Leveraging Green Loans to Support Thai Farmers' Transition to Climate-Smart Technologies

Content referenced and adapted from the study report titled 'BAAC's Green Loan/Credit Portfolio Improvement to Enhance Financial Access to Climate Smart Technology'.

In collaboration with

Disclaimer

This report references and adapts content from the study titled **'BAAC's Green Loan/Credit Portfolio Improvement to Enhance Financial Access to Climate Smart Technology',** conducted by a research team from the Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University. All data, facts, figures, and statements presented in this report reflect the situation as of September 2025 and may be subject to future changes.

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Table of Contents

List of Abbriviation

AWD	Alternate Wetting and Drying
BCG	Bio-Circular-Green Economy
BMZ	The German Federal Ministry for Economic Cooperation and Development
CB	Certification Bodies
CST	Climate Smart Technology
DSR	Dry Direct Seeded of Rice
FWM	Farm-level Water Management
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
IPM	Integrated Pest Management
LLL	Laser Land Levelling
RCS	Rice-based Cropping System
RVI	Rice Variety Identification
SNM	Soil Nutrient Management
SRP	Sustainable Rice Platform
SSM	Straw and Stubble Management
TAS	Thai Agricultural Standard
WFAS	Weather Forecast Advisory Services
BAAC	Bank for Agriculture and Agricultural Cooperatives
BoT	Bank of Thailand

Background

Climate change trends have a direct impact on the productivity, income, and economic stability of Thai farmers, particularly within the rice sector, which is one of the country's most important agricultural industries. Within this context, the financial sector plays a crucial role in developing and enhancing environmentally friendly financial products (Green Finance) to support farmers in adapting to climate risks and strengthening their capacity to respond sustainably.

The study titled 'BAAC's Green Loan/Credit Portfolio Improvement to Enhance Financial Access to Climate Smart Technology' was conducted through a collaboration between BAAC and the AgriCRF Project (Developing Agricultural Financial Instruments for Climate Adaptation in ASEAN), supported by the German Federal Ministry for Economic Cooperation and Development (BMZ), and the ISRL Project (Integrated Sustainable Rice Landscapes), supported by the Global Environment Facility (GEF) and BMZ. Both projects are implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ commissioned a research team from the Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University, to carry out this study with the following objectives:

1. To review concepts and international case studies on green finance that have successfully supported farmers in adapting to climate change;
2. To analyze the overall landscape of green finance in Thailand's agricultural sector;
3. To assess the financing needs of farmers and agricultural service providers in order to identify opportunities for developing and expanding access to green financial products suited to local contexts.

The findings of this study aim to propose approaches and criteria for developing effective green financial products that respond to farmers' needs, support the adoption of Climate-Smart Technology (CST) in agriculture, and contribute to long-term sustainability for the country's economy and environment.

Study Scope

The study employed a combination of desk research and a review of relevant literature, as well as in-depth interviews with key stakeholders involved in green finance and the application of CST technologies in rice production. These stakeholders included the Bank of Thailand (BOT), the Fiscal Policy Office (FPO), the Stock Exchange of Thailand, the Bank for Agriculture and Agricultural Cooperatives (BAAC), various commercial banks, the Rice Department, the Land Development Department, the Royal Irrigation Department, Kasetsart University, agricultural machinery companies, and carbon measurement companies.

In addition, field interviews were conducted in three provinces: Suphan Buri (Doem Bang Nang Buat District and Nong Ya Sai District), Ubon Ratchathani (Trakan Phuet Phon District and Warin Chamrap District), and Chiang Rai (Mae Chan District and Wiang Pa Pao District). Respondents included farmers, leaders of farmer groups, rice traders, local government agencies such as Provincial Agriculture Offices, Rice Research Centers, Rice Seed Centers, and BAAC provincial and branch offices, as well as rice mills.

A total of 150 farmers were interviewed across the three study provinces, with 50 samples per province (25 samples per district). The collected data were used to support the study's analysis.

Concepts and Case Studies on the Development and Application of Green Finance in Other Countries

1. Green Finance Concepts in the Agricultural Sector

Green finance for the agricultural sector refers to all types of financial resources directed toward the agriculture and food sector with the objectives of:

- Enhancing the efficient use of resources (water, soil, and natural resources);
- Supporting the adoption of climate-smart technologies to ensure environmental sustainability; and
- Improving the quality and safety of agricultural food products.

2. Case Studies on Credit, Green Credit and Finance Products from Other Countries

Agribank Vietnam: Agribank implements special loan programs to promote clean agriculture by offering financial incentives through reduced interest rates of 0.5–1.5 % per year. In addition, there are large-scale special credit programs jointly undertaken with the Ministry of Agriculture and Rural Development (MARD), which serve as key examples of financial support for sustainable agriculture.

These programs aim to develop one million hectares of high-quality and low-carbon rice fields. Agribank provides special credit support across all stages of the value chain—from cultivation, procurement, and processing to the consumption of high-quality, low-carbon rice. Target beneficiaries include individual farmers, farming households, farmer groups, cooperatives, cooperative unions, and private-sector entities.

Rabo Foundation and Pandawa Agri Indonesia (PAI) Indonesia: This collaboration brings together the Rabo Foundation—which provides low-interest revolving funds to smallholder farmers—and Pandawa Agri Indonesia (PAI), an agricultural bioscience company. PAI offers comprehensive, science-based support to farmers, covering all stages from planting and crop management to harvesting, and also connects farmers with processors to promote the marketing of high-quality rice.

This partnership enables farmers to access working capital, technical support, and stable market opportunities. In addition, the Rabo Foundation has facilitated cooperation between PAI and Indonesia's Asuransi Central Asia (ACA) to provide agricultural insurance services to farmers, thereby enhancing security and reducing risks in agricultural production.

Rabobank, The Netherlands: Rabobank has implemented the pilot program 'Planet Impact Loan,' which aims to promote environmentally friendly agricultural practices by offering interest rate discounts to dairy farmers based on their scores from the Biodiversity Monitor assessment tool. The program is a collaboration between Rabobank and Dutch dairy product companies, designed to incentivize farmers to adopt production methods aligned with environmental conservation principles. Farmers who achieve high assessment scores receive financial benefits through lower loan interest rates, as well as premium prices for raw milk sold to participating dairy companies.

Rentenbank, Federal Republic of Germany: Rentenbank has identified a set of "Future Areas" -priority development pathways that merit enhanced support and innovation. These include efficient irrigation systems, initiatives that promote the participation of next-generation farmers -particularly women, the expansion of regional food production, the application of agrivoltaic systems (solar energy in agriculture), environmentally friendly farming practices, the transition toward agroecological systems, as well as the promotion of integrated farming and agricultural processing. In addition, loans under this program receive supplementary support in the form of interest subsidies.

Green Microfinance in Nicaragua, the ECOMICRO Project, and the FONDESURCO Project in Peru: These initiatives provide microcredit services along with technical assistance.

3. Overview of Green Finance in Thailand

Thailand is undergoing a transition toward environmentally sustainable development. The Bank of Thailand (BOT) has outlined a sustainability direction that integrates environmental considerations into the business operations of financial institutions, including the development of the Thailand Taxonomy as a reference standard for environmentally friendly economic activities.

For the **agricultural sector, Taxonomy** provides sustainable farming guidelines that are internationally recognized as effective in reducing greenhouse gas emissions. These guidelines are categorized **into 'tiers'** as follows:

- **Basic practices** such as alternate wetting and drying (AWD) water management in rice fields, efficient water resource management, appropriate pest and disease control, and crop rotation;
- **Intermediate practices** such as planting drought- and heat-tolerant, short-duration rice varieties, laser land leveling, and direct seeding;

- **Advanced practices** such as sustainable straw and stubble management and the provision of agro-meteorological advisory services.

