Project name	*Carbon Capture and Greenhouse Gas Emission Reduction Project in Rubber Plantations in Buriram Province Using Cryptocurrency, Blockchain , and Satellite Technology*
Project Description	*Buriram Rubber Plantation Carbon Sequestration & GHG Emission Reduction Project: A Cryptocurrency, Blockchain, and Satellite Technology Initiative.*
Project developer	ETM Group Company Limited
Joint project developers	-
Project owner	Carbon Solution (Thailand) Limited Partnership
Project location	No. 199, Village No. 13, Samrong Mai Subdistrict, Lahan Sai District, Buriram Province
Project location coordinates	48 PX 267206 Y 1590783
Project type	( ) Renewable energy or energy that replaces fossil fuels ( ) Improving efficiency in electricity production and heat production ( ) Using public transportation ( ) Use of electric vehicles ( ) Engine efficiency improvement ( ) Improving the efficiency of building and factory use and household use. ( ) Modification of natural refrigerant ( ) Use of materials to replace cement pellets ( ) Waste management ( ) Community wastewater management ( ) Methane gas recovery ( ) Industrial wastewater management (/) Reduction, absorption and sequestration of greenhouse gases in the forestry and agriculture sectors ( ) Capture, storage and/or utilization of greenhouse gases. ( ) other
Project Implementation Model	( ) Single type (/) Combined or group type

Project size	( ) very small (less than 500 rai) (/) small (Size 500 rai but not more than 20,000 rai) ( ) Large (size more than 20,000 rai or more)
Greenhouse gas reduction methodology and calculation tools used	According to the ETM Carbon Trade Standard (ECT)
Project activities	
Total investment of the project	580,000 baht (five hundred and eighty thousand baht)
The amount of greenhouse gases expected to be reduced/absorbed	8,578.98 tons of carbon dioxide equivalent per year 60,052.86 tons of carbon dioxide for a period of 7 years
Project carbon credit calculation period	(/) 7 years back (starting from 1 January 2016 - 31 December 2022) ( ) 7 years (specify start date/month/year – end date/month/year) ( ) 10 years (specify start date/month/year – end date/month/year)

Document preparation details	
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Part 1 Project details and activities

1. Executive Summary

The project's primary goal is to advance the importance of carbon sequestration and greenhouse gas emission reduction in rubber plantations in Buriram Province, a key contributor to mitigating the impacts of climate change. The project will integrate cutting-edge technologies, including cryptocurrency, blockchain , and satellite technology, to enhance operational efficiency, transparency, and sustainability. The project focuses on creating a verifiable system for trading carbon credits and rubber plantation produce, incentivizing farmers to participate in sustainable resource conservation and management.

The project's primary objectives include demonstrating and measuring carbon sequestration in rubber plantations; reducing greenhouse gas emissions from agricultural activities within the project area; establishing an efficient, transparent, and fair carbon credit trading system using blockchain and cryptocurrency technologies ; promoting the use of satellite technology to accurately monitor and track carbon sequestration and project performance; and generating additional income and improving the quality of life for farmers in Buriram Province through project participation.

The anticipated benefits of this project are diverse and comprehensive. The project will have a clear positive environmental impact by increasing carbon sequestration capacity, mitigating climate change, promoting biodiversity, and improving soil quality. It is also expected to have a positive economic impact at both the local and national levels by creating a credible carbon credit market, attracting investment in green technologies, and creating new business opportunities. On the social front, the project will help strengthen the capacity of farming communities, raise awareness and understanding of sustainable development, and promote inclusive participation.

2. The need for climate action the role of rubber plantations and technology integration

2.1 Urgency of addressing climate change

Climate change is a global challenge that requires urgent and comprehensive action. Strong scientific evidence from organizations like NASA and the IPCC confirms that human activities, particularly the burning of fossil fuels, are the primary contributor to global warming. The increase in greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in the atmosphere results in the greenhouse effect, which traps heat and leads to the climate changes observed around the world, such as rising global temperatures, warming seas, melting ice sheets, and an increased frequency of extreme weather events. The scientific community agrees that rapid and significant reductions in greenhouse gas emissions, coupled with the removal of carbon dioxide from the atmosphere, are essential to limit global warming to 1.5 degrees Celsius above pre-industrial levels, as targeted by the Paris Agreement.

2.2 The role of the agricultural sector and rubber plantations in carbon sequestration

Agriculture plays a crucial role in the global carbon cycle, the cycling of carbon between living organisms, the atmosphere, oceans, and the Earth's crust, and rubber plantations, a major cash crop, are a valuable part of this carbon sequestration ecosystem **(Reference 1).**

2.2. 1 Carbon sequestration process in rubber trees and rubber plantation systems

2.2. 1.1 CO2 absorption through photosynthesis

- The rubber tree (Hevea Brasiliense's) , which is a perennial crop , acts as **natural carbon sink** Important

- The process begins with the rubber tree absorbing carbon dioxide (CO_2) from the atmosphere through its leaves (Stomata) into the process of photosynthesis using solar energy and water.
- This chemical reaction converts CO_2 into organic carbohydrate compounds, which provide energy and structural support for the tree.

2.2. 1.2 Biomass Carbon Storage

- The absorbed carbon is stored in the form of **Biomass** In various parts of the rubber tree for a long period of time (decades throughout the tree's life cycle)
- **Above-ground Biomass** It consists of the trunk, branches, stems and leaves, which are the main parts of the carbon sequestration system. This part increases with the growth and age of the rubber tree.
- **Below-ground Biomass** It consists of the root system of the rubber tree that extends into the soil. These roots not only help to hold the soil together and absorb water/nutrients, but are also an important source of carbon storage.
- **Dead Organic Matter** This includes rubber leaf debris, fallen branches, or dead rubber trees, which will gradually decompose and release carbon back into the atmosphere or accumulate in the soil.

2.2. 1.3 Soil Carbon Sequestration

- Soil in rubber plantations is also an important carbon sink.
- Carbon enters the soil in the form of Soil **Organic Carbon (SOC)** From the accumulation of organic matter from leaves, fallen branches, plant root remains and dead soil microorganisms.
- Sustainable management of rubber plantations such as **Do not burn plant debris** Mulching and the use of organic fertilizers can increase the amount of organic matter in the soil, which increases the soil's carbon sequestration potential.

2.2.1.4 Carbon sequestration potential and economic advantages

Carbon sequestration potential (Reference document 2)

- Studies suggest that rubber plantations can store carbon in quantities comparable to agroforestry or some types of forests.
- In general, rubber plantations have the potential to store carbon from **50.68 Up to 193.72 Tons of carbon per hectare in total dry weight** (tons CO_2e/ ha) over the life cycle of a tree. **(Reference document 3)**
- While rubber plantations may not be comparable to pristine rainforests, which have the potential to store up to 300 tonnes of carbon per hectare or more, they are still a valuable alternative.

2.2.2 Economic and practical advantages

- **Economically feasible** Rubber plantations are an important cash crop for farmers in many countries, particularly in Southeast Asia where rubber is widely cultivated. The ability for rubber plantations to generate income from latex and timber production, coupled with carbon sequestration, presents a balanced solution between economic development and environmental issues.
- **Wide cultivation area** With vast rubber plantations in many countries, rubber plantations have the combined potential to store enormous amounts of carbon and can play a tangible role in addressing climate change at the global level.
- **Promote sustainable management** The carbon credit mechanism proposed by this project will incentivize farmers to adopt sustainable rubber plantation

management practices, which will not only increase carbon sequestration but also lead to other co-benefits such as improved soil quality, reduced chemical use, and increased biodiversity.

2.2. 3 Conceptual Diagram Description of Carbon Cycle in Rubber Plantations (Conceptual Diagram Carbon Cycle in a Rubber Plantation)

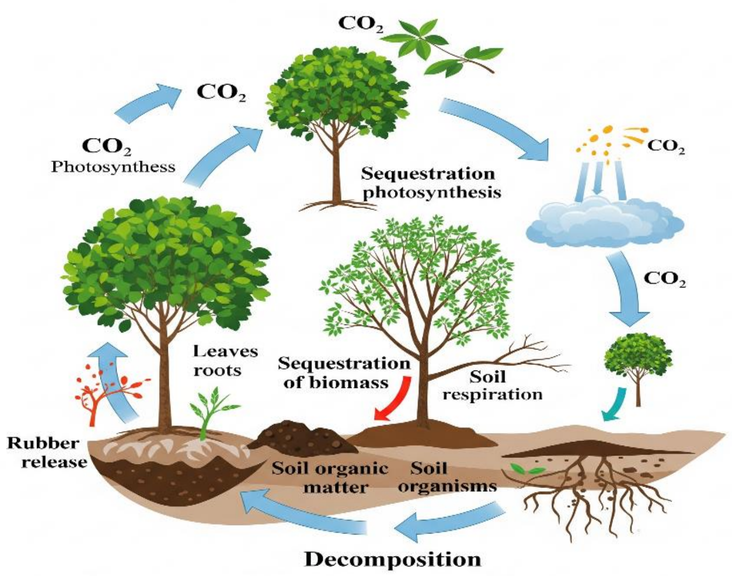

***Figure 1** shows the flow of carbon dioxide (CO2) and various forms of carbon within an ecosystem, driven by rubber trees.*

This chart aims to illustrate the carbon flow in rubber plantations and the role of rubber trees in carbon sequestration. It includes the following components:

Key elements in the diagram

1. **CO2 (Carbon Dioxide)** Shown at the top and around trees in the atmosphere are the main greenhouse gases we are focusing on managing.
2. **Tree** Shown in various stages of growth and roles

Large tree (top left/middle left) It represents a growing tree that plays a major role in absorbing CO2.

Small tree (center right/bottom right) It may refer to a tree that is beginning to grow, or to a part of a tree (such as roots).

3. **Leaves** The important part of a tree that performs photosynthesis
4. **Roots** The underground part of a tree that holds the soil together and plays a role in carbon sequestration.
5. **Soil organic matter** Decomposed plant and animal remains in soil are an important source of carbon storage.
6. **organisms** Microorganisms and small animals in the soil that play a role in the decomposition of organic matter.

Key processes in the carbon cycle

1. **Photosynthesis (photosynthesis) / Sequestration (storage)**

CO2 absorption the blue arrow points from the "CO2" in the atmosphere into the "leaves" of the trees.

process Trees absorb CO_2 from the air, use sunlight and water to convert CO_2 into energy and tree components.

Sequestration of biomass The absorbed carbon is "stored" in the form of tree biomass, both in the "leaves " and "roots ", as well as in the trunk and branches.

2. **Soil Respiration (Soil respiration)**

CO_2 emissions the orange arrow points from the soil (specifically from the roots and soil organisms) up into the atmosphere.

process Plant roots and soil organisms such as bacteria and fungi perform respiration, a process that naturally releases CO_2 back into the atmosphere.

3. **Decomposition**

Carbon flow to soil The blue arrows point from the fallen "leaves" (shown in the picture as fallen leaves) and dead "roots" down to the soil.

process Dead organic matter (such as fallen leaves , dead roots) is decomposed by soil organisms, causing the carbon from that biomass to become part of "soil organic matter ".

4. **Rubber Release (Latex Release)**

Carbon flow from trees The blue arrow points from the trunk of the rubber tree down to the container holding the latex, and the blue arrow points from that point down to the soil.

meaning In the context of the rubber tree, latex secretion is the process by which the tree produces organic compounds (which are primarily carbon-based). This latex is then further processed into rubber products.

The connection to carbon Latex is part of the harvested tree biomass, which contains carbon. Although this process does not directly release significant amounts of CO_2 into the atmosphere, it does move carbon out of the tree biomass.

Relationships and overall cycles

As Figure 1 shows, trees (including rubber trees) are key players in controlling the atmospheric CO_2 balance.

absorption (Sequestration) Trees take in CO_2 for growth and store it in their biomass.

release (Respiration/Decomposition) Soil and soil organisms naturally release CO_2 back into the atmosphere through respiration and decomposition.

Soil carbon sequestration When plants and roots die, carbon is stored in the soil as organic matter.

Your rubber plantation carbon sequestration project focuses on increasing efficiency in the following areas: **"Sequestration (containment)"** Both in the biomass of rubber trees and in " Soil organic matter " through sustainable management to ensure that more CO_2 is absorbed and stored in the system than is released back into the atmosphere.

2.3 Potential of technology to enhance carbon capture projects

Blockchain technology has the potential to significantly transform carbon markets by creating greater transparency, traceability, and efficiency in carbon credit trading. This technology can create a secure and decentralized platform that reduces fraud and improves the auditing process, making the carbon market more accessible and trustworthy. Carbon credits, converted into digital tokens on the blockchain, can streamline trading, increase transparency, and expand participation. Cryptocurrency can facilitate faster and potentially lower cost transactions within this digital ecosystem .

Satellite technology is also a powerful tool for monitoring and tracking carbon sequestration projects over large areas. High-resolution satellite data can be used to map land use, assess forest biomass, and estimate carbon stocks in rubber plantations. Combining satellite data with field measurements and advanced analytical techniques, such as machine learning algorithms , can improve the accuracy of carbon stock estimates and track changes over time. This technology allows for efficient monitoring and large-scale coverage with less intrusion than traditional ground-based survey methods.

2.4 Context of Buriram Province

1. Overview of Buriram Province Buriram Province is located in the lower northeastern region of Thailand. With a total area of approximately 10,322.885 square kilometers (approximately 6.45 million rai), it is the 17th largest province in Thailand. The topography is a plateau with mountains in the southern part of the Phanom Dong Rak mountain range. Important rivers flow through it, including the Mun River and the Chi River. It has a population of approximately 1,576,915 people (as of 2021) , the 6th largest in Thailand. The majority of the people are Thai-Khmer descent. It is divided into 23 districts, 188 sub- districts, 2,212 villages, and 1 city municipality (Buriram City Municipality).

2. The prevalence of rubber plantations in Buriram Province Buriram Province has a rubber plantation area of approximately 227,180 rai, which is ranked among the top 10 provinces with the largest rubber plantation areas in the Northeast. There are many farmers in Buriram Province who work in rubber plantations, with the number of farmers registered in the year 2013 . - 2018 is around 5,000 - 21,924 cases depending on the year of survey and registration criteria. Average rubber production in Buriram for rubber variety 251 can produce up to 0.6 tons per rai per year. **(Reference document 4)**

3. Local Economic Conditions: The agricultural sector is the main economic sector of Buriram Province, particularly rice and rubber cultivation. There are agricultural processing factories, and tourism is also growing. However, the average **per capita income (GPP per capita) is 80,684 baht per year (2021).** This is relatively low compared to the national average, reflecting the need to generate additional income.

4. Environmental concerns in Buriram Province include potential deforestation from past agricultural expansion, the use of agricultural chemicals (chemical fertilizers and pesticides) that may impact soil and water quality (cases of pesticide poisoning have been reported), and air pollution from PM2.5 dust resulting from burning in agricultural areas (which has led to a ban on burning in all areas).

5. Factors related to project implementation: Farmers in Buriram Province are interested in generating additional income from carbon credits if the project can present investment value (due to high costs) and has support from the government sector (e.g. Rubber Authority of Thailand). The Bank for Agriculture and Agricultural Cooperatives (in terms of policies to promote group integration and funds), including cooperation from the private sector (carbon credit buyers , green investors), which will help create financial sustainability for the project.

2.5 Basic information of the project area

2.5.1 General information about rubber plantations

Rubber plantation group, name group 01/ BR01S1, is a group of rubber farmers in the area of Samrong Mai Subdistrict, Lahan Sai District, Buriram Province. There are 131 members, total area 1,936.15 rai. The group president is Mr. Prawit Wattanaphithak, telephone number 0810652968. Group location UTM 48P X267206 Y1590783 , located at number 199 Village No. 13, Samrong Mai Subdistrict, Lahan Sai District, Buriram Province **(Appendix Document/Evidence 1)**

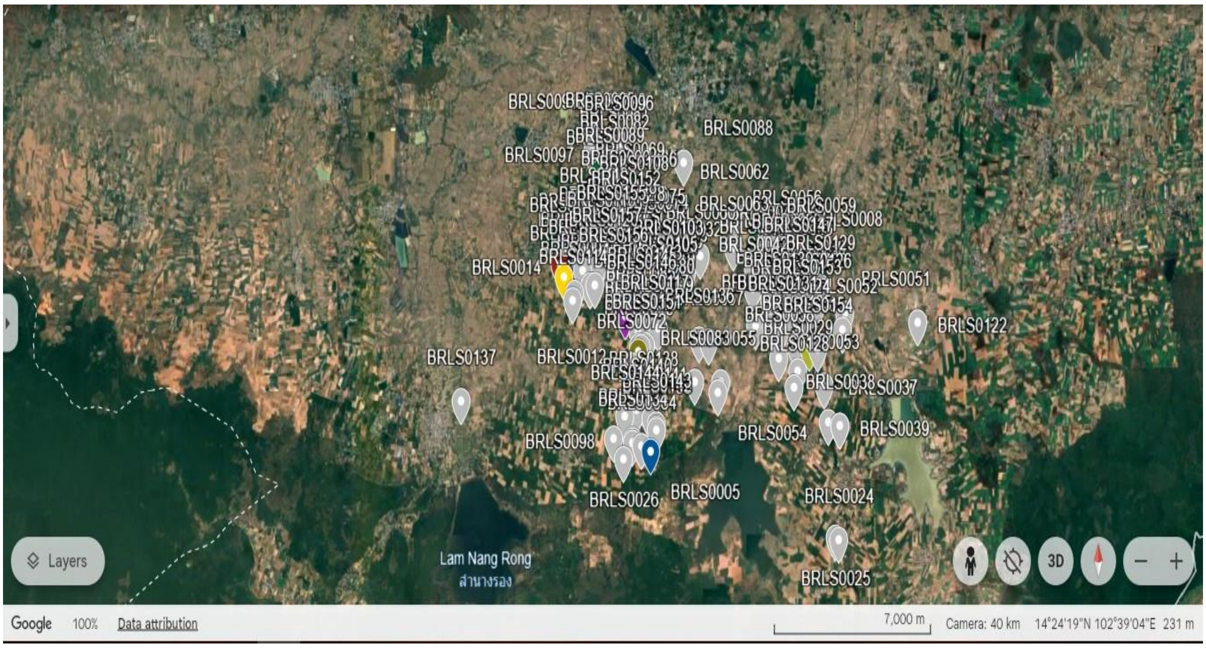

***Figure 6**. shows an aerial photograph of the rubber plantation area of the members of Samrong Mai Subdistrict (information from google.com/maps/d/).*

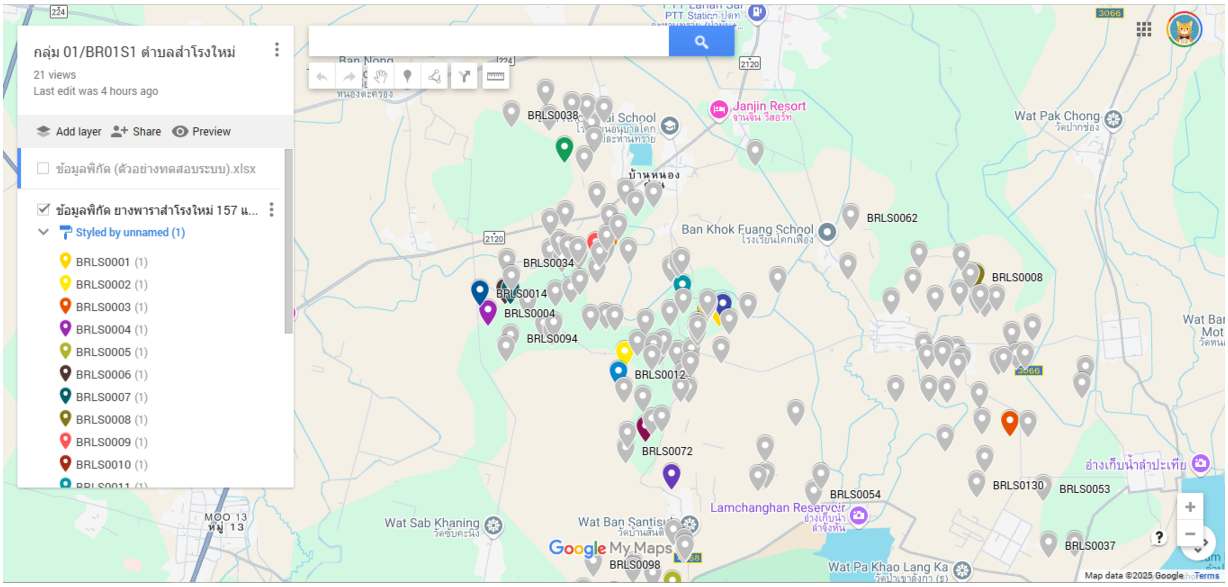

***Figure 7**. shows the administrative boundaries of Samrong Mai Subdistrict (information from google.com/maps/d/).*

2.5.2 Location of rubber plantations of farmers and reference markers in the area

Table 1 shows the location of the rubber plantations of 131 members.

