Monitoring, reporting and verification requirements and implementation costs for climate change mitigation activities

Focus on Bangladesh, India, Mexico, and Vietnam

Working Paper No. 162

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Abstract

This report describes and estimates implementation costs for key monitoring, reporting, and verification (MRV) requirements for low emissions development programs requiring MRV systems. The cost analysis is summarized in table A-1.

Table A-1. Summary of MRV system costs

MRV SYSTEM COST ELEMENTS*	Bangladesh	India	Mexico	Vietnam
AREA COVERED (ha)	**215-1,935**	**3,500-14,100**	**399-1,600**	**340-3,060**
First-Year (Setup) Costs				
Generation of baselines	$50–75	$100–150	$100–150	$50–75
Developing database	$5-60	$5-60	$20-60	$5-60
Printing and distribution of cultivation logbooks	$464	$2,200	$60	$160
Development of reporting guidelines	< $18	< $18	< $18	< $18
Development of QAQC plan	< $12	< $12	< $12	< $12
TOTAL SETUP COSTS	**$549-$629**	**$2,340-$2,440**	**$210-$300**	**$245-$325**
Ongoing (Annual) Costs				
Measurement of number of hectares with adoption and sustainable development indicators, training, and data entry	< $20	< $20	< $20	< $20
Report to the UNFCCC	< $10	< $10	< $10	< $10
Peer or technical review of source data and methodologies	< $5	< $5	< $5	< $5
Routine quality control of activity data, calculations, emission factors, etc.	< $10	< $10	< $10	< $10
External verification process for the information reported on the NAMA	< $10	< $10	< $10	< $10
TOTAL ANNUAL COSTS	**< $55**	**< $55**	**< $55**	**< $55**
TOTAL COST OVER 20 YEARS	**$1,600-$1,700**	**$3,400-$3,500**	**$1,300-$1,400**	**$1,300-$1,400**
TOTAL COST/T OVER 20 YEARS	**$0.05-$0.45**	**$0.05-$1.25**	**$0.30-$1.05**	**$0.01-$0.10**

*Costs are shown in thousands (000s) of USD.

MRV system development and setup costs vary significantly—from a low of $210,000 to a high of $2.44 million—mostly due to the area covered by the Nationally Appropriate Mitigation Action program and the number of participating farmers. Therefore the cost of printing and distributing cultivation logbooks is greater (a key component of data collection). Cultivation logbooks account for over two-thirds of all first-year costs and can reach $2.2 million in the case of India, where reaching one-third of farmers means over 18.5 million

logbooks would be required. Finding an alternative to a printed paper booklet to record key cultivation data in a standardized fashion throughout the project's life cycle could help to drive down this cost.

Ongoing MRV implementation costs may reasonably amount to less than $55,000/year across the four countries and systems studied. Annual monitoring costs could be kept low by collecting data on field size and sustainable development indicators (e.g., tonnes of cereal produced, water usage, revenues) from a random sample of 384 participating farmers. Also, efforts to use existing data-gathering and management systems as much as possible through strategic partnerships with domestic institutions and implementing partners would help to drive down costs while also increasing the quality of MRV systems.

Keywords

Climate change mitigation; greenhouse gases; agricultural practices

About the authors

Rishi Basak is an independent consultant with 20 years of experience working as an analyst and manager in the public and private sectors. He has worked on and contributed to projects in Canada, Chile, China, Colombia, Ghana, India, Mexico, and the United States.

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Contents

Acronyms

AWD	Alternate wetting and drying
BUR	Biennial Update Report (of the UNFCCC)
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CDM	Clean Development Mechanism
GHG	Greenhouse gas
GIS	Geographical information system
GIZ	German Agency for International Cooperation
IPCC	International Panel on Climate Change
LED	Low emissions development
MRV	Monitoring, reporting, and verification
N	Nitrogen
NAMA	Nationally Appropriate Mitigation Action
QA/QC	Quality assurance/quality control
REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation
tCO_2e	Metric tonne of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change
$	United States dollar

1. Introduction

This report is a key component of a CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) project on financing low emissions agriculture. The project gathers empirical evidence and analyzes the finance needed to build business cases for supporting transitions to low emissions agriculture in developing countries. The present report describes key monitoring, reporting, and verification (MRV) requirements and corresponding implementation costs for a selection of low emissions agricultural technologies.