These guidelines support farmers in developing production practices that align with the potential and conditions of their local areas, while connecting with national and international standards. The framework does not require all activities to be certified immediately; instead, it enables farmers and agricultural enterprises to gradually adapt and progress toward certification over time.

Implementation under the Thailand Taxonomy will enhance the sustainability of agriculture nationwide and serve as a critical foundation for designing and developing green loan products that align with farmers' practices across different levels.

Overview of Rice-Related Loans and BAAC's Green Loan Products Supporting the Advancement of Climate-Smart Production Technologies (CST)

1. Overview of BAAC's Loan Portfolio Related to Rice Production

Structure of the BAAC's Total Loan Portfolio Classified by Rice Production Segments: The composition of the BAAC's loan portfolio highlights the pivotal role of the rice production sector within Thailand's agricultural credit system. Loans associated with rice production continue to account for a substantial share approximately 27 % of total loan disbursements in fiscal year 2024. This proportion has shown a steady upward trajectory compared with other categories of agricultural lending. The trend aligns with the increasing demand for financing to support rice cultivation and to enhance the quality of rice products in a market that places growing emphasis on standards, sustainability, and value-added agricultural commodities.

Table 1: Annual Loan Disbursements and Outstanding Principal Classified by Fiscal Year (FY 2023 – 2025)

Item	Fiscal Year		
	2023	2024	2025
% of loan disbursements for rice production relative to total loan disbursements	26	27	29

Note: Data for FY 2025 as of 30 June 2025. | Source: BAAC (2025).

At present, farmers are increasingly shifting toward the cultivation of high-quality rice varieties, such as Jasmine rice, which offer higher added value and stronger market demand. In contrast, the cultivation of general white rice has begun to decline. This shift reflects the ongoing development and adaptability of Thai farmers in response to economic trends and evolving consumer preferences.

Loan Provision for Rice-Related Activities: Between FY2023 and FY2025, loan disbursements across all rice categories show a clear upward trend. This growth reflects rising production costs as well as increased investment in technologies, machinery, and more efficient production processes. Such investments aim to enhance product quality and strengthen farmers' livelihood security.

Loan Quality within the Rice Production Portfolio: Overall, loan performance remains strong. Most farmers are able to meet their repayment obligations, contributing to the stability of agricultural credit systems and supporting a continued improvement in portfolio quality. This indicates the resilience of Thailand's rice production sector and underscores the important role of BAAC in supporting sustainable growth among rice farmers.

2. Overview of BAAC's Green Credit Portfolio

BAAC has actively promoted and supported green credit as well as credit schemes under the Bio-Circular-Green Economy (BCG) framework to drive the 20-Year National Strategy toward sustainable development and to help Thailand achieve its carbon neutrality target by 2050.

These initiatives aim to enhance national competitiveness, strengthen the resilience of the grassroots economy in line with the BCG economic model, and support BAAC's strategic direction to develop community capacity through integrated approaches that foster sustainable economic security at the local level.

Under this framework, BAAC has implemented the BCG Model Credit Promotion Program with a total credit line of 35 billion baht, serving farmers, the general public, entrepreneurs, farmer groups, community enterprises, and agricultural cooperatives. The credit products are categorized into three main groups:

1. **Bio Economy Credit (B)** Designed to promote the use of knowledge and biotechnology innovations to enhance production capacity and add value across agriculture, food, health, medical science, and energy sectors, with an emphasis on efficiency and sustainability.
2. **Circular Economy Credit (C)** Supports efficient resource use and aims to minimize waste generation—ideally achieving zero waste—through reuse, recycling, and value creation from agricultural residues. The goal is to promote employment, increase income, and improve the quality of life for farmers and entrepreneurs, enabling them to remain competitive both within and beyond the agricultural sector.
3. **Green Credit (G)** Focuses on supporting organic agriculture, safe food production, adoption of alternative and clean energy, and conservation of natural resources and the environment. It also promotes cultural preservation and community livelihoods, helping to increase income, improve well-being, and meet market demands that increasingly prioritize health and sustainability.

Under the BCG Model Credit Program, BAAC has established clear guidelines regarding loan purposes, borrower eligibility, lending conditions, repayment periods, interest rates, and collateral requirements. These measures are designed to ensure alignment with the objectives of driving grassroots economic development in accordance with the BCG framework in a concrete and sustainable manner.

Trends in Green Lending for Rice Production under BAAC

As of the end of the 2025 fiscal year, the cumulative loan disbursement under green credit schemes for rice production reached 5.2-million-baht, accounting for 0.01 % of total cumulative loan disbursements in rice-production programs and 0.002 % of the Bank's overall cumulative loan disbursements for the same year. This indicates that the proportion of green credit accessed by rice farmers remains at an early stage.

However, access to green financing among farmers has shown a clear upward trend. As of 30 June 2025, cumulative green-credit disbursement increased significantly to 841 million baht, representing 1.17 % of total cumulative disbursements for rice-production loans and 0.34 % of the Bank's overall cumulative disbursements. This reflects growing awareness and preparedness among farmers to transition toward environmentally friendly agricultural practices and highlights the strong potential for continued expansion of green lending in the future.

"Green-credit disbursement increased more than 160-fold in 2025, demonstrating a pronounced growth trend and reflecting farmers' transition toward sustainable agriculture."

3. Analysis of the Application of Climate-Smart Technologies (CST) in Rice Production

This study analyzes the application of Climate-Smart Technologies (CST) in rice production, covering ten core technologies aligned with the Agriculture Section of the Thailand Taxonomy. The adoption of these technologies generates positive impacts across multiple dimensions, including economic performance, enhanced resilience to climate variability, environmental conservation, and reductions in greenhouse gas emissions.

Despite these benefits, the uptake of CST among rice farmers remains constrained by several factors. Key limitations include high investment costs, uneven access to technology across regions, and the need to strengthen farmers' knowledge and digital skills. These constraints are summarized in Table 2.

Table 2 : Benefits and Limitations of Applying Climate-Smart Technologies (CST)

Technology	Economic Benefits	Climate Adaptation	Environmental Benefits	Key Limitations
WFAS (Weather Forecast Application Systems)	▪ Increased rice yield ▪ Improved efficiency of chemical fertilizer use ▪ Improved grain moisture quality	Reduces risks of yield loss due to natural disasters, pests, and diseases	Reduces chemical use	▪ Elderly farmers require support from younger family members ▪ Lack of linkage with mechanized harvesting service providers ▪ 30-day weather forecasts have limited accuracy
FWM (Farm-level Water Management)	Higher yield and income during dry seasons	Reduces risks from drought and flooding	Reduces water loss	▪ High implementation cost ▪ Effectiveness depends on land suitability and available area
RVI (Use of Climate-Resilient Rice Varieties)	Earlier harvest and reduced water use	Reduces risks from natural hazards and pest outbreaks	▪ Reduces water use ▪ Reduces methane emissions	▪ Limited availability of climate-tolerant, officially certified varieties ▪ Some mills do not accept certain varieties
LLL (Laser Land Levelling)	▪ Reduces pumping cost by 30% ▪ Increases yield by 15–30%	Reduces risks from uneven water distribution that may cause crop diseases	Reduces water and energy use	▪ High investment cost ▪ Difficult to apply on sloped or uneven terrain ▪ Limitations in sandy soils
DSR (Dry Seeded Rice)	▪ Reduces seed rate from 15–25 kg/rai to 5–10 kg/rai ▪ Increases yield by approx. 15%	Wider plant spacing produces stronger seedlings	Reduces methane emissions by 30–70% (Rice Science Centre)	▪ Limited access to seed-drill machinery ▪ Requires adequate water and strong weed control
IPM (Integrated Pest Management)	Reduces chemical costs by 20–50%	Reduces pest-related risks	▪ Requires time to observe results ▪ Labor-intensive ▪ Requires knowledge in mixing bio-agents effectively	▪ Requires time and labour investment ▪ Farmers need technical knowledge for effective formulation of bio-agents

