Project Design Document

Varuna company (Thailand)

myclimate (Switzerland)

Project Details	
Project title	Alternate Wetting and Drying (AWD) in Thailand
Project participant	Varuna company (Thailand)
Co-project participant	myclimate (Switzerland)
Project owner	Varuna
Project location	8 provinces in Thailand: Chachoengsao, Sukhothai, Khon Kaen, Maha Sarakham, Nongbualamphu Kanchanaburi, Nakhon Pathom and Uttaradit.
Coordinates of project location	N/A
Project type	☐ Renewable energy of fossil fuel replacement ☐ Improvement of the efficiency of electricity and heat generation ☐ Use of public transportation system ☐ Use of electric vehicle ☐ Improvement of the efficiency of engine ☐ Improvement of the efficiency of energy consumption in building and factory and in household ☐ Use of natural refrigerant ☐ Use of clinker substitute ☐ Solid waste management ☐ Domestic wastewater management ☐ Methane recovery and utilization ☐ Industrial wastewater management ☑ Reduction, absorption and removal of greenhouse gases from the forestry and agriculture sectors ☐ Capture, storage, and/or utilization of greenhouse gas ☐ Other ....
Project model	☐ Single project ☑ Bundled project
Project size	☐ Micro scale

	☐ Small scale ☑ Large scale
T-VER methodology and tools	T-VER-P-METH-13-08
Project activity	The Emission Reduction Project from Water Management in Rice Cultivation Areas in Thailand (Alternate Wetting and Drying: AWD) has been developed to align with international greenhouse gas reduction goals while creating added value through the development of carbon credit initiatives in the agricultural sector. Covering 8 provinces across Thailand, the programme offers a Smart farm platform to monitor and manage rice areas, integrating satellite data with ground truth data to provide insights and ensure transparency. Smart Watcher digital platform on mobile is used for agricultural activity reporting from farmers, ensuring more efficient field management at scale. A combination of ground data and mathematical modelling will be used to estimate ER related to Methane, Nitrous Oxide and Carbon dioxide fluxes. The programme aims to achieve the following objectives: Reducing methane emissions from traditional rice farming practices. Providing knowledge and incentives to farmers for AWD adoption through carbon credits mechanism. Mitigation outcome units generated by this programme are outside Thailand's unconditional and conditional Nationally Determined Contributions (NDCs), and hence are surplus to its NDC target. According to Thailand's NDC Action Plan, 3% of their target is allocated for use within the cooperative approach framework (Article 6.2). This activity will be counted under this percentage. The AWD programme will be implemented in full compliance with: (i) Article 6 of the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC); (ii) Thailand's Nationally Determined Contributions (NDCs) and its Action Plan 2021-2030 and (iii) The Bilateral Climate Agreement between Switzerland and Thailand under Article 6 of the Paris Agreement. The AWD programme will also be in line with Thailand's

	"Guidelines for the Use of Carbon Credits for International Purposes" (planned to be approved in Q3 2025). The project type does not correspond to an excluded project type (cf. Annex 2a of the CO2-Ordinance).
Project investment cost	N/A
Estimated Greenhouse Gas Emission Reductions/Removals	310,209 tCO2eq/y
Crediting period	☑ 5 years ☐ 15 years ☐ others .... years

Details of report preparation		
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Part 1: Project Information

1.1 Project Information

The purpose of the programme is the dissemination of Alternate Wetting and Drying (AWD) practices in Thailand, replacing traditional rice farming practices. Each project under the programme will support the programme' goal of reducing methane emissions from rice paddies in Thailand.

Rice production in Thailand, while a significant contributor to the national economy, also generates substantial greenhouse gas emissions. Continuous flooding in paddy fields leads to significant methane (CH_4) emissions, while the use of nitrogen-based fertilizers contributes to nitrous oxide (N_2O) emissions. Furthermore, other cropping operations, such as tillage, sowing, harvesting, and water pumping, release carbon dioxide (CO_2) through fossil fuel combustion. Open burning of rice straw, a common practice in Thailand particularly in irrigated areas, releases CO_2 and harmful pollutants such as black carbon, contributing to both air pollution and climate change. Beyond environmental concerns, farmers in Thailand face various challenges. External factors like climate change and natural disasters can significantly impact production, affecting both quality and quantity, and consequently impacting farmers' incomes and livelihoods. Internal factors, such as limited access to modern agricultural technologies, inadequate financial and bookkeeping management, and poor crop-land suitability, also hinder optimal production and profitability.

The AWD method for rice cultivation is a water management technique to cultivate irrigated rice with much less water than the traditional system of maintaining continuous standing water in the crop field. With AWD, a periodic drying and re-flooding irrigation schedule is applied, allowing the fields to dry up to 35 days before irrigation. This alternation between wet and dry conditions disrupts the environment needed for methane-producing bacteria, as the oxygen levels in the soil increase during the dry phases, actively inhibiting their anaerobic methanogenic activity.

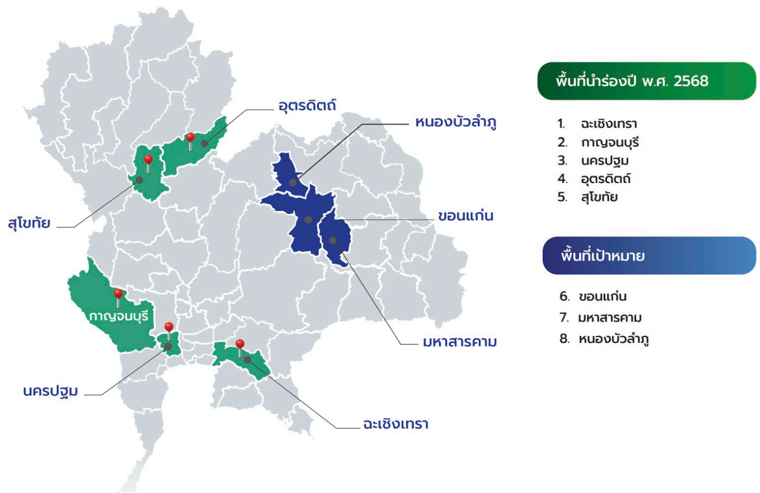


Figure 1: Map Location of Project Area

The programme will target only provinces with set-up irrigation infrastructures, such as those present in the central regions but as well those in the North-East regions and possibly extending to other provinces with similar infrastructures including Chachoengsao, Sukhothai, Khon Kaen, Maha Sarakham, Nongbualamphu, Kanchanaburi, Nakhon Pathom and Uttaradit. The total area is targeted at 196,742 Ha (1,229,633 rai).

Table 1: Area participating in the AWD programme in rai per province and year

Province	**Area (rai)**	**Year**
Chachoengsao	118,456	2025-2026
Khon Kaen	51,376	2026
Maha Sarakham	102,295	2026
Nongbualamphu	7,386	2026
Sukhothai	382,356	2027
Uttaradit	257,706	2028
Kanchanaburi	110,349	2029
Nakhon Pathum	199,710	2029
Total	**1,229,633**	

AWD practices will only focus on the dry seasons, when fields are artificially irrigated and will exclude the crops generated during the rainy seasons, as it is not possible to easily control the water levels in the channels during the rainy season. For this reason, ex-ante emission reduction calculation is based on the conservative assumption that AWD will be implemented only for one harvest season. The expected GHG emission reduction is 1,395,939 tCO2.

AWD's controlled irrigation strategy reduces methane emissions, water use, and pumping costs likely without impacting yield while promoting pest control. Additional benefits, such as improved market access, are expected through the future planned accreditation by the Sustainable Rice Platform (SRP). Practices such as the use of organic amendments (e.g., compost, rice straw) instead of chemical ones will be discussed with the farmers. Their adoption will allow farmers to receive a higher-level certification under the SRP.

1.2 Project Boundary

The geographic boundary encompasses the rice fields where the cultivation method and water regime are changed. The spatial extent of the programme boundary includes all fields that change the cultivation method in the context of the programme activity. The system boundary of the programme can be visualised as follows:

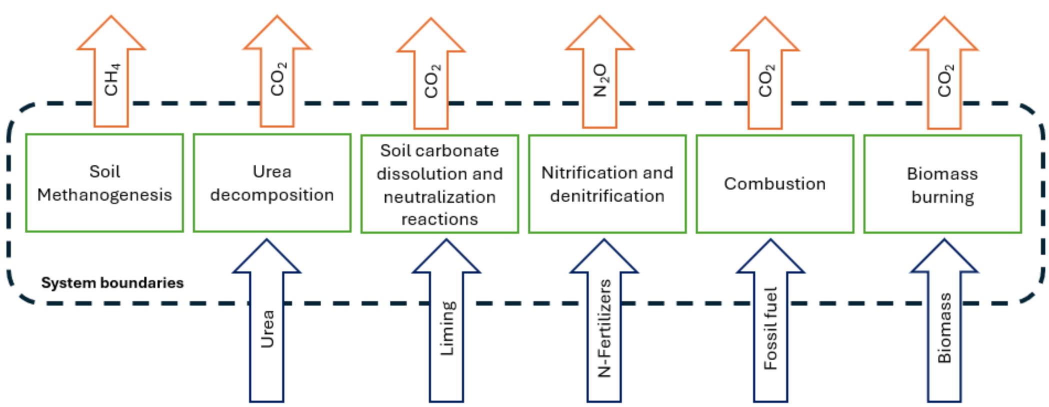


Figure 1: Schematic representation of system boundaries

Soil methanogenesis, urea decomposition, soil carbonate dissolution and neutralization, nitrification and denitrification and fossil fuel combustions and biomass burning are included.

The following emissions are directly influenced by the programme:

- Methane emissions result from the anaerobic decomposition of organic matter by soil methanogen
- microbial transformation of Nitrogen in fertilizers in the soil through nitrification and denitrification processes
- urea decomposition
- soil carbonate dissolution and neutralization reactions
- combustion of fossil fuels (e.g.: from increased machineries use)
- biomass burning (i.e.: straw burning)

The following emissions are indirectly influenced by the programme:

- nitrogen losses through volatilization of ammonia and nitrogen oxides, as well as leaching and surface runoff, which subsequently lead to nitrous oxide emissions

The selection of project areas requires leveraging the national farmer database provided by Rice Department (RD) to preliminarily assess agricultural land size. As AWD farming activities necessitate precise water control for paddy fields, it is essential to integrate irrigation canal data from the Royal Irrigation Department (RID) to identify areas with suitable water inflow and outflow systems. This ensures the identification of optimal locations for implementing AWD farming.

To address the issue of double-counting carbon credits, the project conducted a cross-check of provincial areas against existing carbon credit initiatives related to rice cultivation. The assessment identified 8 provinces eligible for the implementation of this programme. This assessment, together with the final confirmation from the relevant Thai authorities, ensure the avoidance of overlapping activities and unique credit allocations.

The mitigation activity is planned to start with an area of 44,722 ha in the provinces of Chachoengsao (in October 2025), Khon Kaen, Maha Sarakham and Nongbualamphu (in May

2026). It will then include Sukhothai in 2027, followed by Kanchanaburi, Nakhon Pathom and Uttaradit in the following years to reach a total of 196,742 ha by 2029. Provinces' participation to the programme is subject to approval by the Thai authorities.

A stakeholder consultation (SHC) meeting took place in Chachoengsao in February 2025 to introduce the farmers to the programme, and the farmers of Chachoengsao will be visited again by 2026 to sign the contracts. The stakeholder consultation meeting in Khon Kaen, Maha Sarakham and Nongbualamphu are planned for Q2-Q3 2026. SHC for the additional provinces are planned for year 2026 onwards.

Awareness raising and technical trainings will be key activities in the programme implementation as a way of promoting the adoption of climate smart agriculture and ensuring the proper application of AWD practices. The successful adoption of the new farming practice and technology will depend on the involvement of the farming communities. Therefore, AWD communities will be built and scaled up. There will be dedicated field staff working with community leaders or a community leader will be hired part-time to build trust with farmers and enroll farmers into AWD communities.

General approach to stakeholder engagement:

1. **Stakeholder consultation (SHC):** Before the implementation of the programme, a Stakeholder consultation will take place in person in each province in order to present this programme and the opportunities for farmers to join such an initiative. Community leaders will be invited to participate and will be able to ask questions regarding the project.
2. **Signing of contract and trainings:** After the stakeholder consultation, a follow up meeting will be organized for the signing of the contract between the farmers and Varuna. The contract between Varuna and the farmers has the purpose to bind the farmers' participation to the programme with Varuna's support, as well as to waive the carbon rights to the programme owner. At the end of the training session, the farmers will be provided with the contract and

the AWD tubes. The trainings will include the explanation on how the farmers should use the mobile platform. The invitation to the first training session will clarify that the farmer needs to provide proof of the land right or lease of land for the signing of the contract.

3. **Start of implementation:** The signed contract and the proof of land right or land lease will be collected by Varuna before the start of the AWD activity. This will be considered as the start of the implementation activity.

Table 2: Participants: State and non-state actors involved in the implementation of the Activity

	Name	**Roles (can be multiple for one entity)**
Buyer of the ITMOs	KliK Foundation	The KliK Foundation will be the buyer of the Mitigation Outcomes generated by the Activity.
Project Owner	Myclimate	myclimate will be KliK Foundation's contractual partner
Project Developer	Varuna	Implementing-lead responsible for project execution, data collection, data analysis to ensure delivery of emission reductions, marketing and communication, and preparing project documents for MADD registration and validation according to Premium T-VER standard which allows the trading of mitigation outcomes under Article 6.2 of the Paris Agreement) and Swiss Government's requirements.
MRV	myclimate CarbonFarm	myclimate is responsible for the monitoring, reporting and verification (MRV) of the project to ensure the delivery of ITMOs to KliK Foundation. CarbonFarm, a French AWD monitoring provider, will provide support to myclimate for the development, calibration and application of the mathematical model.
Technology Provider	Varuna	Provide technology for the farmers to enhance quality of AWD farming monitoring and managing which is cross checked with satellite and ground data.
Farmers	Farmers, both landowners and renters	Participate to the programme and implement AWD practices. Both farmers owning the fields and farmers renting the fields will be able to participate to the programme.

Main government agency	Rice Department (RD)	Supporting and providing ground data of the potential areas which are suitable for AWD activity, give suggestion to engaging with the farmers for expanding AWD activity across Thailand. The RD shall also confirm that no other AWD programme, neither nationally nor internationally financed, is taking place in the provinces targeted by this programme.
	Royal Irrigation Department (RID)	Providing data on farmer's water usage and areas with water management systems essential for supporting AWD activities and effective water control. The RID shall also confirm that no other AWD programme, neither nationally nor internationally financed, is taking place in the provinces targeted by this programme.
	Department of Agriculture Extension (DoAE)	Supporting local stakeholder initiatives, fostering collaboration, and encouraging farmers to adopt improved rice cultivation practices for enhanced productivity and sustainability.
Government entities responsible for authorization	Department for Climate Change and Environment (DCCE)	Thai authority granting authorization to the programme
	Federal Office for the Environment (FOEN)	Swiss authority granting authorization to the programme

The institutional set up of the AWD Activity involves several key agencies that ensure its effective implementation and sustainability. The RD, as the main government agency, oversees and supports the programme by providing critical ground data and guidelines for engaging with farmers. The RID supplies data on farmers' water usage and identifies areas with necessary water management systems. The AWD schedule will be developed in close collaboration with them, to ensure an optimal implementation of AWD practices. In addition, the DoAE fosters local initiatives and collaboration.

The implementation of the programme is managed by Varuna, which coordinates the farmer engagement activities and training sessions in collaboration with the DoAE. Varuna also oversees data collection, ensuring that accurate and comprehensive information is gathered from all participants.

To ensure smooth and effective communication throughout the programme, a coordination group or committee will be established. This group/committee will include representatives from Varuna, the DoAE, and selected farmer leaders from participating communities. The committee will meet regularly to review progress, address any challenges, and facilitate timely information exchange between all stakeholders.

myclimate is responsible for MRV tasks, including summarising data, preparing monitoring reports, and organising verification processes (as well as organizing the programme's validation before its start). This involves meticulous analysis and reporting to ensure that the programme adheres to established standards and achieves its objectives. myclimate's role is crucial in validating the outcomes and maintaining transparency throughout the implementation phase, thereby enhancing trust among stakeholders.

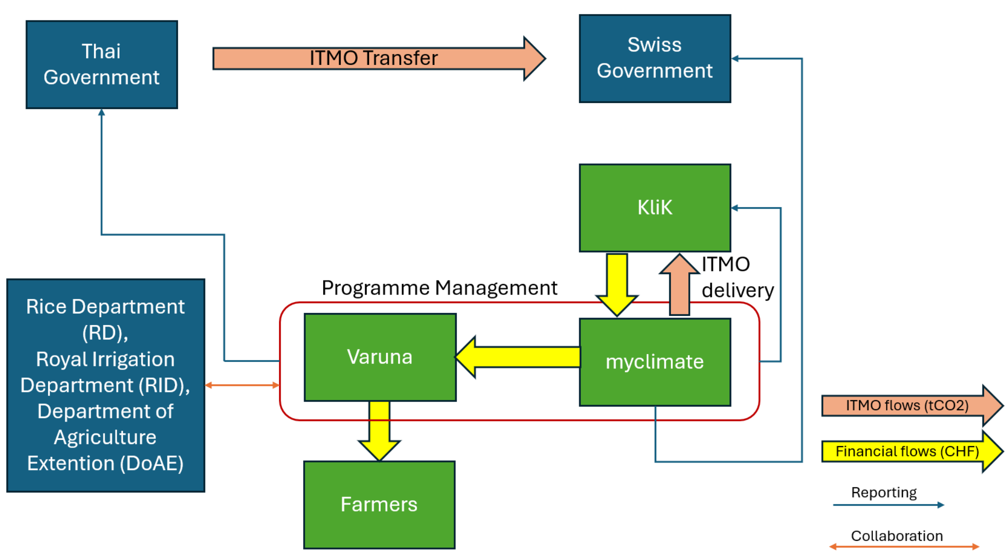


Figure 3: Illustration of the relationships in the programme activity focusing on ITMO revenue flows and reporting/controlling responsibilities.

