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IRRI Technical Guideline for Policy Support

Guide to supporting agricultural NDC implementation: GHG mitigation in rice-production in Vietnam

CCAFS

CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

AUTHORS

Dr. Katherine M. Nelson – Researcher, International Rice Research Institute, Hanoi, Vietnam
Dr. Bui Tan Yen – Scientist, International Rice Research Institute, Hanoi, Vietnam
Dr. Bjoern Ole Sander – Senior Scientist and Country Representative, International Rice Research Institute, Hanoi, Vietnam

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1. Introduction

Agriculture contributes significantly to greenhouse gas (GHG) emissions globally, especially in industrially developing (“transforming”) economies that are currently heavily dependent on income from agriculture, such as Vietnam. The country has identified agriculture-related emission reduction commitments for its Nationally Determined Contributions (NDCs) in the Paris Agreement. However, methods for moving from commitments to developing and implementing action plans for agricultural NDCs have not been well documented. In order for national governments to move beyond “business as usual” scenarios to meeting their NDC commitments with financial and implementation support from international organizations, concrete, actionable, and replicable methods to understanding and measuring mitigation scenarios are necessary for planning and targeting investment strategies.

The purpose of this document is to serve as a guide for research to support national partners to plan, finance, and implement the agricultural NDCs. This is a summary of the collaborative and evolving process initiated by the partnership between the International Rice Research Institute (IRRI) and the Ministry of Agriculture and Rural Development (MARD) of Vietnam.

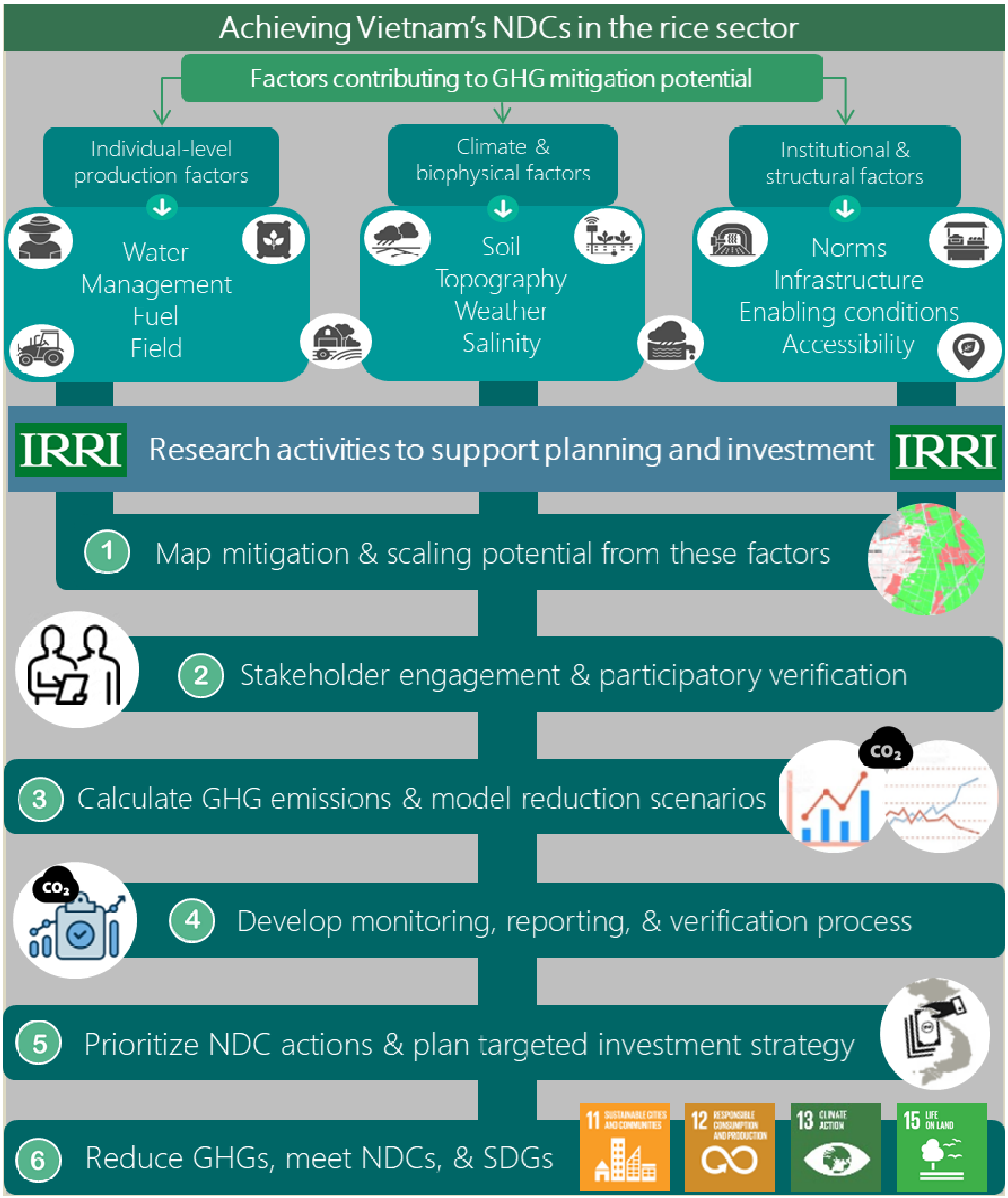
As the third largest exporter of rice globally, Vietnam’s rice sector is a major contributor to national greenhouse gas emissions, surpassing the transport and industrial sectors. Vietnam ranks globally as one of the countries most affected by climate change and this will only worsen in the future, leaving millions vulnerable to natural disasters and food insecure.

