based on modelled data, including from unmanaged trees outside the project area. This represents a distinct environment from the trees growing inside the project area, which can lead to differences in growth rates and patterns.

In accordance with AR-AMS0007, the net anthropogenic GHG removals by sinks is calculated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$ = Net anthropogenic GHG removals by sinks, in year *t*; tCO_2e

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year *t*; tCO_2e

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks, in year *t*; tCO_2e

LK_t = GHG emissions due to leakage, in year *t*; tCO_2e

The summary of key results for the quantification of the net change in carbon stocks for the monitoring period of August 20, 2018 to Jan 9, 2024 is indicated in the table below. According to the set project boundaries, Project GHG emissions for the monitoring period are considered zero. Thus, the total project GHG emissions and removals are found below.

The AFOLU non-permanence risk for this first monitoring period was calculated at 27%. The corresponding report is attached in Annex 14.

Table 29. Net GHG Emission Removals

Monitoring period	Baseline emissions or removals (tCO_2e)	Project removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission removals (tCO_2e)	Buffer pool allocation	VCUs eligible for Issuance
20/Aug/2018 to 09/Jan/2024	0	4,643	0	4,643	1,347	3,296
Total	**0**	**4,643**	**0**	**4,643**	**1,347**	**3,296**

REFERENCES

Abatzoglou et al (2018) Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data 5:170191 [Online] doi:10.1038/sdata.2017.191

Agus et.al. (2017) *The Role of Organic Pot on the Growth of Pongamia pinnata (L.) Pierre Seedling for Rehabilitation of Post Coal Mining Land*. In Proceedings of the International Symposium on Bioeconomics of Natural Resources Utilization (ISBINARU), Center for Plant Conservation Botanic Gardens LIPI, Bogor, Indonesia, 12–14

Arpiwi et.al. (2018). *Conservation and Selection of Plus Tree of Pongamia pinnata in Bali, Indonesia.* Biodiversitas 2018, 19, 1607–1614

Blomley et.al (2011) *Building Forest Carbon Projects; Community Engagement Guidance*, Forest Trends [Online] Available at: https://www.forest-trends.org/publications/community-engagement-guidance/

Boman et al. (2021) *2021–2022 FLORIDA CITRUS PRODUCTION GUIDE: FERTILIZER APPLICATION METHODS* IFAS, [Online] Available at: https://edis.ifas.ufl.edu/publication/CG092

Bohre, P., Chaubey, O. P., & Singhal, P. K. (2014). Biomass production and carbon sequestration by Pongamia pinnata (Linn) Pierre in tropical environment. Int. J. Bio-Sci. Bio-Technol, 6, 129-140.

Buccholz (2022) *Florida Orange Crop Expected to Reach Record Low,* Statista [Online] Available at: https://www.statista.com/chart/26738/florida-california-orange-crop/

Buchhorn et.al. (2021) *Copernicus Global Land Service: Land Cover 100m: version 3 Globe 2015-2019: Product User Manual,* Copernicus Global Land Operations – Lot 1 Date Issued: 31.03.2021 Issue: I3.4, [Online] Available at: doi 10.5281/zenodo.4723921

Calica (2017) *Nodulation and Nitrogen Fixation of Pongamia pinnata.* Journal of Tropical Crop Science. ISSN 2356-0177. Vol. 4 No. 1. pp. 1-12.

Chave, Jérôme & Andalo, Christophe & Brown, Sandra & Cairns, Michael & Chambers, J & Eamus, Derek & Fölster, H & Fromard, F. & Higuchi, Niro & Kira, T & Lescure, Jean-Paul & Nelson, Bruce & Ogawa, H & Puig, Henri & Riera, Bernard & Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia*. 145. 87-99. 10.1007/s00442-005-0100-x.

Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B., ... & Vieilledent, G. (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. Global change biology, 20(10), 3177-3190.

Chojnacky, D. C., Heath, L. S., & Jenkins, J. C. (2014). Updated generalized biomass equations for North American tree species. Forestry, 87(1), 129-151.