Technology and Tool

In Thailand it is common practice that fields are continuously flooded (5–10 cm of standing water) throughout the growing season from the vegetation period, productive period and ripening period. The water is draining out of the field at the end of the growing season (90 days after sowing).

The application of AWD practices instead requires a dynamic management of the flooding level of the fields: at the beginning of the vegetation period, water is introduced into the field. Then, 20 days after sowing, the water is drained to 15 cm below ground level. The field undergoes five drainage cycles: four times between 20 and 60 days after sowing and once during the ripening period. After the final drainage, the field is left dry until harvest.

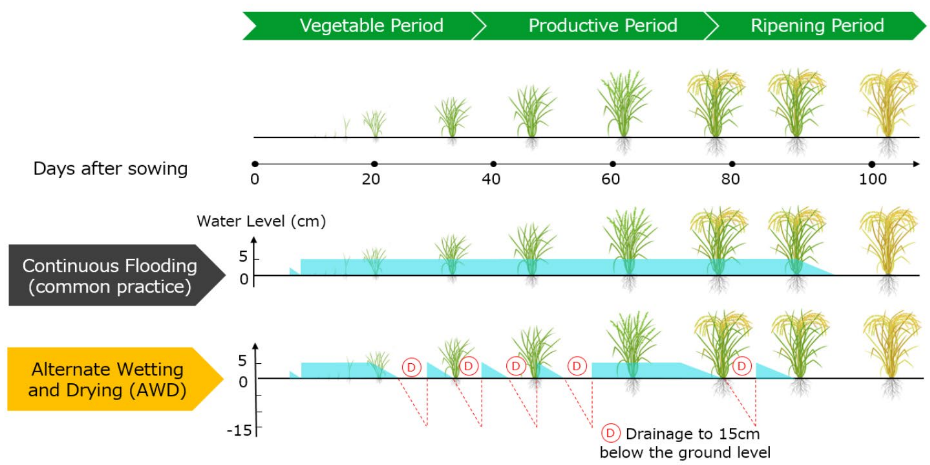


Figure 4: Illustration of AWD practice

The AWD tube to monitor water level below the soil surface is a typical AWD tube with standard size of 7-15 cm diameter and 30-40 cm length and is installed 25 cm below ground level, with 5 cm remaining above the surface. It has 10–15 perforations for water level monitoring, spaced every 2–3 cm along the submerged portion (25 cm below ground). The holes have a diameter of 5–10 mm, preventing clogging while ensuring proper water flow. The programme will distribute 1 tube per field and the number of tubes will increase if the elevation within the field changes.

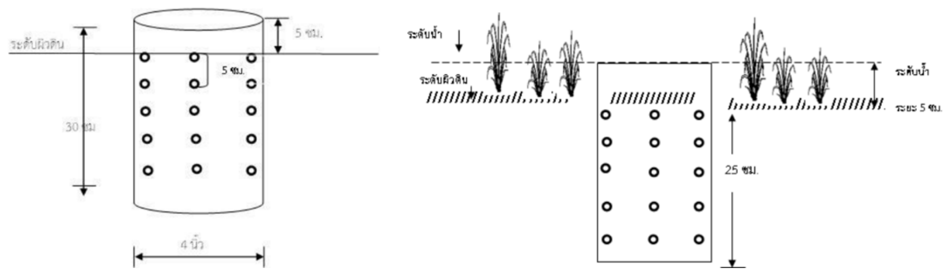


Figure 5: Illustration of the tube's positioning in the soil

Knowledge and expertise of AWD water management practice will be transferred through trainings by experts from Thailand's Rice Department and Varuna Team. Each farmer will receive at least one level measuring tubes, depending on the size and slope of the field, as the location should be representative of the average water depth in the field.

Flat soil is crucial for the successful implementation of AWD as it ensures uniform water distribution across the field, preventing areas from either drying out completely or remaining overly saturated. The provinces targeted in the AWD programme have been assessed for their topography. It has been determined that Laser Land Levelling (LLL), which is an advanced and costly technique to achieve perfectly flat fields, will likely not be necessary in these areas due to their naturally suitable land conditions. This natural advantage simplifies the implementation process and reduces costs, making it easier for farmers to adopt AWD practices.

The Smart Watcher application is designed to collect and monitor data necessary to calculate ex-post mitigation outcomes. The application is accessed by a QR code that the farmers can easily scan from their phone. The primary focus of the application is tracking key agricultural and environmental parameters that are crucial for verifying the effectiveness of mitigation practices.

1.3 Double Counting

The project activity in this project used to register or in the process of registering other carbon other international climate mitigation mechanisms such as Development Mechanism (CDM), Voluntary Carbon Standard (VCS), Gold Standard etc. or Renewable Energy Certificates (REC)

☑ No

☐ Yes

Project Title..

Scheme..

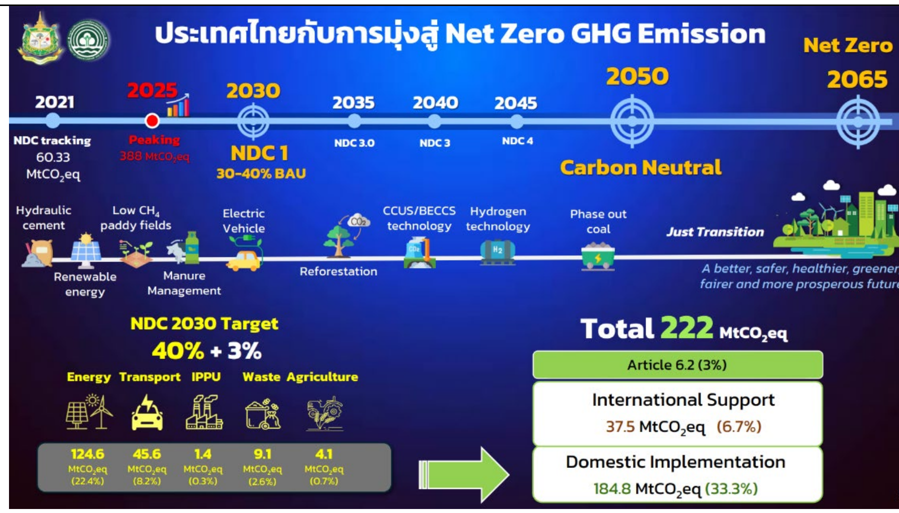
Crediting period that is issued..

1.4 Additionality

Thailand has made significant commitments under its NDC to reduce greenhouse gas emissions and enhance sustainable agricultural practices. As part of its NDC, Thailand aims to improve water management systems and promote the adoption of advanced farming techniques, including AWD. This commitment is reflected in various initiatives and policies aimed at minimizing methane emissions from rice cultivation, a major contributor to the country's greenhouse gas profile.

The proposed AWD project offers an additional layer of mitigation that complements Thailand's existing commitments. By focusing on areas not currently covered by neither the national AWD initiatives nor by climate finance activities (GCF), this programme ensures that its activities do not overlap with or duplicate the efforts already underway. Instead, it provides a supplementary mechanism to go beyond the NDC targets, both conditional and unconditional, thus contributing to Thailand's overall climate goals in a more ambitious manner.

Table 3: Related Policy and Regulation

<table>
<tr><th>Related Policy and Regulation</th><th>Description</th></tr>
<tr><td>Description</td><td>Thailand’s 2nd Updated Nationally Determined Contributions (NDC) and its Action Plan 2021-2030</td></tr>
<tr><td>Type</td><td>Policy</td></tr>
<tr><td>Impact</td><td>


The NDC Action Plan on Mitigation 2021-2030 has been developed as a strategic framework for the main responsible agencies and related organizations to reduce greenhouse gas emissions in Thailand. The plan aims to achieve the country’s Nationally Determined Contribution (NDC) targets, which includes a 30–40% reduction from the Business-As-Usual (BAU) scenario by 2030.

This Action Plan outlines strategies that collectively represent a potential reduction of 222 million tonnes of CO_2 equivalent ($MtCO_2eq$) by 2030. The emissions reductions can be categorized as follows:

184.8 $MtCO_2eq$ (33.3%) from domestic actions (unconditional target).

37.5 $MtCO_2eq$ (6.7%) from international support (conditional target).

Furthermore, 3% (ca. 16.6 M tCO_2eq) will come from Article 6 of the Paris
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	Agreement mechanism, leading to a total of 43%. This will be additional to the country's conditional and unconditional targets. This AWD program falls within this category.

Related Policy and Regulation	**Description**
Description	Guidelines for the Use of Carbon Credits for International Objectives
Type	Guidelines
Impact	The Guidelines for the Use of Carbon Credits for International Objectives have been adopted by the Cabinet on the 26th of August 2025. These provide a list of eligible sectors under Article 6, which includes "methane reduction of rice cultivation". These guidelines replace the Carbon Credit Management Guideline and Mechanism, which was approved by the National Committee on Climate Change in 2022.

1.5 Crediting Period

Project start date : The date of contract signing with farmer which is expected in 4Q2025.

☑ 5 years (2025-2030)

☐ 15 years

☐ others ....years+

The programme is expected to generate 1,551,043 tCO2 of Emissions Reduction (ER) until 2030. The government of Thailand requires that 10% of the total generated ER are not transferred as ITMO to the buying country and will remain in Thailand and contribute to the country's mitigation efforts. Therefore, 155,104 tCO2 from the total ER volume will not be transferred to Switzerland, and the total expected ITMO volume will correspond to 1,395,939 tCO2.

Table 4: Expected ERs and ITMO volume transferrable to Switzerland for the programme

Year	Expected ERs [t CO_2e]	Expected ITMO volume transferrable to Switzerland [t CO_2e]
2025	0	0
2026	100,350	100,350
2027	237,623	237,623
2028	330,145	330,145
2029	441,463	441,463
2030	441,463	286,358
Total	1,551,043	1,395,939

In the table below we indicate the start of the implementation and the day of first effect for this AWD programme and for the projects. The start of implementation is defined as the day for the first project participating in the programme, and it corresponds with the signing of the contracts with the first farmers in the AWD community in the first province (i.e.: at the first trainings). The day of first effect is the moment when emission reduction starts to be generated: in the case of the AWD programme, this is the same for the programme and for the first project participating in the programme, and it corresponds to the first day the farmers start applying AWD practices in a farming cycle. The farming cycle starts with seeding.

Date	Programme	First project
Start of implementation	15/10/2025	15/10/2025
Day of first effect	01/11/2025	01/11/2025
End of crediting period	31/12/2030	31/12/2030

1.6 Document or Certificate of Land Use Rights (For Reduction, absorption and removal of greenhouse gases from the forestry and agriculture sectors)

- Identification document or certificate of land use rights.

- Identification boundaries of plantation.

- Identification the relevant regulation for project.

Part 2 T-VER Methodology

2.1 T-VER Methodology and Tools

No.	Methodology Code	Version	Title of methodology/tool
1	T-VER-P-METH-13-08	1.0	Enhanced Good Practices in Paddy Rice Field

2.2 Project Conditions

Code: T-VER-P-METH-13-08	
Version: Version 1.0	
Methodology/tool: Enhanced Good Practices in Paddy Rice Field	
Project Conditions	**Justification/Explanation**
Project must be located within Thailand	The project is in 8 rice-growing provinces within Thailand.
Paddy rice cultivation areas with identifiable project boundaries	Farm plots will be geo-referenced to ensure clear boundaries and avoid overlap with other projects.
Farmers adopt at least one enhanced good practice (e.g., AWD)	Current practice is continuous flooding, which causes high CH_4 emissions.
Project participants must provide historical data (e.g.: water use, fertilizer application, yields)	Farmers adopt AWD, an approved good practice under the methodology.
Project must demonstrate additionality compared to baseline practices	AWD is not common practice; the project provides training, monitoring, and incentives to ensure adoption.
Monitoring system must be in place (farmer records, field measurements, drone/satellite data, or smart devices)	Farmer logs, digital tools, and remote sensing will track AWD use; chamber sampling (1/province) will validate results.

Code: T-VER-P-METH-13-08	
Version: Version 1.0	
Methodology/tool: Enhanced Good Practices in Paddy Rice Field	
Project Conditions	**Justification/Explanation**
Compliance with Thai laws, regulations, and agricultural standards	Farmers participate voluntarily, and the project complies with all Thai agricultural laws.
No double counting of GHG reductions (with other carbon programs or mechanisms)	Credits will be registered only under TGO to ensure integrity.
Participation must be voluntary by farmers/communities	Data will be stored for at least 2 verification cycles.

2.3 Relevant information for calculating greenhouse gas emissions

Relevant greenhouse gas sources for calculation

Source		**Gas**	**Included?**	**Justification/Explanation**
Baseline emissions	Calculation methane reduction from modelling reference by TGO guideline	CO_2	yes	The CO_2 emissions in the baseline are related to the agricultural practices which burn fossil fuel as well as from the application of limestone, dolomite and urea. The last three have been estimated ex-ante and are excluded because baseline emissions represent < 1% of methane sources (0.33%). The ex-post fossil fuel consumption will be considered for baseline source, despite baseline emissions represents 2.54% of methane sources and according to the methodology, emissions amounting to < 5% of methane sources could be omitted from

				the estimations.
		CH_4	yes	The activity of methanogenic microorganisms in soil, calculated using modelling parameters (ex-post) and based on default values (ex-ante).
		N_2O	yes	The N_20 emissions in the baseline are related to the use of nitrogen-based fertilizers. Direct and indirect baseline emissions have been estimated ex-ante (based on IPCC guidelines) and, despite they represent less than 1% of methane sources (0.14% for direct nitrous oxide emissions and 0.17% for indirect nitrous oxide emissions) and therefore could be neglected, the ex-post emissions will be considered as part of the results of mathematical model developed.
		Other	no	NA
Project emissions	Improving Water Management of rice cultivation activity for methane reduction	CO_2	yes	See above. The project will measure these emissions (ex-post) due to the activity.
		CH_4	yes	The activity of methanogenic microorganisms in soil, calculated using modelling parameters (ex-post) and based on default values (ex-ante).
		N_2O	yes	See above. The N_20 emissions for project activity will be part of the results of mathematical model (ex-post).
		Other	no	NA

Part 3 Calculation of greenhouse gas reduction

3.1 Calculation of baseline sequestration/emission

Code: T-VER-P-METH-13-08
Version: 1.0
Methodology/tools: Enhanced Good Practices in Paddy Rice Field T-VER-P-TOOL-01-13
Equation: $BE_y = \sum_{s=1}^{m} BE_s$ $BE_s = \sum_{i=0}^{n} \left((CH_{4_{SOIL,BL,s,i}} \times CF) + CO_{2_{LIME,BL,s,i}} + CO_{2_{UREA,BL,s,i}} + N_2O_{SOIL,BL,s,i} \right)$

Where:

BE_y	=	Total baseline greenhouse gas emissions in year y (tonnes of carbon dioxide equivalent)
BE_s	=	Baseline greenhouse gas emissions in growing season s (tonnes of carbon dioxide equivalent)
$CH_{4_{SOIL,BL,s,i}}$	=	Methane emissions from soil carbon in the baseline scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
CF	=	Conservativeness factor or below business-as-usual adjustment factor
$CO_{2_{LIME,BL,s,i}}$	=	Carbon dioxide emissions from lime application in the baseline scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
$CO_{2_{UREA,BL,s,i}}$	=	Carbon dioxide emissions from urea fertilizer application in the baseline scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{SOIL,BL,s,i}$	=	Nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
I	=	Sample unit i as listed in Table 1 (n = total number of sample units)
S	=	Growing season (s = number of growing seasons in the project year)

Ex-ante Baseline emissions for $CH_{4SOIL, BL,s,i}$

$$CH_{4_{SOIL,BL,s,i}} = \sum_{i=1}^{n} EF_{CH4BL,s,i} \times A_{s,i} \times L_s \times 10^{-3} \times GWP_{CH4}$$

Where:

$CH_{4_{SOIL,BL,s,i}}$	=	Methane emissions from soil methanogenesis in the baseline scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
$EF_{CH4BL,s,i}$	=	Methane emission factor for rice cultivation in the baseline scenario during growing season s for sample unit i (kilograms of methane per rai per day)
$A_{s,i}$	=	The harvested area of sample unit i in growing season s (rai)
L_s	=	The rice harvest duration in growing season s (days)
i	=	Sample unit i, covering the entire rice cultivation area (n = total number of sample units)
s	=	Growing season (s = number of growing seasons in the project year)
GWP_{CH4}	=	Global warming potential of methane (tonnes of carbon dioxide equivalent per tonne of methane)

When using default emission factors from the IPCC Guidelines (Tier 1), the methane emission factor can be calculated as follows:

$$EF_{CH4BL,s,i} = EF_{BL,c} \times SF_{BL,w} \times SF_{BL,p} \times SF_{BL,o}$$

$$SF_{BL,o} = \left(1 + \sum_i ROA_{BL,s,i,om} \times 0.00625 \times CFOA_{om}\right)^{0.59}$$

Where:

$EF_{CH4BL,s,i}$	=	Baseline methane emission factor for rice cultivation in growing season s of sample unit i (kilograms of methane per rai per day)
$EF_{BL,c}$	=	Baseline methane emission factor for continuously flooded rice cultivation without organic matter application (kilograms of methane per rai per day)
$SF_{BL,w}$	=	Adjustment factor for in-season water management practices in baseline rice cultivation
$SF_{BL,p}$	=	Adjustment factor for pre-season water management practices in baseline rice cultivation
$SF_{BL,o}$	=	Adjustment factor for organic matter application in baseline rice cultivation

$ROA_{BL,s,i,om}$	=	Quantity of organic matter type om applied in growing season s of sample unit i (kilograms per rai; dry weight for straw, fresh weight for other materials)
$CFOA_{om}$	=	Conversion factor for organic matter type om applied (compared to short-term straw application before planting)
0.00625	=	Unit conversion constant (tonnes per hectare)
Om	=	Type of organic matter
0.59	=	Exponent factor to incorporate the timing of rice straw application

Ex-post Baseline emissions for $CH_{4SOIL, BL,s,i}$

The baseline and project emissions source of CH_4 – soil methanogenesis will be assessed by a process-based model. As per the "Guideline for Premium Thailand Voluntary Emission Reduction Program (Premium T-VER) version 5.0"[1], if more than 16,000 tCO_2eq/year, it is considered to be a large project. The project chooses the modelling method including direct measurement for plausibility checks.