The report is organized as follows. Section 2 describes the approach used to undertake this study, and section 3 is a brief background that describes and provides contextual information for MRV, using Nationally Appropriate Mitigation Actions (NAMAs) as one example of a policy context requiring MRV. Section 4 describes specific NAMA MRV requirements, and section 5 estimates the cost of meeting them. Section 6 offers conclusions and recommendations. Annex 1 presents the interview notes. At the end of the report section 7 contains a list of cited references.

2. Approach

This report is based on a desk review of literature and expert interviews. The author reviewed grey and academic literature, including existing NAMA documents, to determine MRV requirements and estimate the corresponding implementation costs. To fill information gaps and validate some of the cost estimates, the author contacted experts in MRV. Best judgment was also used to estimate the time required to complete tasks required by the various MRV system components, based on past experience undertaking similar work and managing consultants who have undertaken similar work.

Please note that all amounts included in this study are in 2014 United States dollars ($) unless stated otherwise.

3. Background

Value of MRV

Measurement and MRV are key elements of credible greenhouse gas (GHG) reduction initiatives. A robust MRV system enables implementing entities to track progress, transparently report results to interested parties (including donors), and verify that the information is correct or quality assured. Outputs from a good MRV system can be used to compare GHG reduction projects, share good practices, and support learning. Having an MRV system is mandatory for all climate finance initiatives, including NAMAs. A strong MRV system may also attract additional finance (GIZ 2013).

Specific context for MRV

Climate finance initiatives have been developing over the last decade. Though representing only 2% of climate finance for mitigation in all sectors, $6 billion in climate finance was allocated to agriculture, forestry, land use, and livestock management in 2013 (Buchner et al. 2014). Most of the funding is public, and a leading mechanism is the NAMA. In 2007 at the 13th United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties in Bali, a decision was made to enhance mitigation actions via NAMAs "...by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner" (UNFCCC 2007). NAMAs can be undertaken by a country on its own (unilateral/ domestically supported NAMAs) or with international support (internationally supported NAMAs).[1] Such support often includes capacity building, finance, or technology. For NAMAs that are financed in whole or in part by developed countries, expectations for MRV components range from Tier 1 to 2 data quality. Tier 1 data use International Panel on Climate Change (IPCC) default factors (IPCC 2006), and Tier 2 uses a more sophisticated approach that includes country-specific data from studies (Lipper et al. 2011). Table 1 shows details about the tiered approach to MRV.

Table 1. Tiered approach to MRV

Tier	Definition	Applications
1	Basic approach using IPCC default factors when no country-specific peer-reviewed studies available	Sectoral or project-level mitigation potential studies, tools like EX-ACT are based on this approach
2	Intermediate approach using data from studies (e.g., modeled/estimated) reflecting national circumstances	State-of-the-art reporting standard for national-level GHG inventories
3	Most sophisticated approach using validated models and/or direct measures of stock change through monitoring networks	Required by CDM and VCS for project-based mitigation actions

Source: Modified from IPCC 2006.

Winkelman et al. (2011) noted that metrics and indicators are decided bilaterally as appropriate to national circumstances, the nature of the NAMA, and the particular needs of

[1] A third type of NAMA is under discussion: Credit-Generating NAMAs, whereby actions would produce credits for sale in the global carbon market, similar to the Clean Development Mechanism (CDM). See Sawyer et al. (2013).

the donor and host countries in cases of bilateral MRV agreements between NAMA host countries and NAMA financial supporters. Reporting also occurs bilaterally. In the case of international MRV provided through the UNFCCC process, the international negotiating community decides on the required metrics, data, and indicators. They are reported in Biennial Update Reports (BURs) of national communications, which contain the national GHG inventories. Standards for MRV reporting in the UNFCCC context tend to be more rigid than those used in bilateral MRV agreements.

4. MRV requirements

This section outlines the MRV requirements for NAMAs as an example of a climate finance mechanism for mitigation in agriculture. Outputs from the MRV system would also help to inform the UNFCCC BURs process, which includes specifics about mitigation actions. Table 2, based on a document produced by the German Agency for International Cooperation (GIZ 2013), provides a high-level overview of the essential elements of an MRV system.