Copernicus (2019) *Copernicus Global Land Cover Layers: CGLS-LC100 collection 3*, [Electronic dataset]. Available at: https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_Landcover_100m_Proba-V-C3_Global

Convention on Biological Diversity (2021) Natural Capital [Online] Available at: https://www.cbd.int/business/projects/natcap.shtml

Dala-Paula et al. (2019) *Effect of Huanglongbing or Greening Disease on Orange Juice Quality, a Review*. Frontiers in Plant Science. 9:1976. [Online] Available at: https://www.frontiersin.org/articles/10.3389/fpls.2018.01976/full

Daehler, C. (2018). *Observational field assessment of invasiveness of Pongamia* (Millettia pinnata), a candidate biofuel crop in Hawai'i. Department of Botany, University of Hawai'i

Dewdney, Megan, et al. "PP-225/CG086: 2022–2023 Florida Citrus Production Guide: Huanglongbing (Citrus Greening)." Edis.ifas.ufl.edu, Nov. 2005, edis.ifas.ufl.edu/publication/CG086.

Dewdney, M. M., Vashisth, A., & Diepenbrock, C. H. (2023). Citrus Greening, Hurricanes, and the Decline of the Florida Citrus Industry. Southern Ag Today. https://southernagtoday.org/2024/01/05/citrus-greening-hurricanes-and-the-decline-of-the-florida-citrus-industry/

Eaton and McFarland (2019) Pongamia in Florida: A Rapid Assessment of CO2 Sequestration Potential, Oystra Conservation and Carbon CoLLC

European Commission - Joint Research Centre, Institute for Environment and Sustainability (2014) *Soil Projects > Support to Renewable Energy Directive,* [Electronic Dataset] Available at: https://esdac.jrc.ec.europa.eu/projects/RenewableEnergy/

FAO (2013) *Managing Huanglongbing/Citrus Greening Disease in the Caribbean* [Online] Available at: https://www.fao.org/3/ax739e/ax739e.pdf

FAO (2017) Agroforestry for landscape restoration [Online] Available at: https://www.agroforesterie.fr/actualites/2017/documents/FAO-Agroforestry-for-landscape-restoration-Exploring-the-potential-of-agroforestry-to-enhance-the-sustainability-and-resilience-of-degraded-landscapes.pdf

Fernandez-Cornejo et.al. (2014) *Pesticide Use in U.S. Agriculture: 21 Selected Crops, 1960-2008*, USDA-ERS Economic Information Bulletin Number 124, Available at SSRN: https://ssrn.com/abstract=2502986 or http://dx.doi.org/10.2139/ssrn.2502986

Ferrarezi et al., (2019) *Citrus Production Under Screen as a Strategy to Protect Grapefruit Trees From Huanglongbing Disease,* Front Plant Sci. 2019; 10: 1598. [Online] Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6930270/citedby/

Ferrarezi et al. (2021) *2021–2022 FLORIDA CITRUS PRODUCTION GUIDE: NUTRITION MANAGEMENT FOR CITRUS TREES* IFAS, [Online] Available at: https://edis.ifas.ufl.edu/publication/CG091

Ferrarezi et al. (2021b) *2021–2022 FLORIDA CITRUS PRODUCTION GUIDE: IRRIGATION MANAGEMENT OF CITRUS TREES IFAS*, [Online]. Available at: https://edis.ifas.ufl.edu/publication/CG093

FDACS (2021) *Agricultural-Environmental Leadership Award* [Online]. Available at: https://www.fdacs.gov/Agriculture-Industry/Agricultural-Awards-and-Honors/Agricultural-Environmental-Leadership-Award

Florida Department of Environmental Protection (2021) *Florida Watersheds Map*, [Online]. Available at: https://floridadep.gov/wra/deepwater-horizon/documents/florida-watersheds-map

FSA and USDA (2017) *Conservation Reserve Program ANNUAL SUMMARY AND ENROLLMENT STATISTICS* [Online]. Available at: https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Conservation/PDF/ANNUAL%20Summary%202017.pdf

Funk et.al. (2015) *The climate hazards infrared precipitation with stations – a new environmental record for monitoring extremes*. Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015

Pekel, et. al. (2016) *High-resolution mapping of global surface water and its long-term changes*, Nature 540, 418-422, doi:10.1038/nature20584

Happ (2021) *Closed out: How U.S. farmers are denied access to conservation programs*, Institute for Agriculture and Trade Policy (IATP) [Online]. Available at: https://www.iatp.org/documents/closed-out-how-us-farmers-are-denied-access-conservation-programs

Harrison et. al. (2018) *Budgets for Pasture Establishment: Seeded and Vegetative.* Agronomy Department, UF/IFAS Extension. SS-AGR-381. DOI: 10.32473/edis-ag386-2014