Assessment Method: Modelling

$$CH_{4_{SOIL,BL,s,i}} = GWP_{CH4} \times fCH_{4_{SOIL,BL,s,i}}$$

Where:

$CH_{4_{SOIL,BL,i,t}}$	=	Methane emissions from soil methanogenesis in the baseline scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
$fCH_{4_{SOIL,BSL,i,t}}$	=	Methane emissions from soil methanogenesis in the baseline scenario as simulated by the model during growing season s for sample unit i (tonnes of methane)
GWP_{CH4}	=	Global warming potential of methane (tonnes of carbon dioxide equivalent per tonne of methane)

[1] Guideline for Premium Thailand Voluntary Emission Reduction Program (Premium T-VER) V.4, provided separately to the validator.

The model predicts greenhouse gas emissions from agricultural areas, such as CH_4 and N_2O emissions from soil. The model is calibrated and validated using gas measurements from the following sources: (1) collecting actual emission data from the project area in representative areas, (2) emission data from experimental plots or research plots, or (3) data from high-quality academic literature, such as those reviewed by experts or published in academic journals. A plausibility check will be performed against measurements carried out with closed chambers. This approach is additional to TGO requirements and ensures that the model is conservative and in line with actual field conditions.

The scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01

Ex-ante Baseline emissions for $CO_{2LIME,\ BL,s,i}$

For the assessment of carbon dioxide emissions from liming (using calcite, calcium carbonate, or calcium magnesium carbonate), the calculation is done based on default values as set in T-VER-P-METH-13-08.

Some liming materials are both locally produced and imported. Only the amount produced locally is considered for baseline emissions:

$$CO_{2_{LIME,BL,s,i}} = \sum\left[\left((M_{Limestone,BL,s,i} \times A_{s,i}) \times EF_{Limestone}\right) + \left((M_{Dolomite,BL,s,i} \times A_{s,i}) \times EF_{Dolomite}\right)\right] \times \frac{44}{12}$$

Where:

$CO_{2_{LIME,BL,s,i}}$	=	Quantity of carbon dioxide emitted from lime application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide)
$M_{Limestone,BL,s,i}$	=	Quantity of lime used in the baseline scenario in growing season s of sample unit i (tonnes of lime per rai)
$EF_{Limestone}$	=	Greenhouse gas emission factor from lime use (tonnes of carbon per tonne of lime)
$M_{Dolomite,BL,s,i}$	=	Quantity of dolomite applied in the baseline scenario in growing season s of sample

		unit i (tonnes of dolomite per rai)
$EF_{Dolomite}$	=	Greenhouse gas emission factor from dolomite application (tonnes of carbon per tonne of dolomite)
$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
$\frac{44}{12}$	=	Molecular weight ratio of carbon dioxide to carbon

The ex-ante ER calculation has shown that CO_2 emissions from liming are below 5%.

Ex-post Baseline emissions for $CO_{2LIME,\ BL,s,i}$

These are assessed as zero, because negligible in ex-ante estimation.

Ex-ante Baseline emissions for $CO_{2UREA,\ BL,s,i}$

Urea is broken down by an enzyme called urease, resulting in the release of carbon dioxide gas. Additionally, the ammonia in urea can be transformed, leading to the release of nitrous oxide gas, which will be calculated in a subsequent section.

Some urea fertilizers are both locally produced and imported. Only the amount produced locally is considered for baseline emissions.

For the assessment of carbon dioxide emissions from urea application, a third assessment approach is necessary: calculation using default values with the following equation:

$$CO_{2\,UREA,BL,s,i} = \sum\left((M_{Urea,BL,s,i} \times A_{s,i}) \times EF_{Urea}\right) \times \frac{44}{12}$$

Where:

$CO_{2\,UREA,BL,s,i}$	=	Carbon dioxide emissions from urea application in the baseline scenario in growing season s of sample unit i (tonnes of CO2)
$M_{Urea,BL,s,i}$	=	Quantity of urea used in the baseline scenario in growing season s of sample unit i

		(tonnes of urea per rai)
EF_{Urea}	=	Greenhouse gas emission factor for urea (tonnes of carbon per tonne of urea)
$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
$\frac{44}{12}$	=	Molecular weight ratio of carbon dioxide to carbon

The ex-ante ER calculation has shown that CO_2 emissions from urea are below 5%.

Ex-post Baseline emissions for $CO_{2UREA,\ BL,s,i}$

These are assessed as zero, because negligible in ex-ante estimation.

Ex-ante Baseline emissions for $N_20_{SOIL,\ BL,s,i}$

Nitrogenous fertilizers applied to cultivated land, whether in the form of chemical fertilizers, organic fertilizers, manure, or agricultural residues, undergo transformations by soil microorganisms through nitrification and denitrification processes. During these processes, direct nitrous oxide emissions occur. Additionally, indirect nitrous oxide emissions arise from losses due to ammonia and nitrogen oxide volatilization, as well as leaching or surface runoff, where lost nitrogen is transformed and released as nitrous oxide.

For the assessment of nitrous oxide emissions from nitrogen fertilizer application, the following method is used:

Assessing N_2O emission by referring to IPCC guidelines:

$$N_2O_{SOIL,BL,s,i} = N_2O_{Direct,BL,s,i} + N_2O_{Indirect,BL,s,i}$$

(1) <u>Direct emissions</u>

$$N_2O_{Direct,BL,i,t} = (F_{SN,BL,s,i} + F_{ON,BL,s,i}) \times EF_{N2ODirect} \times \frac{44}{28} \times GWP_{N2O}$$

$$F_{SN,BL,s,i} = \sum(M_{SN,BL,s,i,j} \times A_{s,i})$$

$$F_{ON,BL,s,i} = \sum(M_{ON,BL,s,i,k} \times A_{s,i})$$

(2) Indirect emissions

$$N_2O_{Indirect,BL,s,i} = N_2O_{ATD,BL,s,i} + N_2O_{L,BL,s,i}$$

$$N_2O_{ATD,BL,s,i} = \left((F_{SN,BL,s,i} \times Frac_{GASF}) + (F_{ON,BL,s,i} \times Frac_{GASM})\right) \times EF_{ATD} \times \frac{44}{28} \times GWP_{N2O}$$

$$N_2O_{L,BL,s,i} = (F_{SN,BL,s,i} + F_{ON,BL,s,i}) \times Frac_{LEACH} \times EF_{LEACH} \times \frac{44}{28} \times GWP_{N2O}$$

Where:

$N_2O_{SOIL,BL,s,i}$	=	Nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{Direct,BL,s,i}$	=	Direct nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{Indirect,BL,s,i}$	=	Indirect nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{ATD,BL,s,i}$	=	Indirect nitrous oxide emissions from the accumulation of volatilized nitrogen from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{L,BL,s,i}$	=	Indirect nitrous oxide emissions from leaching and runoff of nitrogen in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$F_{SN,BL,s,i}$	=	Quantity of nitrogen in chemical fertilizer applied to the soil in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen)
$F_{ON,BL,s,i}$	=	Quantity of nitrogen in organic fertilizer applied to the soil in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen)
$EF_{N2ODirect}$	=	Direct nitrous oxide emission factor from nitrogen fertilizer application (tonnes N2O-N per tonne of nitrogen)
EF_{ATD}	=	Nitrous oxide emission factor from the accumulation of atmospheric nitrogen deposition in soil and water (tonnes N2O-N per tonne of NH3-N + NOX-N)
EF_{LEACH}	=	Nitrous oxide emission factor from leaching and runoff (tonnes N2O-N per tonne of nitrogen leached and run off)
$Frac_{GASF}$	=	Proportion of chemical nitrogen fertilizer applied to the soil that is volatilized as ammonia and nitrogen oxides (tonnes NH3-N + NOX-N per tonne of nitrogen)
$Frac_{GASM}$	=	Proportion of organic nitrogen fertilizer applied to the soil that is volatilized as ammonia and nitrogen oxides (tonnes NH3-N + NOX-N per tonne of nitrogen)

$Frac_{LEACH}$	=	Proportion of nitrogen applied to the soil that is lost through leaching and runoff (tonnes of nitrogen leached and run off per tonne of nitrogen)
$M_{SN,BL,s,i,j}$	=	Quantity of chemical fertilizer type j applied in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen of chemical fertilizer per rai)
$M_{ON,BL,s,i,k}$	=	Quantity of organic fertilizer type k applied in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen of organic fertilizer per rai)
$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
$\frac{44}{28}$	=	Molar mass ratio of nitrous oxide to nitrogen
GWP_{N2O}	=	Global warming potential of nitrous oxide (tonnes of carbon dioxide equivalent per tonne of nitrous oxide)

Ex-post Baseline emissions for $N_20_{SOIL, BL,s,i}$

Nitrogenous fertilizers applied to cultivated land, whether in the form of chemical fertilizers, organic fertilizers, manure, or agricultural residues, undergo transformations by soil microorganisms through nitrification and denitrification processes. During these processes, direct nitrous oxide emissions occur. Additionally, indirect nitrous oxide emissions arise from losses due to ammonia and nitrogen oxide volatilization, as well as leaching or surface runoff, where lost nitrogen is transformed and released as nitrous oxide.

If the project requires an assessment of nitrous oxide emissions from nitrogen fertilizer application, the **modelling method** is used.

The assessment of nitrous oxide emissions from nitrogen fertilizer application is based on mathematical model following the scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.

$$N_2O_{SOIL,BL,s,i} = GWP_{N2O} \times fN_2O_{SOIL,BL,s,i}$$

Where:

$N_2O_{SOIL,BL,s,i}$ = Nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

$fN_2O_{SOIL,BL,s,i}$ = Nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario obtained from the model in growing season s of sample unit i (tonnes of nitrous oxide)

GWP_{N2O} = Global warming potential of nitrous oxide (tonnes of carbon dioxide equivalent per tonne of nitrous oxide)

3.2 Calculation of project sequestration/emission

Code: T-VER-P-METH-13-08
Version: 1.0
Methodology/tool: Enhanced Good Practices in Paddy Rice Field T-VER-P-TOOL-01-13
Equation: $PE_y = \sum_{s=1}^{m} PE_s$ $PE_s = \sum_{i=0}^{n} \left(CH_{4_{SOIL,PJ,s,i}} + CO_{2_{LIME,PJ,s,i}} + CO_{2_{UREA,PJ,s,i}} + N_2O_{SOIL,PJ,s,i} + CO_{2_{FUEL,PJ,s,i}} + Non - CO_{2_{BURNing,PJ,s,i}} \right)$

Where:

PE_y = Total greenhouse gas emissions from project activities in year y (tonnes of carbon dioxide equivalent)

PE_s = Total greenhouse gas emissions from project activities in growing season s (tonnes of carbon dioxide equivalent)

$CH_{4_{SOIL,PJ,s,i}}$ = Methane emissions from soil methanogenesis from project activities in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

$CO_{2_{LIME,PJ,s,i}}$ = Carbon dioxide emissions from lime application from project activities in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

$CO_{2_{UREA,PJ,s,i}}$ = Carbon dioxide emissions from urea fertilizer application from project activities in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

$N_2O_{SOIL,PJ,s,i}$ = Nitrous oxide emissions from nitrogen fertilizer application from project activities in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

$CO_{2_{FUEL,PJ,s,i}}$ = Carbon dioxide emissions from fossil fuel combustion from project activities in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

$Non - CO_{2_{BURNing,PJ,s,i}}$ = Greenhouse gas emissions from biomass burning from project activities in growing season s of sample unit i (tonnes of carbon dioxide equivalent)

I	=	Sample unit I as referred in table 1 (n = The total number of sample units)
S	=	Growing season (s = The total number of growing seasons in the project)

Ex-ante Project emissions for $CH_{4SOIL,\ PJ,s,i}$

As explained for the baseline, the ex-ante project emissions source of CH_4 – methanogen in soil is assessed under default values method.

$$CH_{4_{SOIL,PJ,s,i}} = \sum_{i=1}^{n} EF_{CH4PJ,s,i} \times A_{s,i} \times L_s \times 10^{-3} \times GWP_{CH4}$$

Where:

$CH_{4_{SOIL,PJ,s,i}}$	=	Methane emissions from soil methanogenesis in the project scenario during growing season s for sample unit i (tonnes of carbon dioxide equivalent).
$EF_{CH4PJ,s,i}$	=	The methane emission factor for rice cultivation in the project scenario during growing season s for sample unit i (kilograms of methane per rai per day)
$A_{s,i}$	=	The harvested area of sample unit i in growing season s (rai)
L_s	=	The rice harvest duration in growing season s (days)
I	=	Sample unit i, covering the entire rice cultivation area (n = total number of sample units).
S	=	Growing season (s = number of growing seasons in the project year)
GWP_{CH4}	=	Global warming potential of methane (tonnes of carbon dioxide equivalent per tonne of methane)

When using default emission factors from the IPCC Guidelines (Tier 1), the methane emission factor can be calculated as follows:

$$EF_{CH4PJ,s,i} = EF_{PJ,c} \times SF_{PJ,w} \times SF_{PJ,p} \times SF_{PJ,o}$$

$$SF_{PJ,o} = \left(1 + \sum_i ROA_{PJ,s,i,om} \times 0.00625 \times CFOA_{om}\right)^{0.59}$$

Where:

$EF_{CH4PJ,s,i}$	=	Project methane emission factor for rice cultivation in growing season s of sample unit i (kilograms of methane per rai per day)
$EF_{PJ,c}$	=	Project methane emission factor for continuously flooded rice cultivation without organic matter application (kilograms of methane per rai per day)
$SF_{PJ,w}$	=	Adjustment factor for in-season water management practices in project rice cultivation
$SF_{PJ,p}$	=	Adjustment factor for pre-season water management practices in project rice cultivation
$SF_{PJ,o}$	=	Adjustment factor for organic matter application in project rice cultivation
$ROA_{PJ,s,i,om}$	=	Quantity of organic matter type om applied in growing season s of sample unit i (kilograms per rai; dry weight for straw, fresh weight for other materials)
$CFOA_{om}$	=	Conversion factor for organic matter type om applied (compared to short-term straw application before planting
0.00625	=	Unit conversion constant (tonnes per hectare)
Om	=	Type of organic matter

Ex-post Project emissions for $CH_{4SOIL, PJ,s,i}$

As explained for the baseline, the project emissions source of CH_4 – soil methanogenesis is assessed under modelling method including direct measurement as a plausibility check.

$$CH_{4_{SOIL,PJ,s,i}} = GWP_{CH4} \times fCH_{4_{SOIL,PJ,s,i}}$$

Where:

$CH_{4_{SOIL,PJ,i,t}}$	=	Methane emissions from soil carbon in the project activities during growing season s for sample unit i (tonnes of carbon dioxide equivalent)
$fCH_{4_{SOIL,PJ,i,t}}$	=	Methane emissions from soil carbon in the project activities as simulated by the model during growing season s for sample unit i (tonnes of methane)
GWP_{CH4}	=	Global warming potential of methane (tonnes of carbon dioxide equivalent per tonne of methane)

The model predicts greenhouse gas emissions from agricultural areas, such as CH_4 and N_2O emissions from soil. The sources of the validated mathematical model included: (1) collecting actual emission data from the project area, (2) emission data from experimental plots or research plots, or (3) data from high-quality academic literature, such as those reviewed by experts or published in academic journals. As indicated in the baseline emissions chapter, this approach is additional to TGO's requirements.

The scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.

Ex-ante Project emissions for $CO_{2LIME, PJ,s,i}$

For the assessment of carbon dioxide emissions from liming (using calcite, calcium carbonate, or calcium magnesium carbonate), the calculation is done based on default values as set in the Premium T-VER methodology:

Some liming materials are both locally produced and imported. Only the amount produced locally is considered for project emissions.

$$CO_{2_{LIME,PJ,s,i}} = \Sigma\left[\left((M_{Limestone,PJ,s,i} \times A_{s,i}) \times EF_{Limestone}\right) + \left((M_{Dolomite,PJ,s,i} \times A_{s,i}) \times EF_{Dolomite}\right)\right] \times \frac{44}{12}$$

Where:

$CO_{2_{LIME,PJ,s,i}}$	=	Quantity of carbon dioxide emitted from lime application in the project scenario in growing season s of sample unit i (tonnes of carbon dioxide)
$M_{Limestone,PJ,s,i}$	=	Quantity of lime used in the project scenario in growing season s of sample unit i (tonnes of lime per rai)
$EF_{Limestone}$	=	Greenhouse gas emission factor from lime use (tonnes of carbon per tonne of lime)
$M_{Dolomite,PJ,s,i}$	=	Quantity of dolomite applied in the project scenario in growing season s of sample unit i (tonnes of dolomite per rai)
$EF_{Dolomite}$	=	Greenhouse gas emission factor from dolomite application (tonnes of carbon per tonne of dolomite)
$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
$\frac{44}{12}$	=	Molecular weight ratio of carbon dioxide to carbon

The ex-ante ER calculation has shown that CO_2 emissions from liming are below 5%.

Ex-post Project emissions for $CO_{2LIME, PJ,s,i}$

These are assessed as zero, because negligible in ex-ante estimation.

Ex-ante Project emissions for $CO_{2UREA, PJ,s,i}$

Urea is broken down by an enzyme called urease, resulting in the release of carbon dioxide gas. Additionally, the ammonia in urea can be transformed, leading to the release of nitrous oxide gas, which will be calculated in a subsequent section.

Some urea fertilizers are both locally produced and imported. Only the amount produced locally is considered for project emissions.