Technology	Economic Benefits	Climate Adaptation	Environmental Benefits	Key Limitations
AWD (Alternate Wetting and Drying)	▪ Increases yield by 15–40% ▪ Reduces water use by 30% ▪ Reduces pest control costs by 250 THB/rai	Reduces lodging risk	▪ Reduces water use by 40% ▪ Reduces GHG emissions by 30–50% (highly effective when combined with LLL)	▪ Requires reliable irrigation system ▪ Farmers lack knowledge for proper AWD implementation
SNM (Soil Nutrient Management)	▪ Reduces fertilizer cost by 387–460 THB/rai ▪ Increases yield by 11–50%	Reduces risks from nutrient imbalance that weakens plants against pests, diseases, drought, or flooding	Reduces nitrous oxide emissions	▪ Farmers lack knowledge of proper soil sampling ▪ Shortage of technicians to perform soil testing ▪ Requires a large number of samples for accuracy; laboratory testing takes time
SSM (Straw and Stubble Management)	▪ Reduces fertilizer cost through straw incorporation ▪ Net profit from incorporation approx. 250 THB/rai ▪ Additional income from selling straw	Increases soil organic matter, improving water retention and reducing damage from irregular rainfall	▪ Reduces burning ▪ Reduces PM2.5 ▪ Reduces nitrous oxide emissions from lower fertilizer use	▪ Limitations of incorporation: slow decomposition, some farmers burn to control diseases or weedy rice ▪ Limitations of baling: requires dry straw and adequate storage facilities
RCS (Rice-Centred Cropping Systems / Crop Rotation)	▪ Reduces fertilizer requirement for next rice crop ▪ Provides supplemental income from rotational crops	▪ Reduces risk of water shortages during dry-season rice cropping ▪ Breaks pest and disease cycles	▪ Reduces nitrous oxide emissions (especially with legumes) ▪ Reduces dry-season water use (for low-water crops)	▪ Limited availability of seeds for post-rice or green manure crops ▪ Labor shortage ▪ Water scarcity where no supplementary water source is available

4. Integration of Climate-Smart Technologies (CST) and Innovation to Enhance Rice Production Efficiency

The Bank for Agriculture and Agricultural Cooperatives (BAAC) supports the adoption of Climate-Smart Technologies (CST) throughout the rice production value chain to enhance productivity, reduce costs, and minimize environmental impacts. The integration of CST with complementary innovations or advanced production techniques strengthens the sustainability of rice farming and improves farmers' capacity to cope effectively with changing climatic conditions. The key elements are summarized as follows:

Table 3 : Summary of the Integration of CST and Complementary Innovations to Enhance Rice Production Efficiency

CST Technology	Primary Application	Complementary Innovations / Techniques	Benefits of Integrated Use
WFAS (Weather Forecasting for Agriculture System)	Utilizes advanced weather forecasts, such as rainfall, temperature, and humidity to support crop-planning decisions.	Meteorological data-analysis applications; variety-specific cropping calendars; temperature and humidity sensors.	Reduces risks of crop loss from atypical weather; lowers production costs; enhances accuracy of cultivation planning.
FWM (Field-Level Water Management)	Designs efficient water inflow–outflow systems, including farm ponds, groundwater wells, or solar-powered pumping.	Solar-powered water-pumping systems in combination with AWD (Alternate Wetting and Drying).	Reduces water and energy use; improves flexibility in water management during dry seasons.
RVI (Resilient Variety Identification)	Selects rice varieties tolerant to drought, flood, pests, and diseases.	Collaboration with rice research centres and local milling facilities.	Improves yield quality, enhances climate resilience, and increases market competitiveness.
LLL (Laser Land Levelling)	Uses laser-guided technology to level paddy fields with high precision.	Thermographic surveys; AWD, SNM (Site-Specific Nutrient Management), and IPM (Integrated Pest Management).	Ensures uniform distribution of water and fertilizers; reduces pest incidence; lowers carbon emissions.
DSR (Dry Direct Seeding)	Sows dry rice seeds directly into the soil.	Conducted after LLL or land preparation; uses seed-drilling machines and IPM practices.	Reduces labour costs; conserves water; improves weed control.

CST Technology	Primary Application	Complementary Innovations / Techniques	Benefits of Integrated Use
IPM (Integrated Pest Management)	Combines biological and natural control methods to minimize chemical pesticide use.	Drone-based field monitoring; NDVI-based applications for pest and disease diagnostics.	Enables precise pest control; minimizes environmental impact.
AWD (Alternate Wetting and Drying)	Alternates irrigation with deliberate dry periods during rice cultivation.	Automated water-level sensors; implemented alongside LLL.	Reduces water use; increases precision in irrigation; lowers methane emissions.
SNM (Site-Specific Nutrient Management)	Analyzes soil conditions to apply fertilizers tailored to field-specific needs.	Soil-analysis applications; WFAS; biofertilizers (e.g., PPD 12, 7, 14); combined with AWD, LLL, and RCS.	Enhances fertilizer efficiency; reduces nutrient runoff; increases yields while lowering production costs.
SSM (Straw and Stubble Management)	Incorporates, composts, or compacts rice straw for reuse after harvest.	Decomposition accelerators (e.g., PPD 2 and 17); straw spreaders or pelletizing machines.	Shortens decomposition time; improves soil health; reduces transportation costs.
RCS (Rotational Cropping Systems)	Cultivates low-water-demand crops, such as mung bean or sun hemp after the rice season.	Implemented alongside FWM and use of plant residues as mulch.	Enhances soil fertility; reduces chemical fertilizer use; increases off-season income.

5. Appropriate Technologies for Smallholder Farmers

Insights gathered from a stakeholder consultation held on 21 August 2025 indicate that several climate-smart technologies offer high cost-effectiveness and are particularly suitable for smallholder farmers. These technologies support increased productivity, reduced production costs, and lower greenhouse gas emissions. The key recommendations are summarized below.

Recommended Technologies for Smallholder Farmers	Primary Benefits
FWM	Enhances efficient water management and reduces reliance on rainfall.
SNM	Improves fertilizer-use efficiency and reduces production costs.
AWD	Conserves water and reduce methane emissions.
WFAS	Enables accurate crop-planning based on localized weather conditions.
RVI	Strengthens rice resilience to climatic variability and responds to market demand.

Supporting farmers in accessing credit for the adoption of Climate-Smart Technologies (CST), together with appropriate innovations and complementary techniques, enhances the overall efficiency of rice production in Thailand across economic, environmental, and social dimensions. These technologies enable farmers to reduce production costs, increase yields, and better cope with climate variability. Such an approach is essential for advancing Thailand's agricultural sector toward long-term sustainability in alignment with the BCG economic model.