ตำแหน่ง	พิกัดตำแหน่งที่ตั้ง			Decimal Degrees		ตำแหน่ง	พิกัดตำแหน่งที่ตั้ง			Decimal Degrees	
	Zone	X	Y	Latitude	Longitude		Zone	X	Y	Latitude	Longitude
BRLS0001	48P	267665	1587689	14.3515447	102.8456988	BRLS0046	48P	271975	1586090	14.3374566	102.8857788
BRLS0002	48P	265711	1586875	14.3440248	102.8276607	BRLS0047	48P	271216	1587896	14.3537119	102.8785913
BRLS0003	48P	273629	1585392	14.3312859	102.9011659	BRLS0048	48P	272994	1587898	14.3538770	102.8950698
BRLS0004	48P	262913	1587754	14.3517276	102.8016535	BRLS0049	48P	271664	1588322	14.3575982	102.8827072
BRLS0005	48P	266649	1582178	14.3016656	102.8367603	BRLS0050	48P	272629	1588039	14.3551209	102.8916750
BRLS0006	48P	263277	1588187	14.3556710	102.8049888	BRLS0051	48P	275196	1586472	14.3411725	102.9155975
BRLS0007	48P	263381	1588188	14.3556890	102.8059525	BRLS0052	48P	275131	1586140	14.3381673	102.9150228
BRLS0008	48P	272953	1588401	14.3584185	102.8946473	BRLS0053	48P	274303	1584055	14.3192603	102.9075240
BRLS0009	48P	265142	1589106	14.3641338	102.8221927	BRLS0054	48P	269578	1583981	14.3182019	102.8637455
BRLS0010	48P	267082	1586847	14.3438878	102.8403687	BRLS0055	48P	269740	1584341	14.3214681	102.8652159
BRLS0011	48P	266910	1588231	14.3563781	102.8386547	BRLS0056	48P	272665	1588788	14.3618915	102.8919453
BRLS0012	48P	265580	1586482	14.3404628	102.8264809	BRLS0057	48P	269226	1585628	14.3330538	102.8603426
BRLS0013	48P	266140	1585347	14.3302553	102.8317692	BRLS0058	48P	272291	1585080	14.3283568	102.8887928
BRLS0014	48P	262748	1588153	14.3553183	102.8000892	BRLS0059	48P	271801	1588841	14.3622990	102.8839328
BRLS0015	48P	267401	1587721	14.3518116	102.8432494	BRLS0060	48P	268883	1588364	14.3577459	102.8569289
BRLS0016	48P	267744	1587840	14.3529157	102.8464179	BRLS0061	48P	273406	1586644	14.3425802	102.8989939
BRLS0017	48P	267430	1587795	14.3524826	102.8435118	BRLS0062	48P	270385	1589636	14.3693645	102.8707409
BRLS0018	48P	264524	1591074	14.3818622	102.8162924	BRLS0063	48P	270336	1588621	14.3601895	102.8703735
BRLS0019	48P	266653	1584367	14.3214441	102.8366079	BRLS0064	48P	266352	1590129	14.3734797	102.8333181
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BRLS0021	48P	264052	1587468	14.3492412	102.8122343	BRLS0066	48P	266963	1586762	14.3431098	102.8392732
BRLS0022	48P	264221	1587330	14.3480088	102.8138126	BRLS0067	48P	266792	1586862	14.3439989	102.8376798
BRLS0023	48P	266147	1587520	14.3498895	102.8316452	BRLS0068	48P	264260	1587478	14.3493493	102.8141611
BRLS0024	48P	274853	1579282	14.2761776	102.9130188	BRLS0069	48P	265765	1590197	14.3740442	102.8278716
BRLS0025	48P	274702	1579352	14.2767978	102.9116140	BRLS0070	48P	265980	1587099	14.3460715	102.8301341
BRLS0026	48P	265459	1581943	14.2994417	102.8257546	BRLS0071	48P	266083	1585957	14.3357620	102.8311880
BRLS0027	48P	272557	1586888	14.3447150	102.8911050	BRLS0072	48P	265716	1584916	14.3263252	102.8278775
BRLS0028	48P	272323	1586903	14.3448313	102.8889351	BRLS0073	48P	266911	1586449	14.3402774	102.8388184
BRLS0029	48P	273113	1584660	14.3246295	102.8964457	BRLS0074	48P	266835	1588700	14.3606093	102.8379189
BRLS0030	48P	273689	1587191	14.3475459	102.9015706	BRLS0075	48P	266900	1588759	14.3611479	102.8385162
BRLS0031	48P	266688	1588593	14.3596301	102.8365658	BRLS0076	48P	267873	1587513	14.3499720	102.8476417
BRLS0032	48P	268270	1587824	14.3528154	102.8512942	BRLS0077	48P	265524	1587626	14.3507943	102.8258623
BRLS0033	48P	265865	1582546	14.3049243	102.8294641	BRLS0078	48P	265807	1588984	14.3630881	102.8283666
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BRLS0035	48P	275508	1603841	14.3447982	102.8460785	BRLS0080	48P	267076	1586663	14.3422248	102.8403290
BRLS0036	48P	263400	1588452	14.3580759	102.8061054	BRLS0081	48P	265086	1591559	14.3862923	102.8214590
BRLS0037	48P	274409	1582895	14.3087876	102.9086034	BRLS0082	48P	265138	1591259	14.3835862	102.8219672
BRLS0038	48P	263434	1591794	14.3882739	102.8061259	BRLS0083	48P	268599	1584366	14.3215987	102.8546406
BRLS0039	48P	274938	1582906	14.3089300	102.9135043	BRLS0084	48P	266250	1582351	14.3031950	102.8330483
BRLS0040	48P	272840	1588408	14.3584724	102.8935994	BRLS0085	48P	265768	1585221	14.3290854	102.8283329
BRLS0041	48P	271877	1586992	14.3455986	102.8847942	BRLS0086	48P	266654	1587698	14.3515407	102.8363284
BRLS0042	48P	271940	1586775	14.3436431	102.8853964	BRLS0087	48P	266935	1587945	14.3537961	102.8389112
BRLS0043	48P	273136	1587827	14.3532471	102.8963918	BRLS0088	48P	268451	1590965	14.3812106	102.8527008
BRLS0044	48P	271292	1586115	14.3376260	102.8794471	BRLS0089	48P	264920	1590853	14.3798993	102.8199822
BRLS0045	48P	272125	1587939	14.3541757	102.8870123	BRLS0090	48P	265171	1590123	14.3733250	102.8223725

Table 1 (continued)

ตำแหน่ง	พิกัดตำแหน่งที่ตั้ง			**Decimal Degrees**	
	Zone	X	Y	Latitude	Longitude
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BRLS0092	48P	264195	1588976	14.3628784	102.8134273
BRLS0093	48P	264992	1591931	14.3896453	102.8205551
BRLS0094	48P	263371	1587238	14.3471048	102.8059435
BRLS0095	48P	264666	1591973	14.3899969	102.8175297
BRLS0096	48P	265338	1591868	14.3891056	102.8237677
BRLS0097	48P	264215	1591717	14.3876453	102.8133718
BRLS0098	48P	265032	1582597	14.3053145	102.8217413
BRLS0099	48P	267027	1586136	14.3374591	102.8399205
BRLS0100	48P	267460	1587854	14.3530183	102.8437847
BRLS0101	48P	267192	1587343	14.3483786	102.8413452
BRLS0102	48P	267219	1587285	14.3478568	102.8416004
BRLS0103	48P	267425	1587906	14.3534851	102.8434558
BRLS0104	48P	267226	1587445	14.3493031	102.8416514
BRLS0105	48P	267222	1587391	14.3488148	102.8416190
BRLS0106	48P	264791	1588878	14.3620439	102.8189596
BRLS0107	48P	265157	1588588	14.3594549	102.8223770
BRLS0108	48P	265977	1589946	14.3717944	102.8298584
BRLS0109	48P	263735	1587945	14.3535238	102.8092546
BRLS0110	48P	264301	1588133	14.3552708	102.8144836
BRLS0111	48P	273377	1587945	14.3543332	102.8986155
BRLS0112	48P	265353	1588995	14.3631489	102.8241580
BRLS0113	48P	265224	1588919	14.3624512	102.8229690
BRLS0114	48P	263281	1587004	14.3449829	102.8051300
BRLS0115	48P	264435	1588830	14.3615798	102.8156644
BRLS0116	48P	264516	1589750	14.3698990	102.8163344
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BRLS0120	48P	265431	1589681	14.3693537	102.8248210
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BRLS0126	48P	273015	1585972	14.3364761	102.8954269
BRLS0127	48P	273061	1585435	14.3316278	102.8958985
BRLS0128	48P	273954	1586764	14.3437094	102.9040625
BRLS0129	48P	271979	1586104	14.3375835	102.8858147
BRLS0130	48P	272945	1584146	14.3199713	102.8949321
BRLS0131	48P	274117	1587339	14.3489183	102.9055249
BRLS0132	48P	272579	1586572	14.3418616	102.8913356
BRLS0133	48P	272348	1586082	14.3374151	102.8892363
BRLS0134	48P	266423	1586902	14.3443291	102.8342567
BRLS0135	48P	266525	1587104	14.3461628	102.8351845
BRLS0136	48P	265852	1582460	14.3041462	102.8293511
BRLS0137	48P	266906	1582846	14.3077228	102.8390838
BRLS0138	48P	268598	1584916	14.3265681	102.8545841
BRLS0139	48P	268430	1584313	14.3211057	102.8530791
BRLS0140	48P	272263	1586822	14.3440944	102.8883859
BRLS0141	48P	266678	1583224	14.3111189	102.8369385
BRLS0142	48P	266903	1583037	14.3094483	102.8390395
BRLS0143	48P	266915	1582902	14.3082295	102.8391624
BRLS0144	48P	266306	1587017	14.3453582	102.8331624
BRLS0145	48P	266279	1586799	14.3433862	102.8329312
BRLS0146	48P	273040	1587964	14.3544771	102.8954905
BRLS0147	48P	265366	1589257	14.3655172	102.8242556
BRLS0148	48P	266270	1585497	14.3316216	102.8329608
BRLS0149	48P	266462	1585547	14.3320896	102.8347357
BRLS0150	48P	265623	1589466	14.3674274	102.8266193
BRLS0151	48P	273507	1586675	14.3428686	102.8999273
BRLS0152	48P	274000	1585358	14.3310090	102.9046069
BRLS0153	48P	264773	1588996	14.3631085	102.8187824
BRLS0154	48P	265019	1587619	14.3506881	102.8211828
BRLS0155	48P	264812	1588359	14.3573564	102.8191996
BRLS0156	48P	265692	1586141	14.3373913	102.8275486
BRLS0157	48P	264830	1582035	14.3002196	102.8199186

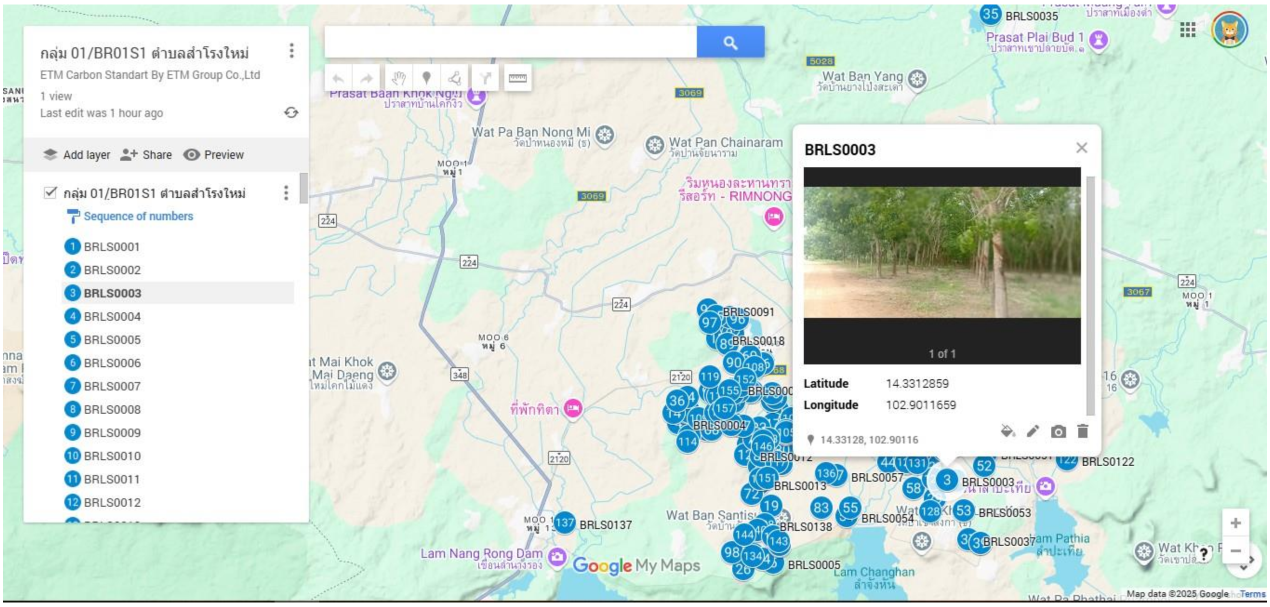


Figure 8 *shows the location of the reference pin, for example, member BRLS0003 (data from google.com/maps/d/).*

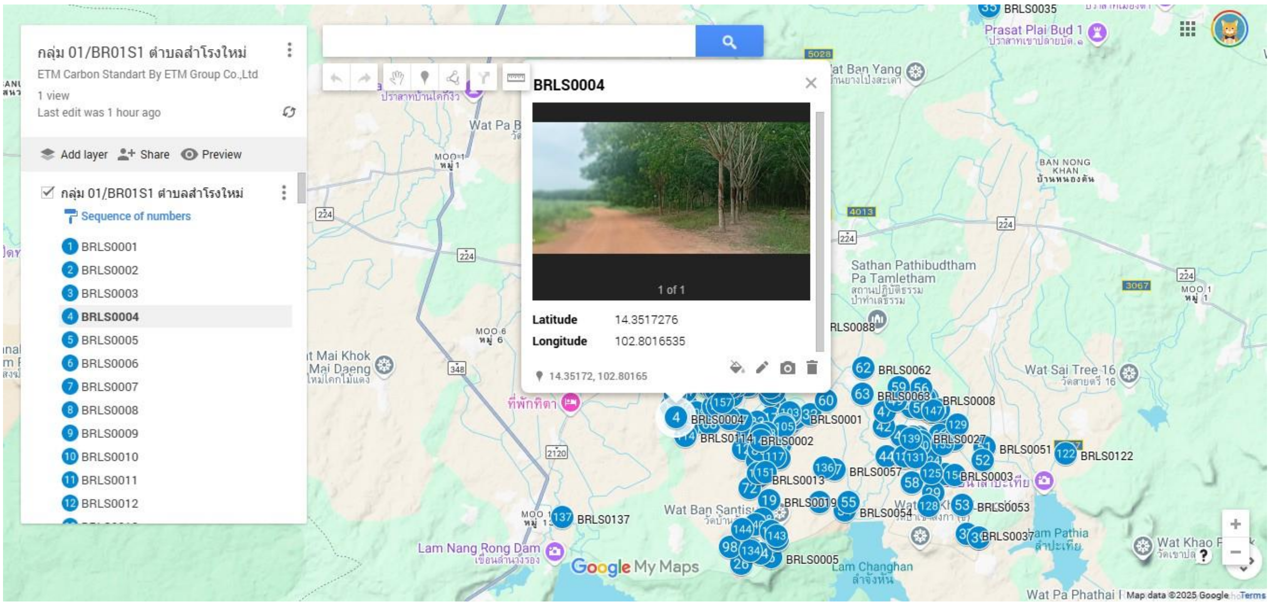


Figure 9 *shows the location of the reference pin, for example, member BRLS0004 (data from google.com/maps/d/).*

2.5.3 Topographical characteristics

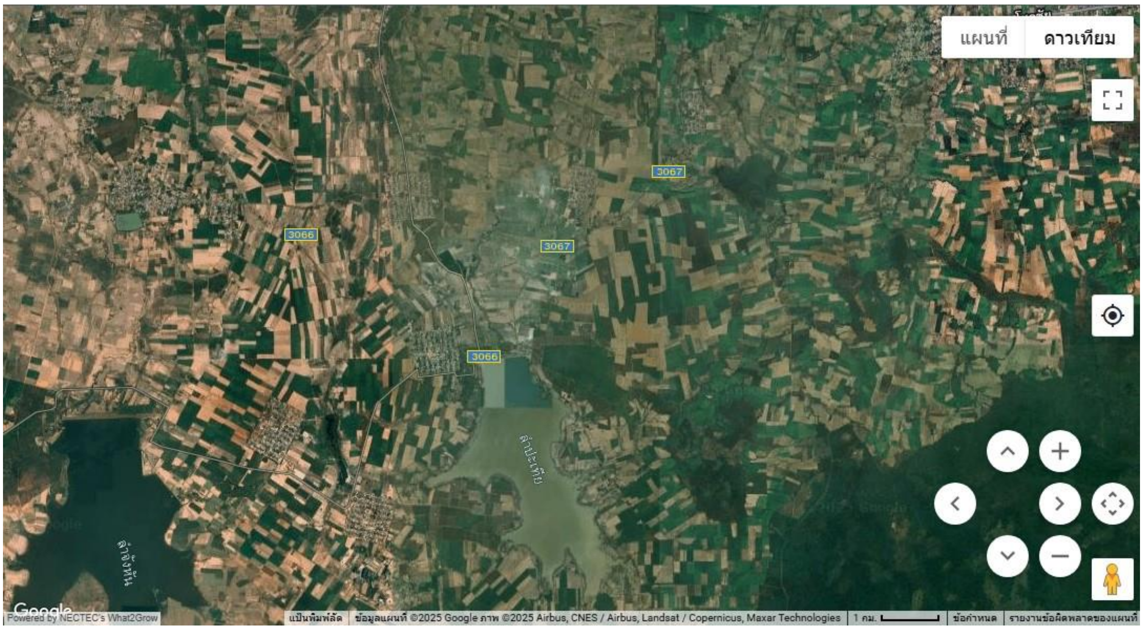


***Figure 10** shows the topography in Samrong Mai Subdistrict, Lahan Sai District, Buriram Province (from the website of the Land Development Department : Agri-Map).*

2.5.4 Climate characteristics

Annual rainfall and average temperature in Buriram Province. Data collected from various sources show the climate of Buriram Province over the past 5 years as follows:

1. Total Annual Rainfall

The average annual rainfall in Buriram Province is approximately **1,188.2 mm** (based on the Meteorological Department's climate statistics for the past 30 years, 1971-2000). Annual rainfall data in the past (from various sources) are as follows:

Year B.E.	Total rainfall (mm)	Sources (approximate)
2018	773.5	Meteorological Department, Nang Rong District (10 years of historical data)
2019	(No direct information found)	
2020	(No direct information found)	
2021	1,623.7	Educational information report, Buriram Province
2022	1,564.2	Educational information report, Buriram Province
2023	2,045.3	Educational information report, Buriram Province (Note: abnormally high value)

Notes The rainfall in 2023 , which was stated to be 2,045.3 millimeters, is significantly higher than normal compared to other years and the long-term average, and may be due to severe storms or is a value that requires further verification.