Table 2. Essential elements of an MRV system

	Measure/Monitor	Report	Verify
What to...	• Activity data • Emissions, where possible	• Description of NAMA activities • Assumptions and methodologies • Objectives of the actions and information on progress	• Emissions reductions • Other sustainable development indicators (e.g., no. participating farmers)
How to…	• Emission factors	• National-level reporting procedures (i.e., BURs to UNFCCC) • NAMA-level reporting procedures, to be determined	• BURs to be verified by international experts • NAMA-level verification, to be determined
Who should ...	• NAMA implementer	• NAMA implementer	• NAMA supporter (national and/or international) and/or third party verifier
When to...	• Performance monitoring annually • Baseline updates every 3-4 years	• National level, every 2 years • NAMA level, to be determined (likely annual)	• National level, every 2 years • NAMA level, to be determined

But what does this entail in terms of on-the-ground implementation? The following subsections offer a “to-do” list for the MRV system, based on advice provided by GIZ (2013).

4.1 Establishing baselines and scenarios

The MRV system for low emissions agriculture should be based on standardized baselines using the following guidelines (GIZ 2013):

- Baselines for rice (one for Bangladesh and another for Vietnam) could be modeled after the baseline developed for the NAMA Option for the Rice Sector in the Philippines, which entailed Philippines-specific default values (GoP 2014).[2] In the Philippines NAMA, the default emission factors provide the value of emissions in kilograms of methane per hectare per season (kg CH_4/ha/season).
- Another set of baselines needs to be developed for nitrogen (N) fertilizer management, per crop and per country.[3] These baselines must be submitted to the UNFCCC Secretariat for review and approval.
- Using the same approach as the calculation of baseline emissions and determination of baseline emission factors, project emission factors and emission reduction factors would also need to be determined (i.e., with NAMA scenario).

4.2 Measurement/monitoring requirements

A data management system would need to be established to identify and record measurable data from different sources. The data management system must accommodate different sets of indicators, use well-documented and standardized methodologies, and enable timely data delivery. The following guidelines describe attributes of the system:

- A central organization should be designated for compiling and evaluating information received through the data management system.
- Roles and responsibilities for various partners involved in the data collection would need to be clearly identified and documented.
- The system should conduct measurements on a regular basis (e.g., every year for the purposes of the national inventory system, every two years for UNFCCC, and upon agreement in the case of bilateral arrangements).
- Monitoring parameters and compliance.[4]

[2] The default values were derived from the results of a Global Environment Facility-funded project on GHGs from rice cultivation led by the International Rice Research Institute and Philippine Rice Research Institute in the late 1990s.

[3] A current CCAFS low emissions agriculture project (Project P22-FP3-CIMMYT), led by the International Maize and Wheat Improvement Centre, and especially activity P22A128 ($960,000 over 2015–2017), will provide crucial data and information to help establish baselines for wheat- and maize-based systems in India and Mexico.

[4] This section has been taken almost verbatim from NAMA option for the rice sector in the Philippines (GoP 2014).

- With the simplified approach of using emission factors for the calculation of GHG emission reductions associated with the NAMA, the only parameter requiring monitoring is the area where alternate wetting and drying (AWD) is actually applied and to confirm drying periods. Monitoring nitrous oxide would also require knowing the amount and timing of fertilizer used in conjunction with irrigation management.
- The aggregated project area in a given season or year could be determined by collecting the project field sizes in a project database. The size of project fields could be determined by Global Positioning System or satellite data. If such technologies are not available, established field size measurement approaches could be used.[5]

To determine whether the participating rice fields are correctly applying AWD, the following protocol could be used:

- Cultivation logbook could be used and maintained, with the following information collected: sowing (date); fertilizer, organic amendments, and crop protection application (date and amount); water regime on the field (e.g., "dry/moist/flooded") and dates where the water regime is changed from one status to another; and yield.
- Statement from farmers that they have followed recommendations provided.
- Ensure that only those farms that actually comply with the project cultivation practice are considered.

Further, a database should be established to contain data and information that allow identification of participating rice farms, including name and address of the rice farmer, size of the field and, if applicable, additional farm-specific information. The database and the compliance system would need to be established by the NAMA implementer. Irrigators' associations, local nongovernmental organizations, or other appropriate entities could collect the data and forward the data to the NAMA implementer.[6] Government entities would utilize the compliance data in the national statistics and provide additional support for this component of MRV, if needed.