6. Application of CST Across the Rice Production Cycle

The use of Climate-Smart Technologies (CST) varies across different stages of rice production, reflecting the diverse conditions and needs of each locality. Prior to cultivation, farmers tend to focus on water management, soil analysis, and selecting climate-resilient rice varieties. During the planting phase, technologies that reduce water and fertilizer use, such as Alternate Wetting and Drying (AWD) and Site-Specific Nutrient Management (SNM) are commonly employed, alongside Integrated Pest Management (IPM) to reduce chemical dependence. For the harvesting and post-harvest stages, emphasis is placed on straw management and crop rotation to minimize waste and enhance long-term sustainability.

Despite these advances, limitations remain in terms of cost, technological access, knowledge, and data availability. Continued support from both the public and private sectors is therefore essential to ensure broader adoption and long-term effectiveness.

Table 4: Summary of Climate-Smart Technology (CST) Applications Across Rice Production Stages

Production Stage	CST Applied	Farmer Application Practices	Key Constraints
Pre-production	FWM	Improving field bunds; installing water-delivery systems such as solar-powered pumps	High investment cost; unsuitable terrain; limited water sources
	SNM	Conducting soil tests and applying fertilizers based on recommended nutrient requirements	Most farmers do not conduct soil testing; limited knowledge and budget
	WFAS	Using weather information from public channels and mobile applications to plan cultivation	Difficulty using applications; limited forecasting accuracy
	LLL	Levelling fields to reduce waterlogging and improve fertilizer efficiency	High capital requirement; suitable mainly for large landholdings
	RVI	Selecting drought-tolerant, flood-tolerant, or high-yield varieties	Limited access to certified varieties; some varieties do not match market demand
Planting Stage	DSR	Direct seeding to reduce labour and water use	Requires effective weed control and proper soil moisture
	AWD	Using PVC tubes to monitor water levels and regulate irrigation intervals	Requires shared water systems and well-levelled fields
	SNM	Applying site-specific fertilizer formulations to reduce costs	Limited availability of base fertilizers, mixing tools, and diagnostic equipment
	IPM	Using biocontrol agents and ecological methods to reduce chemical pesticide use	Results take time; labour-intensive; insufficient knowledge among farmers
Harvest Stage Post-harvest	SSM	Incorporating straw, composting, or baling for reuse	Insufficient machinery, decomposition enhancers, and storage facilities
	RCS	Planting low-water crops such as mung bean, sun hemp, or maize to improve soil fertility and generate off-season income	Limited seed availability, water sources, labour, and market support

7. Promoting Access to Climate-Smart Technology (CST) Financing: Impacts on Reducing Production and Market Risks and Enhancing Farmers' Repayment Capacity

Reducing Production Risks: The study finds that farmers who accessed credit to adopt three or more CST technologies demonstrated significantly higher resilience to production risks compared with those adopting fewer than three technologies, with statistical significance at the 95% confidence level.

Among farmers adopting three or more CSTs, the most commonly used technology was **Alternate Wetting and Drying (AWD)**, followed by **Soil Nutrient Management (SNM)**, **Weather Forecasting for Agriculture (WFAS), Laser Land Leveling (LLL)**, and **Farm-level Water Management (FWM)**. These farmers experienced an average yield reduction of only 29 % during periods of natural disasters or pest outbreaks, compared with a 45 % reduction among farmers using fewer than three technologies. This demonstrates that integrated CST adoption effectively mitigates production uncertainties and enhances farmers' ability to withstand climatic shocks.

Reducing Market Risks: Promoting green credit linked to quality-assured market systems, including rice mills or buyers adhering to TAS or GAP standards, creates incentives for farmers to produce higher-quality rice. Certified products can access better price opportunities, contributing to more stable and sustainable farm incomes. This approach serves as a mechanism to reduce price volatility risks in the agricultural sector. However, the current domestic market for GAP-certified rice does not yet provide a clearly defined premium pricing mechanism. Meanwhile, the National Bureau of Agricultural Commodity and Food Standards (ACFS) is in the process of preparing certification frameworks for Sustainable Rice Platform (SRP) and TAS standards to advance national high-quality rice production.

In-depth interviews with rice mill operators in Ubon Ratchathani Province indicate a growing interest in offering a bonus of 100 THB per ton to farmers who adopt CST and implement variety purification to enhance the quality of Jasmine rice. Some mills also expressed plans to pursue SRP certification.

However, credit provision alone may be insufficient without parallel efforts to strengthen market linkages with rice mills and to encourage farmers to form groups in order to obtain group-based TAS certification. Such collective certification can help reduce auditing costs and ensure an adequate volume of paddy that meets sustainability standards for mill processing. In addition, support for monitoring and certification processes is essential. Therefore, the design of green credit schemes should be integrated with a sustainability-oriented market system to ensure stable and long-term income for farmers.

Farmers' Debt Repayment Capacity: An assessment of farmers' debt repayment capacity, measured by the ratio of total debt obligations to net farm income, indicates that farmers who adopted 0–2 types of CST technologies exhibited significantly higher debt-to-income ratios than those who adopted three or more technologies. The differences are statistically significant at the 99% and 90% confidence levels, respectively.

These findings indicate that access to credit for investing in climate-smart technologies not only helps reduce production and market risks but also has a positive long-term impact on farmers' income-generating capacity and their ability to service debt.

Green credit facilities offered by the Bank for Agriculture and Agricultural Cooperatives (BAAC), financed either through Green Bond proceeds or the bank's own funding sources, are primarily intended to support sustainable agricultural activities and agriculture-related enterprises. Loan approval is based on the stated purpose of borrowing, which must fall within one or more of the following areas:

1. Promotion of organic agriculture or safe food production.
2. Promotion of alternative, renewable, or clean energy.
3. Promotion of natural resource and environmental conservation.

For green credit financed by the bank's internal funds, additional objectives include:

- Promotion of arts, culture, and community heritage; and
- Promotion of initiatives to reduce fine particulate matter (PM2.5).

In this context, the use of credit to adopt Climate-Smart Technologies (CST) is considered fully aligned with the core objectives of green credit.

For individual farmers or farmer groups applying for green credit supported by the bank's internal funds, an interest rate of MRR–1 is offered if the borrower has obtained certified production standards or has completed relevant training provided by government agencies. This requirement serves as an important mechanism for expanding farmers' access to green credit.

However, certification systems, such as organic standards or sustainable rice standards (SRP, TAS) still pose challenges due to relatively high certification costs, and the TAS standard has not yet been widely implemented.

Findings from the study indicate that **only a small proportion of farmers currently hold production certifications, and interest in obtaining GAP or sustainable rice certification remains limited**, except in Suphan Buri Province, where farmers show markedly higher interest in sustainable rice standards compared to other areas. Furthermore, survey results from the three study provinces reveal **strong demand among farmers for technical training, particularly in soil and fertilizer management, rice straw management, and Alternate Wetting and Drying (AWD)** ; all key CST technologies directly linked to sustainable rice production standards (e.g., SRP and TAS) and to eligibility criteria for green credit.

Strengthening integration among government agencies, such as the Department of Agricultural Extension and the Royal Irrigation Department in delivering technical training, alongside promoting awareness of production standards and publicizing BAAC's green credit programs, can significantly enhance farmers' understanding and awareness. Such coordinated efforts will support a broader transition toward sustainable rice production

Analysis and Recommendations: Green Loans and the Scaling Up of Green Financing for Rice Farmers

1. Credit Demand Among Rice Farmers in the Study Areas

Credit demand: Survey results indicate that most rice farmers require credit primarily as working capital for agricultural production. The highest proportion of farmers expressing a need for loans was found in Suphan Buri Province (54%), followed by Ubon Ratchathani (42%) and Chiang Rai (18%).