2. Average Annual Temperature

The average temperature of Buriram Province is generally in the range **Approximately 27-28 degrees Celsius** (referring to the Meteorological Department's climate statistics). Average annual temperature data in the past (from various sources) is as follows:

Year B.E.	Average temperature (°C)	Sources (approximate)
2014	24.65	Nang Rong Meteorological Station
2015	27.60	Nang Rong Meteorological Station
2016	27.80	Nang Rong Meteorological Station
2017	(No direct information found)	
2018	27.24	Information from the Buriram Provincial Development Plan
2019	28.08	Information from the Buriram Provincial Development Plan
2020	27.49	Information from the Buriram Provincial Development Plan
2024	Approximately 28.7-30.8	Monthly average temperature (Oct. 2024 - Apr. 2025 from E-Report)

Average temperature for the last 5 years (2018-2020) From the available data: (27.24 + 28.08 + 27.49) / 3 = **27.60 °C** (There is still a lack of complete data for 2021-2025 in a single source)

Notes Data on average annual temperatures for the past five years are not available from a single source, but the available data show that Buriram's average annual temperature is relatively stable, ranging from 27 to 28 °C , with seasonal fluctuations (summer temperatures exceeding 30 °C and winter lows of 13 to 19 °C).

2.5.5 Soil characteristics and soil resources

Soil characteristics in Buriram Province, especially agricultural areas and rubber plantations, generally found that soil in the northeastern region of Thailand, including Buriram Province, has important characteristics, namely: **Korat series** Which is soil developed from sandstone sediment or sandy loam soil. and is often found in plateau-like terrain that has undulating features. The characteristics of the Khorat soil series and related soils in the Buriram area are:

1. Soil Texture The soil is mostly sandy loam or loamy sand to sandy clay loam, which means it has a relatively high sand content.

2. Acidity-alkalinity (pH) Soils tend to be moderately to strongly acidic (low pH).

3. Soil fertility (Fertility) In general, soil in the Northeastern region, including Buriram, has low to moderate fertility. Because it contains relatively little amount of organic matter and essential plant nutrients (such as nitrogen, phosphorus, potassium).

4. Drainage Sandy loam soils tend to have good drainage. This is good for plants whose roots do not like standing water, but it can easily lose nutrients when there is heavy rain.

Potential for rubber plantation Rubber trees can be grown in well-drained sandy loam soils. However, due to their low fertility, they require proper soil management, such as the addition of organic and chemical fertilizers, to ensure good yields.

Relevance to carbon capture projects

Low organic matter content The soil has low organic matter in its natural state. This presents a great opportunity for Soil Carbon Sequestration projects. Sustainable rubber plantation management, such as not burning crop residues , mulching , composting, or using Biochar, can significantly increase the amount of organic matter and carbon in the soil.

Soil structure improvement Adding organic matter improves the structure of sandy loam soil, increasing its water holding capacity and nutrient exchange, which is beneficial for the long-term growth of rubber trees.

In conclusion, soils in rubber plantations in Buriram Province are typically sandy loam soils with low acidity and fertility, requiring sustainable soil management to enhance their carbon sequestration potential and long-term productivity.

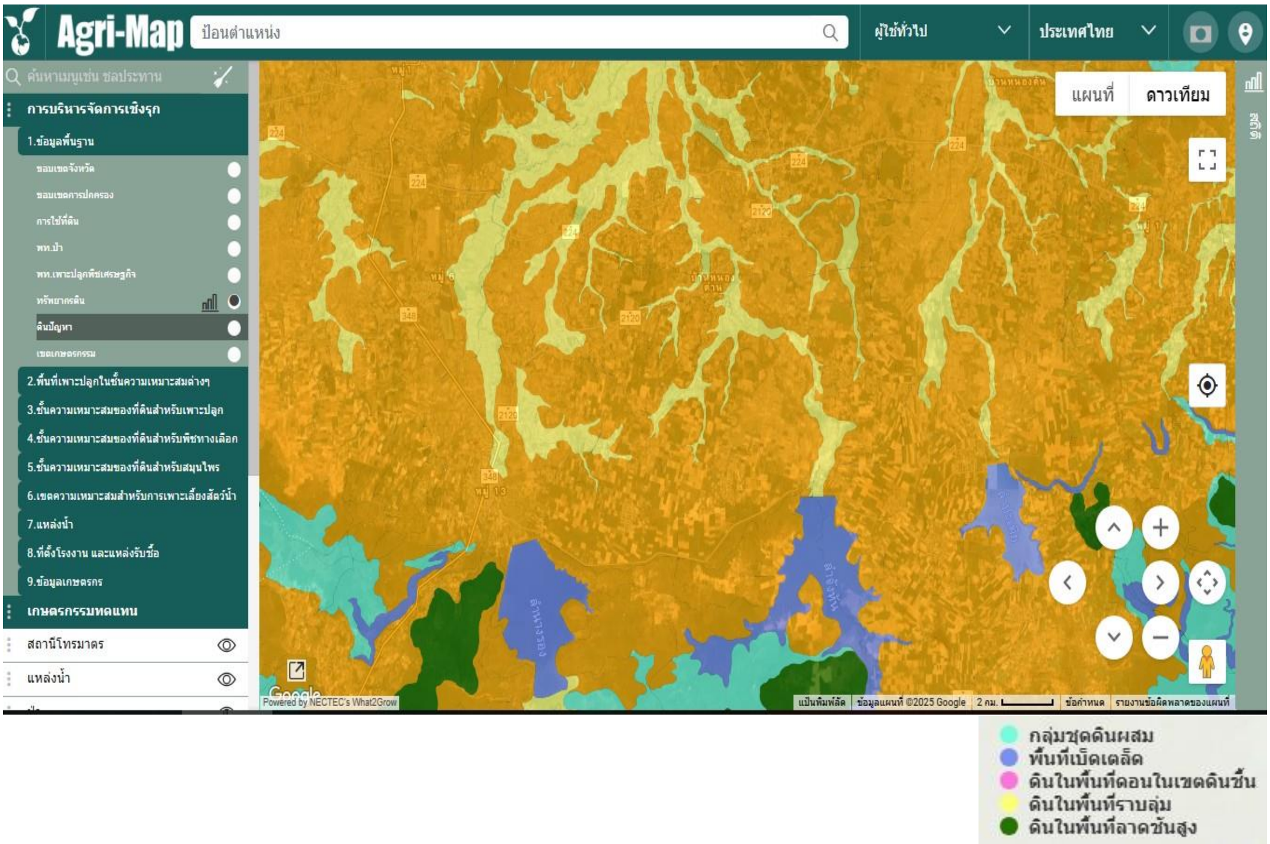


***Figure 12** shows the characteristics of the soil series (from the website of the Land Development Department : Agri-Map).*

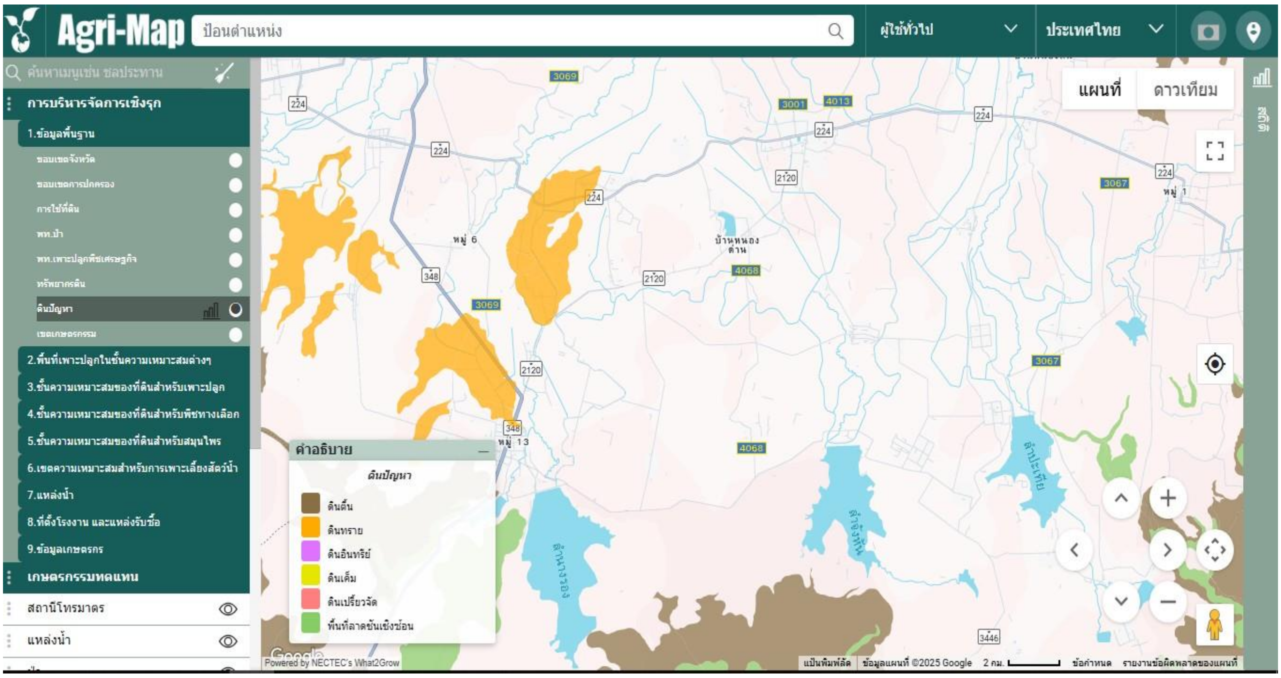


***Figure 13** shows the soil characteristics and slope (from the website of the Land Development Department : Agri-Map).*

2.5.6 Water resources

1. Topography and main water sources

Buriram Province is located in the lower northeastern region of Thailand. Its topography is a plateau and rugged terrain. Important rivers flow through it, including: **Mun River** and **Chi River** These are the main water sources of the Northeastern region. However, these main rivers are often located far from small farmland and access to water depends more on local water sources. For Lahansai District, which is located in the south of Buriram Province, close to the Phanom Dong Rak mountain range, the water sources in the area include:

surface water sources

Stream/Canal There are small streams and canals that may have water only during the rainy season or may have water all year round in some periods.

Reservoir/Marsh/Swamp Each sub-district and village usually has a small reservoir, pond or natural lake that is used to store rainwater or water flowing from higher areas for local consumption and agriculture.

Rainwater It is the main water source for agriculture in the Northeastern region. Buriram is also influenced by the southwest monsoon during the rainy season (approximately mid-May - mid-October). The average annual rainfall in Buriram is approximately **1,188.2 mm**

Underground water sources

groundwater Some farmers may rely on groundwater for agriculture, especially during the dry season when surface water supplies are depleted. However, the quantity and quality of groundwater can vary from one sub-region to another.

2. Water use in rubber plantations

Rubber plantations generally rely primarily on rainfall, but supplementary irrigation is important during the dry season or early planting period. Effective water management helps rubber trees grow well and produce consistent yields.

High water demand period Rubber trees require a lot of water during the dry season to maintain growth and latex production.

Supplementary watering During the dry season or drought, farmers may have to use water from local water sources (reservoirs , canals , artesian wells) to supplement the water supply to the rubber trees.

In conclusion, the rubber plantation site in Samrong Mai Subdistrict, Lahan Sai District, Buriram Province relies primarily on rainfall, along with small surface water sources and groundwater. Implementing the project with sustainable management practices will help reduce the risk of chemical contamination and promote the conservation of local water resources.

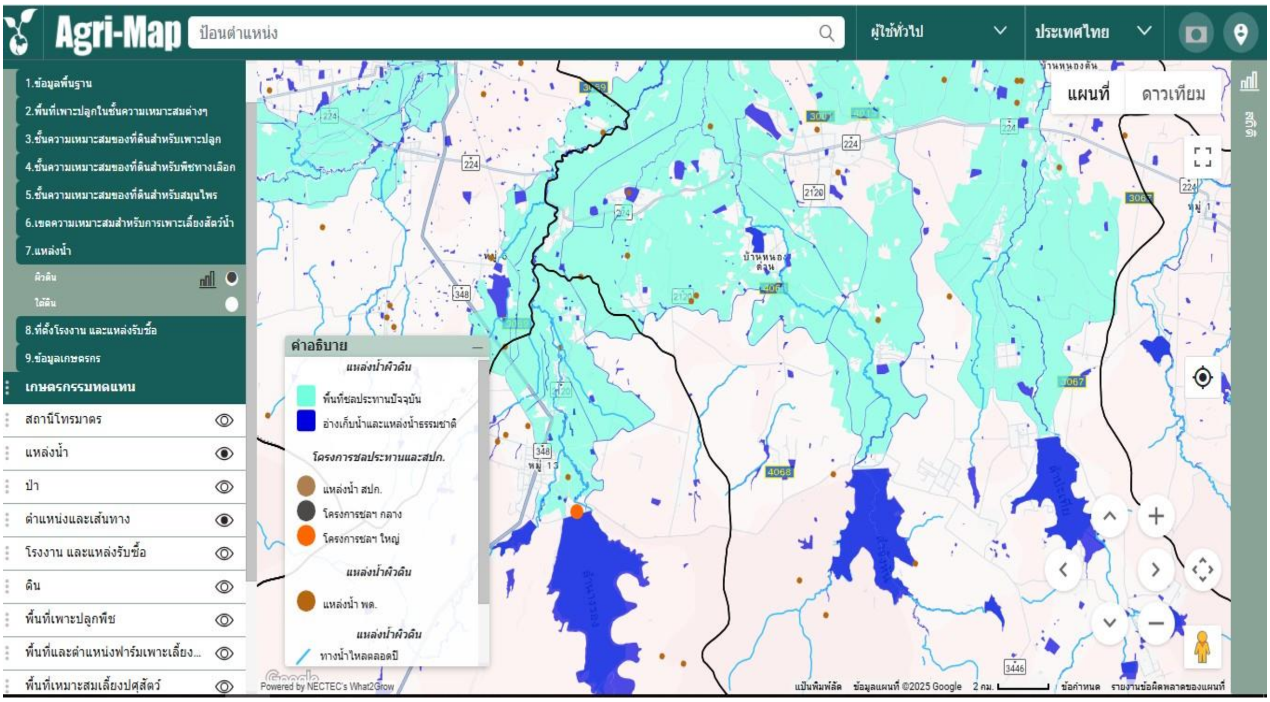


Figure 14 *shows water sources in the area (from the website of the Land Development Department : Agri-Map).*

2.5.8 Land use in the area of the Buriram Provincial Land Reform Office (PLRO)

1. Overview of land use in Buriram Province Buriram Province is a province in the lower northeastern region with a vast area and diverse land uses, mostly focused on agriculture.

agricultural areas It is the main land use of the province, especially for growing rice, cassava, sugarcane and **rubber** Most rice farming is rain-fed.

Forest area There are some forest areas, especially in the Phanom Dong Rak mountain range in the southern part of the province (where Lahansai District is located).

Community areas and buildings It is home to cities, communities and various infrastructures.