For the assessment of carbon dioxide emissions from urea application, a third assessment approach is necessary: calculation using default values with the following equation.

$$CO_{2\,UREA,PJ,s,i} = \sum\left((M_{Urea,PJ,s,i} \times A_{s,i}) \times EF_{Urea}\right) \times \frac{44}{12}$$

Where:

$CO_{2\,UREA,PJ,s,i}$	=	Carbon dioxide emissions from urea application in the project scenario in growing season s of sample unit i (tonnes of CO2)
$M_{Urea,PJ,s,i}$	=	Quantity of urea used in the project scenario in growing season s of sample unit i (tonnes of urea per rai)
EF_{Urea}	=	Greenhouse gas emission factor for urea (tonnes of carbon per tonne of urea)
$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
$\frac{44}{12}$	=	Molecular weight ratio of carbon dioxide to carbon

The ex-ante ER calculation has shown that CO_2 emissions from urea are below 5%.

Ex-post Project emissions for $CO_{2UREA, PJ,s,i}$

These are assessed as zero, because negligible in ex-ante estimation.

Ex-ante Project emissions for $N_20_{SOIL, PJ,s,i}$

Nitrogenous fertilizers applied to cultivated land, whether in the form of chemical fertilizers, organic fertilizers, manure, or agricultural residues, undergo transformations by soil microorganisms through nitrification and denitrification processes. During these processes, direct nitrous oxide emissions occur. Additionally, indirect nitrous oxide emissions arise from losses due to ammonia and nitrogen oxide volatilization, as well as leaching or surface runoff, where lost nitrogen is transformed and released as nitrous oxide.

If the project requires an assessment of nitrous oxide emissions from nitrogen fertilizer application, the following method is used:

Assessing N_2O emission by referring to IPCC guidelines:

$$N_2O_{SOIL,PJ,s,i} = N_2O_{Direct,PJ,s,i} + N_2O_{Indirect,PJ,s,i}$$

(1) *Direct emissions*

$$N_2O_{Direct,PJ,i,t} = (F_{SN,PJ,s,i} + F_{ON,PJ,s,i}) \times EF_{N2ODirect} \times \frac{44}{28} \times GWP_{N2O}$$

$$F_{SN,PJ,s,i} = \sum(M_{SN,PJ,s,i,j} \times A_{s,i})$$

$$F_{ON,PJ,s,i} = \sum(M_{ON,PJ,s,i,k} \times A_{s,i})$$

(2) *Indirect emissions*

$$N_2O_{Indirect,PJ,s,i} = N_2O_{ATD,PJ,s,i} + N_2O_{L,PJ,s,i}$$

$$N_2O_{ATD,PJ,s,i} = \left((F_{SN,PJ,s,i} \times Frac_{GASF}) + (F_{ON,PJ,s,i} \times Frac_{GASM})\right) \times EF_{ATD} \times \frac{44}{28} \times GWP_{N2O}$$

$$N_2O_{L,PJ,s,i} = (F_{SN,PJ,s,i} + F_{ON,PJ,s,i}) \times Frac_{LEACH} \times EF_{LEACH} \times \frac{44}{28} \times GWP_{N2O}$$

Where:

$N_2O_{SOIL,PJ,s,i}$	=	Nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{Direct,PJ,s,i}$	=	Direct nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{Indirect,PJ,s,i}$	=	Indirect nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{ATD,PJ,s,i}$	=	Indirect nitrous oxide emissions from the accumulation of volatilized nitrogen from nitrogen fertilizer application in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$N_2O_{L,PJ,s,i}$	=	Indirect nitrous oxide emissions from leaching and runoff of nitrogen in the baseline scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$F_{SN,PJ,s,i}$	=	Quantity of nitrogen in chemical fertilizer applied to the soil in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen)
$F_{ON,PJ,s,i}$	=	Quantity of nitrogen in organic fertilizer applied to the soil in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen)
$EF_{N2ODirect}$	=	Direct nitrous oxide emission factor from nitrogen fertilizer application (tonnes N2O-N per tonne of nitrogen)
EF_{ATD}	=	Nitrous oxide emission factor from the accumulation of atmospheric nitrogen deposition in soil and water (tonnes N2O-N per tonne of NH3-N + NOX-N)
EF_{LEACH}	=	Nitrous oxide emission factor from leaching and runoff (tonnes N2O-N per tonne of nitrogen leached and run off)
$Frac_{GASF}$	=	Proportion of chemical nitrogen fertilizer applied to the soil that is volatilized as ammonia and nitrogen oxides (tonnes NH3-N + NOX-N per tonne of nitrogen)
$Frac_{GASM}$	=	Proportion of organic nitrogen fertilizer applied to the soil that is volatilized as ammonia and nitrogen oxides (tonnes NH3-N + NOX-N per tonne of nitrogen)
$Frac_{LEACH}$	=	Proportion of nitrogen applied to the soil that is lost through leaching and runoff (tonnes of nitrogen leached and run off per tonne of nitrogen)
$M_{SN,PJ,s,i,j}$	=	Quantity of chemical fertilizer type j applied in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen of chemical fertilizer per rai)
$M_{ON,PJ,s,i,k}$	=	Quantity of organic fertilizer type k applied in the baseline scenario in growing season s of sample unit i (tonnes of nitrogen of organic fertilizer per rai)

$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
$\frac{44}{28}$	=	Molar mass ratio of nitrous oxide to nitrogen
GWP_{N2O}	=	Global warming potential of nitrous oxide (tonnes of carbon dioxide equivalent per tonne of nitrous oxide)

Ex-post Project emissions for $N_20_{SOIL, PJ,s,i}$

Nitrogenous fertilizers applied to cultivated land, whether in the form of chemical fertilizers, organic fertilizers, manure, or agricultural residues, undergo transformations by soil microorganisms through nitrification and denitrification processes. During these processes, direct nitrous oxide emissions occur. Additionally, indirect nitrous oxide emissions arise from losses due to ammonia and nitrogen oxide volatilization, as well as leaching or surface runoff, where lost nitrogen is transformed and released as nitrous oxide. If the project requires an assessment of nitrous oxide emissions from nitrogen fertilizer application, the **modelling method** is used.

The assessment of nitrous oxide emissions from nitrogen fertilizer application is based on mathematical model following the scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.

$$N_2O_{SOIL,PJ,s,i} = GWP_{N2O} \times fN_2O_{SOIL,PJ,s,i}$$

Where:

$N_2O_{SOIL,PJ,s,i}$	=	Nitrous oxide emissions from nitrogen fertilizer application in the project scenario in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$fN_2O_{SOIL,PJ,s,i}$	=	Nitrous oxide emissions from nitrogen fertilizer application in the project scenario obtained from the model in growing season s of sample unit i (tonnes of nitrous oxide)
GWP_{N2O}	=	Global warming potential of nitrous oxide (tonnes of carbon dioxide equivalent per tonne of nitrous oxide)

Potentially neglected emissions

The following emissions sources will be monitored and reported in the ex-post monitoring only if they should account to more than 5% of the total greenhouse gas emissions, as defined in the premium T-Ver methodology. These emissions have been excluded from the ex-ante estimation as they represent less than 5% of estimated total greenhouse gas emissions.

Carbon dioxide emissions from fossil fuel combustion

In cases where the project involves the use of machinery or equipment in addition to the existing management practices, such as laser land levelling (LLL) for land preparation or using pumps to pump water into or out of the field, it is necessary to assess the amount of carbon dioxide emissions from the combustion of fossil fuels, either from the use of fossil fuels or the use of electricity (such as electric tractors). It is not expected that neither LLL nor additional pumping will be needed for the implementation of this programme and it is therefore included in the neglected emissions. If the total greenhouse gas emissions exceed 5% of the amount of greenhouse gas reduction, the assessment of carbon dioxide emissions according to Method 3 (Section 5.2.6 from T-VER-P-METH-13-08), which is calculated using default values, would be calculated using the following equation:

$$CO_{2\,FUEL,PJ,s,i} = \sum\left((FC_{PJ,s,i,a} \times NCV_a \times 10^{-6} \times EF_{CO2,a}) \times A_{s,i}\right) \times 10^{-3} + \sum(EC_{PJ,s,i} \times EF_{Elec,s} \times (1 + TDL_s) \times A_{s,i})$$

Where:

$CO_{2\,FUEL,PJ,s,i}$	=	Amount of carbon dioxide emissions from the combustion of fossil fuels in the project during growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$FC_{PJ,s,i,a}$	=	Quantity of fuel type a used in growing season s of sample unit i (units per rai)
$A_{s,i}$	=	Harvested area in growing season s of sample unit i (rai)
NCV_a	=	*Net calorific value of fuel type a (megajoules per unit)*

$EF_{CO2,a}$	=	Greenhouse gas emission factor from the combustion of fossil fuel type a (kilograms of carbon dioxide/terajoule)
a	=	Type of fossil fuel
$EC_{PJ,s,i}$	=	Electricity consumption in growing season s of sample unit i (MWh/rai)
$EF_{Elec,s}$	=	Greenhouse gas emission factor for electricity generation/consumption in growing season s (tCO_2/MWh)
TDL_s	=	Proportion of electricity loss in the power grid for electricity supply to the point of use in growing season s

Non-CO_2 emissions from biomass burning

The implementation of AWD practices is not expected to change the practices of burning rice stubble and straw within the project area. Nevertheless, if this activity was to occur and if the total greenhouse gas emissions from this activity would exceeds 5% of the total greenhouse gas reduction target, a more detailed assessment of greenhouse gas emissions from biomass burning would be required. This assessment should use Method 3 (Section 5.2.6 from T-VER-P-METH-13-08), which involves calculations using default values based on the following equation:

$$Non-CO_{2\,BURNing,PJ,s,i} = \frac{\sum MB_{PJ,s,i} \times C_f \times A_{burn,s,i} \times [(EF_{CH_4} \times GWP_{CH_4}) + (EF_{N2O} \times GWP_{N2O})]}{10^6}$$

Where:

$Non-CO_{2\,BURNing,PJ,s,i}$	=	Greenhouse gas emissions from biomass burning in growing season s of sample unit i (tonnes of carbon dioxide equivalent)
$MB_{PJ,s,i}$	=	Mass of rice stubble and straw burned in the baseline scenario in growing season s of sample unit i (kilograms per rai)
C_f	=	Burning factor of rice stubble and straw (proportion of biomass as fuel before burning)
$A_{burn,s,i}$	=	Area burned in growing season s of sample unit i (rai)
EF_{CH4}	=	Methane emission factor from burning agricultural residues (grams of methane per kilogram of dry biomass burned)

EF_{N2O}	=	Nitrous oxide emission factor from burning agricultural residues (grams of nitrous oxide per kilogram of dry biomass burned)
GWP_{CH4}	=	Global warming potential of methane (tonnes of carbon dioxide equivalent per tonne of methane)
GWP_{N2O}	=	Global warming potential of nitrous oxide (tonnes of carbon dioxide equivalent per tonne of nitrous oxide)
10^6	=	Unit conversion (grams per tonne)

3.3 Calculation of Leakage Emission

Code: T-VER-P-METH-13-08
Version: 1.0
Methodology/Tool : Enhanced Good Practices in Paddy Rice Field T-VER-P-TOOL-01-13

The Methodology T-VER-P-METH-13-08, as well as guidelines from FOEN, define leakage as any GHG emission impact outside the ITMO project boundary. The Methodology T-VER-P-METH-13-08 considers leakage for AWD to be negligible and therefore does not require any assessment. Most trade-offs are already integrated in the ER calculation (i.e.: estimates of nitrogen emissions, increased fuel consumption, etc). Other potential leakages (e.g.: changes in soil organic carbon) fall outside the scope determined by FOEN for implementing projects abroad under the Framework of the Article 6.2 of the Paris Agreement. Consequently, in line with the T-VER-P-METH-13-08 methodology, the programme is not considered to generate any leakage.

3.4 Summary of greenhouse gas emissions reduction

Code: T-VER-P-METH-13-08	
Methodology : Enhanced Good Practices in Paddy Rice Field T-VER-P-TOOL-01-13	

$$ER_{total} = BE_y - PE_y - Leakage$$

Where:

ER_{total}	=	Total expected emission reductions over the project in year y (tonnes of carbon dioxide equivalent)
BE_y	=	Total baseline greenhouse gas emissions in year y (tonnes of carbon dioxide equivalent)
PE_y	=	Total greenhouse gas emissions from project activities in year y (tonnes of carbon dioxide equivalent)

3.5 Fixed and Monitored Parameters

Parameters determined and fixed ex-ante

The next parameters are determined and fixed ex-ante and are applied for ex-ante ER calculation,

Name	Description	Unit	Value	Source
CF	Below BAU (Conservativeness factor)	-	0.89	T-VER-P-METH-13-08 Version 01
$EF_{BL,c}$	The standard amount of methane gas released from a rice paddy that is continuously flooded and doesn't receive any organic fertilizer	Kilograms of methane per rai per day	0.1424	T-VER-P-METH-13-08 Version 01[2]
$SF_{BL,w}$ or $SF_{PJ,w}$	Adjustment factor based on water management practices during the growing season in rice-growing areas under baseline or project implementation	-	• Continuous flooding: 1.00 • Periodic flooding with one drainage: 0.71	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 5, Table 5.12

[2]Please note that the default value assumed by the Premium T-VER methodology is 0.1952. The programme has conservatively adopted a lower value, as recommended by consultation with Thai rice experts

			• Periodic flooding with multiple drainages or alternate wetting and drying: 0.55	
$SF_{BL,p}$ or $SF_{PJ,p}$	Adjustment factor based on pre-season flooding patterns in rice-growing areas under baseline or project conditions. In case, using IPCC recommended value		• Flooding for more than 30 days: 2.41 • No flooding or short-term flooding (< 180 days): 1.00 • No flooding for more than 180 days: 0.89 • No flooding for more than 365 days or alternate wetting and drying with non-flooded crops: 0.59	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 5, Table 5.13
$ROA_{BL,s,i,om}$	Kilograms per rai, dry weight for straw and fresh weight for other materials	Kilograms per rai	800 (rice straw)	Historical cultivation data spanning at least three years, or relevant documents and research findings suitable for the project area, obtained from reliable sources, farmer interviews, expert interviews, or sampling. GS Methodology: Methane Emission Reduction by Adjusted Water Management Practice in Rice Cultivation Version 1.0, page 17
$CFOA_{om}$	Conversion factor for applied organic materials (compared to applying straw shortly before planting) when using the IPCC recommended value.	-	• Rice straw plowed in less than 30 days before planting: 1.00 • Rice straw plowed	IPCC Guidelines 2019, Volume 4, Chapter 5, Table 5.14

			in more than 30 days before planting: 0.19 • Manure: 0.21 • Compost: 0.17 • Green Manure: 0.45	
$M_{Dolomite,BL,s,i}$	Quantity of dolomite applied in the baseline scenario in growing season s of sample unit i	Tonnes of dolomite per rai	0	Historical cultivation data for at least three years or related documents, research results suitable for the project area, from reliable official sources, farmer interviews, expert interviews, purchase documents, farmer's notebooks, or sampling. No information available for ex-ante calculation. Baseline surveys study report - Thai Rice NAMA
$EF_{Limestone}$	Greenhouse gas emissions from limestone usage	Tonnes of carbon per tonne of limestone	0.12	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11.3
$EF_{Dolomite}$	Greenhouse gas emission factor from dolomite application	Tonnes of carbon per tonne of dolomite	0.13	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11.3
$M_{Urea,BL,s,i}$	Quantity of urea fertilizer used in the baseline scenario in growing season s of sample unit i	Tonnes of urea per rai	0.001	Historical cultivation data for at least three years or relevant documents, research results suitable for the project area, from reliable sources such as interviews with farmers, experts, purchase documents, farmer's notebooks, or sampling.

				Baseline surveys study report - Thai Rice NAMA (for ex-ante calculation)
EF_{Urea}	Greenhouse gas emission factor from urea application	Tonnes of carbon per tonne of urea	0.20	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11.4
$M_{SN,BL,s,i,j}$	Quantity of chemical fertilizer applied in the baseline scenario during growing season s of sample unit i, fertilizer type j	Tonnes of nitrogen from chemical fertilizer per ha	0.002	Data on historical cultivation for at least three years or related documents, research results suitable for the project area, from reliable sources such as interviews with farmers, experts, purchase documents, farmers' notebooks, or random sampling. Baseline surveys study report – Thai Rice NAMA (for ex-ante calculation)
$M_{ON,BL,s,i,k}$	Quantity of organic fertilizer applied in the baseline scenario in growing season s of sample unit i, fertilizer type k	Tonnes of nitrogen from organic fertilizer per ha	0.0	Historical cultivation data for at least three years or relevant documents, studies suitable for the project area, from reliable official sources, farmer interviews, expert interviews, purchase documents, farmer's notebooks, or sampling. Baseline surveys study report - Thai Rice NAMA (for ex-ante calculation)
$EF_{N2O,Direct}$	Direct nitrous oxide emission factor from applied nitrogen in chemical fertilizers, organic fertilizers, soil amendments, and crop residues In the case of using the IPCC recommended value	Tonnes of N2O-N per tonne of nitrogen	• continuous flooding throughout the growing season: 0.003 • one or more	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.1

			drainages or drying periods: 0.005	
$Frac_{GASF}$	Proportion of nitrogen fertilizer applied to the soil that is volatilized as ammonia and nitrogen oxides	Tonnes of NH3-N + NOX-N per tonne of nitrogen	0.11	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
$Frac_{GASM}$	Proportion of organic nitrogen fertilizer applied to the soil that is volatilized as ammonia and oxides of nitrogen	Tonnes of NH3-N + NOX-N per tonne of nitrogen	0.21	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
EF_{ATD}	Emission factor of nitrous oxide from atmospheric nitrogen deposition to soil and water surfaces	Tonnes of N2O-N per tonne of NH3-N + NOX-N	0.010	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
$Frac_{LEACH}$	Proportion of nitrogen applied to the soil (chemical and organic fertilizers) that is lost through leaching and runoff	Tonnes of nitrogen leached and runoff per tonne of nitrogen	0.24	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
EF_{LEACH}	Emission factor of nitrous oxide from leaching and runoff	Tonnes of N2O-N per tonne of nitrogen leached and runoff	0.011	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
NCVa	Net Calorific Value of fossil fuel type a (diesel)	Megajoules per liter	36.42	Option 1: From the fuel supplier's invoice: The NCV can be obtained directly from the information provided by the company that supplies the fuel. Option 2: From measurement: The NCV can be determined experimentally by measuring the amount of

				heat released when a sample of the fuel is burned completely. Option 3: From the Thai Department of Alternative Energy Development and Efficiency (DEDE): This option suggests that the NCV can be found in published reports or databases maintained by the DEDE[3].
$EF_{CO_2,a}$	Emission factor of greenhouse gases from the combustion of fossil fuel type a diesel	Kilograms of carbon dioxide per terajoule	74100	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Table 1.4
EF_{CH4}	Methane emission factor from agricultural biomass burning	Grams of methane per kilogram of dry biomass burned	2.7	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 2, Table 2.5
EF_{N2O}	Nitrous oxide emission factor from agricultural biomass burning	Grams of nitrous oxide per kilogram of dry biomass burned	0.07	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 2, Table 2.5
C_f	Combustion coefficient of rice stubble and straw	Proportion of biomass as fuel before combustion	0.8	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 2, Table 2.6
TDL_s	The proportion of electrical power loss in the electrical grid for supplying electricity to the point of use during growing season s is defined as 0.03 (3%).	-	3%	T-VER-P-METH-13-08 Version 01