The desired loan amounts ranged from 5,000 to 250,000 baht for general working capital. Some farmers also expressed a need for loans to invest in on-farm water management (40,000–150,000 baht) and to purchase agricultural machinery (50,000–1,000,000 baht). Across all study areas, approximately 20 % of farmers indicated demand for credit specifically to support the adoption of climate-smart technologies (CST), particularly for purposes such as water management, land preparation services, and straw baling services.

Preferred interest-payment schedules: Farmers in Suphan Buri expressed preferences for annual or semiannual interest payments, whereas farmers in Ubon Ratchathani and Chiang Rai preferred annual payment schedules exclusively.

Table 5. Number of Sample Farmers by Credit Needs for the Upcoming Production Season

Credit Needs	Suphan Buri	Ubon Ratchathani	Chiang Rai
No credit needed	23 farmers (46%)	29 farmers (58%)	41 farmers (82%)
Credit needed	27 farmers (54%)	21 farmers (42%)	9 farmers (18%)
Working capital*	24 farmers (48%)	13 farmers (26%)	8 farmers (16%)
Desired loan amount	THB 10,000 –200,000	THB 5,000–250,000	THB 30,000 –100,000
▪ Land preparation services	19 farmers (79%)[1]	10 farmers (77%)[1]	7 farmers (78%)[1]
▪ Harvesting services	21 farmers (88%)[1]	6 farmers (46%)[1]	6 farmers (75%)[1]
▪ Purchase of rice seed	20 farmers (83%)[1]	5 farmers (38%)[1]	6 farmers (75%)[1]
▪ Purchase of chemical fertilizers/inputs	21 farmers (88%)[1]	5 farmers (38%)[1]	4 farmers (50%)[1]
▪ Straw incorporation services	10 farmers (40%)[1]	2 farmers (15%)[1]	6 farmers (75%)[1]
▪ Straw baling services	–	5 farmers (38%)[1]	–
▪ Purchase of perennial tree seedlings	–	4 farmers (31%)[1]	2 farmers (25%)[1]
Water management*	3 farmers (6%)	5 farmers (10%)	–
Desired loan amount	100,000–150,000 baht	40,000–100,000 baht	–
Purpose*	Solar-powered irrigation	Water conveyance systems; pond / reservoir construction	–
Machinery purchases*	–	3 farmers (6%)	2 farmers (4%)
Desired loan amount	–	50,000–1,000,000 baht	THB 50,000 –300,000
Purpose	–	Purchase of tractors	Tractors and disc plows
Preferred repayment schedule	▪ Annual (56%) ▪ Semi-annual (44%)[2]	▪ Annual (100%)	▪ Annual (89%) ▪ Semiannual (11%)[2]

Notes:

* A single farmer may report more than one loan objective.

[1] % of farmers expressing demand for working-capital loans.

[2] Farmers cultivating rice twice per year.

Key incentives that encourage farmers to adopt Climate-Smart Technologies (CST) include access to premium rice prices, secure market outlets, low-interest credit, and public support for on-farm water management systems. Among these, low-interest credit emerged as a particularly effective motivator for CST adoption in Ubon Ratchathani Province. However, to ensure long-term and sustainable impacts, such financial incentives should be complemented by the development of reliable markets for low-carbon rice, the establishment of fair and attractive pricing mechanisms, and continued investment in water-management infrastructure to enhance production efficiency over the long term.

Linking credit demand with farmers' debt-servicing capacity shows that most farmers in Suphan Buri and Ubon Ratchathani who expressed interest in CST-related loans have strong repayment histories. They generally repay both principal and interest on schedule, typically using farmland as collateral. Their average rice-growing area ranges from 24 to 30 rai, and between 31% and 73% of these farmers have a debt-service-to-net-farm-income ratio below 40%, which falls within the safe threshold established by the Bank of Thailand. These findings indicate that the majority of farmers possess sound financial capacity and effective debt-management practices—factors that are essential to expanding access to financial resources for the long-term development and upgrading of sustainable agricultural production systems.

2. Options for Verifying the Actual Use of Climate-Smart Technologies (CST)

Table 6: Opportunities and Constraints of Various Verification Options for CST Adoption

Verification Option	Opportunities	Constraints
Certification under Sustainable Rice Production Standards	▪ The National Bureau of Agricultural Commodity and Food Standards (ACFS) is promoting collaboration to link farmers certified under TIS 4408-2565 with millers and exporters operating under the Sustainable Rice Platform (SRP). This aims to reduce farmers' certification costs for SRP-compliant fields and enable the use of both TAS and SRP certification marks, thereby enhancing international recognition.	▪ Farmers are often reluctant to change production practices or apply for certification due to complex procedures and paperwork. ▪ There is a limited number of qualified auditors capable of assessing compliance with sustainable rice standards, constraining the scalability of certification efforts. ▪ Rice mills/exporters face high SRP membership fees, limiting smaller mills' ability to participate in SRP and to export rice carrying the SRP certification mark.
Issuance of Verification Documents by	▪ Academic institutions can deploy personnel to collect preliminary data to verify CST	▪ Risks of misconduct, such as improperly assisting farmers to obtain certification.

Verification Option	Opportunities	Constraints
External Organizations	adoption or compliance with sustainable rice standards.	▪ Fertilizer-use verification based on soil analysis results is technically difficult.
Farmer Progress Reports on Rice Production Plans	▪ Can be linked to ongoing programs that subsidize the adoption of CST.	▪ If farmers do not keep written records, they may be unable to recall details accurately, leading to data inconsistencies—particularly regarding fertilizer quantities and formulations used. ▪ In the absence of strong incentives, farmers may be unwilling to complete the required documentation.
Satellite Imagery to Verify AWD Practices and No-Burn Management	▪ Availability of private start-up companies offering satellite imaging services. ▪ GISTDA is piloting the use of satellite data to assess chlorophyll content and rice plant growth, which can indicate whether fertilizer application is excessive or insufficient.	▪ Cloud cover can obstruct imagery, and data inaccuracies may arise without field verification.

Each verification option for assessing the adoption of Climate-Smart Technologies (CST) offers distinct opportunities and faces different constraints. Therefore, a blended verification approach is recommended to ensure the accuracy and reliability of data. Low-cost satellite imagery may be utilized to verify practices such as Alternate Wetting and Drying (AWD) and no-burn residue management, in combination with ground-truth surveys, farmer progress reports, and data collection or verification conducted by technically qualified academic institutions in the area.

In addition, BAAC may consider developing user-friendly reporting forms or mobile applications to record rice-growing activities and allow farmers to upload photographic evidence of actual practices. BAAC could also take on a role as an “agricultural coach,” working alongside model farmers to strengthen learning and practical implementation. Financial incentives may be linked to progress reports and compliance with green credit requirements, thereby promoting efficient and sustainable rice production.