Efforts to reduce GHG emissions from rice production are a national priority for achieving Vietnam’s nationally determined contributions (NDCs). Unlike the livestock industry where the animal itself is responsible for the majority of emissions, in rice production it is not the plant *per se* that is the culprit of GHG production, rather it is the way in which the crop is grown and managed that makes a difference in the amount of GHGs emitted. The single largest factor influencing the amount of GHG emitted from rice production is the management of water[1]. The process of alternating between wet periods and dry periods during rice production is herein referred to as alternate wetting and drying (AWD) which has been proven to reduce GHG emissions in rice production by 30%-70% without affecting yields. Given that changes in water management represent the highest potential to mitigate GHGs in rice production, the following sections will explain the process of actions needed to define suitable areas, plan, and target investment for achieving the NDCs. This document details the process for engaging national partners and supporting agricultural NDC implementation.

Outline of the process:

- Map suitable area for AWD (climatic suitability and adoption capacity)
- Validate and merge maps through participatory verification process to define target regions
- Perform cost-benefit analysis for mitigation strategies based on maps
- Calculate GHG emissions of rice production area and model reduction scenarios
- Standardize methods for measuring, reporting, and verification
- Collaborate with national partners to develop investment plans to take NDC actions to scale
- Create long-term financial plans for securing funding to achieve NDCs
- Secure funding sources for next stages of NDC action

[1] Additional factors that contribute to GHG emissions include fertilizer, crop duration, residue/ post harvest management, and on-farm fuel use


Achieving Vietnam's NDCs in the rice sector
Factors contributing to GHG mitigation potential
Individual-level production factors
Climate & biophysical factors
Institutional & structural factors
Water
Management
Fuel
Field
Soil
Topography
Weather
Salinity
Norms
Infrastructure
Enabling conditions
Accessibility
IRRI
Research activities to support planning and investment
IRRI
1 Map mitigation & scaling potential from these factors
2 Stakeholder engagement & participatory verification
3 Calculate GHG emissions & model reduction scenarios
CO2
CO2
4 Develop monitoring, reporting, & verification process
5 Prioritize NDC actions & plan targeted investment strategy
6 Reduce GHGs, meet NDCs, & SDGs
11
12
13 CLIMATE ACTION
15 LIFE ON LAND

2. Mapping suitable rice land for AWD implementation

Starting in 2006, IRRI has been in partnership with national research institutions, to develop and pilot AWD in Vietnam. In 2016, AWD has been identified as a promising practice for GHG mitigation and selected as an option in the Vietnam NDCs. However, there was no previous science-based approach that could be used to identify where and when AWD could be applied. To support Vietnam's agricultural NDC implementation, IRRI has tested a methodology to identify spatial and temporal climatic suitability for AWD application in the country. The methodology has been adapted to map AWD suitability for the whole country and then this process has been applied to regional and provincial levels.