In addition to GHG emissions, an MRV system would need to monitor additional sustainable development co-benefits. These could include food security benefits (tons of cereal produced), adaptation benefits (e.g., access to reliable irrigation, water usage), economic benefits (e.g.,

[5] USAID Feed the Future (2013) produced a comprehensive protocol for such measurements.

[6] NAMA implementers would need to determine which organization/entity would be best placed to undertake such collection, based on field presence/availability, capacity, and cost considerations.

increase in revenues), and technology adoption (e.g., percent agricultural land area where AWD was adopted).[7]

In terms of structure and responsibility, the number of hectares where AWD is adopted and other sustainable development indicators would be collected by the irrigators' association, local nongovernmental organizations, or other entities.[8] This information would then be forwarded to the implementer for data processing, aggregation, and archiving.

4.3 Reporting requirements

Various reporting mechanisms (e.g., BURs submission guidelines, specific donor reporting requirements) should be followed for form and methodology. A central organization should be designated for reporting to the UNFCCC, donors, and the national government.

4.4 Verification requirements

A quality assurance/quality control (QA/QC) plan must be developed and include the following elements (UNFCCC 2013):

- Peer or technical review of source data and methodologies and provisions for public and/or relevant stakeholder input and review if applicable.
- Identification and review indicators that are capable of "verifying" results (e.g., production volume of targeted entity).
- Routine QC checks of activity data, calculations, emission factors, and other estimation parameters and methods, including procedures for correction if the QC checks identify errors.
- Additionally, the following verification actions would be required:
    - External verification process for the information reported on in the activity receiving climate finance.

[7] USAID (2013) produced a comprehensive guide for such indicators, including a data collection protocol.

[8] In the case of MRV in the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (REDD) program in Indonesia, for example, field data are collected at the provincial level through 19 decentralized offices of their Ministry of Forestry, which acts as the data collection hubs. A Central Management Unit, composed of a head and five technical officers, coordinate the work of staff in these 19 offices. Technical officers have project management experience, in addition to excellent communication and technical knowledge of forest inventories and plot sampling (UN-REDD Program Indonesia 2011).

- At the international level, BURs are subject to the process of international consultation and analysis.[9]
- Verification of information by different organizations and different stages of the MRV framework, including application of transparency, completeness, consistency, comparability, accuracy criteria.

5. MRV implementation costs

5.1 Cost to generate baselines

Generating baselines is a key cost component. To follow the guidelines described in the section above, an expert would need to be hired to generate the baselines using secondary data sources. The expert would need to work with country officials to determine which emission factors to use and which technologies to include in the LED proposal. Project emission factors and emission reduction factors would also need to be determined (i.e., the "with project scenario"). It is estimated that this work could be completed at a cost of $50,000–$75,000 each for Bangladesh and Vietnam, assuming that the "with project scenario" is focused on AWD only. For India and Mexico, the cost would likely be higher due to the greater number of technologies to be included (i.e., N sensors, plus perhaps a few more). As such, a conservative cost estimate is $100,000–$150,000.[10] This would include the cost of updating baselines every 3–4 years. This assumes the work would take at most 125 days to complete for Bangladesh and Vietnam and 250 days for India and Mexico, at a daily rate of $600 for an international expert.[11]

[9] The two-step process for international consultation and analysis consists of (1) technical analysis of BURs by a team of technical experts and initiated within six months of submission, and (2) facilitative sharing of views among parties. This process aims to enhance the transparency and accountability of information reported in BURs by non-Annex I Parties. (Additional information is available from: http://unfccc.int/national_reports/non-annex_i_natcom/cge/items/8621.php).

[10] If more technologies are implemented in Bangladesh or Vietnam, the cost estimate would also be $100,000–$150,000.

[11] Based on 1.5 times average salary of a senior climate change analyst in the U.S.: $99,000 according to payscale.com.

5.2 Cost of measurement/monitoring

Database

As mentioned in section 4, a database will need to be developed to store and manage all data collected to monitor the extent and impact of implementation of each LED project. A standalone database with key fields relevant to the given LED project could cost under $5,000 to develop in Bangladesh, India, and Vietnam,[12] especially if developed locally and hosted on a single desktop PC using an MS-Access platform. This basic, standalone database could cost below $20,000 in Mexico.[13] This assumes a medium level of complexity and a development, training, and troubleshooting time period of about six months.