2. Land use for rubber plantations in Buriram

Expansion of area Over the past several years, Buriram Province has continuously expanded its rubber plantation area as it is an important economic crop in the Northeastern region. **Buriram currently has approximately 227,180 rai of rubber plantation area.** which is ranked among the top 10 provinces with the largest rubber plantation areas in the Northeastern region **(Reference Document 4)**

ตารางแสดงพื้นที่ปลูกยางพารา แยกตามเขตเหมาะสมพืชเศรษฐกิจยางพาราระดับภาค

คำอธิบาย	เนื้อที่ (ไร่)					
	ภาคเหนือ	ภาคกลาง	ภาคตะวันออก	ภาคตะวันออกเฉียงเหนือ	ภาคใต้	รวมทั้งหมด
พื้นที่มีความเหมาะสมสูง	59,863	31,378	229,549	375,475	5,040,899	**5,737,164**
พื้นที่มีความเหมาะสมปานกลาง	220,878	152,233	843,564	884,993	4,792,206	**6,893,874**
พื้นที่มีความเหมาะสมเล็กน้อย	230,212	164,249	805,641	2,805,084	1,996,460	**6,001,646**
พื้นที่ไม่เหมาะสม	77,861	28,017	121,086	60,211	1,970,992	**2,258,167**
พื้นที่เขตป่าไม้	383,282	147,046	483,672	521,596	2,581,845	**4,117,441**
รวมทั้งหมด	**972,096**	**522,923**	**2,483,512**	**4,647,359**	**16,382,402**	**25,008,292**

ที่มา กรมพัฒนาที่ดิน 2554 (ปรับปรุง ณ วันที่ 5 กรกฎาคม 2556)

หมายเหตุ วิเคราะห์คุณภาพที่ดินตามปัจจัยคุณภาพที่ดินตามความต้องการของยางพารา 13 ปัจจัย ตามหลักการณ์ของ FAO ดังนี้

1. ความเข้มของแสงอาทิตย์ (Radiation regime)
2. ระบอบอุณหภูมิ (Temperature regime)
3. ความชุ่มชื้นที่เป็นประโยชน์ต่อพืช (Moisture availability)
4. ความเป็นประโยชน์ของอ็อกซิเจนต่อรากพืช (Oxygen availability)
5. ความเป็นประโยชน์ของธาตุอาหาร (Nutrient availability)
6. ความจุในการดูดยึดธาตุอาหาร (Nutrient retention capacity)
7. สภาวะการหยั่งลึกของราก (Rooting conditions)
8. ความเสียหายจากน้ำท่วม (Flood hazard)
9. การมีเกลือมากเกินไป (Excess of salts)
10. สารพิษ (Soil toxicities)
11. สภาวะการเขตกรรม (Soil workability)
12. ศักยภาพการใช้เครื่องจักร (Potential for mechanization)
13. ความเสียหายจากการกัดกร่อน (Erosion hazard)

***Table 2** shows the rubber plantation area divided by the appropriate zone for rubber economic crops at the regional level.*

From Table 2, it was found that the land quality analysis based on 13 land quality factors according to rubber demand according to FAO principles.

From forest to rubber plantation In the past, some rubber plantation expansion may have occurred on areas that were once forested or encroached, raising concerns about deforestation and its impact on the ecosystem.

Monoculture rubber plantation Most rubber plantations in Thailand, including in Buriram, are monocultures, which has resulted in a decrease in biodiversity in the area.

3. Land use in the project area (Samrong Mai Subdistrict, Lahan Sai District) For Samrong Mai Subdistrict, Lahan Sai District, which is located in the southern part of Buriram Province, near the Phanom Dong Rak mountain range, it is expected that the main land uses are:

rubber plantation It is the main land use in the project area.

Other agricultural areas Other crops or vegetables may be grown alongside it.

Some forest areas There may be some scattered areas of forest or degraded forest, especially in areas near mountain ranges.

In summary, land use within the project area in Buriram Province is primarily rubber plantations, and the project has high potential to improve these land uses to be more environmentally friendly and sustainable.

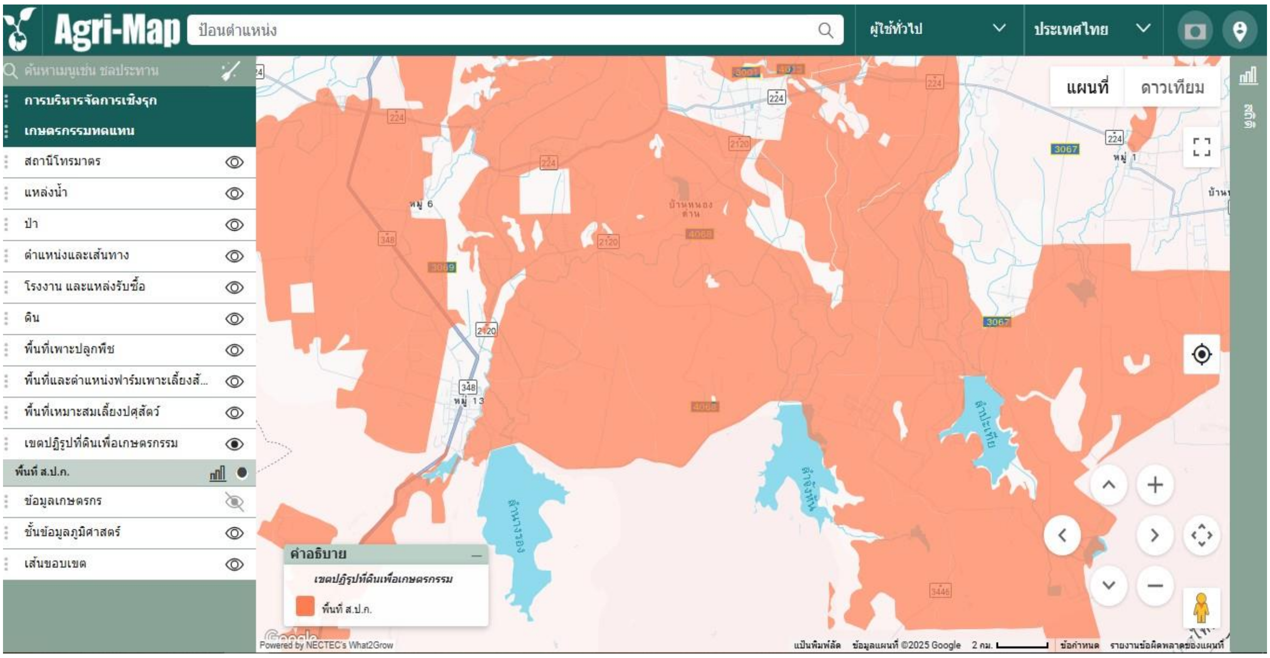


Figure 15 *shows the agricultural land reform area (from the website of the Department of Land Development : Agri-Map).*

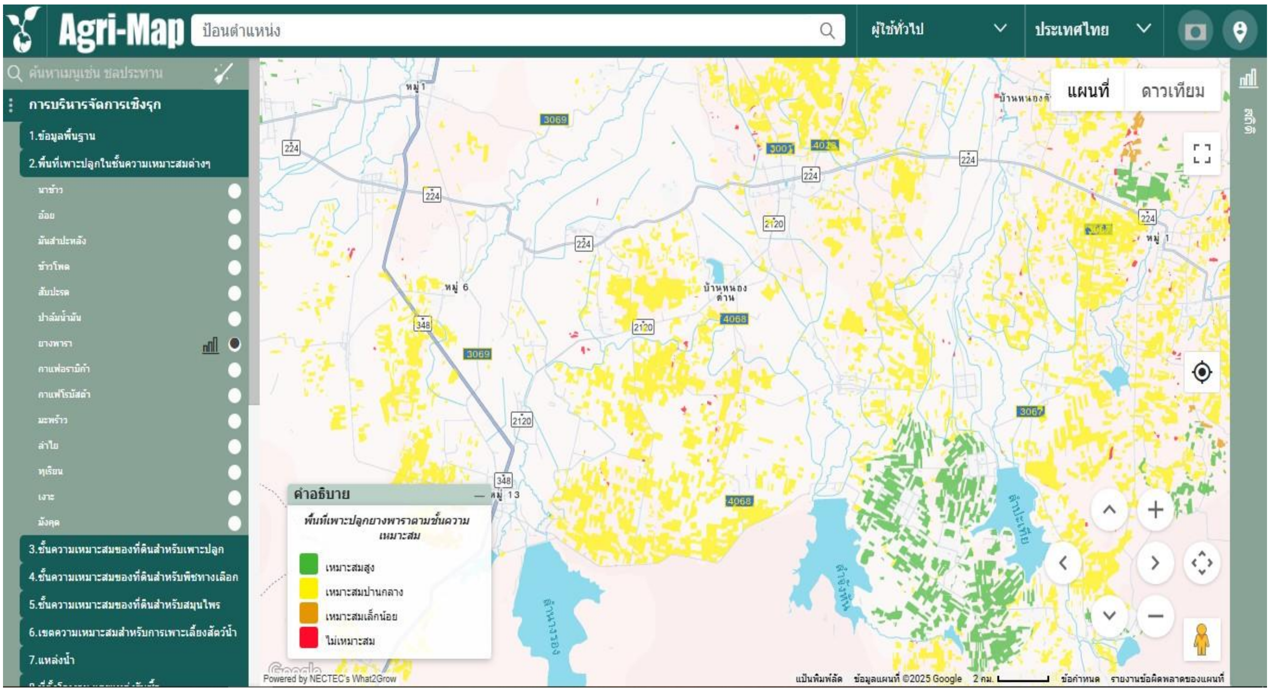


Figure 16 *shows the rubber plantation area according to suitability levels (from the website of the Land Development Department : Agri-Map).*

3. Sustainable project management operations under the Carbon Capture and Greenhouse Gas Emission Reduction Project in Rubber Plantations, Buriram Province

The implementation of the carbon capture and greenhouse gas emission reduction project in a rubber plantation in Buriram Province is not limited to achieving greenhouse gas reduction targets. It also aims to serve as a model for sustainable project management in all dimensions, encompassing environmental, social, and economic aspects. This report aims to present guidelines and proposals for project management operations that reflect comprehensive responsibility and integrate technologies for maximum sustainability.

1. Environmental Sustainability Management

Environmental project management focuses on reducing negative impacts and creating positive impacts on natural resources and ecosystems in the project area, in accordance with the principles of **ETM CARBON TRADE Standard** (ECT) and **Good Agricultural Practices (GAP)**

1.1 Greenhouse gas reduction and management (GHG Reduction & Management)

Promoting non-burning Set as a main policy and strictly control the cessation of burning of agricultural waste (rubber leaves, branches, weeds) in all plots participating in the project to reduce the emission of CO2, CH4, N2O, PM2.5 and black carbon into the atmosphere.

Increasing carbon sequestration Promote practices that increase carbon sequestration in rubber tree biomass (Above-ground & Below-ground Biomass) and soil (Soil Organic Carbon), such as canopy management, cover crops, and biochar production and use.

Efficient fertilizer management Provide knowledge and promote the appropriate use of chemical fertilizers (Right Source, Right Rate, Right Time, Right Place) and support the use of organic/biological fertilizers to reduce N2O emissions from nitrogen fertilizer use.

1.2 Biodiversity Conservation

Promote agroforestry systems Encourage farmers to plant a variety of intercrops (e.g. vegetables , fruits , perennials) in rubber plantations to increase the complexity of the ecosystem, create habitats and food for micro-organisms, pollinators and birds.

Reduce the use of chemicals Provide knowledge and support to reduce reliance on herbicides and pesticides, emphasizing Integrated Pest Management (IPM) and the use of biological agents to reduce the impact on soil and aquatic life.

1.3 Soil & Water Resource Management

Improving soil health Promote the increase of organic matter in the soil through mulching, composting and the use of Biochar , which improves soil structure, water and nutrient holding capacity.

Reduce erosion Establish guidelines for preventing soil erosion, such as planting ground cover plants, building embankments, or managing waterways appropriately.

Water quality management Promote the use of environmentally friendly latex coagulants (such as formic acid) to reduce wastewater contamination and provide knowledge on effective water management for agriculture.

1.4 Waste & Pollution Management

Waste reduction at the source Promote the reuse of agricultural waste materials instead of throwing them away or burning them.

Hazardous Chemical Management Establish procedures for storing, using and disposing of chemical containers correctly and safely according to the principles **Hazardous Substances Act B.E. 1992**

2. Social aspect (Social Sustainability Management)

Social project management focuses on improving the quality of life, promoting participation and creating fairness for farmers and local communities.

2.1 Improved Livelihoods & Well-being

Health and safety Provide training and promote safe work practices, including the correct use and management of chemicals according to principles. **Occupational Safety, Health**

and Working Environment Act B.E. 2011 and **ISO 45001** To reduce the health risks of farmers from exposure to chemicals and air pollution.

food security Support the intercropping of diverse crops to increase household food sources and create food security.

Environmental quality in the community Improving air quality (reducing PM2.5 from burning), soil and water quality results in a better living environment for communities, reducing the risk of public health problems, according to the principles. **Public Health Act B.E. 1992**

2.2 Participation & Capacity Building

Ongoing consultation Regularly hold meetings and listen to feedback from farmers and stakeholders to ensure the project addresses their needs and concerns.

Training and knowledge transfer Organize a comprehensive training program covering sustainable rubber plantation management , technology use (Blockchain, digital data recording), and financial management, including knowledge about the carbon market.

Promote group integration Encourage farmers to form groups to build networks, exchange knowledge, and increase their bargaining power in the market.

2.3 Equity & Benefit Sharing

Transparent benefit-sharing mechanism Establish clear and fair proportions and methods for sharing revenue from carbon credit sales among farmers, using blockchain and cryptocurrency platforms to ensure transparent, verifiable, and rapid profit distribution.

Non-discrimination Ensure that the selection of farmers to participate in the project and the benefit-receiving mechanisms are fair and non-discriminatory.

3. Economic Sustainability Management

Economic project management focuses on creating sustainable income, value and new business opportunities for farmers and local communities.

3.1 Income Generation & Cost Reduction

Carbon credit income Efficiently manage the trading of carbon credits generated from the project to create stable and sustainable additional income for farmers.

Income from intercropping Support intercropping that can increase production and diversify income sources, reducing reliance on rubber alone.

Reduce production costs Promote practices that reduce reliance on chemicals (fertilizers , herbicides) and efficient waste management, which will reduce farmers' production costs in the long term.

Add value to products Promote the improvement of rubber quality through sustainable management (e.g. the use of formic acid) so that it can be sold at higher prices in the premium market.

3.2 Market Access & Investment

Access to carbon markets Manage a blockchain platform to enable smallholder farmers to access national and international carbon markets efficiently and transparently.

Investment attraction Present sustainable and technologically supported projects to attract green investors and responsible carbon credit buyers.

Value Added Creation Build the brand and credibility of "Buriram Sustainable Rubber" to reach the high-demand sustainable agricultural product market.

4. Technological and Innovation Management

Technology integration is the key to driving sustainable project management across all dimensions.

4.1 Data Management with Blockchain

Record activity data Blockchain is used to record farmers' rubber plantation management activities (e.g., fertilizer use , waste management , intercropping), ensuring that the data is accurate, untraceable, and traceable.

Transparency of carbon transactions Record the issuance, trading, and offsetting of carbon credits on the blockchain for transparency and reliability, reducing the risk of double counting and fraud.

4.2 Satellite tracking and verification

Remote monitoring Use satellite imagery and geographic information (GIS) techniques to monitor land use change , biomass growth , and compliance with guidelines (e.g., no-burn) in large project areas, enhancing the accuracy and efficiency of monitoring.

Potential Assessment Using satellite data to assess the carbon sequestration potential and health of rubber plantations

4.3 Financial facilitation with Cryptocurrency

Distribution of benefits Use cryptocurrency as a mechanism to deliver financial benefits from selling carbon credits directly to farmers, quickly and transparently, reducing the steps and fees of middlemen.

Motivation Incentivize farmers to continue participating and following sustainable practices.

5. Governance & Transparency Management

Project management will adhere to the principles of good governance to build trust and credibility.

5.1 Clear responsibility structure Clearly define the roles, duties and responsibilities of the working group, project developers, project owners and farmers.

Compliance with laws and standards Carry out all activities in accordance with relevant laws and regulations of Thailand (e.g. Environmental Quality Promotion and Conservation Act , Safety Act, etc.) and international standards (e.g. ETM CARBON TRADE, ISO 14064, GAP).

Communication and reporting Prepare regular progress and performance reports and disseminate important information to all stakeholders in a transparent and easily understandable manner.

Inspection mechanism It has a strong internal control system (in accordance with the internal control system manual) and is prepared for audit and certification by an external, neutral agency.

6. Monitoring and Evaluation Management

Continuous monitoring and evaluation is essential to measure success and drive improvement.

Determination of indicators Establish clear and measurable success indicators for each dimension (environmental , social , economic , technological).

Data collection Using field surveys , digital platform data recording , and satellite data analysis to collect data accurately and systematically.

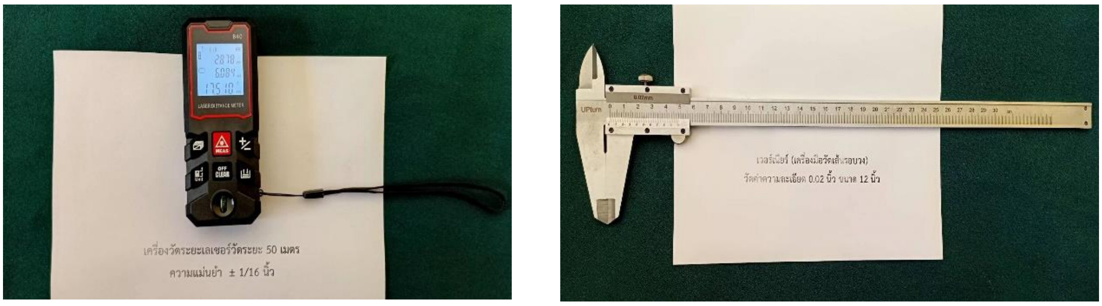


Figure 16*. Field survey data collection tools*

Data analysis Analyze the collected data to evaluate the project's success, identify joint benefits, and identify areas for improvement.

Continuous improvement The evaluation results are used to review operational plans and continuously improve strategies to enhance the project's long-term efficiency and sustainability.

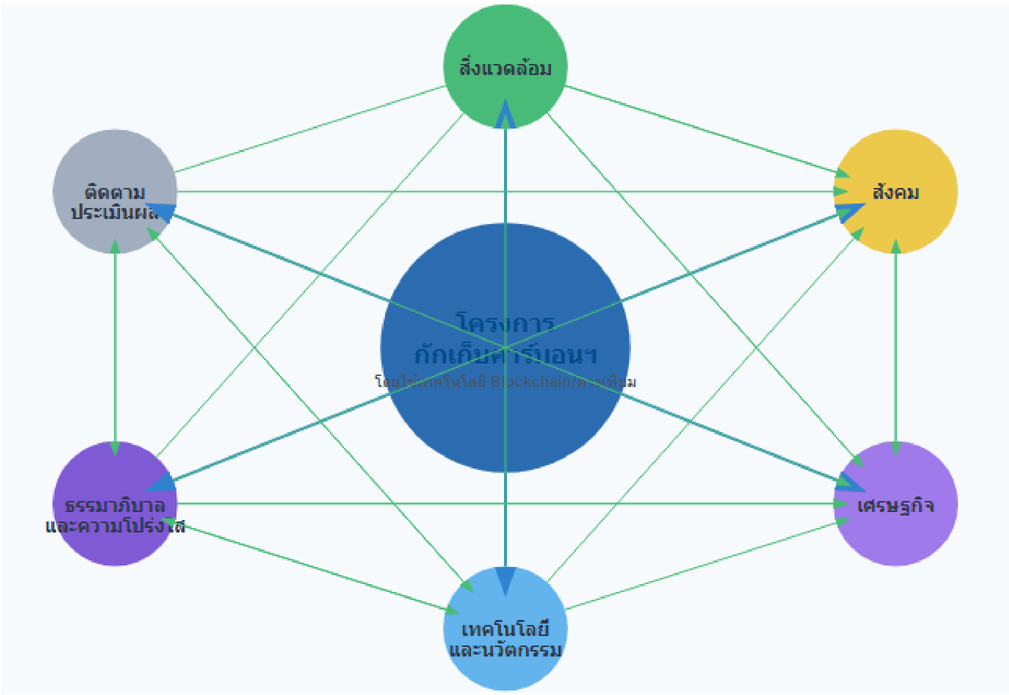


Figure 17 *shows the relationship of the project with 6 sustainability aspects by driving a holistic concept to create balance and maximum value in all dimensions.*

In summary, the management of the Carbon Capture and GHG Mitigation Project in a rubber plantation in Buriram Province is not merely a technical process. It demonstrates a commitment to creating truly sustainable value across all dimensions by integrating environmental, social, and economic practices with cutting-edge technology. The project exemplifies a development model that balances carbon returns, community benefits, and environmental conservation, the foundations for long-term sustainability.