Hengl and Nauman (2018) *Predicted USDA soil great groups at 250 m (probabilities) (Version v01)* [Electronic dataset]. Available at: 10.5281/zenodo.1476844

Humphries (2019) *Saving Florida's Oranges Starts With Soil*, NationSwell, [Online]. Available at: https://nationswell.com/fighting-citrus-greening-florida-locus-ag/

IDB (2017) *Meaningful Stakeholder Consultation* [Online]. Available at: https://publications.iadb.org/publications/english/document/Meaningful-Stakeholder-Consultation.pdf

IAIA (2015) *Social Impact Assessment: Guidance for assessing and managing social impacts of projects* [Online]. Available at: https://www.socialimpactassessment.com/documents/IAIA%202015%20Social%20Impact%20Assessment%20guidance%20document.pdf

IFAS (2019) *Assessment of Non-native Plants in Florida's Natural Areas: Millettia pinnata*. University of Florida Institute of Food and Agriculture [Online]. Available at: https://assessment.ifas.ufl.edu/

IFAS (2021) *Establishment and Production Costs of a New Citrus Grove.* University of Florida Institute of Food and Agriculture [Online]. Available at: https://crec.ifas.ufl.edu/economics/economic-tools-files/

IUCN (2021) *Global Invasive Species Database* [Online]. Available at: http://www.iucngisd.org/gisd/search.php on 27-10-2021

IFC (2007) Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets [Online] Available at: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_handbook_stakeholderengagement__wci__1319577185063

Jothivel (2016) Diversity of wood specific gravity among Forest Trees, Kolli hills, Southern Tamilnadu, India, International Journal of Environmental Biology, 6, 29-33

Justesen (2020) *Selecting a Pasture Base: Bahiagrass vs. Bermudagrass.* UF/IFAS Marion County Extension. Available at: https://blogs.ifas.ufl.edu/marionco/2020/03/26/selecting-a-pasture-base-bahiagrass-vs-bermudagrass/

Kadyampakeni et.al (2015) *Nutrient Management Options for Florida Citrus: A Review of NPK Application and Analytical Methods*, Journal of Plant Nutrition, 38:4, 568-583, DOI: 10.1080/01904167.2014.934470

Kriticos,et al (2014), *Balancing bioenergy and biosecurity policies: estimating current and future climate suitability patterns for a bioenergy crop*. GCB Bioenergy, 6: 587-598. https://doi.org/10.1111/gcbb.12068

Lehner, et al (2008): New global hydrography derived from spaceborne elevation data. Eos, Transactions, AGU, 89(10): 93-94.

Leksono, B. et al., (2021) *Pongamia: A Possible Option for Degraded Land Restoration and Bioenergy Production in Indonesia*. Forests, 12(11), p.1468. Available at: http://dx.doi.org/10.3390/f12111468

Li et al. (2020) *Citrus Greening: Management Strategies and Their Economic Impact*, HortScience horts, 55(5), 604-612. [Online]. Available at: https://journals.ashs.org/hortsci/view/journals/hortsci/55/5/article-p604.xml

Li et al. (2021) *Controlling Citrus Huanglongbing: Green Sustainable Development Route Is the Future*. Frontiers in Plant Science. 9:1976. [Online]. Available at: https://www.frontiersin.org/articles/10.3389/fpls.2021.760481/full#B33

Litvany and Ozores-Hampton (2002) *Compost Use in Commercial Citrus in Florida,* HortTechnology, Florida Agricultural Experiment Station journal series R-08570, July-September 2002

Magarik, Yasha A.S, Roman, L., Henning, J., How should we measure the DBH of multi-stemmed urban trees?, Urban Forestry & Urban Greening, Volume 47, 2020, 126481, ISSN 1618-8667, https://doi.org/10.1016/j.ufug.2019.126481

Market Intel (2019) *EQIP and CSP Conservation Programs in the 2018 Farm Bill,* [Online]. Available at: https://www.fb.org/market-intel/eqip-and-csp-conservation-programs-in-the-2018-farm-bill

McPherson, E. G., van Doorn, N. S., & Peper, P. J. (2016). Urban tree database and allometric equations (Vol. 253). Albany, CA, USA: US Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Miao et.al. (2016) *Assessing Cost-effectiveness of the Conservation Reserve Program (CRP) and Interactions between CRP and Crop Insurance,* Land Economics August 25, 2021 0:wple.97.2.042919-0058Rv1-42919-0058R

Moffis, Brooke L. , et al. “PP326/PP326: Frequently Asked Questions about Huanglongbing (HLB;Citrus Greening) for Homeowners.” Edis.ifas.ufl.edu, May 2016, edis.ifas.ufl.edu/publication/PP326.