Table 7: Proposed Options for Developing Practical and Appropriate Verification Modalities

Verification Modality	Proposed Options
Certification under Sustainable Rice Production Standards	The National Bureau of Agricultural Commodity and Food Standards (ACFS) should promote the use of Thai Agricultural Standard TAS 4408-2022 in conjunction with the Sustainable Rice Platform (SRP) Standard, and further develop domestic certification bodies to serve as SRP auditors. This would help reduce certification costs and enhance international recognition. In addition, a central organization at the provincial or inter-provincial level could apply for SRP membership and certification on behalf of farmers to share membership and certification expenses.
Issuance of Certification Documents by External Agencies	Utilize academic institutions with relevant expertise and technical capacity to collect data and verify compliance with sustainable rice production standards. This should be complemented by digital or blockchain-based verification systems to reduce the risk of fraud.
Progress Reporting on Rice Production Plans	▪ Develop user-friendly reporting forms or mobile applications for rice cultivation that enable farmers to record fertilizer and water use, along with uploading photographic evidence of actual farming practices. ▪ BAAC should serve as agricultural coaches or mentors in collaboration with model farmers. ▪ Establish financial incentives by linking progress reports on rice production plans to the approval of green credit.
Use of Satellite Imagery for Verification	Coordinate with GISTDA or satellite imaging technology firms to monitor the use of AWD technology and compliance with no-burn practices. Satellite-based verification may be combined with blockchain technology for validating uploaded images, along with random field inspections.

3. Monitoring and Evaluation

Approach to Monitoring the Loan Portfolio for Sustainability Assessment

The monitoring and evaluation framework for the Green Credit Scheme may be structured into two levels and stages, as follows:

- **Step 1: Collection of Baseline Information Prior to Signing the Green Loan Agreement**

  Baseline data should be collected before loan approval to serve as a reference for subsequent impact assessments. This process is carried out by the relevant BAAC provincial branches.

- **Step 2: Monitoring the Overall Performance of the Loan Portfolio**

The BAAC headquarters monitors overall loan disbursement and repayment, conducts loan portfolio segmentation to assess credit quality, and tracks risks related to repayment behavior, overdue debt, and the duration of delinquency. The efficiency of the loan portfolio is also evaluated based on net interest income.

In addition, overall project performance is monitored through indicators such as the number of farmers adopting climate-smart rice technologies (CST) and the cultivated area transitioning to these technologies, thereby reflecting the project's effectiveness in terms of economic outcomes and agricultural sustainability.

Approaches for Monitoring the Use of Loan Funds to Ensure Alignment with Intended Objectives (Implemented by BAAC Branch Offices)

Monitoring the use of loan funds by farmers is essential to ensure that expenditures align with the approved objectives. This process relies on supporting evidence such as payment receipts or documents verifying actual expenses, on-site inspections of agricultural plots, and the use of satellite imagery to assess the adoption of alternate wetting and drying (AWD) practices and the avoidance of crop residue burning.

In addition, a monitoring checklist is developed to summarize key steps in the adoption of ten key production technologies—for example, the use of weather forecasting data for agricultural planning, proper soil and seed preparation, appropriate fertilizer application based on crop requirements, and correct irrigation and crop management practices.

These guidelines aim to help farmers clearly understand each operational step, ensure correct and consistent implementation, and effectively track progress throughout the production cycle.

Approaches for Monitoring the Outcomes of Loan-Funded Activities (Implemented by BAAC Branch Offices)

Outcome monitoring focuses on assessing the results of loan utilization by comparing farmers' net income from rice production before and after adopting CST technologies. This enables an evaluation of the benefits gained from technology adoption. In parallel, branch offices monitor farmers' debt-servicing capacity and any changes in their agricultural assets or machinery, based on comparisons between baseline data and post-loan information.

Additionally, the development or adoption of **digital applications may be considered to track loan utilization and the implementation of production technologies**. Such tools could enhance data collection efficiency and be integrated with remote sensing technologies to reduce field-monitoring costs. Monitoring efforts should also capture indicators related to sustainability and farmers' capacity to adapt to climate change, ensuring that green credit support contributes to effective and long-term resilience in rice production.

Monitoring Sustainability and Climate Adaptation Capacity of Farmers (Implemented by BAAC Branch Offices)

Indicator	Monitoring Method
Reduction in water and seed use	Verification of receipts and field records; comparison of data before and after the adoption of CST.
Use of bio-fertilizers or organic fertilizers	Review of receipts and field documentation prior to and following CST implementation.
Reduction in chemical fertilizer and agrochemical use	Examination of purchase receipts and field logs; comparison of pre- and post-CST application data.
Crop diversification	Review of crop types and planting calendars to assess diversification or crop rotation practices before and after the use of CST.
Resilience to natural disasters and pest outbreaks	Analysis of yield variability (per rai) during years affected by drought, flooding, or pest incidents, comparing pre- and post-CST adoption.
Reduction in energy consumption	Verification of electricity and fuel expenditure receipts before and after CST implementation.
Reduction in greenhouse gas emissions	▪ Assessment using the Carbon Emission Score under ACFS guidelines ▪ Use of satellite imagery to observe farming practices influencing emission levels

Integrating Sustainable Agriculture Standards with the Monitoring System

The integration of sustainable agriculture standards into the monitoring framework—particularly for rice production under the Sustainable Rice Platform (SRP) and the Thai Agricultural Standard (TAS), which can be achieved through the following key approaches:

- **Adopting SRP or TAS indicators as monitoring criteria** : Incorporate relevant indicators from SRP or TAS into the credit monitoring and evaluation process to ensure alignment with sustainable agriculture principles.
- **Developing a "Sustainability Score" system** : Establish a scoring mechanism to assess farmers' performance against sustainability criteria. This score may serve as a basis for providing financial incentives, such as preferential interest rates, to farmers who achieve or exceed the required standards.
- **Using the SRP Assurance Scheme as an MRV mechanism :** Employ the SRP Assurance Scheme as a structured tool for Monitoring, Reporting, and Verification (MRV) in the implementation of green credit programs. This enhances transparency, accountability, and the credibility of the monitoring system.

4. Criteria for Selecting New Technologies for Integration into Green Credit Products

The selection of new technologies for integration into green credit products is based on three core components, comprising a total of six indicators, as follows:

1. **Production Efficiency** : Assessed through indicators such as yield per rai, soil fertility, water-use efficiency, and reductions in expenditure on chemical pesticides.
2. **Climate Resilience** : Evaluated by examining the robustness of crop production systems in adapting to changing climatic conditions.
3. **Climate Change Mitigation** : Determined by the technology's potential to enhance carbon sequestration and reduce carbon dioxide emissions.

The selection of CST technologies for green credit financing requires a structured assessment and scoring process based on the technology's potential to improve production efficiency, strengthen adaptive capacity to climate variability (climate resilience), and reduce the environmental footprint associated with rice production (climate mitigation).

Each indicator is scored on a three-point scale: –1, 0, and 1. The aggregate score is then used to evaluate the overall suitability of the technology. Technologies deemed appropriate for inclusion in green credit products should obtain a total score greater than 0, indicating a positive contribution relative to baseline conditions prior to adoption.

Table 8. Criteria for Selecting New Technologies to Be Integrated into Green Credit Products

Core Component	Sub-Component	Indicator	Scoring Criteria
Production Efficiency (Productivity)	Crop System	1. Increase in yield per rai (%) resulting from the technology	▪ Score = 1 if the %age increase exceeds the average yield growth over the past three years. ▪ Score = 0 if the %age increase is equal to the three-year average. ▪ Score = –1 if the %age increase is lower than the three-year average.
		2. Improvement in soil fertility attributable to the technology	▪ Score = 1 if soil fertility indicators improve relative to the year prior to adoption. ▪ Score = 0 if indicators remain unchanged. ▪ Score = –1 if indicators decline relative to the year prior to adoption.
	Water Use	3. Water savings, measured by the number of operating hours for pumping/irrigation	▪ Score = 1 if operating hours decrease from the year before adoption. ▪ Score = 0 if operating hours remain unchanged. ▪ Score = –1 if operating hours increase.
	Pest Management	4. Reduction in expenditure on chemical pesticides	▪ Score = 1 if expenditure decreases relative to the year prior to adoption. ▪ Score = 0 if expenditure remains unchanged. ▪ Score = –1 if expenditure increases.
Climate Resilience	Crop System	5. Resilience of the crop system to climatic stresses (e.g., drought, pests) compared with	▪ Score = 1 if Likert > 3. ▪ Score = 0 if Likert = 3.