4. Organizational structure

In the implementation of this project, the project implementation model is called the integrated or group model. Therefore, an Internal Control System Manual has been prepared for farmer groups to be applied as a guideline and clear requirements for rubber farmer groups participating in the project "Carbon Sequestration and Greenhouse Gas Emission Reduction in Rubber Plantations, Buriram Province" with the main objectives to:

Create mutual understanding To ensure that all parties involved, especially farmers, understand their roles and responsibilities and proper practices in accordance with ETM CARBON TRADE standards.

Promote compliance with laws and standards It is a tool for overseeing the project's operations to ensure compliance with relevant laws and regulations both at the national level and international standards on the environment, safety and greenhouse gas management.

Increase efficiency and reliability Establish an efficient, transparent and auditable management system to ensure that the amount of carbon credits generated is accurate and reliable.

Reduce risk Identify and manage potential risks arising from operations, including environmental, social, and financial risks.

Improving the quality of life and the environment Support operations that lead to co -benefits, including improved environment, better health of farmers and increased income.

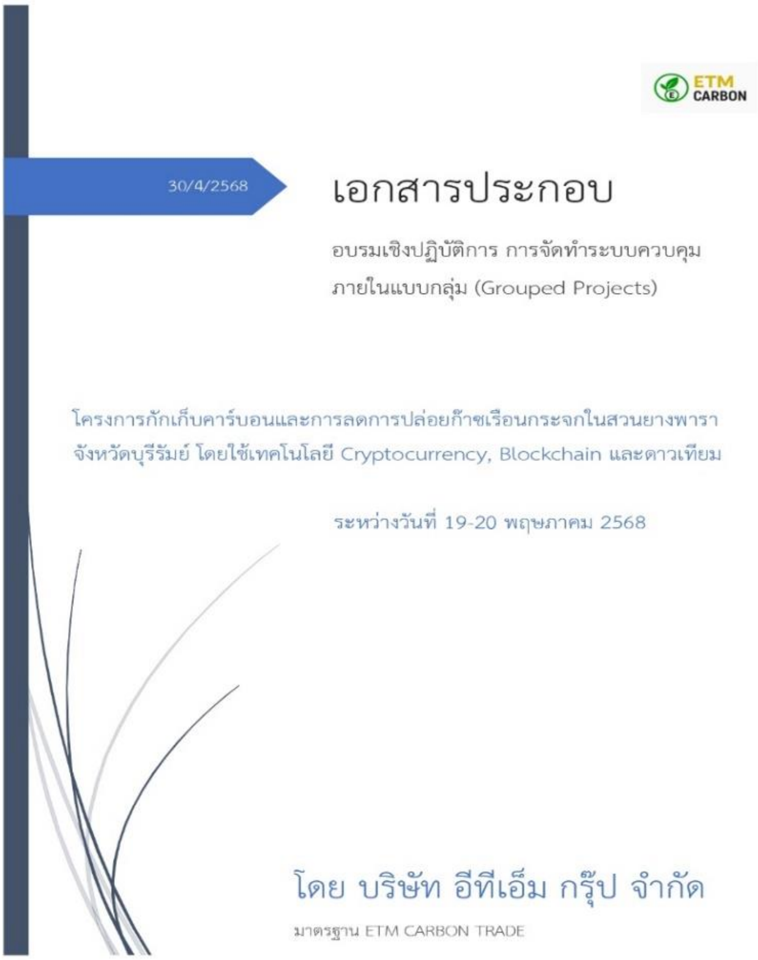


Figure 18 *shows an example of a group internal control system manual.*

This manual covers the fundamental principles, accountability structures, specific internal control processes, monitoring and evaluation mechanisms, and continuous improvement to ensure that projects achieve their objectives in a sustainable and exemplary manner.

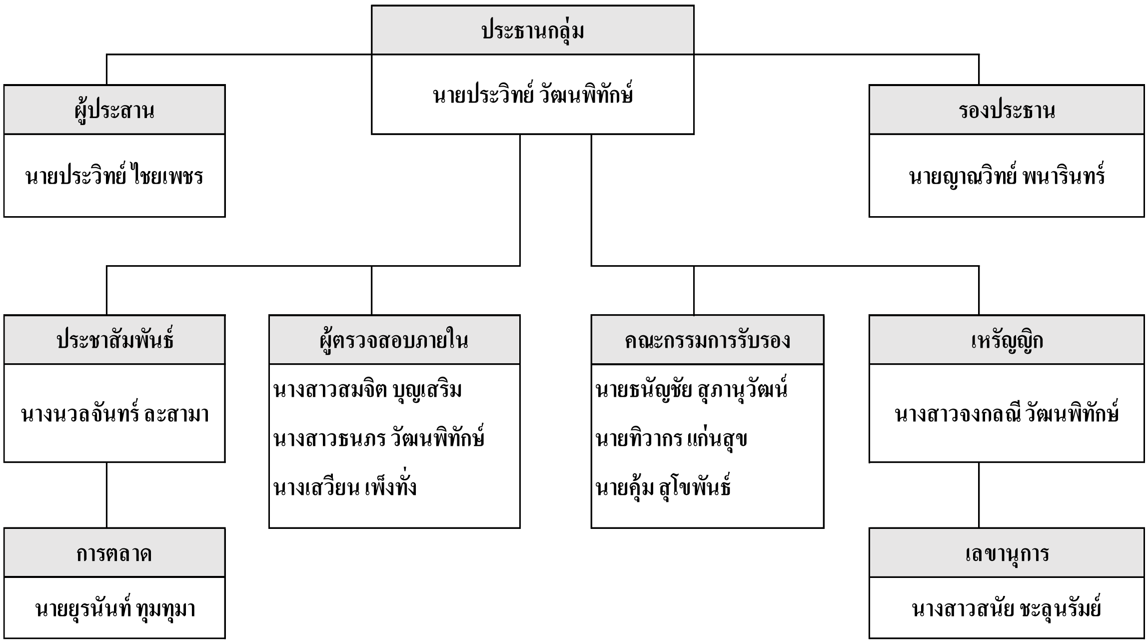


Figure 19 *Organizational structure*

With project conditions

(1) There is a document showing the legal right to use the land.

(2) It is an area where land use is appropriate for the land use zone.

(3) Not an area at risk of landslides.

(4) There is a record of data on the use of fertilizers and/or soil conditioners retrospectively in the project area or reference data from nearby areas retrospectively throughout the rubber tree's production life, with consideration of fertilizer use according to the age of the rubber tree at that time.

(5) In cases where there is no information on fertilizer use in Section (4), reference data from government agencies, values from research published in academic journals in the research database, or academic journals accepted by *ETM Carbon Trade Standard (ECT)* and which are values appropriate to the project area can be used.

(6) It is not an area where rubber trees have been cut down before the production cycle/cutting cycle has been completed in order to plant new rounds of perennial agricultural crops.

5. Project implementation area

5.1 Project operating area 01/BR01S1, Samrong Mai Subdistrict, Lahan Sai District, Buriram Province, has 131 members, 157 plots, total area 1,936.15 rai **(Details in table 2).**

Table 2 shows the plot code, area coordinates, age, number of planting areas, mean height (m), mean diameter (cm) , and aboveground biomass .

Case Processing Summaries Aboveground Biomass [a]

Case Number	Conversion Code	UTM X	UTM Y	Age	Rai	High (m)	DBH (cm)	AGB (Ton)
1	BRLS0001	267665	1587689	14	38.44	15	21.00	524
2	BRLS0002	265711	1586875	14	8.75	14	21.90	112
3	BRLS0003	273629	1585392	20	15.00	21	21.90	144
4	BRLS0004	262913	1587754	20	35.25	19	21.00	332
5	BRLS0005	266649	1582178	22	13.98	18	22.00	167
6	BRLS0006	263277	1588187	22	11.50	19	21.90	100
7	BRLS0007	263381	1588188	22	9.25	18	20.00	95
8	BRLS0008	272953	1588401	12	15.00	13	14.50	174
9	BRLS0009	265142	1589106	15	4.10	18	21.90	18
10	BRLS0010	267082	1586847	15	4.00	17	20.00	28
11	BRLS0011	266910	1588231	15	5.02	18	21.00	57
12	BRLS0012	265580	1586482	19	15.00	11	15.00	150
13	BRLS0013	266140	1585347	13	10.00	13	16.50	176
14	BRLS0014	262748	1588153	19	14.25	20	22.90	118
15	BRLS0015	267401	1587721	20	5.98	20	25.46	73
16	BRLS0016	267744	1587840	12	34.66	14	15.00	282
17	BRLS0017	267430	1587795	20	15.75	20	22.00	151
18	BRLS0018	264524	1591074	19	13.50	21	21.50	123
19	BRLS0019	266653	1584367	20	6.00	19	22.50	92
20	BRLS0020	265412	1589139	12	9.61	13	15.50	108
21	BRLS0021	264052	1587468	19	14.96	21	20.90	151
22	BRLS0022	264221	1587330	20	18.00	11	14.50	167
23	BRLS0023	266147	1587520	20	30.00	21	20.80	249
24	BRLS0024	274853	1579282	11	12.75	13	14.50	85
25	BRLS0025	274702	1579352	11	23.00	13	14.50	210
26	BRLS0026	265459	1581943	20	12.25	22	22.90	226
27	BRLS0027	272557	1586888	22	15.00	19	23.00	171
28	BRLS0028	272323	1586903	20	10.00	21	23.50	120
29	BRLS0029	273113	1584660	20	10.00	21	22.75	187
30	BRLS0030	273689	1587191	20	15.00	21	23.50	109
31	BRLS0031	266688	1588593	19	7.00	20	20.10	53
32	BRLS0032	268270	1587824	15	22.00	18	21.90	216
33	BRLS0033	265865	1582546	15	13.15	19	22.30	126
34	BRLS0034	263308	1588776	15	15.27	18	20.80	111
35	BRLS0035	275508	1603841	21	24.25	13	14.80	236
36	BRLS0036	263400	1588452	14	17.25	15	21.20	139
37	BRLS0037	274409	1582895	15	15.00	18	22.20	123
38	BRLS0038	263434	1591794	17	6.00	13	15.90	40
39	BRLS0039	274938	1582906	13	13.00	14	19.50	103
40	BRLS0040	272840	1588408	13	9.00	15	18.75	174
41	BRLS0041	271877	1586992	15	5.44	17	21.90	16
42	BRLS0042	271940	1586775	12	7.00	13	16.50	66
43	BRLS0043	273136	1587827	10	15.00	12	14.50	166
44	BRLS0044	271292	1586115	17	9.00	20	23.50	82
45	BRLS0045	272125	1587939	17	12.10	19	22.80	80
46	BRLS0046	271975	1586090	17	5.00	21	23.10	50
47	BRLS0047	271216	1587896	15	3.00	18	21.90	17
48	BRLS0048	272994	1587898	20	15.00	23	14.50	177
49	BRLS0049	271664	1588322	18	19.00	21	13.30	163
50	BRLS0050	272629	1588039	20	6.00	20	15.30	49

51	BRLS0051	275196	1586472	21	15.00	19	14.40	148
52	BRLS0052	275131	1586140	21	6.00	19	15.10	96
53	BRLS0053	274303	1584055	21	9.00	20	15.30	36
54	BRLS0054	269578	1583981	17	4.00	19	10.20	8
55	BRLS0055	269740	1584341	12	15.00	15	16.20	93
56	BRLS0056	272665	1588788	18	10.00	19	22.20	145
57	BRLS0057	269226	1585628	17	15.16	21	19.10	124
58	BRLS0058	272291	1585080	14	10.00	15	20.70	77
59	BRLS0059	271801	1588841	20	27.75	23	22.15	304
60	BRLS0060	268883	1588364	14	10.50	17	20.30	73
61	BRLS0061	273406	1586644	11	15.00	13	13.80	131
62	BRLS0062	270385	1589636	21	10.00	23	24.40	118
63	BRLS0063	270336	1588621	16	2.00	19	23.00	7
64	BRLS0064	266352	1590129	14	4.11	21	21.90	55
65	BRLS0065	265344	1587647	20	16.31	21	20.90	156
66	BRLS0066	266963	1586762	15	5.00	22	21.10	23
67	BRLS0067	266792	1586862	18	15.00	24	22.15	110
68	BRLS0068	264260	1587478	21	10.00	25	23.30	132
69	BRLS0069	265765	1590197	12	6.75	15	15.60	40
70	BRLS0070	265980	1587099	20	9.00	22	21.10	96
71	BRLS0071	266083	1585957	17	6.00	21	19.80	18
72	BRLS0072	265716	1584916	15	14.50	20	21.90	119
73	BRLS0073	266911	1586449	18	9.75	21	21.40	68
74	BRLS0074	266835	1588700	18	1.50	22	22.50	20
75	BRLS0075	266900	1588759	18	6.00	19	21.90	35
76	BRLS0076	267873	1587513	17	19.75	19	22.00	210
77	BRLS0077	265524	1587626	10	9.25	14	14.75	60
78	BRLS0078	265807	1588984	14	5.25	18	21.85	39
79	BRLS0079	267096	1586914	8	12.79	10	13.80	106
80	BRLS0080	267076	1586663	11	7.00	14	15.50	36
81	BRLS0081	265086	1591559	12	16.06	14	14.30	117
82	BRLS0082	265138	1591259	14	4.17	15	20.25	7
83	BRLS0083	268599	1584366	19	14.75	21	23.60	100
84	BRLS0084	266250	1582351	20	16.50	25	20.40	118
85	BRLS0085	265768	1585221	21	14.50	24	22.20	123
86	BRLS0086	266654	1587698	21	35.00	24	23.70	383
87	BRLS0087	266935	1587945	18	10.00	21	24.10	96
88	BRLS0088	268451	1590965	20	16.00	22	20.60	130
89	BRLS0089	264920	1590853	11	6.00	14	15.40	41
90	BRLS0090	265171	1590123	23	5.77	25	24.25	50
91	BRLS0091	264143	1592222	15	5.50	22	21.60	17
92	BRLS0092	264195	1588976	16	6.50	22	22.10	45
93	BRLS0093	264992	1591931	19	3.25	24	22.25	22
94	BRLS0094	263371	1587238	19	14.00	24	21.95	138
95	BRLS0095	264666	1591973	18	10.00	23	19.30	89
96	BRLS0096	265338	1591868	18	4.25	22	20.85	29
97	BRLS0097	264215	1591717	18	20.00	23	22.60	77
98	BRLS0098	265032	1582597	7	14.00	10	10.21	140
99	BRLS0099	267027	1586136	11	5.00	13	14.30	31
100	BRLS0100	267460	1587854	21	9.00	25	22.40	103
101	BRLS0101	267192	1587343	20	6.50	24	23.10	60
102	BRLS0102	267219	1587285	18	6.00	22	19.60	61
103	BRLS0103	267425	1587906	20	9.00	25	22.30	116
104	BRLS0104	267226	1587445	20	13.50	25	24.10	109
105	BRLS0105	267222	1587391	15	6.00	19	23.00	58
106	BRLS0106	264791	1588878	20	5.00	25	20.75	51
107	BRLS0107	265157	1588588	19	9.50	24	21.30	83

108	BRLS0108	265977	1589946	19	27.00	24	22.10	271
109	BRLS0109	263735	1587945	20	16.79	25	24.10	171
110	BRLS0110	264301	1588133	19	5.00	20	20.90	37
111	BRLS0111	273377	1587945	20	10.00	26	21.20	50
112	BRLS0112	265353	1588995	12	13.26	14	16.20	110
113	BRLS0113	265224	1588919	19	5.50	21	18.20	33
114	BRLS0114	263281	1587004	20	11.00	23	23.60	125
115	BRLS0115	264435	1588830	18	2.25	20	21.45	29
116	BRLS0116	264516	1589750	16	20.63	21	21.30	177
117	BRLS0117	264389	1589164	15	21.00	15	14.60	167
118	BRLS0118	264573	1589055	15	10.50	22	15.20	109
119	BRLS0119	266853	1586153	13	13.75	20	20.10	111
120	BRLS0120	265431	1589681	14	8.50	21	18.40	61
121	BRLS0121	264214	1589582	19	14.49	25	25.45	121
122	BRLS0122	264619	1588189	16	19.15	18	21.30	249
123	BRLS0123	272673	1586713	23	15.00	16	13.90	138
124	BRLS0124	278392	1586159	15	9.50	15	14.60	97
125	BRLS0125	273776	1586764	20	10.50	15	15.90	143
126	BRLS0126	273015	1585972	13	5.00	14	13.30	20
127	BRLS0127	273061	1585435	23	14.98	15	14.20	156
128	BRLS0128	273954	1586764	10	5.00	23	20.75	27
129	BRLS0129	271979	1586104	12	9.00	16	15.20	50
130	BRLS0130	272945	1584146	19	12.00	22	21.70	144
131	BRLS0131	274117	1587339	12	15.00	18	20.10	169
132	BRLS0132	272579	1586572	21	10.00	20	20.75	81
133	BRLS0133	272348	1586082	14	5.00	15	13.80	18
134	BRLS0134	266423	1586902	16	34.25	23	22.00	429
135	BRLS0135	266525	1587104	10	16.75	22	24.10	116
136	BRLS0136	265852	1582460	20	15.27	25	21.90	180
137	BRLS0137	266906	1582846	16	13.50	17	16.60	152
138	BRLS0138	268598	1584916	20	15.00	18	16.50	129
139	BRLS0139	268430	1584313	14	14.00	14	13.50	122
140	BRLS0140	272263	1586822	13	15.00	21	20.80	191
141	BRLS0141	266678	1583224	20	5.30	23	21.90	23
142	BRLS0142	266903	1583037	16	12.75	20	19.20	117
143	BRLS0143	266915	1582902	16	13.20	19	20.25	126
144	BRLS0144	266306	1587017	20	18.92	19	23.00	204
145	BRLS0145	266279	1586799	20	11.77	24	20.00	127
146	BRLS0146	273040	1587964	23	15.00	25	21.50	136
147	BRLS0147	265366	1589257	24	3.50	23	24.50	42
148	BRLS0148	266270	1585497	21	15.00	17	19.50	116
149	BRLS0149	266462	1585547	22	33.75	23	20.25	314
150	BRLS0150	265623	1589466	22	10.31	22	23.80	69
151	BRLS0151	273517	1586574	14	8.00	25	22.50	76
152	BRLS0152	274000	1585358	19	15.00	25	23.80	205
153	BRLS0153	264773	1588996	19	5.00	20	16.80	47
154	BRLS0154	265019	1587619	19	23.00	20	21.20	349
155	BRLS0155	264812	1588359	19	5.00	19	22.40	38
156	BRLS0156	265010	1587619	20	14.00	18	20.40	125
157	BRLS0157	264812	1588359	21	15.50	19	20.90	154
N	157							
Mean				17.13	12.3322	19.25	19.8310	117.29

Table 3 shows the age range of rubber plantations using the command ***Descriptive Statistics*** *In SPSS to display descriptive statistics*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 10 years	3	.1	1.9	1.9
	11 - 15 years	55	2.2	35.0	36.9
	16 - 20 years	77	3.1	49.0	86.0
	More than 21 years	22	.9	14.0	100.0
	Total	157	6.4	100.0	
Missing	System	2307	93.6		
Total		2464	100.0		

In summary, from the data of 157 plots, there were 3 plots in the age range under 10 years, 55 plots in the age range 11 - 15 years, 77 plots in the age range 16 - 20 years, and 22 plots in the age range over 21 years.