National Research Council (2010) *Strategic Planning for the Florida Citrus Industry: Addressing Citrus Greening Disease*, Washington, DC: The National Academies Press [Online] Available at: https://doi.org/10.17226/1288

National Wildlife Federation (2014) *The Growing Business Of Cover Crops*, [Online]. Available at: https://www.nwf.org/~/media/PDFs/Wildlife/A-G/TheGrowingBusinessofCoverCropsWhitePA882014.pdf

National Weather Service (2021) *NOWData - NOAA Online Weather Data*, [Online]. Available at: https://www.weather.gov/wrh/Climate?wfo=mlb

Neil and Morgan (2021) *Beyond Scale and Scope: Exploring Economic Drivers of U.S. Specialty Crop Production With an Application to Edamame*, Front. Sustain. Food Syst., 11 January 2021 [Online] Available at: https://doi.org/10.3389/fsufs.2020.582834

O'Connor (2020) *Barriers For Farmers & Ranchers To Adopt Regenerative Ag Practices In The US,* Patagonia [Online] Available at: https://forainitiative.org/wp-content/uploads/Barriers-to-Adopt-Regnerative-Agriculture-Interactive.pdf

Oh J. and Guan Z (2018) *Conservation Reserve Program: Overview and Discussion*, University of Florida, publication FE973 [Online] Available at: https://edis.ifas.ufl.edu/publication/FE973

Parsons and Morgan (2017) *Management of microsprinkler systems for Florida citrus*, University of Florida, IFAS extension, Series HS958, doi.org/10.32473/edis-hs204-2004

Patel et.al. (2021) *Soil carbon dynamics during drying vs. rewetting: Importance of antecedent moisture conditions*, Soil Biology and Biochemistry, Volume 156, 2021, 108165, ISSN 0038-0717, https://doi.org/10.1016/j.soilbio.2021.108165.il

Penman et al (2003) Chapter 3: LUCF Sector Good Practice Guidance, IPCC [Online] Available at: https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

Rao, G.R., Raju, B.M., Reddy, P.S., & Kumar, P.S. (2017). Developing Allometric Equations for Prediction of Total Standing Biomass of *Pongamia pinnata* L.: an important Biodiesel Plant.

Ramachandran and Radhapriya (2016) *P. Restoration of Degraded Soil in the Nanmangalam Reserve Forest with Native Tree Species: Effect of Indigenous Plant Growth-Promoting Bacteria*. Sci. World J. 2016, 2016, 1–9

Resolve (2017) *Ecoregions,* [Electronic dataset]. Available at: https://ecoregions.appspot.com/

Richards M (2011) *Building Forest Carbon Projects; Social Impacts Guidance*, Forest Trends [Online] Available at: https://www.forest-trends.org/publications/social-impacts-guidance/

Schulze, K., Malek, Ž., Schepaschenko, D. et al. Pantropical distribution of short-rotation woody plantations: spatial probabilities under current and future climate. Mitig Adapt Strateg Glob Change 28, 28 (2023). https://doi.org/10.1007/s11027-023-10066-5

Schoeneberger et al (2017) *Agroforestry: Enhancing resiliency in U.S. agricultural landscapes under changing conditions*. Gen. Tech. Report WO-96. Washington, DC: U.S. Department of Agriculture, Forest Service. Chapter 9. https://doi.org/10.2737/WO-GTR-96

Scott, PT, Pregelj, L, Chen, N (2008) *Pongamia pinnata: An untapped resource for the biofuels industry of the future?* Bioenergy Research 1(1): 2–11.

Shukla (2004) *Watersheds—Functions and Management* IFAS, [Online]. Available at: https://edis.ifas.ufl.edu/pdf/AE/AE26500.pdf

Singerman, Ariel, and Pilar Useche. "Impact of Citrus Greening on Citrus Operations in Florida: FE983/FE983, 2/2016." EDIS 2016.2 (2016): 4-4.

Singerman, A., Burani-Arouca, M., Olmstead, M. (2021). Establishment and Production Costs for Peach Orchards in Florida: Enterprise Budget and Profitability Analysis. University of Florida IFAS Extension. DOI: 10.32473/edis-fe1016-2017.