Sub-sections below summarize the case study of An Giang, a representative rice production province in the Mekong River Delta. The AWD suitability analysis consists of 4 steps:

1) Develop suitability maps based on climatic and biophysical factors that affect the application of AWD (i.e., rainfall, topography, soil type, etc)
2) Develop adoption capacity maps based on human factors that affect the application of AWD (i.e., irrigation infrastructure, farmer knowledge, institutional capacity)
3) Merge the maps to create an overall AWD suitability map for the region
4) Verify the content and assumptions of the overall AWD suitability map with local officials

2.1 Develop climatic suitability maps

In the first step, planted area of rice is mapped based on statistical land-type data, rice cropping calendar and remote sensing images. Climatic factors including rainfall, potential evapotranspiration and soil percolation rate of rice land were then used to assess the water balance. A suitability score was assigned to each area unit based on the number of water deficit dekads[2] during a rice season. The overall score was classified into three groups representing: high suitability (green), moderate suitability (yellow) and low/no suitability (red). Figure 1 shows maps of climatic AWD suitability in winter-spring, summer-autumn and autumn-winter seasons of An Giang province.

a b c

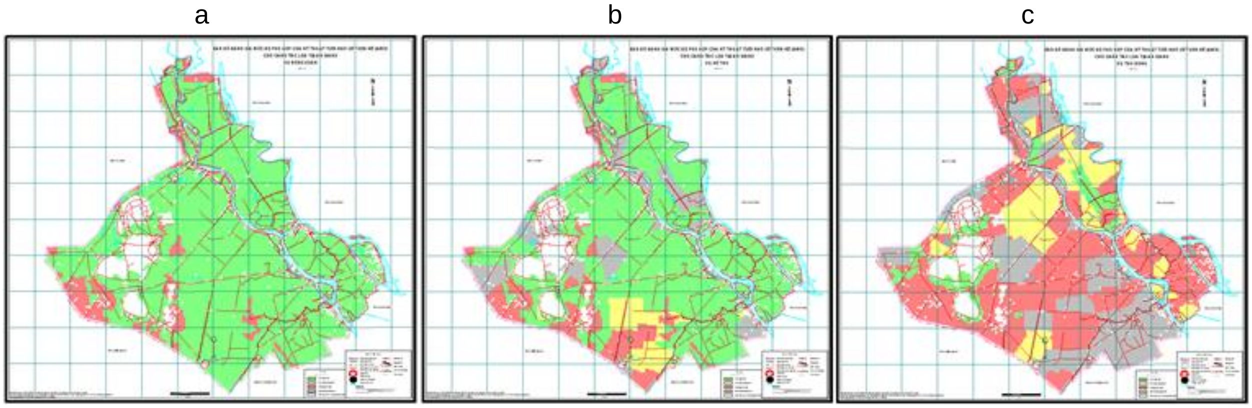


Figure 1. An Giang Province AWD climatic suitability maps for (a) winter-spring season, (b) summer-autumn season and (c) autumn-winter season. Green color represents high suitability, yellow is moderate suitability, red is low or no suitability, gray color means no rice is planted, and white color means other land-use types.

[2] A dekad is a 10 days period

2.2 Adoption capacity maps

The second step focuses on evaluation of human factors that influence the adoption capacity for AWD. In this step, human factors and influences were identified through discussions with key personnel from local agencies under the Department of Agriculture and Rural Development (DARD) and researchers from national research institutes. In the case of An Giang, the 4 human influencing factors were taken into evaluation, including: canal irrigation infrastructure, drainage capability, farmer awareness of the technology, and cooperative authority. A scoring method was used to rate the factors for each commune. The list of adoption factors and ratings are shown in Table 1. Each factor was scored on a scale from 1-10, with 1 representing low capacity and 10 being high capacity in that category. Based on the final rating score, AWD adoption capacity maps (Figure 2) were classified into 3 groups, i.e. high, moderate, and low capacity. In total 22 DARD staff, two staff from each of the 11 districts in An Giang Province, scored each commune in their respective districts (for a total of 149 communes) according to the adoption capacity criteria.

Table 1. Scoring factors for AWD adoption capacity

	Low capacity	**Moderate capacity**	**High capacity**
Canal infrastructure	<30% concrete canal	30%-50% concrete	>50% concrete
Drainage capability (combination of flooding, rainfall, pumping stations)	Seasonally low drainage capability	Seasonally moderate drainage capability	Seasonally high drainage capability
Farmer awareness	Unaware or unwilling to adapt	Some awareness but lack ability or motivation	Aware and willing to adapt
Cooperative authority	Low authority - farmers don't follow rules/ recommendations	Moderate authority - farmers rarely follow rules/ recommendations	High authority - farmers follow rules/ recommendations