Table 4 shows the rubber varieties using the command ***Descriptive Statistics*** *In SPSS to display descriptive statistics*

Rubber Type

		Frequency	Percent	Valid Percent	Cumulative Percent	Bootstrap for Percent[a]			
						Bias	Std. Error	95% Confidence Interval Lower	95% Confidence Interval Upper
Valid	Native Rubber	24	15.3	15.3	15.3	-.2	2.9	9.5	21.0
	Recommernded Rubber	133	84.7	84.7	100.0	.2	2.9	79.0	90.5
	Total	157	100.0	100.0		.0	.0	100.0	100.0

a. Unless otherwise noted, bootstrap results are based on 157 bootstrap samples

Summary of the data on rubber species: 24 plots of native rubber species and 133 plots of promoted rubber species. From a total of 157 plots

5.2 Calculation of distribution coefficient (CV) of biomass in rubber plantation area.

Table 5 shows the distribution coefficient of 157 rubber plantations using the command ***Descriptive Statistics*** *In SPSS to calculate the representative values (Mean) and Standard Deviation*

Descriptive Statistics

	N	Maximum	Mean	Std. Deviation
AGB (Ton)	157	524	117.29	82.899
Valid N (listwise)	157			

Summary of calculation of distribution coefficient (CV) of biomass in rubber plantation area, Group 01/BR01S1, Samrong Mai Subdistrict, Lahan Sai District, Buriram Province.

Area (farm)	Planting year		ABG (Ton)	biomass			
	Age range (years)	Age level (years) average		Tons/rai	Mean	Std. Deviation	CV (%)
1,936.15	7 - 24	17.13	18,414	9.51	117.29	82.899	70.678

Meaning of CV (Coefficient of Variation) value

The coefficient of variation (CV) is a statistic used to measure the spread of data relative to the mean of a set of data, expressed as a percentage. This allows for comparison of the variability of different data sets, even if they have different units or sizes, in the context of measurement. **Biomass** In this area, the CV value = 70.67 % has the following meaning:

Highly distributed The high CV value of 70.67 % indicates that the measured biomass data in the area are quite widely dispersed from the mean (117.29) , which means that the biomass amounts in each plot or each measured point in the area are significantly different and not closely clustered.

Biomass unevenness This reflects that in the project area, there may be many factors that cause biomass to differ significantly, such as:

1. **The age of rubber trees varies greatly.** Younger trees have less biomass than older trees (from Table 3). There are rubber trees with ages ranging from 7 to 24 years, which has a high variety)

2. **Different soil conditions** Although the soil is mainly of the Khorat series, the fertility profile in each sub-plot may differ, resulting in uneven growth of rubber trees (from 2.5.5, the soil has low to medium fertility).

3. **Different garden management** Inconsistent maintenance, fertilization or irrigation in each plot may affect the growth and biomass of the rubber trees.

4. **Different rubber tree species** Although most are promoted varieties, there are also native varieties, which may have different growth rates and biomass.

Challenges in estimation Such high CV values indicate that estimating the total biomass of the entire area from only a few measurement points may be highly inaccurate due to the large variability of the data.

The importance of proper monitoring and management These results highlight the importance of using technologies such as satellite and precise field monitoring to continuously monitor and assess biomass at each sub-area to obtain reliable data for carbon credit calculations and to consider tailored management approaches for each plot to reduce future biomass variability.

In conclusion, this high CV value is an important indicator of biomass variability in the rubber plantation of the project, which should be considered for more efficient planning of data collection, analysis, and project management.

5.3 Repeat counting

In the same area, there are other greenhouse gas reduction projects that carry out similar greenhouse gas reduction activities.

[/] do not have

[ ] Project name, name of the mechanism/standard that registered the project, and the period for which carbon credit certification is requested.

5.4 Evidence of additional operations beyond normal operations (Additionality)

[ ] No need to prove additional operations beyond normal operations.

[/] Must prove additional operations from normal operations.

Additionality is demonstrating that the project has generated GHG reductions or sequestrations beyond those already occurring under business-as-usual (BAU) or regulatory requirements. Without the project, these reductions/sequestrations would not have occurred. This proof is important for the credibility of the carbon credits generated.

[/] There are additional operations from normal operations (Additionality)

[ ] No additional operations beyond normal operations (Additionality)

Table 6 Summary of Additionality Evidence : BAU and Project Scenario

Criteria for proof	***Normal Operations (BAU)***	***Project Scenario***
Financial incentives	*The income from rubber (0.6 tons/rai/year) and the total cost of 10,243.64 baht/rai are not sufficient to invest in sustainable practices.*	*There is additional income from carbon credits averaging ~1,300 THB/rai, making the project financially attractive.*
Cost of change	*Farmers bear the cost of labor for managing crop residues (350 baht/day , 5-7 days/month) and weed management costs (250 baht/rai/time).*	*580,000baht higher cost from changing sustainable practices and investing in technology is offset by carbon credit income.*
Knowledge/Techniques	*Farmers lack knowledge and skills in sustainable crop residue/fertilizer management.*	*Intensive training and knowledge transfer project for sustainable rubber plantation management*
General practices	*Burning of crop residues and traditional management practices are common; the use of advanced technologies is not widespread.*	*, Blockchain/ satellite technology is not a common practice in the area.*
Legal requirements	*The basic burning ban is enforced, but there is no requirement to carry out additional carbon sequestration activities.*	*Go "beyond" the law by promoting carbon-neutral non-burning crop residue management and using advanced monitoring technology.*

In conclusion, based on the comprehensive analysis, the Buriram Rubber Plantation Carbon Capture and GHG Mitigation Project clearly has "Additionality." Initiating this project, investing in technology, and promoting sustainable practices will generate additional GHG mitigation and absorption that would not have been possible without the support of this project, in overcoming cost barriers, knowledge, and creating the necessary financial incentives.

5.4.1 Barrier Analysis

The project faces significant barriers that prevent farmers from shifting to sustainable rubber plantation management practices without carbon credit incentives.

Technical and knowledge barriers

Non-burning plant waste management Despite the ban on burning in agricultural areas, farmers still prefer burning due to its ease and low cost. Switching to other methods, such as composting or mulching, requires knowledge, skills, and additional labor costs. The minimum daily wage is 350 baht, and approximately 5-7 days of labor per month may be required, which is a significant burden for small-scale farmers.

Weed management The use of agricultural machinery for weed control costs a flat rate of 250 baht per rai, twice a year. Changing to more sustainable methods (such as cover crops) requires knowledge and may have initial costs.

Financial obstacles

1. **Cost of changing practices** Sustainable practices have higher startup and operating costs than traditional methods.

2. **Investment in advanced technology** The project requires investments in Blockchain technology, Cryptocurrency and satellites, which will cost up to 580,000 baht. Which small farmers cannot invest on their own

3. **Low population income** The average per capita income in Buriram is 80,684 baht per year. Reflecting the need to generate additional income, increasing costs without clear returns is a major obstacle.

5.4.2 Investment Analysis

The project would not be viable without additional revenue from carbon credits, as the returns from normal operations are not sufficiently attractive.

Business-as-Usual (BAU) Scenario

1. **Main income** The average fresh rubber yield of farmers in Buriram is approximately 0.6 tons per rai per year.

2. **Cost of rubber lump production in farms in the Northeastern region in 2022** (From the database of the Office of Agricultural Economics (OAE), there is information on the cost of rubber production each year. You can follow it on the website. Office of the Permanent Secretary, Ministry of Agriculture and Cooperatives)

- Variable cost 6,398.40 baht/rai
- Fixed cost 3,845.24 baht/rai
- Total cost per rai: 10,243.64 baht/rai
- Total cost per kilogram 22.97 baht/kilogram

3. Given these costs and the income from conventional tapping, farmers have little incentive to invest further in sustainable practices that do not directly impact latex yields in the short term.

Project Scenario

1. The project creates significant financial incentives from carbon credits, with an average investment return from carbon credit trading of approximately per rai. **1,300 -1,500 baht**

2. This additional revenue helps offset the increased costs associated with adopting sustainable practices and technology, making the project financially attractive and feasible.

Common Practice Analysis

The activities undertaken by the project are not yet common practice in the area.

Traditional rubber plantation management Most farmers still manage their rubber plantations in a traditional way, including felling rubber trees at an average age of over 25 years, without focusing on additional carbon sequestration from management.

Use of technology The use of blockchain, cryptocurrency, and satellites for carbon credit management and tracking is not yet widespread in Thailand's agriculture sector, particularly among small-scale farmers.

5. 4.4 Regulatory Surplus

The project carried out activities that exceeded existing legal requirements.

Burning ban Despite the ban on burning to control PM2.5 , the project does not stop at just no burning, but also promotes alternative crop residue management techniques such as composting or biochar production , which increase soil carbon sequestration beyond basic legal requirements.

5.4.5 Technology-based inspection The use of satellite technology to accurately and continuously monitor and track carbon emissions goes beyond conventional monitoring requirements and significantly increases the project's credibility.

5.5 Rights to use the project land

Implementation of project 01/ BR01S1, Samrong Mai Subdistrict, Lahan Sai District, Buriram Province, has 131 members, 157 plots, total area 1,936.15 rai. Farmers have registered with government agencies, through the Department of Agricultural Extension (DRA) and/or have registered with the Rubber Authority of Thailand (details in Appendix 1).

Part 2 Greenhouse gas reduction methodology and Project implementation details

2.1 Greenhouse gas reduction methodology and calculation tools used

Sequestration and Reducing Emission for Perennial Crop Plantation project for rubber plantations, small project size. (Size 500 rai but not more than 20,000 rai)

The project will be conducted in accordance with the ETM Carbon Trade Standards (ECT) by ETM Group Co., Ltd., which is an auditing standard for grouped projects. and may be consistent with international standards such as ISO 14064-2 (Measurement of Greenhouse Gas Emissions in Projects).

2.2 Conditions of project activities

Table 7: Characteristics of eligible activities and conditions of project activities

Characteristics of eligible activities and project conditions	***Project rationale***
1. There is compliance with the internal control system manual. Including planting, care and proper management activities	*There is compliance with the standards of proper planting, care and management as per section (2.5.2).*
2. It is rubber (has a cutting cycle of 25 years)	*It is a rubber plantation owned by farmers in their own area.*
3. There is a certificate of legal land use rights and a carbon credit purchase contract. or Memorandum of Understanding (MOU)	*There is a certificate of registration of rubber farmers with the relevant government agencies such as the Department of Agricultural Extension or the Rubber Authority of Thailand.*
4. The project area can include several areas together or be in the same community, such as the sub-district, district, or provincial level.	*The area of the rubber plantation in Samrong Mai Subdistrict and nearby areas may be used as farmer housing or one of the following:*
5. In the case where the original land area is a forest or there is cutting down of forest trees to plant rubber trees (considered not to accept)	*The project area was a forest area before the project commencement date.*
6. There has been no cutting down of rubber trees in the past 10 years.	*No rubber trees or parts of rubber trees should be cut from rubber plantations unless they are dead or there is an epidemic.*

Target area determination

Target rubber plantation areas in Samrong Mai Subdistrict, Lahan Sai District, Buriram Province, which meet the criteria for Grouped Projects, with 131 members and a total area of 1,936.15 rai, are identified as follows:

Baseline Data

1. Baseline Data It is a data set that reflects the situation or trend of greenhouse gas emissions/absorption that is expected to occur if the project is not implemented. Determining accurate base case data is crucial for assessing the actual amount of carbon credits generated from the project implementation. Using satellite technology as the main tool for preparing base case data helps increase efficiency, accuracy and coverage in assessing large project areas of rubber plantations. Group 01/BR01S1, Samrong Mai Subdistrict, Lahan Sai District, Buriram Province (according to the map)

2. Using satellite images to prepare baseline data

The project will use satellite imagery and geospatial information to determine base case data for all 157 member rubber plantations (Appendix 3), with the objective of:

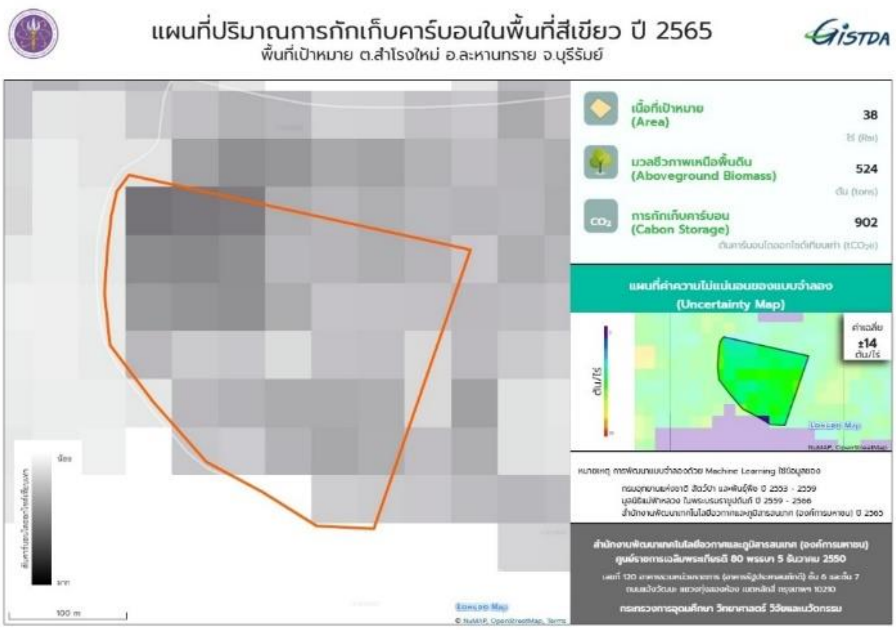
2.1 Historical Land Use Mapping

1. Use historical satellite imagery (preferably images that correspond to the start of the project's carbon credit period, e.g., 7 years from 1 January 2016) to map land use in the project area.

2. The objective is to confirm that these rubber plantations are not primeval forests or that the forests have been clear-cut for rubber plantations prior to the project's inception. Which may affect the additionality of the project.

3. Satellite imagery helps identify past land use patterns, such as agricultural land, former rubber plantations, or changes from forest (if assessed for exemption).

Figure 20 shows an example of using the Gistda satellite database. To find the amount of carbon sequestration in the area BRLS0001, Ms. Jongklanee Wattanaphithak



2.2 Initial Biomass & Carbon Stock Assessment

1. Satellite imagery combined with vegetation models and indices (e.g., NDVI, EVI) was used to estimate the Above Ground Biomass (AGB) and the amount of carbon stored in rubber trees at the beginning of the carbon credit period.

2. This data is a baseline of the amount of carbon stored in rubber trees before project activities that promote increased growth and carbon sequestration are implemented.

2.3 Identification and Confirmation of Baseline practice (Baseline Practice Identification)

1. Satellite imagery can help identify certain past practices, such as traces of burning in agricultural areas. To be used in determining the baseline of greenhouse gas emissions before implementing projects that focus on "*no burning*".

2. This information will be used in conjunction with field data collected on the history of orchard management, such as fertilizer and chemical use. To determine the overall picture of the BAU situation

2.4 Project Area Boundary Mapping

1. High-resolution satellite imagery was used to accurately map the extent of each project member's rubber plantation (Appendix 3) and confirm consistency with the coordinates provided by farmers.

2. Accurate maps are essential to define the scope for calculating the project's total carbon footprint.

3. Benefits of using satellite imagery for base case data

3.1 Accuracy and coverage It allows for the evaluation of data over large areas (e.g. 1.9 36.1 5 rai). and multiple plots accurately and consistently, reducing errors from field surveys alone.

3.2 Can be checked retrospectively Historical photographs can be accessed to create accurate base case data for a given time period.

3.3 Efficiency and cost reduction Reduce the need for time-consuming and expensive initial field surveys.

3.4 As part of continuous monitoring and inspection. The base case data obtained from the satellite also serves as a basis for comparison with changes that occur after the implementation of the project in the follow-up period.

In summary, the use of satellite imagery for base case data is a key component of this project, enabling a reliable and efficient assessment of the initial state of the rubber plantation. The data obtained from analyzing past and present satellite imagery provides a solid foundation for calculating the actual carbon sequestration/reduction and strongly supports the project's Additionality determination.