Singerman, Arile. “Citrus Acreage Attrition by County in Florida” CitrusIndustry.net, October 18, 2023, https://citrusindustry.net/2023/10/18/citrus-acreage-attrition-by-county-in-florida/

South Florida Water Management District (2009) *St. Lucie River Watershed Protection Plan* [Online]. Available at: https://www.sfwmd.gov/sites/default/files/documents/ne_slrwpp_main_123108.pdf

Sprague (2019) *Keep an Eye Out for Citrus Greening this Winter*, University of Florida - IFAS Extension [Online]. Available at: https://nwdistrict.ifas.ufl.edu/phag/2019/12/20/keep-an-eye-out-for-citrus-greening-this-winter/

State of Queensland (2016) *Invasive plant risk assessment: Pongamia (Millettia pinnata syn. Pongamia pinnata)* [Online]. Available at: https://www.daf.qld.gov.au/__data/assets/pdf_file/0003/67575/IPA-Pongamia-Risk-Assessment.pdf

Strauss et al. (2019) *Cover crops for citrus* IFAS, [Online]. Available at: https://crec.ifas.ufl.edu/media/crecifasufledu/extension/extension-publications/2019/2019_april_cover.pdf

Sulla-Menashe et.al. (2018) *User Guide to Collection 6 MODIS Land Cover (MCD12Q1 and MCD12C1) Product*, [Online]. Available at: https://lpdaac.usgs.gov/documents/101/MCD12_User_Guide_V6.pdf

Sulla-Menashe et.al. (2019). *MCD12Q1 MODIS/Terra+Aqua Land Cover Type Yearly L3 Global 500m SIN Grid V006* [Data set]. NASA EOSDIS Land Processes DAAC. Accessed 2021-12-07 from https://doi.org/10.5067/MODIS/MCD12Q1.006

Tamang, B., Andreu, M. G., Staudhammer, C. L., Rockwood, D. L., & Jose, S. (2012). Equations for estimating aboveground biomass of cadaghi (Corymbia torelliana) trees in farm windbreaks. Agroforestry systems, 86, 255-266.

TerraClimate (2020) *Soil Moisture*, [Electronic dataset]. Available at: http://www.climatologylab.org/terraclimate.html

Terviva (2021) *Sustainability* [Online]. Available at: https://www.terviva.com/sustainability/

This Farm CARES (2021) *Home* [Online]. Available at: https://www.thisfarmcares.org/

United States Department of Agriculture, National Agricultural Statistics Service, Florida Department of Agriculture and Consumer Services. (2014). Florida citrus statistics 2012-2013. Florida Department of Agriculture and Consumer Services. https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Statistics/2012-13/fcs1213.pdf

United States Department of Agriculture, National Agricultural Statistics Service, Florida Department of Agriculture and Consumer Services. (2024). Florida citrus statistics 2022-2023. Florida Department of Agriculture and Consumer Services. https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Statistics/2022-23/FCS2023.pdf

US SDG (2022) *U.S. National Statistics for the U.N. Sustainable Development Goals* [Online] Available at: *https://sdg.data.gov/*

USDA (1980) *Soil Survey of St Lucie County Area* [Online]. Available at: https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/florida/FL111/0/lucie.pdf

USDA (2014) *Pesticide Use in U.S. Agriculture: 21 Selected Crops, 1960-2008.* [online]. Available at: https://www.ers.usda.gov/webdocs/publications/43854/46734_eib124.pdf.

USDA (2016) *Citrus Abandoned Acres Report*, [Online]. Available at: https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Abandoned_Acreage/CitAA16.pdf

USDA (2017a) *Land Use Practices,* [Online]. Available at: https://www.nass.usda.gov/Publications/Highlights/2020/census-land-use-practices.pdf

USDA (2017b) *2017 State Agricultural Overview Florida,* [Online]. Available at: https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=florida&year=2017

USDA (2017c) *Table 8. Farms, Land in Farms, Value of Land and Buildings, and Land Use: 2017 and 2012*, [Online]. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Florida/

USDA (2018) *OpenLandMap USDA soil taxonomy great groups,* [Electronic dataset]. Available at: https://developers.google.com/earth-engine/datasets/catalog/OpenLandMap_SOL_SOL_GRTGROUP_USDA-SOILTAX_C_v01#bands

USDA (2019a) *Florida Citrus Statistics 2017-2018*, [Online]. Available at: https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Statistics/2017-18/fcs1718.pdf