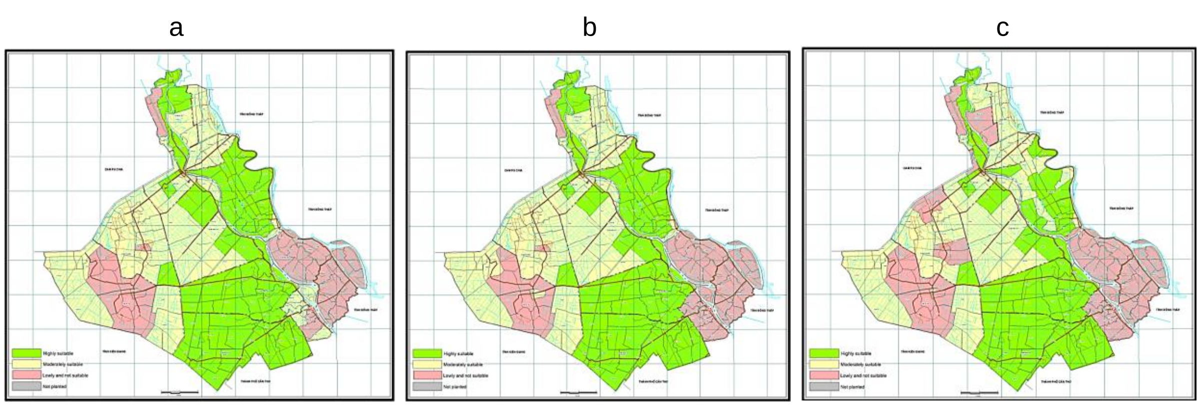


Figure 2. Adoption capacity maps for (a) winter-spring, (b) summer-autumn and (c) autumn-winter season of An Giang province. Green color represents high adoption capacity, yellow is or moderate capacity, red is low capacity.

2.3. Overall AWD suitability maps

In the third step, seasonal climatic-suitability maps and adoption capacity maps are combined to generate overall suitability maps. There is an assumption that the climatic and adoption factors have equal weighted value. Therefore, the average weighted method was applied to calculate overall suitability score, again classified as high, moderate and low suitability and represented by the colors green, yellow, and red, respectively (Figure 4).

2.4 Participatory verification of overall AWD suitability maps

In the last step, the overall AWD suitability maps are verified through a participatory feedback process. This was conducted in An Giang province with participation of provincial and district officials of DARD. In this process, local officials were asked to review suitability levels for each of the three seasons. Updates of improved infrastructure, recent land-use changes, water saving practices applied in last seasons, and other local knowledge were used to verify suitability levels. In general, suitability levels in most of the rice land of the province were accepted by participants. Suitability levels in some areas were adjusted with consultation of local officials.

Figure 3. Photos of the participatory verification and feedback sessions for AWD suitability mapping.

After feedback from local stakeholders, the overall AWD suitability maps are finalized. Figure 4 shows the final verified AWD suitability maps for three rice seasons of An Giang province. The AWD suitability maps were officially transferred to An Giang DARD (Figure 5) with representatives from the Department of Crop Production from 8 provinces in the Mekong River Delta attending.

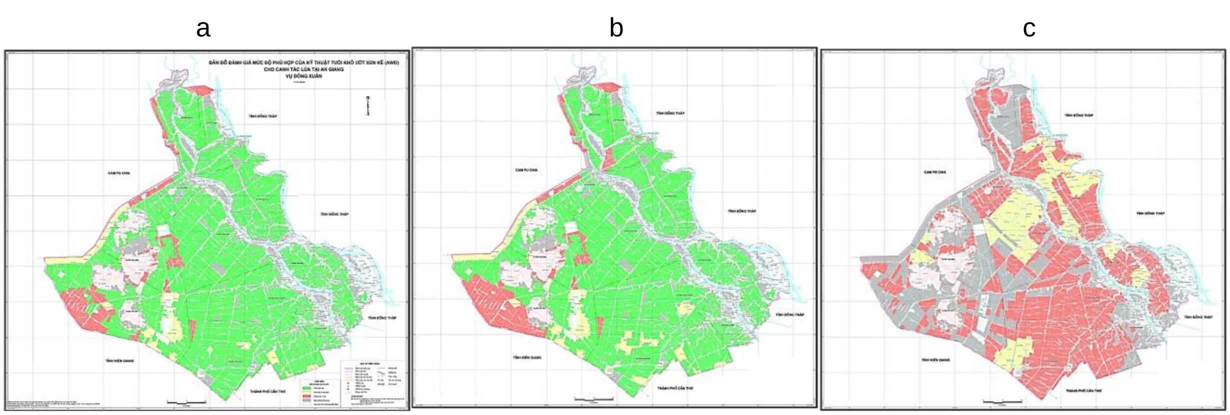


Figure 4. Overall AWD suitability maps for (a) winter-spring, (b) summer-autumn and (c) autumn-winter season of An Giang province. Green color represents high suitability, yellow is moderate suitability, red is low suitability, gray color means no rice is planted, and white color means other land-use type.