[3] Sources for ex-ante calculation: The study of emission factor for an electricity system in Thailand 2009, calorific value of fuel and DEDE summary of Thailand's energy situation

The next parameters are determined and fixed ex-ante and are applied for ex-post ER calculation,

Name	Description	Unit	Value	Source
CF	Below BAU (Conservativeness factor)	-	0.89	T-VER-P-METH-13-08 Version 01
NCVa	Net Calorific Value of fossil fuel type a (diesel)	Megajoules per liter	36.42	Option 1: From the fuel supplier's invoice: The NCV can be obtained directly from the information provided by the company that supplies the fuel. Option 2: From measurement: The NCV can be determined experimentally by measuring the amount of heat released when a sample of the fuel is burned completely. Option 3: From the Thai Department of Alternative Energy Development and Efficiency (DEDE): This option suggests that the NCV can be found in published reports or databases maintained by the DEDE[4].
$EF_{CO_2,a}$	Emission factor of greenhouse gases from the combustion of fossil fuel type a diesel	Kilograms of carbon dioxide per terajoule	74100	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Table 1.4
EF_{CH4}	Methane emission factor from agricultural biomass burning	Grams of methane per kilogram of dry biomass burned	2.7	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 2, Table 2.5

[4] Sources for ex-ante calculation: The study of emission factor for an electricity system in Thailand 2009, calorific value of fuel and DEDE summary of Thailand's energy situation

EF_{N2O}	Nitrous oxide emission factor from agricultural biomass burning	Grams of nitrous oxide per kilogram of dry biomass burned	0.07	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 2, Table 2.5
C_f	Combustion coefficient of rice stubble and straw	Proportion of biomass as fuel before combustion	0.8	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 2, Table 2.6
TDL_s	The proportion of electrical power loss in the electrical grid for supplying electricity to the point of use during growing season s is defined as 0.03 (3%).	-	3%	T-VER-P-METH-13-08 Version 01

3.6 Summary of estimated greenhouse gas emission reductions

Year	d/m/y – d/m/y	Baseline Emission	Project Emission	Leakage Emission	Emission Reduction
1	01/01/2026-31/12/2026	268,655	168,304		
2	01/01/2027-31/12/2027	636,158	398,535	NA	100,350
3	01/01/2028-31/12/2028	883,853	553,709	NA	237,623
4	01/01/2029-31/12/2029	1,181,871	740,408	NA	330,145
5	01/01/2030-31/12/2030	1,181,871	740,408	NA	441,463
Total (tCO_2eq)		**4,152,408**	**2,601,364**		**1,551,043**
Average (tCO_2e/y)		**830,482**	**520,273**		**310,209**

Part 4 Monitoring of project

4.1 Monitoring Plan

The yearly monitoring process will be grounded in a sophisticated process-based modelling framework. The selected model has undergone validation for application in Thailand by the TGO. This model is designed to ensure the highest levels of precision and reliability in emissions data reporting. Under said standard, the model must be validated for the project activities (AWD) using data that is representative of local environment. In addition, measurements will be taken from closed chambers and act as a plausibility check, serving to verify the accuracy and consistency of the modelled emissions. In doing so, we ensure that the model is validated using data that matches project conditions as closely as possible. This multi-faceted approach underscores our commitment to rigorous monitoring practices and reliable quantification of emissions reductions. The data collection of the model input data is described in detail below.

Field Monitoring via Smart Watcher

The **Smart Watcher** application is designed to collect and monitor data necessary to calculate ex-post mitigation outcomes. The application is accessed by a QR code that the farmers can easily scan from their phone. The primary focus of the application is tracking key agricultural and environmental parameters that are crucial for verifying the effectiveness of mitigation practices.

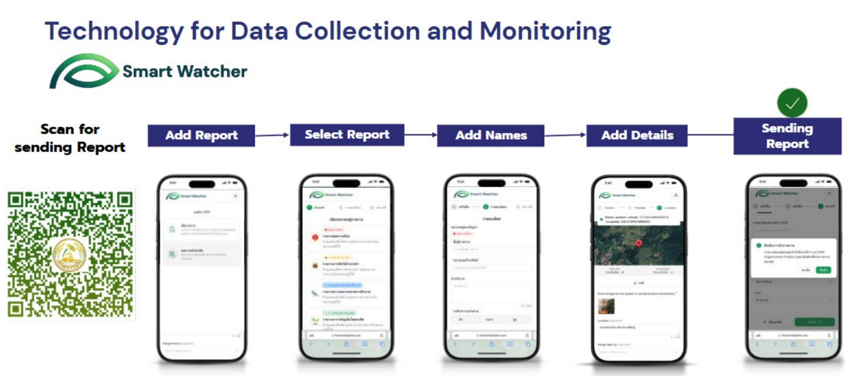


Figure 6: Smart Watcher Application: How it works

The platform conveniently supports and guides the farmers in the process of data entry. Above is an illustration of some of the data that the farmer can enter on the platform. Farmers collect field-specific data on crop growth and conditions, such as pictures of activities in the field, pictures of water level, input on field data and yield estimates. The collected data is then uploaded to a centralized digital platform called **Smart Farm platform** where it is analysed using ground data and satellite data. Multiple parameters are collected and used to monitor the AWD practices and ensure that mitigation outcomes are verifiable and reliable for carbon credit generation.

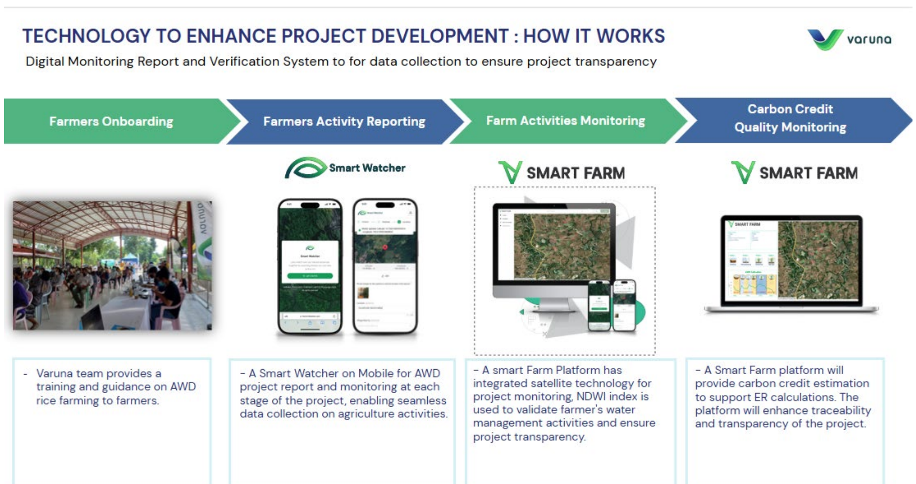


Figure 7: Smart Farm Platform : How it work

Satellite-MRV

Satellite-based MRV is used to monitor rice cultivation activities at a high spatial and temporal resolution using a combination of Synthetic Aperture Radar (SAR) and optical remote sensing data. SAR data is used as the primary data source due to its ability to penetrate cloud cover and vegetation canopy, allowing for all-weather monitoring, particularly important in tropical rice-growing regions with persistent cloud cover, e.g., Thailand.

The different practices assessed by the remote-sensing approach include: (1) initial seeding/transplanting dates; (2) field drainage events, which are critical for identifying AWD practices; (3) harvest dates.

Process-Based Model Approach

The methane emissions reduction estimation will be calculated with a process-based model approach. A mathematical model calibrated specifically for two climatic regions in Thailand and validated under the Verra standard will be applied for the calculation of emissions reduction. Direct measurements with closed chambers will be carried out through the entirety of the programme as a plausibility check.

The input data of the model, which corresponds to the factors affecting ER, are a combination of remote sensing data and data collected from the field via the Smart Farm Platform. Satellite imagery will be used for broader-scale monitoring, offering real-time insights into the cropping calendar, the irrigation practices and drainages employed in the field, and the burning of straw residue. Complementing this, mobile data collection tools will enable farmers to capture on-the-ground data, such as picture of tube with water depth, plant growth stages and yield data. These data sources will be integrated, analysed and used as inputs to the validated mathematical model.

4.2 Monitored Parameters

Data / Parameter 1:	GWP_{CH4}
Data unit:	tCO_2eq/tCH_4
Description:	Global warming potential of methane
Measurement procedures (if any):	For project proposal documents: use the latest GWP_{CH4} value announced by TGO, according to IPCC Fourth Assessment (AR4) 2007. For monitoring greenhouse gas reduction: use the GWP_{N2O} value announced by TGO to assess the amount of greenhouse gases during the crediting period for greenhouse gas certification.
Monitoring frequency:	Every time TGO announces a new value

Source of data:	IPCC Fourth Assessment (AR4) 2007 The latest value announced by TGO (October 27, 2021)
QA/QC procedures	Default value

Data / Parameter 2:	GWP_{N2O}
Data unit:	$tCO_2eq/tN2O$
Description:	Global warming potential of N2O
Measurement procedures (if any):	For project proposal documents: Use the latest GWPN2O value announced by TGO, according to IPCC Fourth Assessment (AR4) 2007. For monitoring greenhouse gas reduction: use the GWPN2O value announced by TGO to assess the amount of greenhouse gases during the crediting period for greenhouse gas certification.
Monitoring frequency:	Every time TGO announces a new value
Source of data:	IPCC Fourth Assessment (AR4) 2007 The latest value announced by TGO (October 27, 2021)[5]
QA/QC procedures	Default value

Data / Parameter 3:	A_S
Data unit:	Rai (1 rai = 0.16 ha)
Description:	Harvested area in growing season s of sample unit i
Measurement procedures (if any):	On-site survey: physical inspection of the area. Satellite/aerial imagery: using satellite or aerial photographs to assess the land.
Monitoring frequency:	Every growing season
Source of data:	Survey report with geographic references

[5] https://ghgreduction.tgo.or.th/en/premium-t-ver-download/download/6964/3553/32.html

QA/QC procedures	The geological survey report and satellite image data are thoroughly checked for completeness

Data / Parameter 4:	L_s
Data unit:	Day
Description:	Rice harvesting age in growing season s
Measurement procedures (if any):	On-site survey: physical inspection of farmer record
Monitoring frequency:	Every growing season
Source of data:	Digital record
QA/QC procedures	Data completeness check from farmer records

Data / Parameter 5:	**Water Management During the Growing Season**
Data unit:	-
Description:	• Continuous flooding throughout the growing season • Periodic flooding with one drainage • Periodic flooding with multiple drainages: The field is flooded and drained multiple times, including the practice of alternate wetting and drying, where the water level is lowered to 10-15 cm below the soil surface
Measurement procedures (if any):	On-site survey: physical inspection of farmer record and project area
Monitoring frequency:	Throughout the growing season
Source of data:	Digital record
QA/QC procedures	Data completeness check from farmer or project developer records

Data / Parameter 6:	**Pre-Planting Water Management**
Data unit:	**-**
Description:	• Flooding for more than 30 days before planting • Short-term flooding of less than 30 days before planting • No flooding for less than 180 days before planting • No flooding for more than 180 days before planting • No flooding for more than 365 days or crop rotation without flooding
Measurement procedures (if any):	On-site survey: physical inspection of farmer record and project area
Monitoring frequency:	Throughout the growing season
Source of data:	Digital record
QA/QC procedures	Data completeness check from farmer or project developer records

Data / Parameter 7	$\mathbf{M}_{SN,PI,s,i}$
Data unit:	Tonnes of nitrogen from chemical fertilizer per rai
Description:	Quantity of chemical fertilizer used in the project during growing season s of sample unit i, fertilizer type j
Measurement procedures (if any):	Data collected and recorded by farmers using appropriate methods (corroborated with photo provided via Smart Watcher)
Monitoring frequency:	Throughout the growing season
Source of data:	Digital record
QA/QC procedures	Data completeness check from invoices or withdrawal records or farmer or project developer records
Any comment:	The parameter is utilized for ex-ante estimation of emission reductions, while for ex-post verification, it serves to demonstrate whether the application of nitrogen-based chemical fertilizers has been reduced by at least 5% compared to baseline levels, in accordance with the requirements outlined in T-VER-P-METH-13-08 Version 01.

Data / Parameter 8	$M_{ON,PL,s,i,k}$
Data unit:	Tonnes of nitrogen from organic fertilizer per rai
Description:	Quantity of organic fertilizer used in the project during growing season s of sample unit i, fertilizer type k
Measurement procedures (if any):	Data collected and recorded by farmers using appropriate methods
Monitoring frequency:	Throughout the growing season
Source of data:	Digital record
QA/QC procedures	Data completeness check from invoices, withdrawal records, farmer or project developer records
Any comment:	The parameter is utilized only for ex-ante estimation of emission reductions

Data / Parameter 9	$FC_{PL,s,i,z}$
Data unit:	Units per rai
Description:	Quantity of fuel type a used in growing season s of sample unit i
Measurement procedures (if any):	Option 1: If fuel is purchased or withdrawn all at once without storage, the quantity used can be tracked from invoices or withdrawal records. Option 2: If fuel is stored and used from a storage container, the quantity used should be measured and recorded continuously.
Monitoring frequency:	Throughout the growing season
Source of data:	Digital record from invoices or withdrawal records provided by the farmers on the Smart Farmer application
QA/QC procedures	Data completeness check from invoices or withdrawal records or farmer or project developer records

Data / Parameter 10	$MB_{PL,s}$
Data unit:	Kg

Description:	Mass of rice stubble and straw burned in the baseline scenario in growing season s of sample unit i
Measurement procedures (if any):	Use the proportion of agricultural residues to yield based on suitable reference documents for the project area corroborated with photo provided via Smart Watcher.
Monitoring frequency:	Throughout the growing season
Source of data:	Digital record
QA/QC procedures	Data completeness check from farmer or project developer records

Data / Parameter 11	$ROA_{PJ,s,i,om}$
Data unit:	Kilograms per rai, dry weight for straw and fresh weight for other materials
Description:	Quantity of organic material type OM applied in the project during growing season s of sample unit i
Measurement procedures (if any):	Data collected and recorded by the farmer or project developer using via the Smart Watcher Platform (e.g.: photos of farm record book)
Monitoring frequency:	Throughout the growing season
Source of data:	Digital records
QA/QC procedures	Data completeness check from farmer or project developer records
Any comment:	The parameter is utilized for ex-ante estimation of emission reductions, while for ex-post verification, it serves as an input of the mathematical model.

Data / Parameter 12	$fN_2O_{SOIL,BL,s,}$
Data unit:	Tonnes of nitrous oxide
Description:	Quantity of nitrous oxide emissions from nitrogen fertilizer application in the baseline scenario obtained from a model in growing season s of sample unit i
Measurement procedures (if any):	Details according to the selected evaluation method, including sampling and data, the use of reference values or recommended values from reliable sources, and calculations using appropriate equations. The scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.