USDA (2019b) *Ag Census 2017*, [Online]. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Ag_Census_Web_Maps/Data_download/index.php

USDA (2019c) *Agricultural Resources and Environmental Indicators, 2019*. [online]. Available at: https://www.ers.usda.gov/webdocs/publications/93026/eib-208.pdf

USDA (2019d) *Conservation Practices That Save: Crop Residue Management*. [online]. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/energy/conservation/?cid=nrcs143_023637

USDA (2019e) *Agricultural Chemical Use Program* [Online]. Available at: https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/

USDA (2021a) *Collaborative Forest Landscape Restoration Program Glossary* [Online]. Available at: https://www.fs.fed.us/restoration/CFLRP/glossary.shtml

USDA (2021b) *Millettia pinnata (L.) Panigrahi* [Online]. Available at: https://plants.usda.gov/plant-profile/MIPI9

USDA (2021c) *Citrus Greening* [Online]. Available at: https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/citrus/citrus-greening

USDA (2021d) *Web Soil Survey* [Online]. Available at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

USDA, National Agricultural Statistics Service, Florida Department of Agriculture and Consumer Services. (2014). Florida citrus statistics 2012-2013. Florida Department of Agriculture and Consumer Services. https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Statistics/2012-13/fcs1213.pdf

USDA, National Agricultural Statistics Service, Florida Department of Agriculture and Consumer Services. (2024). Florida citrus statistics 2022-2023. Florida Department of Agriculture and Consumer Services. https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/Citrus_Statistics/2022-23/FCS2023.pdf

USDA - Natural Resources Conservation Service (2012) *Highly Erodible and Non-Highly Erodible Cropland, by Region and Year* [Online]. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/nra/nri/results/?cid=nrcs143_013654

USDA - Natural Resources Conservation Service (2019) *Florida Soil Survey Geographic Database SSURGO* [Electronic database]. Available at: https://ca.dep.state.fl.us/arcgis/rest/services/Map_Direct/Program_Support/MapServer/3

USDA - Natural Resources Conservation Service (2020) *NRCS Conservation Programs - Florida* [Online]. Available at: https://www.nrcs.usda.gov/Internet/NRCS_RCA/reports/cp_fl.html

USDA (2021) *EQIP – Regular: Number of Applications by State and Contract Fiscal Year*, Contract Fiscal Years 2005-2020

USDA - Natural Resources Conservation Service (2021a) *Conservation Stewardship Program* [Online]. Available at: nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

USDA - Natural Resources Conservation Service (2021b) *Environmental Quality Incentives Program* [Online]. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/main/fl/programs/financial/eqip/#

Volk et al. (2017) *Florida Land Use and Land Cover Change in the Past 100 Years* [Online]. Available at: 10.17125/fci2017.ch02

Wang, Q. (2019). *COVER CROP BENEFITS FOR SOUTH FLORIDA COMMERCIAL VEGETABLE PRODUCERS*. [online] University of Florida: IFAS Extension. Available at: https://edis.ifas.ufl.edu/publication/ss461.

Workman, et al (2014). *The Practice and Potential of Agroforestry in the Southeastern United States*. UF/IFAS Extension. Circular 1446. 1-42 [Online]. Available at: http://www.edis.ifas.ufl.edu/pdffiles/FR/FR14600.pdf

Wu, F., et al (2013) *The spillover effects of biofuel policy on participation in the Conservation Reserve Program*. Journal of Economic Dynamics and Control, 37:1755–1770, [Online]. Available at: https://edis.ifas.ufl.edu/publication/FE973

Wu, F. and Weber B. (2012) *Implications of a Reduced Conservation Reserve Program*, FARE The Council on Food, Agricultural & Resource Economics [Online]. Available at: https://ideas.repec.org/p/ags/cfarer/156625.html

WWF HydroSHEDS (2021) *Hydrological data and maps*, [Electronic dataset]. Available at: https://www.hydrosheds.org/

Wylie et al (2021) A Technical and Economical Appraisal of Pongamia Pinnata in Northern Australia, Agrifutures Australia.

Zanne, Amy E. et al. (2009). Data from: Towards a worldwide wood economics spectrum [Dataset]. Dryad. https://doi.org/10.5061/dryad.234

Zimmerman, Sarah. "Tropicana Orange Supplier Alico to Exit Citrus Business." Agriculture Dive, 8 Jan. 2025, www.agriculturedive.com/news/alico-exits-citrus-tropicana-orange-supplier/736801/.

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