For a database accessible to several users, or even online, it would need to be installed on a server with sufficient capacity and a more sophisticated platform (e.g., Oracle, MySQL, Microsoft SQL Server), driving up the cost to over $60,000,[14] assuming medium complexity and a development, training, and troubleshooting time of about six months using an international expert.[15] Costs would be lower if the data fields could be included in an existing database (e.g., from a participating ministry), although this may involve more transaction costs (i.e., negotiation, coordination, contracting, etc.). It would avoid costs associated with front-end design, testing, set up, user training, troubleshooting, and fixing bugs.

To estimate the cost of the annual measurement of the number of hectares under a given technology (e.g., AWD), various sources of information are acceptable. For example, the data could be collected via traditional field surveys, using more sophisticated methods such as portable tablets or even remote sensing.

Remote sensing: A UNFCCC technical paper (2009) analyzed the cost of satellite-based monitoring systems. They found that Archived Landsat and CBERS satellite images for mapping units of 0.5–5.0 ha are available free of charge. CBERS-2 and HRCCD, at a 20-m resolution and coverage, are also free of charge for developing countries. For India, imagery can be acquired at $300 per scene of the Advanced Wide Field Sensor. In addition, the study

[12] In India, a database developer earns an average annual salary of Rs 408,020 ($6,246), according to payscale.com and $24,136 in Mexico (salaryexplorer.com). It is assumed that a database developer would charge 1.5 times the average annual salary.

[13] This is estimated simply by adjusting for the differential in database developers' annual salaries between India and Mexico (i.e., 3.86 times higher in Mexico).

[14] Very complex databases can cost well over $500,000. See, for instance, this tender notice for database development and training: http://www.cleansky.eu/sites/default/files/documents/calls/gmt/GMT%20Tender%20Specifications.pdf.

[15] The average database developer's annual salary in the United States is $80,000 according to glassdoor.com, with a median salary of $72,000 according to payscale.com. The salary range for database developers in the United Kingdom is $58,507–$89,711. It is assumed that a database developer would charge 1.5 times the average annual salary.

pointed out that there are also costs for supplying technical and office resources and that these should not exceed $120,000–$150,000, even in larger countries. The study also indicated that an annual budget would be needed for operational costs and maintaining hardware and software needs, although they did not estimate the cost for that component.

William Salas, a remote sensing expert who is currently undertaking work on GHG emissions from paddy rice, has developed a rice GHG model that is being used in the United States for compliance markets. The required inputs for his model are data on daily weather, soil characteristics, and management practices.

A geographical information system (GIS) database with information stored at the regional and national levels underpins the model Salas is using. The model can be used at various levels of detail, from "what-if" scenarios at the national level to emissions trading. The model uses national census and remote sensing data that are calibrated with mobile applications. Pictures are taken in the field and additional field-level data are gathered and geo-tagged, including information on management practices (e.g., bailed straw on a given day). That richness of detail is required for emissions trading, but not at lower MRV tiers.

Remote sensing and GIS experts would need to determine whether remote sensing approaches are a viable option for MRV purposes, based on the specific low emissions or climate finances project. Although no comprehensive cost estimates are available for such approaches, it seems likely they would be too expensive and more accurate than needed for a Tier 1 MRV system.

Survey-based data collection: A traditional survey-based approach could be used to collect required monitoring data. This would entail establishing a field size measurement methodology, and data would be recorded in farmers' logbooks then collected by responsible entities via site visits. This approach is used for the Philippines rice sector NAMA.

The costs of manual measurement and data collection can be estimated by looking at existing data collection costs in developing countries. GIZ (nd) discussed survey and sampling. Leisher (2014) compared tablet-based and paper-based survey data collection methods and found that tablet-based surveys cost $13 per interview question (for 104 questions) compared with $51 per interview question for paper-based surveys (for 83 questions).[16] Using this information and a sample of 384 locations—300 samples were mentioned in UNFCCC guidance (2009)—the costs would be $5,000–$20,000, depending on whether the collection is

[16] This included enumerator fees, supervisor fees, enumerator and supervisor training, pre-testing, data entry costs, data cleaning costs, and survey materials.

done via paper or tablet-based surveys.[17] A sample of 384 would provide a 95% confidence level and a margin of error of 5% in all target countries.[18]

Cultivation logbook

To ensure that all data collected by farmers are standardized, each participating farmer should be given a cultivation logbook and be shown how to use it. At a printing and distribution cost of $0.12 per logbook,[19] the cost would be $464,000 in Bangladesh and $160,000 for Vietnam.[20] Distributing the logbooks to farmers' associations (or other entities responsible for data collection) and training them to explain their use to farmers will decrease costs and increase the effectiveness of the intervention.