Monitoring frequency:	According to the round of evaluation and monitoring for certification
Source of data:	Measurement report: The values are obtained from the mathematical model that predicts greenhouse gas emissions from agricultural areas, such as CH_4 and N_2O emissions from soil. The sources of the model include: (1) collecting actual emission data from the project area, (2) emission data from experimental plots or research plots, or (3) data from high-quality academic literature, such as those reviewed by experts or published in academic journals, can be used. The selected reference data should be appropriate and applicable to the project area, especially if there is data consistent with the control factors or agricultural activities of the project.
QA/QC procedures	Appendix 3 - T-VER-P-METH-13-08 Version 01

Data / Parameter 13	$fN_2O_{SOIL,PS,s,i}$
Data unit:	Tonnes of nitrous oxide
Description:	Quantity of nitrous oxide emissions from nitrogen fertilizer application in the project scenario obtained from a model in growing season s of sample unit i
Measurement procedures (if any):	Details according to the selected evaluation method, including sampling and data, the use of reference values or recommended values from reliable sources, and calculations using appropriate equations. The scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.
Monitoring frequency:	According to the round of evaluation and monitoring for certification
Source of data:	Measurement report: The values are obtained from the mathematical model that predicts greenhouse gas emissions from agricultural areas, such as CH_4 and N_2O emissions from soil. The sources of the model includes: (1) collecting actual emission data from the project area, (2) emission data from experimental plots or research plots, or (3) data from high-quality academic literature, such as those reviewed by experts or published in academic journals, can be used. The selected reference data should be appropriate and applicable to the project area, especially if there is data consistent with the control factors or agricultural activities of the project.
QA/QC procedures	Appendix 3 - T-VER-P-METH-13-08 Version 01

Data / Parameter 14	$\overline{fCH_{4}}_{SOIL,BSL,i,t}$
Data unit:	Tonnes of methane
Description:	Quantity of methane emissions from soil carbon sources in the baseline scenario obtained from the model, in growing season s of sample unit i
Measurement procedures (if any):	Details according to the selected evaluation method, including sampling and data, the use of reference values or recommended values from reliable sources, and calculations using appropriate equations. The scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.
Monitoring frequency:	According to the round of evaluation and monitoring for certification
Source of data:	Measurement report: The values are obtained from mathematical model that predicts greenhouse gas emissions from agricultural areas, such as CH_4 and N_2O emissions from soil. The sources of the model includes (1) collecting actual emission data from the project area, (2) emission data from experimental plots or research plots, or (3) data from high-quality academic literature, such as those reviewed by experts or published in academic journals, can be used. The selected reference data should be appropriate and applicable to the project area, especially if there is data consistent with the control factors or agricultural activities of the project.
QA/QC procedures	Appendix 3 - T-VER-P-METH-13-08 Version 01

Data / Parameter 15	$\overline{fCH_{4}}_{SOIL,PJL,i,t}$
Data unit:	Tonnes of methane
Description:	Quantity of methane emissions from soil carbon sources in the project scenario obtained from the model, in growing season s of sample unit i

Measurement procedures (if any):	Details according to the selected evaluation method, including sampling and data, the use of reference values or recommended values from reliable sources, and calculations using appropriate equations. The scientific principles for using models to assess greenhouse gas emissions from agricultural areas are detailed in Appendix 3 of T-VER-P-METH-13-08 Version 01.
Monitoring frequency:	According to the round of evaluation and monitoring for certification
Source of data:	Measurement report: The values are obtained from the mathematical model that predicts greenhouse gas emissions from agricultural areas, such as CH_4 and N_2O emissions from soil. The sources of the model includes: (1) collecting actual emission data from the project area, (2) emission data from experimental plots or research plots, or (3) data from high-quality academic literature, such as those reviewed by experts or published in academic journals, can be used. The selected reference data should be appropriate and applicable to the project area, especially if there is data consistent with the control factors or agricultural activities of the project.
QA/QC procedures	Appendix 3 - T-VER-P-METH-13-08 Version 01

Data / Parameter 16	$EC_{PI,s}$
Data unit:	MWh
Description:	Electricity consumption in growing season s of sample unit i
Measurement procedures (if any):	Modelling calculation based on rated power from equipment manufacturers and recorded operating hours of machinery/equipment from farmers information via the Smart Farmer application, throughout the growing season
Monitoring frequency:	Throughout the growing season
Source of data:	Measurement report
QA/QC procedures	Data completeness check from kWh Meter measure or farmer or project developer records

Data / Parameter 17	$EF_{Elec,s}$
Data unit:	Greenhouse gas emission factor for electricity production/consumption in growing season s
Description:	Greenhouse gas emission factor report for electricity production/consumption from projects and activities to reduce greenhouse gases, as announced by TGO.
Measurement procedures (if any):	For project proposal documents: • Use the latest EFElec,y value announced by TGO. For monitoring greenhouse gas reduction: • Use the EFElec,y value announced by TGO to assess the amount of greenhouse gases during the crediting period for greenhouse gas certification. However, if TGO has not yet announced an EFElec,y value for that specific year, use the most recent EFElec,y value announced by the TGO for that year instead.
Monitoring frequency:	Every time TGO announces a new value
Source of data:	For project proposal documents: based on latest value announced by TGO (October 30, 2022)[6]
QA/QC procedures	Default value

[6] https://ghgreduction.tgo.or.th/en/premium-t-ver-download/download/6966/3801/32.html

Part 5 Local Stakeholder Consultation

5.1 Stakeholders consultation process

The stakeholder consultation process for the AWD rice farming project under T-VER Premium is designed to ensure transparency, inclusiveness, and community ownership. The process begins with early engagement, where local stakeholders—including farmers, community leaders, local government agencies, women's groups, and vulnerable populations—are informed about the project's objectives, methods, and expected impacts. Public hearings and focus group discussions are then conducted in project areas to gather feedback on potential benefits, risks, and challenges, with attention to diverse perspectives such as age, gender, education level, and farming experience. Inputs from these consultations are systematically recorded, analyzed, and incorporated into the project design to improve feasibility and responsiveness to local needs. The process also includes continuous two-way communication, where stakeholders are updated on project progress, monitoring results, and grievance mechanisms, ensuring that concerns can be raised and addressed throughout implementation.

Stakeholder	Role and Responsibilities
Farmers	- Project Implementors
Local Community (Village Head, Subdistrict Head, District Officer)	- Project Supporters
Government Agencies	- Provide policies and support for AWD - Ensure the project complies with laws and government policies
Private Sector	- Supply necessary materials, equipment, and technology - Participate in promoting marketing and product sales
Academics and Agricultural Experts	- Provide technical guidance on AWD rice cultivation - Assess project impacts and feasibility

5.2 Summary of comments from stakeholders

The stakeholder engagement meeting, held on 26 February 2025 at the Agricultural Learning Center for Increasing Production Efficiency in Village 4, Don Ko Ka Subdistrict, Bang Nam Prieo District, Chachoengsao Province, aimed to gather opinions, concerns, and attitudes from diverse stakeholders, including details such as gender, age, education level, and occupation. This meeting served as the first public hearing for the Alternate Wetting and Drying (AWD) rice farming project, which will begin in Chachoengsao and expand to Kanchanaburi, Nakhon Pathom, Uttaradit, Sukhothai, Khon Kaen, Maha Sarakham, and Nong Bua Lamphu.

The objectives were to build understanding and awareness of the project’s approach, operations, and potential benefits, while also acknowledging possible impacts. It promoted participatory decision-making by enabling stakeholders to express their views, thereby ensuring inclusivity and community acceptance. The meeting also assessed potential economic, social, and environmental impacts to support effective implementation and minimize risks. Additionally, it strengthened relationships among government agencies, private sector actors, and local communities through information exchange and mutual understanding.

Summary of Participants (By Gender, Age, Farming Experiences and Roles)

Gender	No. of people	Percentage (%)
Male	11	61.11
Female	7	38.89
Total	18	100

Age	No. of people	Percentage (%)
Less than 30 years old	0	0

31-40 years old	4	22.2
41-50 years old	5	27.8
Above 51 years	9	50
Total	18	100
Farming Experiences	No. of people	Percentage (%)
1-5 years	2	11.11
6-10 years old	3	16.67
11-20 years old	3	16.67
Above 21 years	7	38.89
	3	16.67
Total	18	100

Role	No. of people	Percentage (%)
Farmers	11	61.11
Local Leaders	2	11.11
Government	5	27.78
Others	0	0
Total	18	100

Summary of Comments

1. **In the past, how has local agriculture in your area been affected?**

Farmers explained that their agricultural activities have faced many challenges over the years. Unstable weather conditions and recurring droughts have reduced productivity and made rice farming increasingly uncertain. High production costs, unstable crop prices, and persistently low rice prices have placed significant financial pressure on farming households. Poor soil quality has also contributed to reduced yields, while pests and environmental problems add further difficulties. Despite these hardships, some farmers highlighted positive experiences with Alternate Wetting and Drying (AWD) cultivation, as it uses less water and can help reduce environmental impacts.

2 What concerns do you have about this project?

Several concerns were raised regarding the implementation of this project. Farmers worried about the compatibility of the rice varieties grown locally with AWD techniques and the increased risk of pests, such as rats, during dry periods. Additional challenges include saline soil areas, weed management, and potential rat infestations. Many farmers expressed uncertainty about the clarity, sustainability, and long-term commitment of the project, questioning whether companies involved would continue to provide sufficient support. Concerns were also raised about the willingness of farmers to adopt low-carbon rice cultivation, especially among elderly farmers who may prefer traditional methods and struggle with the introduction of new technology or applications. Farmers further questioned whether compensation would be attractive enough and whether the trial period would justify the effort and potential risks involved.

3 What are your additional expectations for this project?

Despite these concerns, farmers have clear expectations for positive outcomes. They hope the project will lead to higher yields, lower production costs, and increased income through AWD rice farming. Expectations also include achieving better rice prices, both domestically and internationally, and securing more stable markets for high-quality rice. Farmers want the project to deliver tangible benefits, such as improved livelihoods and reduced environmental impacts, and they emphasize the importance of the project being long-term, with continuity to ensure lasting results. Many expressed interests in field visits tailored to local conditions, as well as opportunities for study tours and practical training on AWD methods, where farmers can learn directly from experts while practicing alongside project staff. Ultimately, they expect the project to provide economic stability, environmental sustainability, and greater opportunities for accessing premium markets, ensuring that both current and future generations of farmers can benefit.

5.3 Corrective actions for issues identified in section 5.2

Topic Area	Problems & Concerns	Farmers' Expectations	Alternative Solution Ideas
Weather & Water Management	• Unstable weather and drought• Risk of pests (rats) during dry periods	• More stable yields• Reduced production costs	• Promote AWD and other water-saving practices• Develop climate-resilient rice varieties• Improve irrigation and water-sharing systems• Community pest control campaigns
Soil & Crop Conditions	• Poor soil quality• Saline soil areas• Rice varieties may not suit AWD	• Higher yields and better quality rice	• Use salt-tolerant and locally adapted rice varieties• Soil rehabilitation programs (organic matter, soil amendments)• Seed support and trials of suitable varieties
Pests & Weeds	• Rat infestation• Weed management challenges	• Fewer crop losses, higher income	• Integrated pest management (IPM)• Community-based rat control• Training in weed control under AWD conditions
Economic Pressures	• High production costs• Unstable and low rice prices• Compensation may not be attractive	• Higher income and stable rice prices• Better access to premium/export markets	• Farmer cooperatives to lower input costs• Branding/marketing of low-carbon rice• Certification to access international markets• Incentive schemes linked to performance
Farmer Participation & Capacity	• Limited cooperation among farmers• Elderly farmers reluctant to adopt new methods• Difficulty using applications and technology	• Practical training and study visits• Desire for project continuity	• Peer-to-peer learning with farmer champions• Field visits tailored to local conditions• Simplified or offline tech support• Ongoing staff support for digital tools
Project Design & Support	• Uncertainty about project clarity, sustainability, and duration• Concerns whether company will provide ongoing support• Worry if project trial period will be worthwhile	• Long-term project with guaranteed benefits• Assurance of sustained support	• Transparent communication on project scope and timelines• Secure multi-year funding and partnerships• Phased scaling with clear milestones• Continuous support mechanisms

Appendix 1:
Summary of Additionality

The programme demonstrates clear additionality at financial, farmer, provincial, and programme levels, showing that adoption of Alternate Wetting and Drying (AWD) practices in Thailand would not be possible without the support of ITMO revenues under the Article 6 framework.

Financial additionality is established through a simple cost analysis aligned with FOEN's 2025 requirements. In the absence of ITMO revenues, the Net Present Value (NPV) of the programme is reflecting the high fixed costs and the lack of alternative income streams from AWD implementation. In contrast, with ITMO revenues, the NPV turns positive, demonstrating that carbon revenues are the decisive factor for programme feasibility. Without ITMOs, AWD implementation would remain financially unattractive and would not be scaled up.

Additionality at the farmers' level arises from entrenched practices and financial constraints. Farmers traditionally rely on continuous flooding because it reduces risks such as weed infestation and water shortages, and because it is perceived as the most secure method for maintaining stable yields.

In the target districts, there are currently no awareness campaigns or training opportunities that could equip farmers with the knowledge needed to implement AWD correctly. Furthermore, AWD does not directly generate additional income: savings on fuel and pumping costs are modest and uncertain, and cannot be relied upon for daily financial planning. Even modest investments, such as purchasing PVC pipes for AWD tubes, present a barrier for smallholders, who are reluctant to take on extra costs. Finally, without the programme, farmers would lack access to the digital monitoring tools that reduce risks and provide guidance for correct implementation. These barriers apply across Thai rice farmers, the majority of whom are smallholders with limited financial capacity.

At the provincial level, the programme addresses gaps in existing government efforts. Provinces were selected specifically because no current or planned programmes are sufficient to shift agricultural practices toward AWD at scale. For example, in Chachoengsao, the government AWD program accounts for 1,900 rai (304 ha) out of more than 1.9 million rai of rice land, representing just 0.1% of the province’s rice-growing area.

Such small-scale efforts are valuable but insufficient to change prevailing practices. The programme complements these initiatives by expanding coverage, building farmer capacity, and introducing financial and organizational mechanisms that enable more widespread adoption. Collaboration with Thai authorities is also planned to ensure robust governance, including tools to avoid double counting such as joint committees, centralized registration systems, and potentially a national farmer registration application.

In conclusion, the programme demonstrates robust additionality at all levels. Farmers face strong cultural, financial, and organizational barriers to adopting AWD; provinces lack sufficient support to trigger large-scale practice change; and at the programme level, implementation is only financially feasible through ITMO revenues. The programme therefore clearly meets the additionality requirements and represents a contribution to achieving emission reductions under Article 6.

Appendix 2:

Stakeholder Consultation Report

Project: Alternate Wetting and Drying (AWD) Rice Farming for Thai Farmers

Agricultural Learning Center for Increasing Production Efficiency

Village 4, Don Ko Ka Subdistrict, Bang Nam Prieo District, Chachoengsao Province

26 February 2025

Varuna (Thailand) Co., Ltd.

1.Background

The project to promote Alternate Wetting and Drying (AWD) rice farming in Thailand is a collaboration between Thailand and Switzerland. Its objectives are to reduce greenhouse gas emissions, enhance sustainable rice production efficiency, and conserve natural resources.

The project is planned to be implemented in 8 provinces: Chachoengsao, Kanchanaburi, Nakhon Pathom, Uttaradit, Sukhothai, Khon Kaen, Maha Sarakham, and Nong Bua Lamphu, with a project duration until 2030. Varuna Company, as the project developer, plays a key role in transferring knowledge and technology to Thai farmers to promote sustainable rice farming systems and reduce environmental impacts.

2. Introduction

2.1 Project Type: Land Use (Agriculture & Forestry) – Reduction, absorption, and sequestration of greenhouse gases from the forestry and agriculture sectors.

2.2 Project Scale: Large-scale – total reduction/sequestration of more than 16,000 tCO_2eq per year.

2.3 Project Location: Chachoengsao (first province where the project starts), Kanchanaburi, Nakhon Pathom, Uttaradit, Sukhothai, Khon Kaen, Maha Sarakham, Nong Bua Lamphu.

2.4 Expected Completion Period: 5 years (2025 – 2030).

3.Goals

The objective of conducting the stakeholder engagement meeting is to ensure that the organization is informed of the opinions, concerns, and attitudes of stakeholders, and to use this information to develop appropriate engagement plans for each stakeholder group. It also enables the organization to report key issues and concerns raised by stakeholders regarding the implementation of the Alternate Wetting and Drying (AWD) rice farming project.

4.Objectives

The objectives of the Stakeholder Consultation Meeting for the Alternate Wetting and Drying (AWD) Rice Farming Project are as follows;

4.1 Gather feedback and suggestions from stakeholders:
To provide opportunities for relevant parties—such as farmers, local communities, and related agencies—to express their opinions and offer suggestions that can be used to further improve the project's efficiency and better meet stakeholder needs.

4.2 Build understanding and awareness about the project:
The meeting aims to ensure that stakeholders understand the project's approach, operations, and potential benefits, as well as possible impacts. This will allow all parties to receive accurate information and develop a clear understanding.

4.3 Promote participatory decision-making:
By allowing stakeholders to express their opinions, the project encourages inclusive decision-making and active involvement in implementation, ensuring sustainability and community acceptance.

4.4 Assess potential project impacts:
To evaluate economic, social, and environmental impacts that may arise from project implementation, supporting effective execution and minimizing unforeseen negative consequences.

4.5 Strengthen relationships among stakeholders:
The meeting also aims to build positive relationships between government agencies, the private sector, and local communities through the exchange of information and mutual understanding.

4.6 Improve project implementation based on feedback:
Suggestions from the meeting will be considered and integrated into project implementation to align with the local context and stakeholder needs, thereby increasing the likelihood of project success.

5. Scope of Work

5.1 Stakeholder groups: Farmers, local communities, government agencies, private sector, and experts in agriculture and water management.

5.2 Key issues for stakeholder feedback:

- Knowledge and awareness of Alternate Wetting and Drying (AWD) rice farming
- Support from various organizations (TGO, government/private sector organizations)
- Resource use (water, land, fuel)
- Environmental impacts
- Economic and social impacts

5.3 Project area and conditions: Suitability of areas for AWD rice farming and potential limitations.

5.4 Impacts and evaluation: Assessment of economic, social, and environmental impacts of project implementation.

5.5 Support needs: Requirements for financial support, technical guidance, and training.

5.6 Implementation period and monitoring: Feedback on the project duration and monitoring process.

6. Stakeholders Planning

This meeting aims to provide all stakeholder groups with the opportunity to share their opinions and suggestions in order to improve the project, making it more effective and responsive to the needs of the community and farmers.