Carbon dioxide gas volume of rubber plantations (Table 8)

= 31,650 tons of carbon dioxide (Co2/Ton)

Table 8 Calculation of total carbon dioxide emissions of rubber plantations BRLS0001 - BRLS0157

Case Processing Summaries Aboveground Biomass[a]

Case Number	Conversion Code	UTM X	UTM Y	Age	Rai	High (m)	DBH (cm)	AGB (Ton)
1	BRLS0001	267665	1587689	14	38.44	15	21.00	524
2	BRLS0002	265711	1586875	14	8.75	14	21.90	112
3	BRLS0003	273629	1585392	20	15.00	21	21.90	144
4	BRLS0004	262913	1587754	20	35.25	19	21.00	332
5	BRLS0005	266649	1582178	22	13.98	18	22.00	167
6	BRLS0006	263277	1588187	22	11.50	19	21.90	100
7	BRLS0007	263381	1588188	22	9.25	18	20.00	95
8	BRLS0008	272953	1588401	12	15.00	13	14.50	174
9	BRLS0009	265142	1589106	15	4.10	18	21.90	18
10	BRLS0010	267082	1586847	15	4.00	17	20.00	28
11	BRLS0011	266910	1588231	15	5.02	18	21.00	57
12	BRLS0012	265580	1586482	19	15.00	11	15.00	150
13	BRLS0013	266140	1585347	13	10.00	13	16.50	176
14	BRLS0014	262748	1588153	19	14.25	20	22.90	118
15	BRLS0015	267401	1587721	20	5.98	20	25.46	73
16	BRLS0016	267744	1587840	12	34.66	14	15.00	282
17	BRLS0017	267430	1587795	20	15.75	20	22.00	151
18	BRLS0018	264524	1591074	19	13.50	21	21.50	123
19	BRLS0019	266653	1584367	20	6.00	19	22.50	92
20	BRLS0020	265412	1589139	12	9.61	13	15.50	108
21	BRLS0021	264052	1587468	19	14.96	21	20.90	151
22	BRLS0022	264221	1587330	20	18.00	11	14.50	167
23	BRLS0023	266147	1587520	20	30.00	21	20.80	249
24	BRLS0024	274853	1579282	11	12.75	13	14.50	85
25	BRLS0025	274702	1579352	11	23.00	13	14.50	210
26	BRLS0026	265459	1581943	20	12.25	22	22.90	226
27	BRLS0027	272557	1586888	22	15.00	19	23.00	171
28	BRLS0028	272323	1586903	20	10.00	21	23.50	120
29	BRLS0029	273113	1584660	20	10.00	21	22.75	187
30	BRLS0030	273689	1587191	20	15.00	21	23.50	109
31	BRLS0031	266688	1588593	19	7.00	20	20.10	53
32	BRLS0032	268270	1587824	15	22.00	18	21.90	216

33	BRLS0033	265865	1582546	15	13.15	19	22.30	126
34	BRLS0034	263308	1588776	15	15.27	18	20.80	111
35	BRLS0035	275508	1603841	21	24.25	13	14.80	236
36	BRLS0036	263400	1588452	14	17.25	15	21.20	139
37	BRLS0037	274409	1582895	15	15.00	18	22.20	123
38	BRLS0038	263434	1591794	17	6.00	13	15.90	40
39	BRLS0039	274938	1582906	13	13.00	14	19.50	103
40	BRLS0040	272840	1588408	13	9.00	15	18.75	174
41	BRLS0041	271877	1586992	15	5.44	17	21.90	16
42	BRLS0042	271940	1586775	12	7.00	13	16.50	66
43	BRLS0043	273136	1587827	10	15.00	12	14.50	166
44	BRLS0044	271292	1586115	17	9.00	20	23.50	82
45	BRLS0045	272125	1587939	17	12.10	19	22.80	80
46	BRLS0046	271975	1586090	17	5.00	21	23.10	50
47	BRLS0047	271216	1587896	15	3.00	18	21.90	17
48	BRLS0048	272994	1587898	20	15.00	23	14.50	177
49	BRLS0049	271664	1588322	18	19.00	21	13.30	163
50	BRLS0050	272629	1588039	20	6.00	20	15.30	49
51	BRLS0051	275196	1586472	21	15.00	19	14.40	148
52	BRLS0052	275131	1586140	21	6.00	19	15.10	96
53	BRLS0053	274303	1584055	21	9.00	20	15.30	36
54	BRLS0054	269578	1583981	17	4.00	19	10.20	8
55	BRLS0055	269740	1584341	12	15.00	15	16.20	93
56	BRLS0056	272665	1588788	18	10.00	19	22.20	145
57	BRLS0057	269226	1585628	17	15.16	21	19.10	124
58	BRLS0058	272291	1585080	14	10.00	15	20.70	77
59	BRLS0059	271801	1588841	20	27.75	23	22.15	304
60	BRLS0060	268883	1588364	14	10.50	17	20.30	73
61	BRLS0061	273406	1586644	11	15.00	13	13.80	131
62	BRLS0062	270385	1589636	21	10.00	23	24.40	118
63	BRLS0063	270336	1588621	16	2.00	19	23.00	7
64	BRLS0064	266352	1590129	14	4.11	21	21.90	55
65	BRLS0065	265344	1587647	20	16.31	21	20.90	156
66	BRLS0066	266963	1586762	15	5.00	22	21.10	23
67	BRLS0067	266792	1586862	18	15.00	24	22.15	110
68	BRLS0068	264260	1587478	21	10.00	25	23.30	132
69	BRLS0069	265765	1590197	12	6.75	15	15.60	40
70	BRLS0070	265980	1587099	20	9.00	22	21.10	96
71	BRLS0071	266083	1585957	17	6.00	21	19.80	18
72	BRLS0072	265716	1584916	15	14.50	20	21.90	119
73	BRLS0073	266911	1586449	18	9.75	21	21.40	68

74	BRLS0074	266835	1588700	18	1.50	22	22.50	20
75	BRLS0075	266900	1588759	18	6.00	19	21.90	35
76	BRLS0076	267873	1587513	17	19.75	19	22.00	210
77	BRLS0077	265524	1587626	10	9.25	14	14.75	60
78	BRLS0078	265807	1588984	14	5.25	18	21.85	39
79	BRLS0079	267096	1586914	8	12.79	10	13.80	106
80	BRLS0080	267076	1586663	11	7.00	14	15.50	36
81	BRLS0081	265086	1591559	12	16.06	14	14.30	117
82	BRLS0082	265138	1591259	14	4.17	15	20.25	7
83	BRLS0083	268599	1584366	19	14.75	21	23.60	100
84	BRLS0084	266250	1582351	20	16.50	25	20.40	118
85	BRLS0085	265768	1585221	21	14.50	24	22.20	123
86	BRLS0086	266654	1587698	21	35.00	24	23.70	383
87	BRLS0087	266935	1587945	18	10.00	21	24.10	96
88	BRLS0088	268451	1590965	20	16.00	22	20.60	130
89	BRLS0089	264920	1590853	11	6.00	14	15.40	41
90	BRLS0090	265171	1590123	23	5.77	25	24.25	50
91	BRLS0091	264143	1592222	15	5.50	22	21.60	17
92	BRLS0092	264195	1588976	16	6.50	22	22.10	45
93	BRLS0093	264992	1591931	19	3.25	24	22.25	22
94	BRLS0094	263371	1587238	19	14.00	24	21.95	138
95	BRLS0095	264666	1591973	18	10.00	23	19.30	89
96	BRLS0096	265338	1591868	18	4.25	22	20.85	29
97	BRLS0097	264215	1591717	18	20.00	23	22.60	77
98	BRLS0098	265032	1582597	7	14.00	10	10.21	140
99	BRLS0099	267027	1586136	11	5.00	13	14.30	31
100	BRLS0100	267460	1587854	21	9.00	25	22.40	103
101	BRLS0101	267192	1587343	20	6.50	24	23.10	60
102	BRLS0102	267219	1587285	18	6.00	22	19.60	61
103	BRLS0103	267425	1587906	20	9.00	25	22.30	116
104	BRLS0104	267226	1587445	20	13.50	25	24.10	109
105	BRLS0105	267222	1587391	15	6.00	19	23.00	58
106	BRLS0106	264791	1588878	20	5.00	25	20.75	51
107	BRLS0107	265157	1588588	19	9.50	24	21.30	83
108	BRLS0108	265977	1589946	19	27.00	24	22.10	271
109	BRLS0109	263735	1587945	20	16.79	25	24.10	171
110	BRLS0110	264301	1588133	19	5.00	20	20.90	37
111	BRLS0111	273377	1587945	20	10.00	26	21.20	50
112	BRLS0112	265353	1588995	12	13.26	14	16.20	110
113	BRLS0113	265224	1588919	19	5.50	21	18.20	33
114	BRLS0114	263281	1587004	20	11.00	23	23.60	125

115	BRLS0115	264435	1588830	18	2.25	20	21.45	29
116	BRLS0116	264516	1589750	16	20.63	21	21.30	177
117	BRLS0117	264389	1589164	15	21.00	15	14.60	167
118	BRLS0118	264573	1589055	15	10.50	22	15.20	109
119	BRLS0119	266853	1586153	13	13.75	20	20.10	111
120	BRLS0120	265431	1589681	14	8.50	21	18.40	61
121	BRLS0121	264214	1589582	19	14.49	25	25.45	121
122	BRLS0122	264619	1588189	16	19.15	18	21.30	249
123	BRLS0123	272673	1586713	23	15.00	16	13.90	138
124	BRLS0124	278392	1586159	15	9.50	15	14.60	97
125	BRLS0125	273776	1586764	20	10.50	15	15.90	143
126	BRLS0126	273015	1585972	13	5.00	14	13.30	20
127	BRLS0127	273061	1585435	23	14.98	15	14.20	156
128	BRLS0128	273954	1586764	10	5.00	23	20.75	27
129	BRLS0129	271979	1586104	12	9.00	16	15.20	50
130	BRLS0130	272945	1584146	19	12.00	22	21.70	144
131	BRLS0131	274117	1587339	12	15.00	18	20.10	169
132	BRLS0132	272579	1586572	21	10.00	20	20.75	81
133	BRLS0133	272348	1586082	14	5.00	15	13.80	18
134	BRLS0134	266423	1586902	16	34.25	23	22.00	429
135	BRLS0135	266525	1587104	10	16.75	22	24.10	116
136	BRLS0136	265852	1582460	20	15.27	25	21.90	180
137	BRLS0137	266906	1582846	16	13.50	17	16.60	152
138	BRLS0138	268598	1584916	20	15.00	18	16.50	129
139	BRLS0139	268430	1584313	14	14.00	14	13.50	122
140	BRLS0140	272263	1586822	13	15.00	21	20.80	191
141	BRLS0141	266678	1583224	20	5.30	23	21.90	23
142	BRLS0142	266903	1583037	16	12.75	20	19.20	117
143	BRLS0143	266915	1582902	16	13.20	19	20.25	126
144	BRLS0144	266306	1587017	20	18.92	19	23.00	204
145	BRLS0145	266279	1586799	20	11.77	24	20.00	127
146	BRLS0146	273040	1587964	23	15.00	25	21.50	136
147	BRLS0147	265366	1589257	24	3.50	23	24.50	42
148	BRLS0148	266270	1585497	21	15.00	17	19.50	116
149	BRLS0149	266462	1585547	22	33.75	23	20.25	314
150	BRLS0150	265623	1589466	22	10.31	22	23.80	69
151	BRLS0151	273517	1586574	14	8.00	25	22.50	76
152	BRLS0152	274000	1585358	19	15.00	25	23.80	205
153	BRLS0153	264773	1588996	19	5.00	20	16.80	47
154	BRLS0154	265019	1587619	19	23.00	20	21.20	349
155	BRLS0155	264812	1588359	19	5.00	19	22.40	38

156	BRLS0156	265010	1587619	20	14.00	18	20.40	125
157	BRLS0157	264812	1588359	21	15.50	19	20.90	154
N	157							
Mean				17.13	12.3322	19.25	19.8310	117.29

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2.3 Greenhouse gas emission activities used in calculations

Table 9 Greenhouse gas emission/storage activities used in the calculation for the carbon sequestration and greenhouse gas emission reduction project in rubber plantations, Buriram Province.

Greenhouse gas emission/storage sources	Main types of greenhouse gases involved	Details of activities that emit/storage greenhouse gases
1. Cultivation and maintenance period	CO_2, N_2O, CH_4	(1) **Fertilizer production and use** Direct release of N_2O from soil after nitrogen fertilizer application and CO_2 from fertilizer production and transportation processes. (2) **Production and use of chemicals** GHG emissions from the production and transportation of pesticides and herbicides (3) **Energy used in the garden** The combustion of fuels (e.g. diesel) for machinery (tractors , lawn mowers) and the use of electricity for water pumps. (4) **Management of agricultural waste,** burning of weeds, rubber leaves and branches, which releases CO_2, CH_4, N_2O, PM2.5 and black carbon.
2. Harvesting and collection period of latex	CO_2	(1) **Production and use of rubber accelerators** GHG emissions from the production and transportation of rubber accelerators (if used) (2) **Energy for collection** Use of fuel for vehicles or transport systems in collecting latex

		(3) **Transportation of raw latex** Fuel combustion in the transport of raw latex from the plantation to the collection point or primary processing plant.
3. Preliminary processing stage	CO_2	(1) **Production and use of coagulant chemicals** GHG emissions from the production and transportation of chemicals such as formic acid (2) **Energy for processing** The combustion of fuels (such as fuel for rubber smoking kilns) or the use of electricity for rubber mills, which release CO_2. (3) **wastewater treatment** Potential greenhouse gas emissions from wastewater treatment processes from primary processing (4) **Transportation of processed raw rubber** Fuel combustion in the transport of processed raw rubber from farmer groups to the final processing plant
4. Carbon sequestration in biomass	CO_2	(1) **Growth of rubber trees** Rubber trees absorb CO_2 from the atmosphere through photosynthesis and store it as biomass in various parts of their life cycle (trunk , branches , leaves , roots). (2) **Canopy and shrub management** Appropriate pruning techniques to increase photosynthesis efficiency and CO_2 absorption (3) **Agroforestry** Intercropping in rubber plantations increases biomass diversity and carbon sequestration potential.
5. Carbon sequestration in soil	CO_2	(1) **Accumulation of organic matter in soil** Carbon enters the soil in the form of organic carbon from leaves, fallen branches, plant roots and microorganisms. (2) **Do not burn plant debris** Managing agricultural waste without burning increases soil organic matter and increases soil carbon sequestration. (3) **Mulching and composting/ Biochar** Helps improve soil structure and increase the amount of organic matter and carbon in the soil.

Part 3 Calculation of Greenhouse Gas Sequestration / Emission

The project will be conducted in accordance with the ETM Carbon Trade standard , a standard for cluster projects, whereby the actual amount of greenhouse gases sequestered or reduced will be calculated based on the project site data. **1,936.15 rai** and follow-up period **7 years (retrospective)**

1. Calculation of greenhouse gas sequestration/emission from the baseline case (Baseline Sequestration/Emission)

baseline scenario is an estimate of the net greenhouse gas emissions (both emissions and sequestration) expected to occur if the project is not implemented, reflecting a business-as-usual (BAU) rubber plantation management approach.

- **Total carbon dioxide emissions (baseline)**

31,650 tons of carbon dioxide for a period of 7 years

- so **Annual Net Baseline GHG Balance** It can be calculated as follows:

Annual Net Baseline GHG Balance = Project Duration (Years) Total Baseline CO2e
Annual Net Baseline GHG Balance = 7 Year 31,650 tons of CO2e = 4.521.42 tons CO2e/ year

- This figure represents the net total greenhouse gas emissions (Emissions) minus carbon sequestration (Sequestration) that would occur under typical conditions in each year.

2. Calculation of carbon sequestration from project implementation (Project Sequestration)

It is the amount of carbon sequestered in rubber tree biomass (Above Ground Biomass - AGB and Below Ground Biomass - BGB) and in soil (Soil Organic Carbon - SOC) resulting from the implementation of the project activities that promote sustainable rubber plantation management.

- **AGB increase from project implementation** (over **7 years**) 18,414 ton
- **Conversion of biomass (AGB) to carbon (C)** Biomass is generally considered to contain approximately 50% carbon (0.50). **(Reference document 5)**

Total Carbon (C) from AGB = Total AGB × Carbon Fraction Total Carbon (C) from AGB = 18,414 Ton AGB×0.50 = 9,207 Ton C

- **Conversion of carbon (C) to carbon dioxide equivalent (CO2e)** The conversion factor is 44/12 or approximately 3.6667. **(Reference document 5)**

Total CO2e Sequestration from AGB = Total Carbon (C) × 1244

Total CO2e Sequestration from AGB = 9, 207 tons C × 3.6667 = 33,759.31 Tons of CO2e (over 7 years)

Annual Project Sequestration from AGB

Annual Project Sequestration = Project Duration (Years) Total CO2e Sequestration from AGB

Annual Project Sequestration = 7 year 33, 759.31 Tons of CO2e = 4,822.76 tons CO2e / year

3. Calculation of greenhouse gas emissions from project operations (Project Emission)

It is the amount of greenhouse gases generated from the activities under the project, which have included guidelines for reducing greenhouse gas emissions.

Land preparation and rubber planting Including the use of fertilizers , chemicals , and energy in soil preparation.

Rubber plantation maintenance Fertilizing , weeding , disease and insect prevention

Rubber tapping and latex collection Use of labor , equipment , and energy

Preliminary processing of latex into cup lumps Coagulation of latex , collection

GHG data from various activities **(Reference document 6 Greenhouse gas emission coefficient Emission Factor)** as follows:

Prepare the plot (tractor diesel oil)	**40,337.53**	**kgCO2e**
Garden care (NPK chemical fertilizer)	**161,088.30**	**kgCO2e**
Harvest (automotive oil for transportation)	**50,421.91**	**kgCO2e**
Processed (Fresh latex) + (Formic acid)	**513,353.78**	**kgCO2e**

Annual Project Emissions from these activities

Annual Project Emission = Σ (Emissions from each activity) Annual Project Emission = 40,337.53 + 161,088.30 + 50,421.91 + 513,353.78 kgCO2e/ year

Annual Project Emission = 765,201.52 kgCO2e/ year = 765.20 tons of CO2e/ year

4. Carbon emissions from leakage (Leakage Emission)

Leakage is the increase in greenhouse gas emissions that occurs outside the project scope but is a result of the project's activities. Leakage must be assessed and deducted from the project's net greenhouse gas emissions .

Leakage volume At this moment Specific numbers have not been specified. **[No carbon emissions from leakage]** This requires an assessment of potential impacts outside the project scope.

5. Calculation of carbon sequestration from the project (Net Carbon Sequestration / GHG Reduction)

It is the net amount of greenhouse gases that the project can actually increase or decrease in each year, calculated from a comparison between the base case scenario, the project scenario and leakage.

Calculation formula

Net Carbon Sequestration (tons CO2e/ year) = (Annual Net Baseline GHG Balance) − (Annual Project Emission − Annual Project Sequestration) − (Annual Leakage Emission)

Where

- The Annual Net Baseline GHG Balance is the net value of greenhouse gas emissions and sequestration in a no-project scenario (from point 1).
- (Annual Project Emission − Annual Project Sequestration) is the net balance of releases and sequestration under project operations.