To date these maps are the best reference to support AWD implementation plans. This process can be applied to other provinces of Vietnam, as well as in other countries, to put the NDC commitments into action at the regional and local level. At meso- and macro levels, the AWD suitability analysis method together with GHG measurements can be applied to assess the potential for regional and national GHG mitigation in the rice sector.

Figure 5. The ceremonial handover of the AWD suitability map representing the final stage in the mapping process

3. Cost-benefit analysis (CBA)

In spite of ample evidence on the technical feasibility of GHG mitigation in rice production, the adoption of these practices still remains fragmented at the country scale. One of the reasons for the slow uptake of mitigation practices is a lack of reliable data on related costs and benefits which can be used by planning departments and implementation organizations to help target technical capacity needs and infrastructure development. There are multiple strategies for assessing costs and benefits which can be done at the farm-level or aggregated to regional and national scales. Different purposes require different methods and choosing the right methodology depends on the level of intervention and expected outcomes for the project.

Farm-level cost-benefit analyses are useful if the goal is to understand the financial costs or savings incurred by farmers using a particular mitigation technology[3]. These can then be useful to guide the development of carbon payment schemes or subsidies. At the **national level**, if the goal is to determine the appropriate agricultural technologies and practices to promote over the long-term that will benefit farmer livelihoods and have high mitigation potential, the marginal abatement cost curve (MACC) methods can be good options to weigh trade-offs between different technologies and their business as usual options (Carbonari et al. 2019). However, if the goal is to calculate the highest mitigation impact-to-cost ratio in order to reach the NDCs, project investment analyses are necessary as these include the required implementation costs for infrastructure development, capacity building (i.e., training of farmers on the technologies), and expenses related to taking baseline measurements, monitoring, reporting, and verifying farmer practices and the resulting emission reductions. These are all part of the process of transitioning to low-emission production and are an essential part of proving the emission reductions in a transparent and standardized way that is accepted for NDC reporting so they

[3] For farm-level cost-benefit analysis of AWD refer to: McKinley, J., Sander, B.O., Vuduong, Q., Mai, V.T., and LaFrance, J. *Forthcoming*. The influence of farmers' expectations, information, and subsidies on the adoption of Alternate Wetting and Drying in Vietnam's River Deltas.

cannot be omitted from national level cost-benefit analyses. Cost-benefit analyses and MACCs that do not incorporate project implementation costs run the risk of being misinterpreted and can be misleading at best and detrimental for mitigation (and funding) at worst.

We have developed a project implementation cost-benefit analysis tool that enables the comparison of multiple low-emission rice production scenarios to BAU scenarios by allowing users to include implementation costs over the project period and also allowing for an extended timeframe to calculate the payback period and mitigation beyond the life of the project. This tool is intended to be used together with **data from the suitability maps** allowing decision-makers to adjust investment scenarios (e.g., improving canal infrastructure to upgrade to cement canals or investing in farmer training programs or other irrigation infrastructure) to **create an efficient investment strategy to approach donors**. Given the diversity of rice production systems, CBA can be a useful tool to aid decision-making processes at **multiple levels** (e.g., policy makers, researchers, international donors, and private sector).

4. Measuring GHG emissions, establishing mitigation potential and progress

IRRI is one of the leading international institutes for climate change research in agriculture with over 20 years of experience in Asia and Africa working on GHG emissions in rice production. In addition to the myriad of field experimental studies on research stations and in farmers' fields, IRRI has designed, tested, and refined farm-level surveys and calculation tools to estimate GHG mitigation on an individual, regional, and national level following the International Panel on Climate Change (IPCC) guidelines. The SECTOR tool, developed by IRRI to be a user-friendly GHG calculator, requires inputs on crop areas, yields and management. The tool offers a high range of flexibility in terms of entering newly obtained emission factors, easy data transfer from crop statistics for entering activity data and detailed specifications of GHG scenarios, as well as providing the ability to select a range of scales for aggregation (Wassman et al. 2019). Moreover, SECTOR provides a streamlined framework for accelerated data input that will facilitate rapid assessments of multiple scenarios for domains with many spatial units.

Figure 6 shows a case study for rice production in Thai Binh province (Vietnam) demonstrating the potential to display GHG results in combination with GIS[4]. SECTOR can be used to calculate business-as-usual as well as scenarios showing the impact of different levels of technology adoption.