Table 1: Expectation of Stakeholders Group Attending the Meeting

Stakeholder	Expectations
Meeting Organizer (Project Developer)	- Prepare and conduct the meeting according to the plan - Share relevant information with stakeholders in advance - Coordinate with all stakeholder groups - Collect and summarize feedback from the meeting

Stakeholders (Farmers, Communities, Relevant Agencies)	- Provide opinions and suggestions about the project - Share views on potential impacts - Collaborate in improving the project to meet needs
Government Agencies (District Chief, District Agricultural Office, Land Development Department, Rice Department, Village Head, Subdistrict Head)	- Provide opinions and suggestions about the project - Share views on potential impacts - Collaborate in improving the project to meet needs

7 Stakeholder Identification

Table 2: Roles and Responsibilities of Stakeholders

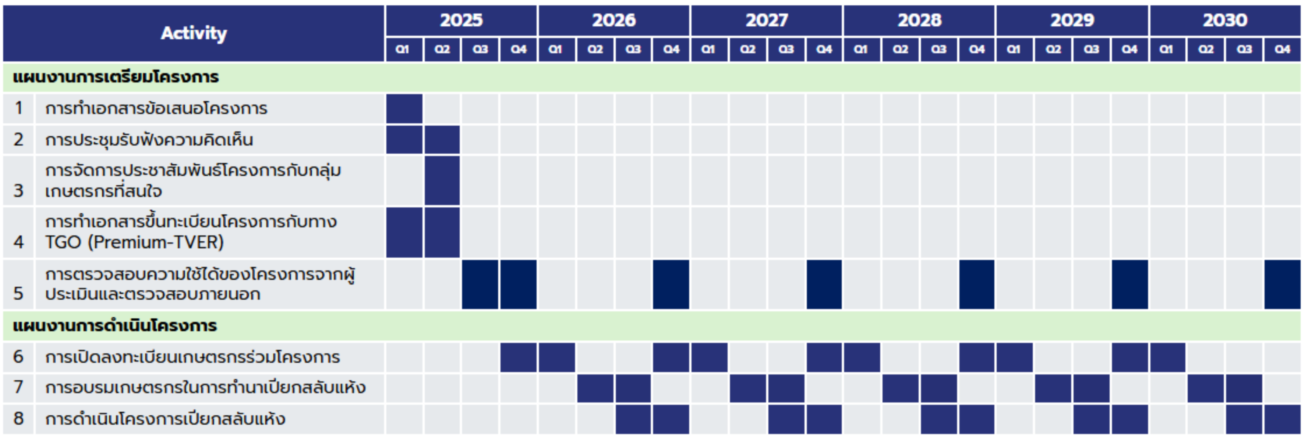
Stakeholder	Role and Responsibilities
Farmers	- Project Implementors
Local Community (Village Head, Subdistrict Head, District Officer)	- Project Supporters
Government Agencies	- Provide policies and support for AWD - Ensure the project complies with laws and government policies
Private Sector	- Supply necessary materials, equipment, and technology - Participate in promoting marketing and product sales
Academics and Agricultural Experts	- Provide technical guidance on AWD rice cultivation - Assess project impacts and feasibility

Table 3: Activities for stakeholders

Activities	Stakeholders	Objectives	Communication Channel	Timeline
Public consultation meeting	Farmers, local communities	To gather feedback and suggestions on Alternate Wetting and Drying (AWD) rice farming	On-site meeting	Half-day
Opinion survey	Farmers, local communities, supporters	To collect feedback from stakeholders who are unable to attend activities	TGO website	30 days

8. Operation Plan

After the public consultation in Chachoengsao Province, additional consultations will be carried out in other provinces. At the same time, the project proposal and registration documents will be revised, and the project will undergo a review by 3rd party validators within 2025. For project implementation, farmer registration for participation and training on Alternate Wetting and Drying (AWD) rice cultivation will be conducted to enable the project to commence in by 4Q of 2025 or 1Q of 2026.



9.Stakeholder Consultation Results

From the stakeholder consultation meeting on Alternate Wetting and Drying (AWD) rice cultivation, conducted on 26 February 2025, a total of 18 respondents' responses to the questionnaire, accounting for 66.67% of the total 27 meeting participants.

9.1 General Information

Gender	No. of people	Percentage (%)
Male	11	61.11
Female	7	38.89
Total	18	100

Age	No. of people	Percentage (%)
Less than 30 years old	0	0
31-40 years old	4	22.2
41-50 years old	5	27.8
Above 51 years	9	50
Total	18	100

Farming Experiences	No. of people	Percentage (%)
1-5 years	2	11.11
6-10 years old	3	16.67
11-20 years old	3	16.67

Above 21 years	7	38.89
	3	16.67
Total	18	100

Role	No. of people	Percentage (%)
Farmers	11	61.11
Local Leaders	2	11.11
Government	5	27.78
Others	0	0
Total	18	100

9.2 Assessment Scoring Results

Assessment Criteria	Level of Understanding/ Acceptance

(5 = Very High, 4 = High, 3 = Moderate, 2 = Low, 1 = Very Low)

9.3: Additional Questions / Suggestions Regarding Participating in the Project

9.3.1 In the past, how has local agriculture in your area been affected?

- Unstable weather conditions
- Drought problems
- Reduced environmental impact
- High production costs; unstable crop prices

- High expenses
- Low rice prices
- Positive effects because Alternate Wetting and Drying (AWD) rice cultivation uses less water
- Poor soil quality

9.3.2. What concerns do you have about this project?

- Rice varieties in the area
- Pests during dry periods (rats)
- Saline soil areas
- Rat infestation
- Weeds
- Clarity and sustainability of the project
- Farmers may not cooperate in cultivating low-carbon rice
- This farming method may face some obstacles
- Whether the company will provide support or not
- Elderly farmers may hold on to traditional beliefs and practices, making it difficult to change their mindset and habits
- The technology introduced may not be suitable for local farmers
- Whether the duration of the project will be worth the trial
- Using applications may be a limitation for elderly farmers
- Compensation may not be attractive enough

9.3.3 What are your additional expectations for this project?

- Conduct field visits tailored to each different area
- Achieve higher yields
- Gain higher income from alternate wetting and drying rice farming
- Higher rice prices

- Hope that this project will help farmers earn more income
- Increase income while reducing environmental impacts
- Receive more benefits
- Desire for this project to continue
- Hope that the project will be long-term and ensure good rice prices
- The project will benefit farmers
- Rice prices meet expectations
- Want study visits on alternate wetting and drying farming so that interested farmers can gain more knowledge by practicing together with staff
- Lower production costs
- Better access to international markets for quality rice and higher rice prices compared to conventional farming

10. Appendices

10.1. Participant Lists

10.2 Letter of Invitation to join the stakeholder consultation

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ที่ VRN0010/2568

14 กุมภาพันธ์ 2568

เรื่อง ขอเชิญเข้าร่วมประชุมการรับฟังความคิดเห็นผู้มีส่วนได้ส่วนเสียโครงการการทำนาเปียกสลับแห้ง ภายใต้ความตกลงปารีสข้อ 6

เรียน นายจรรเกียรติ รักพานิชมณี ผู้ว่าราชการจังหวัดฉะเชิงเทรา

เมื่อวันที่ 24 มิ.ย. 65 นายวราวุธ ศิลปอาชา รัฐมนตรีว่าการกระทรวงทรัพยากรธรรมชาติและสิ่งแวดล้อม กับนางซีมอเน็ตตา ซอมมารูกา มนตรีแห่งสมาพันธ์ รัฐมนตรีว่าการกระทรวงสิ่งแวดล้อมคมนาคม พลังงานและสารสนเทศ สมาพันธรัฐสวิสได้ร่วมลงนามในข้อตกลงการดำเนินงานภายใต้ความตกลงปารีสระหว่างราชอาณาจักรไทยกับสมาพันธรัฐสวิส (Implementing Agreement to the Paris Agreement between the Kingdom of Thailand and the Swiss Confederation) ณ กรุงเบิร์น สมาพันธรัฐสวิส ข้อตกลงครั้งนี้ เปิดโอกาสให้ประเทศไทยกับสมาพันธรัฐสวิสดำเนินความร่วมมือภายใต้ข้อ 6 ของความตกลงปารีสโดยความสมัครใจ เพื่อขับเคลื่อนการดำเนินงานตามเป้าหมายการมีส่วนร่วมที่ประเทศกำหนด (Nationally Determined Contribution: NDC) ถ่ายโอนผลการลดก๊าซเรือนกระจกระหว่างประเทศโดยความร่วมมือนี้นับเป็นส่วนเพิ่มเติมนอกเหนือจากมาตรการภายใน NDC ของประเทศ ทั้งนี้ การดำเนินงานภายใต้ข้อตกลงฯ จะช่วยให้ประเทศไทยเรียนรู้แนวทางการดำเนินงานจากโครงการ เพื่อนำองค์ความรู้ที่ได้รับมาต่อยอดและขับเคลื่อนการดำเนินงานให้บรรลุ NDC ของไทย การมุ่งสู่เป้าหมายความเป็นกลางทางคาร์บอน (Carbon neutrality) และการปล่อยก๊าซเรือนกระจกสุทธิเป็นศูนย์ (Net zero GHG emission)

เพื่อต่อยอดความสำเร็จ ในการส่งเสริมการขับเคลื่อนการดำเนินงานให้บรรลุเป้าหมาย NDC ของประเทศไทย และสอดคล้องกับนโยบายการส่งเสริมการปลูกข้าวแบบเปียกสลับแหงแก่กลุ่มเกษตรกรนาแปลงใหญ่ และศูนย์ข้าวชุมชน ทางบริษัท วรุณา (ประเทศไทย) จำกัด ร่วมกับ Klik Foundation ในฐานะผู้รับซื้อเครดิตในนามของรัฐบาลสวิตเซอร์แลนด์กำลังพัฒนาข้อเสนอโครงการส่งเสริมการปลูกข้าวแบบเปียกสลับแห้งในพื้นที่ 7 จังหวัด ดังนี้ ฉะเชิงเทรา อุตรดิตถ์ กาญจนบุรี สุโขทัย ปราจีนบุรี นครปฐม และกรุงเทพมหานคร

ในโอกาสนี้ ทางบริษัท วรุณา (ประเทศไทย) จำกัด **ใคร่ขอเชิญท่านเข้าร่วมประชุมรับฟังความคิดเห็นผู้ที่มีส่วนได้ส่วนเสีย สำหรับการส่งเสริมการปลูกข้าวแบบเปียกสลับแห้ง (Alternate Wetting and Drying) การดำเนินโครงการภายใต้ Article 6 และ Methodology Premium T-VER ในวันพุธที่ 26 กุมภาพันธ์ 2568 เวลา 8:30 – 12:00 น. ณ ศูนย์เรียนรู้การเพิ่มประสิทธิภาพการผลิตสินค้าเกษตร (หลัก) หมู่ 4 ตำบลดอนเกาะกา อ.บางน้ำเปรี้ยว จ.ฉะเชิงเทรา** ทั้งนี้ทางบริษัทฯ ได้มอบหมายให้นางสาวสิริรัตน์ เสือมัจฉา โทร 082 978 0053 เป็นผู้ประสานงานการนัดหมายในครั้งนี้

จึงเรียนมาเพื่อโปรดพิจารณาให้ความอนุเคราะห์และขอขอบพระคุณมาในโอกาสนี้

แผนที่ศูนย์เรียนรู้การเพิ่มประสิทธิภาพ
การผลิตสินค้าเกษตร (หลัก)

ขอแสดงความนับถือ

พณัญญา เจริญสวัสดิ์พงศ์

(นางสาวพณัญญา เจริญสวัสดิ์พงศ์)
ผู้ร่วมก่อตั้งธุรกิจ
บริษัท วรุณา (ประเทศไทย) จำกัด


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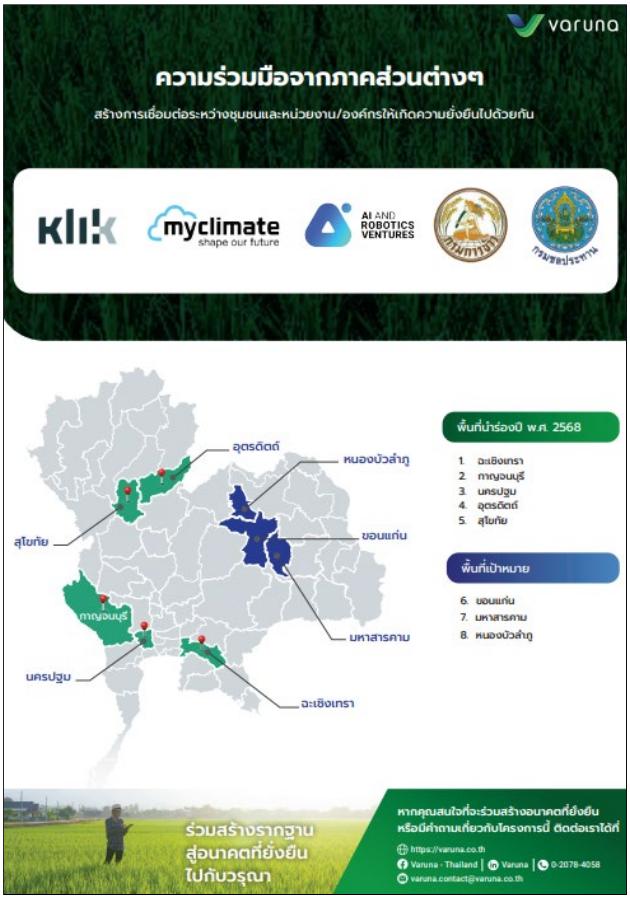
Seeding the Sustainable Future
โครงการสนับสนุนการทำนาเปียกสลับแห้งของเกษตรกรไทย
Alternative Wetting and Drying (AWD) In Thailand
บริษัท วรุณา (ประเทศไทย) จำกัด ร่วมมือกับหน่วยงาน Klik Foundation จากประเทศสวิตเซอร์แลนด์ ในการทำโครงการการลดการปล่อยก๊าซมีเทนจากการจัดการน้ำในพื้นที่ปลูกข้าวของประเทศไทย (การทำนาเปียกสลับแห้ง) เพื่อดำเนินงานในการมุ่งสู่เป้าหมายการลดก๊าซเรือนกระจกของประเทศและสร้างมูลค่าเพิ่มด้วยการพัฒนาโครงการคาร์บอนเครดิตในภาคการเกษตร และได้มีการช่วยเหลือและสนับสนุนการดูแลพื้นที่การเกษตรกรรมโดยการให้บริการในรูปแบบของแพลตฟอร์มที่สามารถใช้ในการตรวจตราและดูแลการเจริญเติบโตของนาข้าวในแต่ละพื้นที่จากเทคโนโลยีภาพถ่ายดาวเทียม(Satellite) นำมาประมวลผลแสดงค่าต่างๆ และระบบรายงานผลการดำเนินกิจกรรมในเชิงการเกษตรผ่านดิจิตอลแพลตฟอร์ม (Smart Watcher) เพื่อให้พื้นที่ดังกล่าวสามารถได้รับการดูแลที่มีประสิทธิภาพมากยิ่งขึ้น
เป้าหมายโครงการ
- ลดการปล่อยก๊าซมีเทนจากการทำนาแบบดั้งเดิม
- การปรับปรุงโครงสร้างดินให้ดียิ่งขึ้นและเพิ่มผลผลิตข้าวในระยะยาว
- เพิ่มรายได้แก่เกษตรกรจากการปลูกข้าวแบบคาร์บอนต่ำ
พื้นที่เป้าหมาย
พื้นที่นาข้าว 8 จังหวัด ทั่วประเทศไทย
ระยะเวลาโครงการ
5 ปี (พ.ศ. 2568 - 2573)
ปริมาณก๊าซเรือนกระจกที่คาดว่าจะลดได้
523,000 – 1,185,000 ตันคาร์บอนออกไซด์เทียบเท่า
มาตรฐานการรับรองคาร์บอนเครดิต
โครงการ T-VER มาตรฐานขั้นสูง (Premium T-VER)
เป้าหมายการพัฒนาอย่างยั่งยืน (SDG Goals)
ร่วมสร้างรากฐาน
สู่อนาคตที่ยั่งยืน
ไปกับวรุณา
หากคุณสนใจที่จะร่วมสร้างอนาคตที่ยั่งยืน
หรือมีคำถามเกี่ยวกับโครงการนี้ ติดต่อเราได้ที่
https://varuna.co.th
Varuna - Thailand | Varuna | 0-2078-4058
varuna.contact@varuna.co.th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ความร่วมมือจากภาคส่วนต่างๆ
สร้างการเชื่อมต่อระหว่างชุมชนและหน่วยงาน/องค์กรให้เกิดความยั่งยืนไปด้วยกัน
myclimate
shape our future
AI AND ROBOTICS VENTURES
อุตรดิตถ์
หนองบัวลำภู
สุโขทัย
ขอนแก่น
กาญจนบุรี
มหาสารคาม
นครปฐม
ฉะเชิงเทรา
พื้นที่นำร่องปี พ.ศ. 2568
1. ฉะเชิงเทรา
2. กาญจนบุรี
3. นครปฐม
4. อุตรดิตถ์
5. สุโขทัย
พื้นที่เป้าหมาย
6. ขอนแก่น
7. มหาสารคาม
8. หนองบัวลำภู
ร่วมสร้างรากฐาน
สู่อนาคตที่ยั่งยืน
ไปกับวรุณา
หากคุณสนใจที่จะร่วมสร้างอนาคตที่ยั่งยืน
หรือมีคำถามเกี่ยวกับโครงการนี้ ติดต่อเราได้ที่
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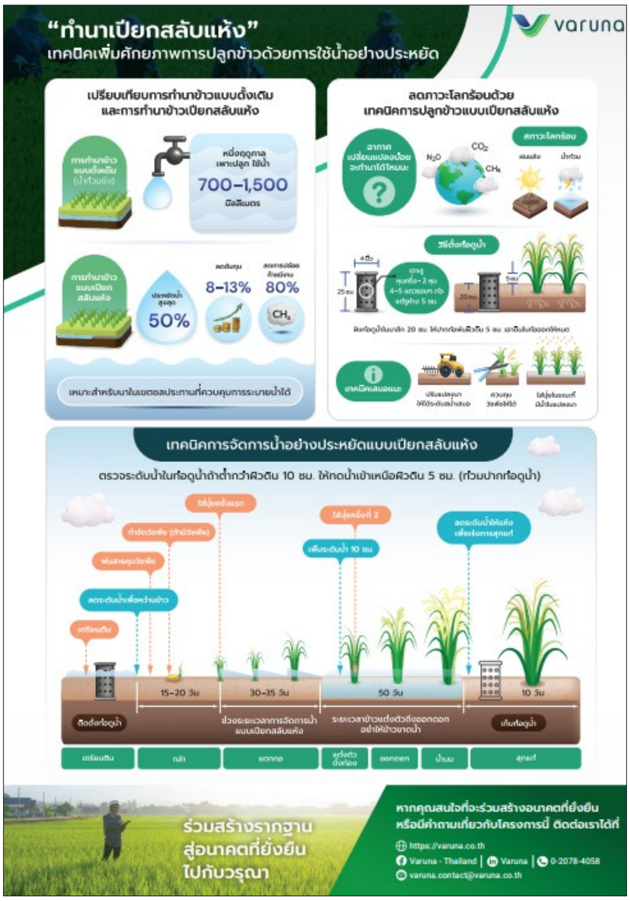
Smart Watcher
เทคนิคเพิ่มศักยภาพการดูแลพื้นที่การเกษตรกรรม เพื่อเกษตรกรไทย
แพลตฟอร์ม Smart Watcher คือผู้ช่วยเกษตรกรในการติดตามและรายงานผลของการทำกิจกรรมทางการเกษตรแบบครบวงจร และการบูรณาการเทคโนโลยีดาวเทียม (Satellite) ที่จะช่วยให้การดูแลแปลงเกษตรง่ายขึ้น ที่ออกแบบมาเพื่อให้ใช้งานง่าย สะดวก และตอบสนองความต้องการของเกษตรกร
ฟีเจอร์หลัก Smart Watcher
1. เก็บบันทึกข้อมูลรายแปลง
บันทึกและติดตามกิจกรรมแปลง เพื่อตรวจสอบย้อนกลับ
2. ใช้งานสะดวก และให้ความแม่นยำสูง
ออกแบบมาเพื่อให้ใช้งานง่ายต่อเกษตรกรภาคสนาม แต่ยังคงความถูกต้องและความแม่นยำของข้อมูลด้วยการผสานระบบ AI ในการจดจำข้อมูลต่างๆ ในการรายงานได้อัตโนมัติ
3. การเข้าร่วมโครงการ และขอรับรองคาร์บอนเครดิต
สร้างรายได้ที่เพิ่มขึ้นจากการเข้าร่วมโครงการ Carbon Farming พร้อมให้คำแนะนำวิธีการเพาะปลูกที่ถูกต้องตามหลักการมาตรฐาน Premium T-VER
SMART FARM แพลตฟอร์ม
นอกจากนี้ ยังสามารถติดตามพื้นที่การเกษตรได้ในระดับวงกว้าง ผ่านภาพถ่ายดาวเทียม ผ่าน Smart Farm Platform พร้อมประมวลผลค่าความเปลี่ยนแปลงในด้านพื้นที่เชิงลึก เช่น Normalized Difference Water Index (NDWI)
ประโยชน์ของการทำนาเปียกสลับแห้ง
การปล่อยให้ข้าวขาดน้ำ จะช่วยกระตุ้นการเจริญเติบโตของรากข้าวและลำต้นของข้าวให้แข็งแรง ส่งผลโดยตรงต่อการเจริญเติบโต รวมถึงช่วยสร้างผลผลิต
ความชื้นในแปลงนาลดน้อยลง จะช่วยลดการระบาดของโรคและแมลง
มีผลกำไรจากการผลิตข้าวมากขึ้น
ช่วยประหยัดปริมาณการใช้น้ำในการทำนา ร้อยละ 25–40
ลดต้นทุนการเพาะปลูก เช่น ค่าน้ำมันเชื้อเพลิงในการสูบน้ำ สารเคมีในการป้องกันกำจัดโรคและแมลง เป็นต้น
ช่วยลดการปล่อยก๊าซมีเทน ซึ่งเป็นสาเหตุของภาวะโลกร้อน