Core Component	Sub-Component	Indicator	Scoring Criteria
		similar current practices (Likert scale 1–5)	▪ Score = –1 if Likert < 3.
Climate Change Mitigation	Carbon Sequestration	6. Relative potential of the technology to enhance carbon sequestration (Likert scale 1–5)	▪ Score = 1 if Likert > 3. ▪ Score = 0 if Likert = 3. ▪ Score = –1 if Likert < 3.
	Reduction of GHG Emissions	7. Reduction in greenhouse gas emissions (calculated from input/output data using the TAS methodology)	▪ Score = 1 if emissions decrease relative to the year prior to adoption. ▪ Score = 0 if emissions remain unchanged. ▪ Score = –1 if emissions increase.

Policy Recommendations for Scaling Up and Enhancing Access to Green Loans for Rice Production

1. Setting Proportional Targets for the Green Loan Portfolio

Currently, the proportion of rice-farming loans that qualify as "green loans" remains low compared to the total rice-farming loan portfolio. Therefore, clear and measurable proportional targets for green loans should be established. For example, within a 3-year period, the share of green loans in the rice segment should be increased to a specified %age. This will provide direction for driving sustainable lending practices and support the transition toward environmentally friendly agricultural systems.

2. Expanding Green Loans to the Rice Production Segment

The loan portfolio in the rice production sector demonstrates good performance, as reflected by a low level of overdue debt and strong potential for sustainable growth, given that total loan repayments exceed cumulative loan disbursements. **The rice varieties with outstanding performance include Pathum fragrant rice, various RD glutinous rice varieties, and jasmine rice. These groups show high potential and are well-suited for promoting and expanding green loans in the next phase.**

3. Expanding Green Loans to Rice Production Groups

Promote and broaden access to green loans for rice farmers, particularly community rice centers, community enterprises, and community soil and fertilizer management centers. This should be carried out through integrated collaboration among all relevant stakeholders to achieve cohesive and sustainable impacts on the country's rice production system.

4. Creating Incentives to Promote Sustainable Rice Production

Creating incentives is a key mechanism for encouraging farmers to shift toward sustainable agricultural systems. This can be implemented through several approaches, as follows:

- **Linking farmers to buyers and exporters:** Support farmers' access to markets that demand rice certified under the Sustainable Rice Platform (SRP) or other sustainable agriculture standards. Buyers are willing to pay a **premium price** for certified rice, thereby creating economic incentives and increasing farmers' income.
- **Using incentive-based lending systems:** For example, encouraging financial institutions such as the Bank for Agriculture and Agricultural Cooperatives (BAAC) to consider offering lower interest rates to farmers who consistently adopt CST technologies or obtain certification in sustainable agriculture standards.
- **Linking to carbon credit mechanisms:** Promote collaboration with carbon-credit agencies or intermediaries to enable farmers to earn additional income from reducing greenhouse gas emissions. This serves as an incentive for farmers to transition from conventional rice farming practices toward more environmentally friendly production systems.

5. Monitoring and Evaluating Farmers' Adoption of CST Technologies

Verifying that farmers are genuinely applying CST technologies is a crucial step in assessing outcomes and ensuring the credibility of implementation. The following approaches and tools can be used for monitoring:

- **Use of greenhouse gas emission assessment applications:** The National Bureau of Agricultural Commodity and Food Standards (ACFS) has developed an application for assessing greenhouse gas emissions from rice production processes. This application also serves as an important tool in advancing the country's sustainable rice standards.
- **Use of greenhouse gas emission assessment applications:** The National Bureau of Agricultural Commodity and Food Standards (ACFS) has developed an application for assessing greenhouse gas emissions from rice production processes. This application also serves as an important tool in advancing the country's sustainable rice standards.
- **Verification by academic institutions:** Academic institutions with relevant expertise and capacity can serve as verifiers to confirm that farmers have indeed adopted CST systems in their production areas.

6. Supporting Infrastructure and Knowledge Provision for Integrated Adoption of CST Technologies

Promoting the effective and sustainable use of CST technologies requires collaboration among multiple agencies across the public sector, private sector, and international organizations. Each agency plays an important role as follows:

- **Rice Department:** Select rice varieties suitable for local climatic conditions and provide farmers with access to quality seeds at affordable prices.
- **Land Development Department :** Support soil testing and analysis for precise fertilizer application, promote the use of decomposing microorganisms, microbial accelerator, green manure crops, and develop small water sources to enhance cultivation efficiency.
- **Department of Agriculture :** Provide knowledge on soil nutrient management and guidelines for post-rice cropping.
- **Department of Agricultural Extension, Rice Department, and Universities:** Serve as technology transfer units for CST, covering knowledge on effective and site-appropriate CST application based on soil and local conditions, as well as knowledge on selecting quality rice seeds and reducing varietal contamination.
- **Department of Agricultural Extension, Rice Department, and Academic Institutions:** Deliver comprehensive CST training to farmers, emphasizing site-specific application, proper use of technologies, and techniques for maintaining seed purity and minimizing contamination.
- **Department of Groundwater Resources:** Support the drilling of groundwater wells to expand water reserves for cultivation.
- **Royal Irrigation Department:** Manage water release schedules in alignment with the timing required for alternate wetting and drying (AWD) rice farming practices.

- **Agricultural machinery companies:** Provide machinery and digital applications that support planning for rice cultivation and harvesting.
- **BAAC and GIZ:** Provide financial literacy training to farmers, raise awareness, and promote adaptation to climate change.