[4] Wassmann, R., Pasco, R., Zerrudo, J., Ngo, D.M., Vo, T.B.T. and Sander, B.O., 2019. Introducing a new tool for greenhouse gas calculation tailored for cropland: rationale, operational framework and potential application. *Carbon Management*, *10*(1), pp.79-92.

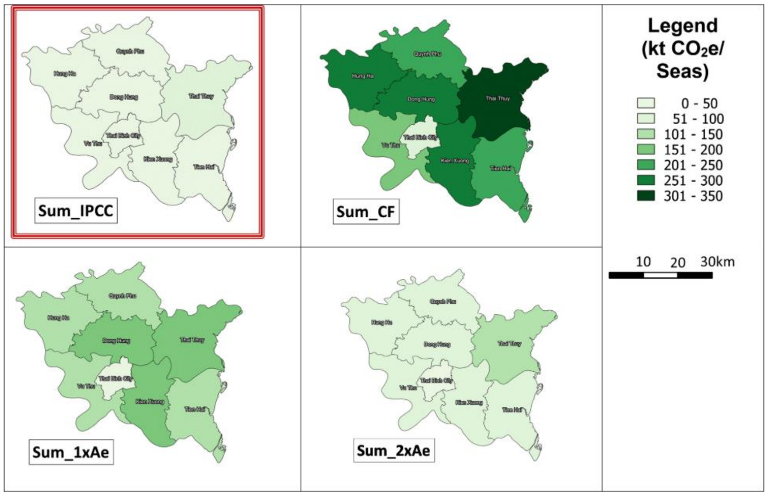


Figure 6. GHG emissions in Thai Binh Province from rice calculated using different emission factors - a) the IPCC default value b) empirical data for continuous flooding (CF)[5], c) single aeration (1xAe) and d) double aeration (2xAe). Source: Wassman et al. (2019)[7].

5. Measurement, reporting, verification (MRV)

MRV is a concept that integrates three independent processes of GHG emission mitigation initiatives; of which (M) involves i) measuring GHGs emission from paddy rice fields and ii) monitoring and calculating emissions, (R) reporting emissions, and (V) verifying results from monitoring, calculation and reporting activities (verification often refers to third party auditing results but other verification processes may be explored, such as satellite remote sensing[6] and digital sensors, to prove mitigation activities). The "measuring" component includes the measurement of baseline conditions and is imperative to the process.

Although MRV is an important part of the NDC implementation process to ensure compliance with international UNFCCC reporting requirements to track emissions and emissions reductions, a national standardized and transparent protocol for reporting emission reductions in rice production that is suitable for the NDCs has yet to be defined. MRV guidelines exist for certified emission reductions through the UNFCCC Clean Development Mechanism but these MRV requirements are far too strict and economically infeasible to be used for NDC reporting.

The Prime Minister of Vietnam approved the national program on greenhouse gas emission management and management of carbon credit business activities[7]. The main targets of this program include strengthening the capacity of ministries, sectors and localities for national greenhouse gas inventory; and developing the measurement, reporting, verification system (MRV). IRRI is working together with national and local governments and the implementing agencies to develop MRV systems to meet the following objectives: improve the basis of

[5] Tariq, A., Vu, Q.D., Jensen L.S., de Tourdonnet, S., Sander, B.O., Wassmann, R., de Neergaard, A. 2017. Mitigating CH4 and N2O emissions from intensive rice production systems in northern Vietnam: efficiency of drainage patterns in combination with rice residue incorporation. *Agriculture, Ecosystems & Environment* 249, 101–111.
[6] Lovell, R.J., 2019. Identifying Alternative Wetting and Drying (AWD) Adoption in the Vietnamese Mekong River Delta: A Change Detection Approach. *ISPRS International Journal of Geo-Information*, *8*(7), p.312.
[7] Decision 1775/QD-TTg issued on 21 November 2012

information and the monitoring of rice-related mitigation actions, coordinate individual mitigation activities (such as bottom-up actions / policies, top-down goals), and track emission reductions.

In the rice sector, the Ministry of Agriculture and Rural Development (MARD) has prioritized the AWD practice as a key mitigation action in Vietnam's NDC implementation plan. In line with the national target, IRRI is supporting MARD to establish an MRV system for mitigation actions in the rice sector through the development of a provincial rice production statistical reporting system. This approach expands the existing reporting system to monitoring of additional rice crop management factors and it is being piloted by the provincial Department of Agriculture and Rural Development (DARD) in An Giang province in 2021 (see Figure 7). By integrating additional rice crop management factors into this system, the area and level of AWD adoption can be monitored and reported. A GIS plug-in component is also being developed to quickly map distribution of monitoring variables (e.g. transplanting area, rice varieties, AWD adoption, climate risks and yield lost).