“ทำนาเปียกสลับแห้ง”
เทคนิคเพิ่มศักยภาพการปลูกข้าวด้วยการใช้น้ำอย่างประหยัด
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เปรียบเทียบการทำนาข้าวแบบดั้งเดิม และการทำนาข้าวเปียกสลับแห้ง
การทำนาข้าวแบบดั้งเดิม (น้ำท่วมขัง)
หนึ่งฤดูกาลเพาะปลูก ใช้น้ำ
700–1,500
มิลลิเมตร
การทำนาข้าวแบบเปียกสลับแห้ง
ประหยัดน้ำสูงสุด
50%
ลดต้นทุน
8–13%
ลดการปล่อยก๊าซมีเทน
80%
เหมาะสำหรับนาในเขตชลประทานที่ควบคุมการระบายน้ำได้
ลดภาวะโลกร้อนด้วย เทคนิคการปลูกข้าวแบบเปียกสลับแห้ง
อากาศเปลี่ยนแปลงบ่อย จะทำนาได้ไหมนะ
สภาวะโลกร้อน
วิธีตั้งท่อดูน้ำ
เทคนิคเสนอแนะ
เทคนิคการจัดการน้ำอย่างประหยัดแบบเปียกสลับแห้ง
ตรวจระดับน้ำในท่อดูน้ำถ้าต่ำกว่าผิวดิน 10 ซม. ให้ทดน้ำเข้าเหนือผิวดิน 5 ซม. (ท่วมปากท่อดูน้ำ)
ใส่ปุ๋ยครั้งแรก
ใส่ปุ๋ยครั้งที่ 2
เพิ่มระดับน้ำ 10 ซม.
ลดระดับน้ำให้แห้ง เพื่อเร่งการสุกแก่
ลดระดับน้ำเพื่อหว่านข้าว
เตรียมดิน
15–20 วัน
30–35 วัน
50 วัน
10 วัน
ติดตั้งท่อดูน้ำ
ช่วงระยะเวลาการจัดการน้ำ แบบเปียกสลับแห้ง
ระยะเวลาข้าวแต่งตัวถึงออกดอก อย่าให้ข้าวขาดน้ำ
เก็บท่อดูน้ำ
เตรียมดิน
กล้า
แตกกอ
แต่งตัว ตั้งท้อง
ออกดอก
น้ำนม
สุกแก่
ร่วมสร้างรากฐาน
สู่อนาคตที่ยั่งยืน
ไปกับวรุณา
หากคุณสนใจที่จะร่วมสร้างอนาคตที่ยั่งยืน
หรือมีคำถามเกี่ยวกับโครงการนี้ ติดต่อเราได้ที่
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10.3 Pictures of Events

Appendix 3:

Sustainable Development and Safeguards assessment

SDGs and Environmental and Social Risk Assessment for the implementation of AWD practices in Thailand under the framework of the Article 6 of the Paris Agreement

Introduction

Alternate Wetting and Drying (AWD) is a water management practice designed to enhance sustainability in irrigated rice cultivation by reducing methane emissions and improving resource use efficiency. Developed by Varuna and myclimate under the framework of Article 6 of the Paris Agreement and the Switzerland–Thailand bilateral agreement, this programme seeks to balance environmental and social benefits with social responsibility.

The activity does not fall under any of the category of projects that are required to carry out an Environmental (and Social) Impact Assessment[7] according to the Thai law, nevertheless the programme has carried out an Environmental and Social risk assessment in this document (Safeguards Assessment). In line with TGO requirements to ensure sustainable development and identify safeguards[8], the risk assessment has identified safeguards to mitigate risks of negative environmental and social impacts that may arise from project implementation.

The programme adheres to the Quality, Safety, Security, Health and Environment Policy of AI and Robotic Ventures[9], to which Varuna belongs to.

Sustainable Development Goals (SDGs)

Besides the obvious contribution of the programme to combating climate change (SDG13), this programme will also positively impact farmers' income (SDG 1), ensure sustainable food production and foster food-security (SDG 12, SDG 2), will create job opportunities during the trainings and monitoring (SDG 4 and SDG 8), will broaden the use of high-tech instruments (SDG 9), will optimize water usage (SDG 6), improve soil conditions (SDG 15) and will also promote gender equality by engaging with female farmers (SDG 5). This MA will monitor the three most relevant SDGs among the abovementioned ones. The following targets and indicators identified with the application of the GS impact tool[10] will be monitored to track the programme's progress and its contribution to driving sustainable development in Thailand.

SDG	Target	Relevance:	Monitoring parameter:
SDG 2: Zero hunger	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	The adoption of AWD practices requires less water enabling therefore more drought resistant cultivation practices. This strengthens farmers' capacity for adaptation to climate change.	Number of farmers adopted practices promoted by the project
SDG 3: Good health and wellbeing	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and	The programme will train farmers in avoiding the practice of open straw	Area under reduced/avoided open burning of

[7] https://eiathailand.onep.go.th/imgeditor/maptaput/EIA-Eng-2021.pdf
[8] https://tver.tgo.or.th/index.php/en/en-premium/kar-phathna-khorngkar-en/pre-en-project-specification/pre-en-sustainable-development-and-safeguards-assessment
[9] https://arv.co.th/en/who-we-are/sustainability/2
[10] https://globalgoals.goldstandard.org/430-iq-sdg-impact-tool/

	soil pollution and contamination	burning, which causes considerable air pollution.	biomass, crop residue
SDG 6: Clean Water and Sanitation	6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	The adoption of AWD practices requires less water enabling the preservation of natural freshwater bodies and addressing water scarcity issues	Land area provided with (i) new, (ii) improved irrigation and drainage services

Safeguards assessment

1. Non-Discrimination, Gender equality, Inclusion and Freedom of Expression

Potential Risks:

The risk of discrimination arises primarily from entrenched social hierarchies and institutional barriers that could exclude certain groups—such as women, ethnic minorities, tenant farmers, or those lacking land documentation—from programme access and benefits. In rural Thailand, customary land tenure and informal arrangements are common, potentially preventing renters or sharecroppers from equal participation.
There is a risk that women and marginalized populations may be sidelined in benefit sharing, training, or decision-making, perpetuating existing inequalities.
Power dynamics in rural communities may discourage open feedback, with stakeholders fearing reprisal if they raise concerns about programme implementation or benefit allocation.

Risk and Safeguard assessment:

To address these risks, the programme's eligibility criteria are intentionally broad, welcoming all rice farmers, irrespective of land ownership or gender. Legal land use is verified through a range of accepted documents, including leases and certificates, reducing the administrative burden on non-owners.
Discrimination on the basis of gender or religion is not common in Thailand and is not expected, nevertheless the programme strives to ensure non-discrimination. The programme actively encourages participation of female farmers and ensures equal access to training, technology, and incentives.
To foster a safe environment, multiple reporting channels—including hotlines, anonymous emails, and physical drop-boxes—are actively promoted. Independent committees comprising community representatives, government officials, and third-party experts ensure grievances are reviewed impartially. Whistleblower protections are codified, guaranteeing confidentiality and safeguarding against retaliation.

Risk Likelihood: Negligible

2. Labour, Child Rights, and Equal Opportunity

Potential Risks:

As the AWD initiative creates opportunities in field monitoring, data entry, and community leadership, there is a potential for unintentional child labour or unfair practices, particularly where informal labour arrangements are the norm. Power imbalances could also lead to discrimination or harassment within new employment avenues.

Risk and Safeguard assessment:

The programme adheres to the Thai labour law and ILO conventions, with explicit clauses against child and forced labour. All staff and participants are educated about anti-harassment and equal opportunity policies upon enrolment. A clear, confidential grievance mechanism is accessible for reporting abuses, and all complaints are independently reviewed to guarantee fair outcomes and corrective action.

Risk Likelihood: Negligible

3. Corruption, Fraud, and Good Governance

Potential Risks:

Risks include misallocation of resources, undue influence in benefit distribution, or manipulation of emissions data, particularly given the financial incentives associated with carbon credits. The complex flow of funds across borders raises concerns about transparency and the potential for illicit activity.

Risk and Safeguard assessment:

Varuna adheres to integrity policies, sexual harassment policies, and anti-corruption policies in line with PTTEP requirements and in line with AI Robotic's Quality, Safety, Security, Health and Environment Policy (link). Varuna conducts business with honesty and integrity. Both aggressive and passive corruption will not be permitted.
Varuna has positioned itself to comply with Anti-Money Laundering legislation and laws. By maintaining an organized and ethical business practice, the company is dedicated to preventing any involvement in acts that facilitate money laundering.
Robust financial controls are in place: all transactions are conducted via regulated bank channels, with clear documentation. Data collection leverages secure digital platforms, with traceable audit trails and government oversight, reducing manual intervention and the scope for tampering. Closed chamber measurements—subject to manipulation—are reserved for plausibility checks, while primary verification relies on satellite and remote data, further limiting opportunities for fraud.
Risk Likelihood: Minor

4. Privacy and Data Security

Potential Risks:
The use of digital platforms and remote sensing requires the collection of personal and geospatial data, raising risks of misuse, unauthorised sharing, or data breaches that could undermine trust and violate privacy rights.
Risk and Safeguard assessment:
The data collected will be strictly used only for the MRV of the programme. Any disclosure will be avoided, with the exception of the Thai and Swiss authorities and the VVB bodies.
In the event of a suspected or confirmed data breach, there will be temporary suspension of affected systems. Ther will be an incident response including notification to all related parties and root cause analysis investigation.
Risk Likelihood: Minor

5. Occupational Health and Safety

Potential Risks:
Introducing new practices or technologies may inadvertently expose farmers to unfamiliar risks, from equipment-related injuries to unfamiliar field conditions.
Risk and Safeguard assessment:
Risk assessments confirm AWD does not introduce hazards beyond those in traditional rice cultivation nor does it require the application of heavy machineries. Farmer training cover nevertheless safe operation of technology and best practices for fieldwork. Feedback loops allow prompt identification and mitigation of unforeseen risks, with adjustments to protocols as needed.
Risk Likelihood: Negligible

6. Cultural Heritage and Practices

Potential Risks:
Any shift in farming practice can affect cultural heritage, particularly if traditional methods are deeply tied to local identity or community rituals.
Risk and Safeguard assessment:
There is no significant cultural practices that is expected to be lost; AWD is an adaptation of existing rice farming rather than a fundamental change.
Risk Likelihood: Negligible

7. Economic and Livelihood Risks

Potential Risks:
Transitioning to AWD may present economic risks: initial yield reductions, increased management complexity, or upfront costs could deter adoption or impact farmer incomes.
Risk and Safeguard assessment:
Yield impacts are closely tracked, with rapid-response extension support if unexpected losses occur. Financial incentives from carbon credits cushion short-term income variability and defray costs for technology or

infrastructure upgrades. Ongoing capacity building and technical support lower adoption barriers, and the use of SMARTfarmer platform encourage knowledge exchange.
Risk Likelihood: Minor; mitigated through design

8. Programme Governance, Participation, and Communication

Potential Risks:
Lapses in communication, lack of transparency, or insufficient engagement can erode trust and hinder widespread adoption.
Risk and Safeguard assessment:
Routine stakeholder engagement is built into the programme’s lifecycle, from design through evaluation. Digital and face-to-face communication tools ensure all participants are informed and heard. Feedback and grievance mechanisms are reviewed for effectiveness and accessibility at least annually, with results shared openly.
Risk Likelihood: Negligible

9. Water Quality and Accessibility

Potential risk:
AWD alters irrigation schedules, which could disrupt water allocation for downstream users or impact local water quality due to changes in flooding and drainage patterns.
Risk and Safeguard assessment:
AWD is implemented only in regions with established irrigation infrastructure and in coordination with local water authorities and farmer water-user groups. Impact assessments are conducted before initiation to ensure no adverse effects on community water access. Adaptive management allows for real-time adjustments to scheduling should conflicts or issues arise.
In general, AWD practices improve water accessibility by allowing a reduced use of water resources.
Risk Likelihood: Negligible (Positive)

10. Soil Health and Quality

Potential Risks:
Potential negative impacts on soil organic carbon (SOC) due to increased aeration from intermittent drying.
Risk and Safeguard assessment:
Current science suggests SOC changes are minimal due to offsetting effects. Farmer training emphasizes sustainable residue management improving soil health which is expected to improve due to enhanced root growth and better aeration.
Risk Likelihood: Negligible to Positive

11. Air Quality

Potential Risks:
While AWD has large beneficial effects on air quality due to reducing methane emissions, there are risks associated to the potential increased machinery use and continue field residue burning.
Risk and Safeguard assessment:
Training modules discourage residue burning and promote alternative uses for straw, such as composting or mulching, with compliance monitored via satellite imagery. Machinery use is not expected to be required as the majority of the farmers operate in flat lands. Impact to air quality is monitored and largely compensated by CH_4 emissions reductions
Risk Likelihood: Negligible (Positive)

12. Biodiversity and Ecosystem Services

Potential Risks:
Altering hydrology may affect field flora and fauna, potentially reducing local biodiversity if not managed with ecological sensitivity.
Risk and Safeguard assessment:

AWD supports integrated pest management and reduces periods of stagnant water, which can benefit soil organisms and beneficial insects.
Risk Likelihood: Positive

Conclusions

The programme contributes to 4 SDGs: climate action (SDG 13), zero hunger (SDG 2), good health and wellbeing (SDG 3) and clean water and sanitation (SDG 4).

The Safeguard assessment is summarized in the following table:

Risk Area	Potential Risks	Mitigation Measures (safeguards)	Likelihood
Non-Discrimination, Gender equality, Inclusion & Freedom of Expression	Exclusion of marginalized groups	Broad eligibility; outreach; continuous monitoring	Negligible
Labour, Child Rights & Equal Opportunity	Child labour, unfair practices	Adheres to law; anti-harassment policies; grievance mechanism	Negligible
Corruption & Governance	Resource misallocation, fraud	Financial controls; audits; digital traceability	Minor
Privacy & Data Security	Data misuse or breaches	Restricted use; incident response plan	Minor
Occupational Health & Safety	New operational risks	No complex new technologies required; feedback loops	Negligible
Cultural Heritage & Practices	Impact on traditional practices and local identity	AWD adapts existing rice farming; no significant cultural loss expected	Negligible
Economic & Livelihoods	Yield, income risks	Monitoring; financial incentives; support platforms	Minor
Programme Governance, Participation & Communication	Poor communication, lack of transparency, insufficient engagement	Routine stakeholder engagement; effective communication tools; annual review of feedback mechanisms	Negligible
Water quality & accessibility	Water disruption	Coordination with authorities; adaptive management; AWD practices reduce water usage	Negligible (Positive)
Soil quality	Soil changes	Promotion of sustainable practices	Negligible (Positive)
Air Quality	Increased machine use and Residue burning	Training on avoid use of heavy machineries; Discourage burning; Reduce CH_4 emissions	Negligible (Positive)
Biodiversity	Biodiversity impacts	AWD support ecosystem services	(Positive)

This Environmental and Social Risk Assessment demonstrates that the AWD programme in Thailand developed under the framework of the Article 6 of the Paris Agreement and the bilateral agreement between Switzerland and Thailand, as structured in the Mitigation Activity Design Document, is well-aligned with international best practices and does not generate significant negative impacts. Minor negative impacts are further mitigated by the safeguards in place. The programme includes robust safeguards, transparent monitoring, and strong stakeholder engagement, ensuring that AWD implementation not only reduces greenhouse gas emissions but also delivers social, economic, and environmental co-benefits for Thai rice farmers and their communities.