6. Summary of the amount of greenhouse gases expected to be sequestered

The amount of greenhouse gases expected to be sequestered/reduced by this project will be the net sum of all calculations and will be verified and certified by an external agency.

Table 10 summarizes the amount of greenhouse gases expected to be sequestered.

Calculation details	Greenhouse gas emissions (tons CO_2e/ year)
1. Annual Net Baseline GHG Balance	4.521.42
2. Carbon sequestration from project operations (Annual Project Sequestration) (from AGB)	4,822.76
3. Greenhouse gas emissions from project operations (Annual Project Emission)	765.20
4. Annual Leakage Emission	[No carbon emissions from leakage]
Net greenhouse gas sequestration/reduction expected	[4,521.42 − (765.2 − 4,822.76) − Annual Leakage Emission]
Net greenhouse gas sequestration/reduction (excluding leakage)	≈ 8,578.98

Additional information

1. Total carbon dioxide gas value 31,650 tons of carbon dioxide, which is the base case data **It is a value that includes both release and containment in BAU situations .** Therefore, it can be directly used as the Annual Net Baseline GHG Balance.

2. The Annual Project Sequestration is currently calculated from AGB only. If there is additional soil carbon sequestration (SOC) from the project, it must be calculated in this section.

3. The last digit of Net greenhouse gas sequestration/reduction expected It is complete when the Annual Leakage Emission is assessed and identified. If the Annual Leakage Emission is zero, the net result is: 8,578.98 tons of CO_2e/ year

4. This calculation is based on the assumption that AGB is **Net increase in biomass** Throughout the 7 years of project implementation, if it were just the amount of biomass at any one point, the calculation would be different.

5. Annual Project Sequestration (4,822.76 tons of CO_2e/ year) is greater than the Annual Net Baseline GHG Balance (4.521.42 tons of CO_2e/ year), indicating a significant increase in sequestration under the project.

Note: Calculation method for obtaining GHG value data

(1) **Total amount of diesel fuel used** This is the main data that we will use to calculate the amount of diesel fuel used, 15,489.16 liters. We will use this amount as a base for calculating greenhouse gas emissions (CO_2 , CH_4 , and N_2O) using the standard Emission Factor for diesel fuel. **(Reference document 7)**

Emission Factor and Global Warming Potential (GWP) values used in the calculations

For Diesel

CO_2 Emission Factor	2.604 kg CO_2 / liter
CH_4 Emission Factor	0.000003 kg CH_4 / liter
N_2O Emission Factor	0.0000006 kg N_2O /liter

Global Warming Potential (GWP) (from IPCC AR6)

CO_2	1
CH_4	27.9
N_2O	265

Calculation of greenhouse gas emissions

Data on the amount of diesel used: 15,489.16 liters

From calculations using data on the amount of diesel used, 15,489.16 liters, and the standard Emission Factor value.

CO_2	emissions	40,333.77 kg CO_2	
CH_4	emission volume	0.046467 kg CH_4	Convert to CO_2 e 1.30 kg CO_2 e
N_2O	emission volume	0.0092935 kg N_2O	Convert to CO_2 e 2.46 kg CO_2 e

Summary of total greenhouse gas emissions from land preparation (CO_2 equivalent)

From using 15,489.16 liters of diesel for soil preparation by tractor, the total greenhouse gas emissions will be **40,337.53 kg CO_2 e or approximately 40.34 tons CO_2e.**

CO_2 emissions are the main source of greenhouse gas emissions from diesel combustion.

(2) **Calculation of fertilizer formula 15-15-15 containing nitrogen** (N) 15% by weight and the total amount of fertilizer used is 151,019.31 kilograms. The calculation of greenhouse gas emissions (N_2O and CO_2) will be performed using the Emission Factor values from the IPCC guidelines that have been analyzed previously.

Warming Potential (GWP) for nitrous oxide (N_2O) used in the calculation is: **265** (according to the IPCC AR6 report) , which means that 1 kg of N_2O has the same global warming effect as 265 kg of CO_2 over 100 years. **(Reference document 8)**

Calculation of greenhouse gas emissions

First, we will calculate the total amount of nitrogen (N) applied to the rubber plantation.

Total amount of fertilizer used	151,019.31 kg
Nitrogen (N) ratio in fertilizer	15%
Total amount of nitrogen added	= 151,019.31 kg×0.15 = 22,652.8965 kg N

N_2O and CO_2 emissions. As follows

Based on data and calculations based on IPCC guidelines, the greenhouse gas emissions can be summarized as follows:

Total amount of nitrogen added	22,652.90 kg N
Direct release of N_2O	355.97 kg N_2O

Indirect N_2O emissions from evaporation	35.60 kg N_2O
N_2O emissions from leaching/runoff	80.09 kg N_2O
Total N_2O emissions	471.67 kg N_2O
Total N_2O emissions equivalent to CO_2 (CO_2e)	124,991.40 kg CO_2 e
Estimated urea amount (from N input)	49,245.43 kg Urea
CO_2 emissions From the use of urea	36,096.90 kg CO_2

Summary of total greenhouse gas emissions (CO_2 equivalent)

From the care of rubber plantations using NPK fertilizer (15-15-15) in the amount of 151,019.31 kilograms, there will be a total of greenhouse gas emissions calculated as

Total greenhouse gas emissions = 161,088.30 kg CO_2 e or approximately 161.09 tons CO_2e

direct and indirect emissions of nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions resulting from the decomposition of urea in soil.

(3) The calculation of Emission Factor (EF) from the direct use of diesel fuel will depend on **Amount of diesel used** Basically, using the standard EF value per liter of diesel, the greenhouse gas emissions (CO_2 ,CH_4 ,and N_2O) will be calculated from 19,361.45 liters of diesel, referring to the IPCC guidelines and data from the Thailand Greenhouse Gas Management Organization (TGO). **(Reference document 9)**

Emission Factor and Global Warming Potential (GWP) values used in the calculations

1. **For diesel**

CO_2 Emission Factor	2.604 kg CO_2 / liter
(Based on Thailand's standard values and in line with IPCC)	
CH_4 Emission Factor	0.000003 kg CH_4 / liter
(For Mobile Combustion of Diesel , refer to IPCC Tier 1)	
N_2O Emission Factor	0.0000006 kg N_2O /liter
(For Mobile Combustion of Diesel , refer to IPCC Tier 1)	

2. **Global Warming Potential (GWP) (from IPCC AR6)**

CO_2	1
CH_4	27.9
N_2O	265

Calculation of greenhouse gas emissions

Data on the amount of diesel used: 19,361.45 liters

From calculations using data on the amount of diesel used, 19,361.45 liters, and the standard Emission Factor value.

CO_2 emissions	50,417.22 kg CO_2		
CH_4 emission volume	0.058084 kg CH_4	Convert to CO_2 e	1.62 kg CO_2 e
N_2O emission volume	0.0116169 kg N_2O	converted to CO_2 e	3.08 kg CO_2 e

Summary of total greenhouse gas emissions from harvesting trips (CO_2 equivalent) from using 19,361.45 liters of diesel for harvesting, greenhouse gas emissions will occur.

All in all, **50,421.91 kg CO_2 e** or approximately **50.42 tons of CO_2e**

The emission of carbon dioxide (CO_2) is the main part of greenhouse gas emissions from diesel combustion.

Specific Emission Factor (EF) values for "fresh latex" and " formic acid " , which allows the calculation of greenhouse gas emissions as follows:

Data used in calculations

Fresh rubber volume (Natural Rubber) **1,161,687.00 kg**

formic acid solution used (concentration 2.5%) **92,934.96 cc** .

EF for fresh latex 0.4419 kg CO_2 e / kg

(source: TH-Research, Product Carbon Footprint Assessment Guidelines)

EF for formic acid (pure) 1.8489 kg CO_2 e / kg

(Source: Formic acid method (hydrolysis) in CFP EF Data v.2.01 of Japan , Product Carbon Footprint Assessment Guidelines) **(Reference document 10)**

Calculation steps

1. Convert the volume of formic acid solution to the mass of pure formic acid.

From the original data, the formic acid solution used had a concentration of 2.5%.

Assume the density of a 2.5% formic acid solution is close to that of water, i.e. 1 kg/L or 1 g/cc.

so Total mass of formic acid solution used 92,934.96 cc × (1 g/cc)=92,934.96 g = 92.93496 kg

The mass of pure formic acid in solution is 92.93496 kg. × 0.025 = 2.323374 kg

2. Calculate greenhouse gas emissions from fresh latex.

Release = Fresh latex volume × EF

3. Calculate greenhouse gas emissions from formic acid .

Release = mass of pure formic acid × EF

Total greenhouse gas emissions

From calculations using the data and Emission Factor values obtained

The amount of processed fresh rubber **1,161,687.00 kg**

Amount of pure formic acid used (calculated from 2.5% solution) 2.3234 kg

Greenhouse gas emission calculation results

1. **CO_2e emissions from fresh latex**

   1,161,687.00 kg × 0.4419 kg CO_2 e /kg = 513,349.49 kg CO_2 e

2. **CO_2 emission from formic acid**

   2.3234 kg × 1.8489 kg CO_2 e /kg = 4.30 kg CO_2 e

Summary of total greenhouse gas emissions (CO_2 equivalent)

Total greenhouse gas emissions from processing fresh latex (into cup bottom rubber)

Think about it 513,353.78 kg CO_2 e or approximately **513.35 tons of CO_2e**

The calculations show that the majority of greenhouse gas emissions come from the "fresh latex" itself (which may include cultivation, handling and harvesting as the TH-Research EF might cover), while the use of formic acid contributes only a very small amount of greenhouse gas emissions in this process.

Inspection and certification

The amount of GHG sequestration or reduction must be verified and certified by a Validation/Verification Body (VVB). This verification and certification is carried out periodically to ensure that the project is operating in accordance with established procedures and that GHG sequestration or reduction is actually occurring.

Total investment of the project

= 580,000 baht (five hundred and eighty thousand baht)

The amount of greenhouse gases expected to be reduced/absorbed

= 59,946.11 Tons of carbon dioxide equivalent per year

3.10 Project carbon credit calculation period

Retrospective for 7 years, starting from January 1 , 2016 to December 31 , 2022

Table 11 Summary of the amount of greenhouse gases expected to be sequestered/reduced by the project (past 7 years)

Year/production cycle	Greenhouse gas storage volume from base case (tons CO2e/ year)	Greenhouse gas sequestration volume from project operations (rubber) (tons CO2e/ year)	Calculation of greenhouse gas emissions from project operations (tons of CO2e/ year)	Amount of carbon sequestered by the project (tons CO2e/ year)
2016	4,521.42	4,822. 76	765.20	8.578.98
2017	4,521.42	4,822. 76	765.20	8.578.98
2018	4,521.42	4,822. 76	765.20	8.578.98
2019	4,521.42	4,822. 76	765.20	8.578.98
2020	4,521.42	4,822. 76	765.20	8.578.98
2021	4,521.42	4,822. 76	765.20	8.578.98
2022	4,521.42	4,822. 76	765.20	8.578.98
Total 7 years	**31,649.94**	**33,759.32**	**5,356.41**	**60,052,86**

Note: Calculation of carbon sequestration obtained from the project (Net Carbon Sequestration / GHG Reduction)

Net Carbon Sequestration **Calculation Formula (**tons CO2e/ year) = (Annual Net Baseline GHG Balance) − (Annual Project Emission − Annual Project Sequestration) − (Annual Leakage Emission)

Net Carbon Sequestration = 4,521.42 − (765.20152 − 4,822.76) − 0 Net Carbon Sequestration = 4,521.42 − (−4,0 57.55848) Net Carbon Sequestration = 4,521.42 + 4,057.55848 Net Carbon Sequestration

= 8,578.97848 tons of CO2e/ year

More information

1. Value **Amount of carbon sequestered by the project (tons CO2e/ year)** In each year's summary table, it has been adjusted to **8.578.98 tons of CO2e/ year** which is a calculated result that is consistent with the latest data

2. Total figures for 7 years Greenhouse gas emissions from project operations and The amount of carbon sequestered by the project It is also updated based on the annual average.

Part 4 Project Monitoring and Evaluation Plan

Monitoring and Evaluation is key to ensuring that the Carbon Capture and GHG Mitigation Project in the rubber plantation in Buriram Province is implemented effectively, achieves its objectives, and creates truly sustainable benefits. The project's operations, monitoring and evaluation plan will use accurate and transparent data, combining field surveys, satellite technology, and blockchain data recording covering the entire project area. **1,936.15 rai** and there are 131 members participating. (with rubber plantations with coordinates 157 convert)

4.1 Objectives of monitoring and evaluation

1. Follow the progress of operations according to the specified plan.
2. Evaluate the success of the operation against the project objectives and goals.
3. Identify the positive impacts (Co-benefits) and potential negative impacts of the project.
4. Present accurate and useful information to all stakeholders.
5. Continuously improve and develop project operations processes.

4.2 Success indicators Project success indicators will be defined to be clear, measurable and aligned with the objectives, in particular:

- **Net greenhouse gas sequestration/reduction** Which from preliminary calculations is approximately **8,578.98 Tons of CO2e/ year** (approximately) **60,052,86 tons of CO2e** Throughout the 7 years of the project)
- Ecosystem health (biodiversity , soil quality) as the soil in the project area is sandy loam, low acidity and fertility. The project aims to improve through the addition of organic matter.
- The productivity and income of farmers, who previously had relatively low per capita income **80,684 baht/year** And the project has an average carbon credit compensation. **1,300 baht/rai** to create additional income
- Farmer participation , knowledge and skills , stakeholder satisfaction

4.3 Methods of monitoring and evaluation the project will use an integrated monitoring and evaluation method to obtain complete and reliable data.

- **Satellite tracking** Use satellite data to continuously monitor changes in forest/agricultural areas, carbon sequestration in biomass, and rubber tree health over large areas, particularly in Buriram's rubber plantations. **227,180 rai** Coverage 157 Member's conversion
- **Field survey** Periodically conduct field surveys and collect data within the project area to measure soil carbon and biomass, monitor ecosystem changes, and assess the project's impacts on farmers and communities.
- **Blockchain data tracking** Track carbon credit trading data and other financial transactions related to the project through the developed Blockchain system to ensure transparency and accountability for members 1 31 List With more than 15 7 coordinates convert
- **Data analysis** Use IBM SPSS Statistics to prepare and analyze data collected from various sources (e.g. satellite , Blockchain, field) using relational database principles and Long Format data structures to accurately analyze trends and patterns, including statistical analysis of rubber age data (Mean **17.13 Year** , Std. Dev. **3.602 Year**) and rubber varieties (promoted varieties) **84.7%**, native breed **15.3%**)

Table 12 Statistical analysis of rubber age data using IBM SPSS Statistics

Statistics

Age

N	Valid	157
	Missing	2307
Mean		17.13
Std. Deviation		3.602

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7	1	.0	.6	.6
	8	1	.0	.6	1.3
	10	4	.2	2.5	3.8
	11	6	.2	3.8	7.6
	12	10	.4	6.4	14.0
	13	6	.2	3.8	17.8
	14	12	.5	7.6	25.5
	15	16	.6	10.2	35.7
	16	8	.3	5.1	40.8
	17	8	.3	5.1	45.9
	18	12	.5	7.6	53.5
	19	18	.7	11.5	65.0
	20	32	1.3	20.4	85.4
	21	12	.5	7.6	93.0
	22	6	.2	3.8	96.8
	23	4	.2	2.5	99.4
	24	1	.0	.6	100.0
	Total	157	6.4	100.0	
Missing	System	2307	93.6		
Total		2464	100.0		

```
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  /STATISTICS=STDDEV MEAN
  /ORDER=ANALYSIS.
```

4.4 Parameters measured and methods

To ensure accurate carbon assessment and monitoring, the project will measure the following key parameters:

Table 13 Measured parameters

Measured parameters	Details and analysis	Measurement/Monitoring Methods Used in the Project	Frequency of measurement
1. Project location	*Precise geographic coordinates of each member's rubber plantation (total 157 convert) For clear location identification and use in project mapping.*	*GPS receivers and mapping in geographic information systems (GIS) from high-resolution satellite images.*	*At the project start point Review when new plots are added*
2. Project area	*Total area of the entire project* ***1,936.15 rai*** *and the area size of each participating plot, which is an important factor in calculating the total amount of carbon that can be stored.*	*Area assessment from high-resolution satellite images and confirmation from land title documents*	*At the project start point Review when new plots are added or the scope changes.*
3. Sample plot area	*Random selection of sample areas for participating rubber plantations to collect detailed field data such as tree size measurements and soil sampling. The determination of the number and size of sample plots will be based on the ETM Carbon Trade standard (ECT) methodology to ensure good representation of the entire area.*	*Appropriate statistical sampling Field area measurement using GPS or tape measure*	*At the project start point Or according to the frequency specified by the methodology (e.g. every 2-5 years)*
4. Diameter Medium at chest height (DBH)	*DBH value of each rubber tree in the sample plot is the most important factor in estimating the aboveground biomass (AGB), which is an important factor leading to the carbon sequestration of the project.* ***4,822.76 Tons of CO2e/ year*** *[calculated] average*	*Field measurement with DBH tape measure or caliper*	*At least once a year or as per the prescribed procedures*

5. Total Height	*The height of each rubber tree in the sample plot is an important additional factor in estimating aboveground biomass (AGB) and is an indicator of tree growth rate.*	*Field measurement with a Hypsometer or Laser Rangefinder*	*At least once a year or as per the prescribed procedures*
6. Risks	*Identifying and monitoring risks that may impact the amount of carbon stored or cause carbon emissions through leakage, which requires ongoing management plans, including risks from environmental issues facing Buriram Province, such as air pollution from PM2.5 dust caused by burning in agricultural areas.*	*(1)* ***Fire risk*** *Monitoring hotspots and burn traces from satellite images , field reports from farmers , and regular monitoring of compliance with the "no burn" policy.* ***(2) Risk of cutting trees before the cutting cycle*** *Rubber trees have an average cutting cycle of over 25 years, and premature cutting is monitored by satellite and field inspections.* ***(3) Other risks*** *The excessive use of chemicals (with reports of cases of chemical poisoning), Encroachment (Satellite Tracking)*	*Continuous monitoring with satellites Periodically inspect the field Reports from communities and farmers*

4.5 Frequency of monitoring and evaluation the frequency of monitoring and evaluation will vary depending on the type of data and indicators, with project performance reports being produced periodically (e.g. annually) and for carbon credits with a time horizon. **7 years** There will be a follow-up every 2 years.

4.6 Reporting and Inspection The project will regularly report on its progress and performance, disseminating key information to all stakeholders to ensure transparency. Furthermore, the amount of greenhouse gases sequestered or reduced will be subject to periodic audits and certification by a Validation/ Verification Body (VVB) to ensure the accuracy and reliability of the carbon credits generated.