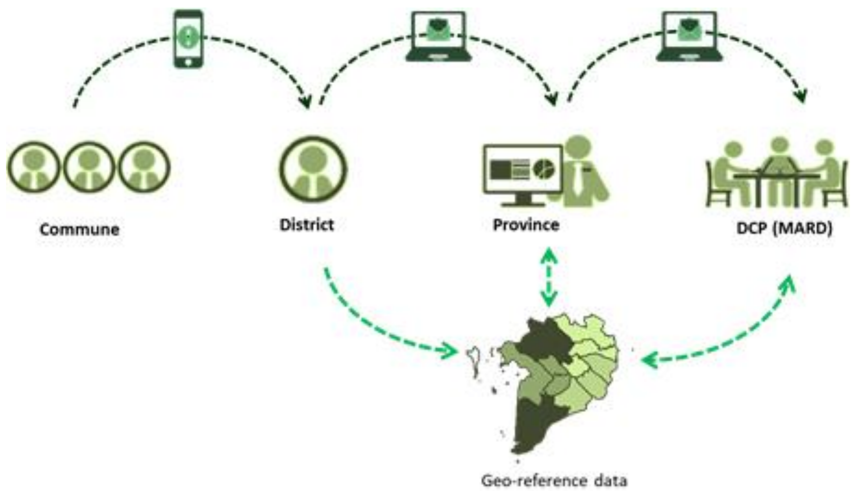


Figure 7. The flow of information in the MRV system for rice management factors

Once the pilot has been proven successful, other mitigation options (e.g. mid-season drainage, fertilizer replacement or adjusted rice straw management) can be easily incorporated. This MRV system is specific to the Vietnamese context, but it could be adjusted for relevance to other country contexts. Additionally, the MRV development process can be applied and adapted to other agricultural, forestry, and other land use (AFOLU) mitigation activities.

6. Investment plan for up-scaling

Finance is critical for the implementation of the mitigation and adaptation actions set out in countries' NDCs. Many of the NDCs submitted include conditions for their full implementation, such as additional or enhanced international support in the form of finance, technology transfer, technical assistance and capacity-building. In order to access finance, countries need clear project concepts at a minimum, and financing propositions need to be developed. IRRI and the government of Vietnam have agreed to work together towards reforming the rice sector since 2015. This has involved securing several bilateral and multilateral grants to work together with the national government on developing and implementing agricultural NDCs.

Building on the aforementioned tools for suitability mapping of mitigation options, cost-benefit analyses, and MRV, NDC actions should be prioritized based on capital costs (e.g. infrastructure), ongoing maintenance costs, capacity-building or training, and the human resources needed to implement, monitor, report, and verify the actions. Existing domestic support should be identified, for example through the national climate strategies and agricultural reform strategies, in addition to expected bilateral and multilateral support. Once potential bilateral, multilateral, and private funding sources that the country already has a history of accessing funds have been identified, IRRI and the Vietnamese government can approach these organizations first for short-to-medium term financing for priority NDC activities. In parallel, new sources of finance that could support NDC actions will be identified and assessed according to the eligibility of each action against the funding criteria. IRRI has engaged in this process together with MARD and an initial working document on approaches for an investment plan has been developed[8].

National government agencies together with IRRI identify, prioritize, and develop project pipelines through the use of a wide range of planning and decision-making tools mentioned in this document. These will then be assessed and approved by relevant government parties to be developed into funding proposals for approaching bilateral, multilateral, and private sector funders, such as the Global Environmental Facility (GEF), the International Climate Initiative of the German government (IKI) or the Green Climate Fund (GCF). The eligibility and viability for the success of proposals that are built on years of partnerships and evidence-based data is promising. IRRI has long-standing relationships and on-going projects in many nations across the globe, with particular focus on nations that are vulnerable to climate change and food insecurity.

7. Roadmap planning

Vietnam is expected to achieve an 8% reduction in GHG emissions by 2030 with national capacity, and by 25% with sufficient international support. Although AWD and straw management have been identified in Vietnam's NDCs as key options in the agriculture sector that could significantly contribute to national GHG mitigation, farmer adoption at scale and the ability to track field-level practices in rice production are still limited. Without significant research and development support to identify suitable regions, target financial investments, secure international funding, remove barriers, and provide reliable MRV systems, the national targets for the rice sector are unlikely to be achieved.