In India, 77 million ha are under rice, wheat, and maize production, and the average farm size is 1.37 ha (Dev 2012). If we assume that one-third of the farmers (18.5 million)[21] could be reached as part of an LED program on N fertilizer management, this would mean a cost of $2.2 million for printing and distributing logbooks.

Farm sizes are larger in Mexico. Although no official estimates exist, over one million farmers are likely engaged in maize, wheat, and rice production in the country, extrapolated from Salinas Álvarez (2006) and Puyana and Romero (2008). Assuming half the estimated number of farmers could be reached as part of an LED program on N fertilizer management, $60,000 would be needed for printing and distributing logbooks.

5.3 Cost of reporting

Reporting guidelines/protocol

The development of tailored reporting guidelines/protocols for each country written in the appropriate languages would be low. Indeed, the initial guidelines would likely cost under $18,000 to develop and could be used to develop guidelines for other countries, where the

[17] With fewer than 10 questions to pose for annual data collection required for the MRV, including questions related to the sustainable development indicators, it is safe to assume that the costs would likely be lower than what Leisher et al. found.

[18] Using the sample size calculator available at http://www.raosoft.com/samplesize.html, any population size above 130,000 would require a sample of 384 for a 95% confidence level and a margin of error of 5%.

[19] This is based on full-color booklet printing rates in India (http://www.meraprint.com/booklet-printing/booklet-printing-1).

[20] The target population is estimated based on the total number of hectares reached under the "aggressive diffusion scenario" in Basak (2016), divided by the average farm size. Average farm size for Bangladesh is from Thapa and Gaiha (2011), and for Vietnam it is from Nguyen (2010). In Bangladesh the estimated number of logbooks to be printed is 3.87 million (1.935 million ha at 0.5 ha/farm). In Vietnam, 1.33 million logbooks would need to be printed (3.06 million ha at 2.3 ha/farm).

[21] Estimated number of farmers is based on 77 million ha with 1.37 ha/farm = 56 million.

main cost would be translating into the appropriate language(s). This assumes the work would take at most 30 days to complete, at a daily rate of $600 for an international expert.[22]

Producing reports

High quality reporting guidelines/protocol would reduce costs of drafting the appropriate reports for reporting to the UNFCCC, donors and national governments. Cost estimates for writing the various reports are under $18,000 per year. Assuming biennial reporting frequency at the national level and annually to the donor, the work would take at most 30 days to complete, at a daily rate of $600 for an international expert.[23]

5.4 Cost of verification

QA/QC plan

Developing the first QA/QC plan would likely cost under $20,000, since the plan would be of low complexity. This assumes the work would take a maximum of 30 working days to complete, at a daily rate of $90 for a local expert[24] and $615 for an international expert.[25] It is likely that the first QA/QC plan could serve as a template for the others, thus reducing costs for other LED programs.

Peer or technical review

A peer or technical review could be undertaken using a combination of local and international experts. They would review source data and methodologies the first year and every three to four years thereafter. This process could be done for under $5,000, assuming most reviewers can undertake the work for free, as is the case for UNFCCC technical analyses and academic peer reviews.

Routine quality control

Routine (at least annual) QC checks of activity data, calculations, emission factors, and other estimation parameters and methods could be done using a combination of CGIAR, local, and international experts. This process could be undertaken for under $10,000, assuming the

[22] Based on 1.5 times average salary of a senior U.S. climate change analyst ($99,000) according to payscale.com.

[23] Based on 1.5 times average salary of a senior U.S. climate change analyst ($99,000) according to payscale.com.

[24] Based on 1.5 times average salary of a university professor in India, Rs 958,269 ($14,718) according to payscale.com.