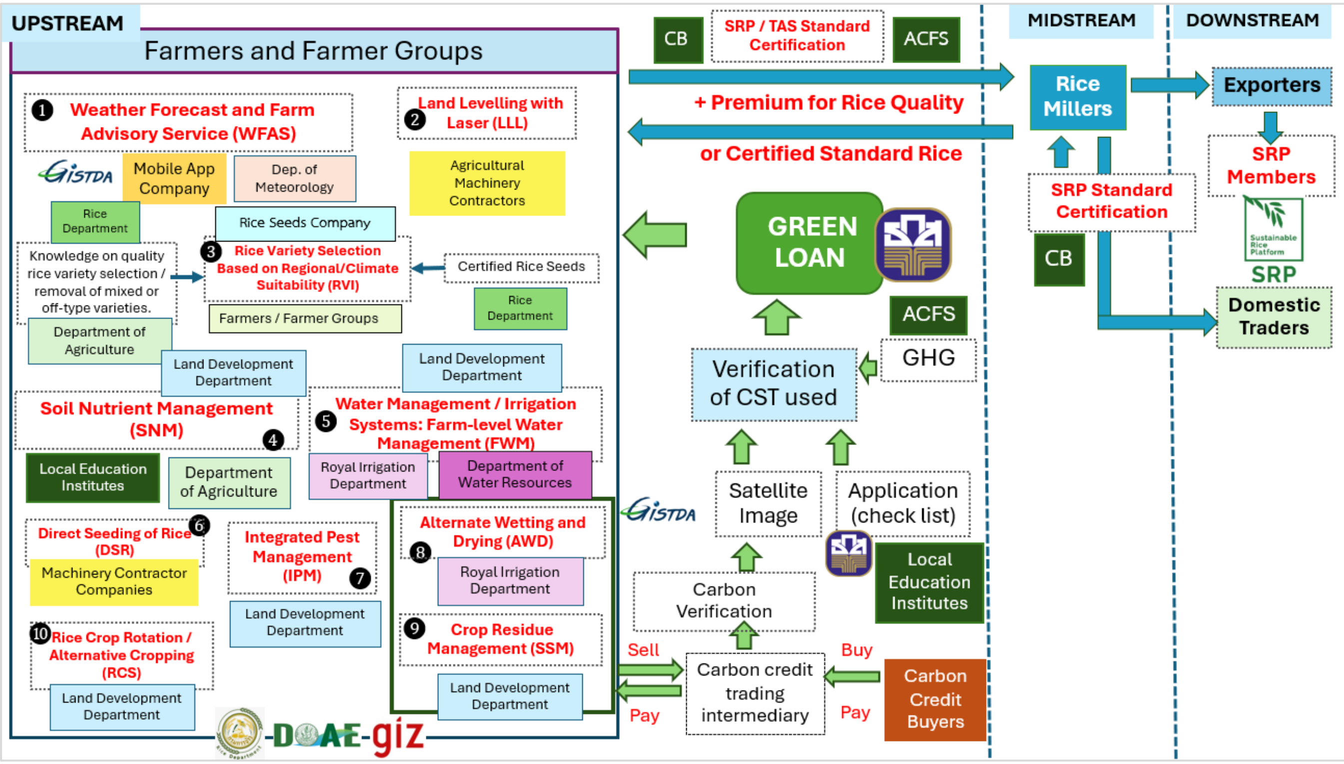

Figure 1: Integration of All Sectors with Green Lending to Support CST Adoption in Rice Farming

7. Selection of Pilot Target Areas for Expanding Green Loans

The expansion of green loans should begin with areas and farmer groups that are ready, determined by assessing the demand for credit to support CST technology adoption alongside the readiness of local infrastructure—such as water systems, farmer group organization, availability of technology service providers, and market support for outputs. Consideration should also be given to farmers' repayment history and the ratio of debt burden to net agricultural income.

Under this study, pilot target areas were selected from sites in three provinces in collaboration with the GIZ project, as follows:

Areas with Potential for Pilot Implementation

- **Doembang Nangbuat District and Nong Ya Sai District, Suphan Buri Province:** These areas show demand for credit to adopt CST technologies and have strong infrastructure readiness, particularly in water systems and well-organized farmer groups. They also have model farmers certified under GAP standards, strong repayment histories (on-time repayment of principal and interest), and a debt-to-net-agricultural-income ratio below 40%. These conditions make the areas suitable for initial expansion of green loans.
- **Trakan Phuet Phon District and Warin Chamrap District, Ubon Ratchathani Province:** These areas also exhibit high potential as pilot sites, with demand for CST-related credit and readiness in infrastructure such as water systems and strong farmer organizations. They

have GAP-certified model farmers and a debt-to-net-agricultural-income ratio below 40%. However, successful implementation in these areas requires collaboration from multiple stakeholders—such as rice mills to provide market-based incentives through premium pricing, and support from the Land Development Department and the Department of Groundwater Resources to address soil salinity issues and expand water reserves. These interventions would enhance farmers' income and long-term repayment capacity.

Target Areas for Future Expansion

- **Mae Chan District and Wiang Pa Pao District, Chiang Rai Province:** Farmers in these areas exhibit very low demand for CST-related credit, and most surveyed farmers have not yet obtained GAP or organic certification. Awareness of sustainable production remains limited. Therefore, these areas are not yet suitable for short-term green loan expansion. However, efforts should focus on capacity building through training, awareness raising, and support to help farmers move toward certification processes—preparing them to become suitable target areas in the future.

8. Transitioning Conventional Loans Toward Supporting CST Technology Adoption

Developing agricultural loan products that align with environmentally friendly production practices and climate-resilient farming is a key strategy for advancing Thailand's agricultural sector toward sustainability. The transition from "conventional loans" to "loans that support CST technologies" can be achieved through the following approaches:

- **Adjusting conventional loan structures to include components of green loans:** Revise loan application forms to incorporate expenses that qualify under CST technologies—for example, laser land leveling services and stubble incorporation services—so that loans can support activities that promote sustainability.
- **Adjusting conventional loan structures to include components of green loans:** Revise loan application forms to incorporate expenses that qualify under CST technologies-for example, laser land leveling services and stubble incorporation services-so that loans can support activities that promote sustainability.
- **Developing a database of farmers and their CST adoption:** Create a comprehensive database containing farmers' training histories related to CST technologies and their actual adoption in the field. This database will help ensure that loan approvals target the intended groups and improve overall loan management efficiency.
- **Coordinating with agricultural extension and technology agencies:** Collaborate with institutions such as the Rice Department, the Department of Agricultural Extension, and research organizations to verify that the technologies adopted by farmers meet CST criteria—especially for technologies that are more difficult to assess, such as selecting appropriate rice varieties (RVI) and applying fertilizers based on soil analysis or site-specific recommendations.
- **Enhancing farmers' knowledge and skills alongside loan disbursement:** Provide training to ensure farmers understand and can effectively use CST technologies while raising awareness about climate change, the need for agricultural adaptation, standardized rice production, low-carbon rice cultivation, and crop insurance.

- **Demonstrating and disseminating results from model farmers:** Establish demonstration plots and showcase outcomes from model farmers to build confidence among farmers about the economic benefits of CST adoption—particularly the increase in net income resulting from sustainable rice production.

9. Developing Bundled Green Credit

The development of **bundled green credit** is a key approach for promoting farmers' access to finance while simultaneously enhancing sustainability in the agricultural sector. Potential strategies include:

- **Combining subsidies with credit and crop insurance:** This approach is suitable for production technologies with high upfront costs. By integrating multiple financial mechanisms, it reduces farmers' initial investment burden and increases incentives to adopt green technologies.
- **Linking crop insurance to loan conditions:** Survey results show that approximately 30–60% of farmers are willing to apply for loans even if crop insurance purchase is required. However, farmers outside high-risk areas or those who have never experienced significant losses from natural disasters often perceive crop insurance as unnecessary. This makes mandating insurance as a loan requirement a continuing challenge.
- **Using sustainable rice certification as an eligibility criterion for green loans:** Although this concept aims to promote sustainable production, there are practical limitations. Most farmers cannot yet access sustainable rice certification processes due to the relatively high cost of obtaining **SRP (Sustainable Rice Platform)** certification and the early-stage development of the **TAS (Thai Agricultural Standard)** certification framework.

10. Designing Loan Products to Match Technology Use and Cost-Effectiveness

- **Investment in water management systems and machinery** varies depending on their functions and technological capabilities. Therefore, the cost-effectiveness of using such technologies should be a key consideration in loan assessment.
- **Expanding green loans to agricultural machinery service providers:** These providers must possess adequate knowledge, expertise, and management capability. They should also have proper operational planning, sufficient service areas, or a comprehensive set of machinery to ensure cost-effective use of the technology.
- **Loan product design should align repayment schedules with harvest cycles and the returns generated from using CST.** Repayment terms should also differ according to agricultural practices in each area. Based on surveys conducted in the three study provinces, farmers in Suphan Buri prefer annual and semi-annual interest repayment schedules, while farmers in Ubon Ratchathani and Chiang Rai prefer annual repayments, which align with their rice-growing cycles.

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