In order to determine limitations and the way forward for scaling of prioritized mitigation options, IRRI is working with the Department of Crop Production and DARD on developing regional roadmaps for scaling-out AWD and sustainable straw management practices (see Figure 8). The best approach towards an effective roadmap is currently being piloted in An Giang province (including the development of business plans and value chain assessments). The roadmap planning process is conducted at the provincial level with the participation of DARD leaders and

[8] For reference example of investment strategy for AWD see: Tran VT, Mai VT, Nguyen TDT, Le HA, Richards MB, Sebastian L, Wollenberg E, Vu DQ, Sander BO. 2019. An investment plan for low-emission rice production in the Mekong River Delta region in support of Vietnam's Nationally Determined Contribution to the Paris Agreement. CCAFS Working Paper no. 263. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

provincial and district officials. The primary outputs of the roadmap planning activity are to identify limitations and requirements needed to support policy, technical, and financial capacity for scaling at a regional level which can then be used as the framework to secure funds for implementation and scaling.

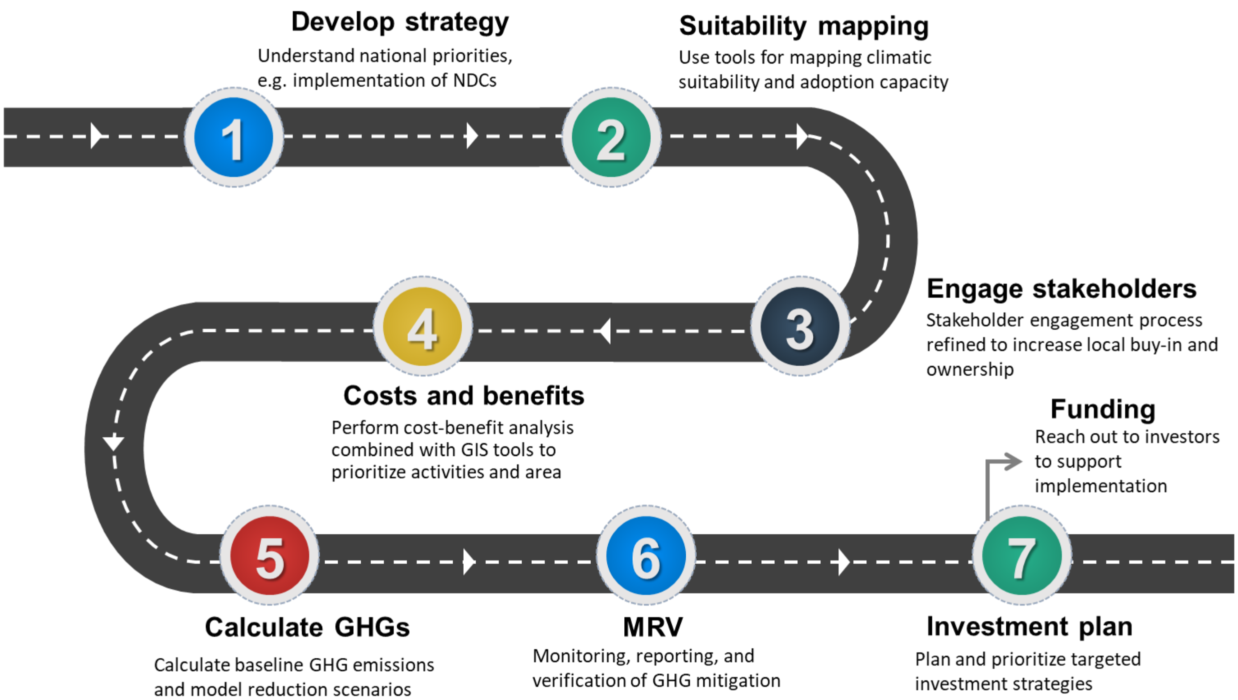


Figure 8. Roadmap for NDC planning in rice sector

8. Next steps

IRRI will work together with MARD in Vietnam using the myriad of tools mentioned herein that have been developed specifically for rice production to i) define high priority regions for various NDC actions in the agriculture sector, ii) develop the MRV framework and iii) establish the associated financing strategies for these actions, and iv) conduct scoping studies to provide evidence-based mitigation packages that are finance-ready for v) preparation and submission to multiple funding sources (including bilateral, multilateral, and private industry sources).

Additionally, behavioral research will be conducted to understand the relationship between individual GHG emissions from rice farming and the psychosocial-economic factors that influence the (non)adoption of low-emissions practices, and to evaluate the effectiveness of different monetary and non-monetary incentives. There is also on-going tool development and research to test MRV systems for AWD and adjusted rice straw management.