[25] Based on 1.5 times average salary of a U.S. management consultant ($102,000) according to payscale.com.

process would take a maximum of 15 working days to complete, at a daily rate of $90 for a local expert[26] and $600 for an international expert.[27]

External verification

An external verification process for the information reported on the NAMA is required under UNFCCC rules. The UNFCCC Secretariat and a technical expert (consultant) for the UNFCCC were contacted (July 13, 2015) to obtain more information on the cost of this process. The UNFCCC responded that experts undertake the technical analysis without charging for labor (they are only paid travel costs and per diems, if applicable). It is also possible for the nominating party government to pay these experts for the external verification if more help is required. As such, it can be reasonably expected that the external verification process would cost under $10,000/year, as it would mostly entail CGIAR and government employee time, with perhaps an international expert hired for three weeks at a daily rate of $600.[28]

5.5 Summary of results

Table 3 summarizes the MRV system costs from up-front setup costs required in the first year to ongoing costs that would need to be disbursed on an annual basis.

Table 3. Summary of MRV system costs*

MRV SYSTEM COST ELEMENTS	Bangladesh	India	Mexico	Vietnam
AREA COVERED (ha)	**215-1,935**	**3,500-14,100**	**399-1,600**	**340-3,060**
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Developing database	$5-$60	$5-$60	$20-$60	$5-$60
Printing and distribution of cultivation logbooks	$464	$2,200	$60	$160
Development of reporting guidelines	< $18	< $18	< $18	< $18
Development of QAQC plan	< $12	< $12	< $12	< $12
TOTAL SETUP COSTS	**$549-$629**	**$2,340-$2,440**	**$210-$300**	**$245-$325**
Ongoing (Annual) Costs				
Measurement of number of hectares with adoption and sustainable development indicators, training, and data entry	< $20	< $20	< $20	< $20
Report to the UNFCCC	< $10	< $10	< $10	< $10

[26] Based on 1.5 times average salary of a university professor in India, which Rs 958,269 ($14,718) according to payscale.com.

[27] Based on 1.5 times average salary of a senior U.S. climate change analyst ($99,000) according to payscale.com.

[28] Based on 1.5 times average salary of a senior U.S. climate change analyst ($99,000) according to payscale.com.

MRV SYSTEM COST ELEMENTS	Bangladesh	India	Mexico	Vietnam
Peer or technical review of source data and methodologies	< $5	< $5	< $5	< $5
Routine quality control of activity data, calculations, emission factors, etc.	< $10	< $10	< $10	< $10
External verification process for the information reported on the NAMA	< $10	< $10	< $10	< $10
TOTAL ANNUAL COSTS	**< $55**	**< $55**	**< $55**	**< $55**
TOTAL COST OVER 20 YEARS	**$1,600-$1,700**	**$3,400-$3,500**	**$1,300-$1,400**	**$1,300-$1,400**
TOTAL COST/TON OVER 20 YEARS	**$0.05-$0.45**	**$0.05-$1.25**	**$0.30-$1.05**	**$0.01-$0.10**

*Costs are shown in thousands (000s) of USD.

Overall, the MRV system development and setup costs could range from $245,000 to $2.44 million, whereas ongoing implementation costs could be under $55,000/year. MRV system costs vary significantly based on the area covered by the LED program. The larger the area covered, the greater the number of participating farmers, and therefore the greater the cost of printing and distributing cultivation logbooks (a key component of data collection) will be. Cultivation logbooks account for over two-thirds of all first-year costs and can reach $2.2 million in the case of India, where reaching one-third of farmers means over 18.5 million logbooks would be required.

These cost estimates can be compared to cost figures found in the grey and academic literature for the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+), the Clean Development Mechanism (CDM), and other carbon trading projects. However, it must be noted that MRV costs are quite project specific, as they depend on the sophistication of the approach chosen (i.e., Tier 1 to 3) and the scopes included in the MRV scheme (e.g., scope 1, 2, or 3).[29] Unfortunately, the literature reviewed did not provide enough granularity or disaggregated data to isolate the cost elements relevant to the four estimates found in table 3 above.

For instance, UNFCCC (2009) found that the average cost to design an MRV system for REDD implementation was $1 million. Documentation for the Indonesia REDD program shows that the full cost of implementation is $4.9 million, with $1.77 million allocated to "improved capacity and methodology design for forest carbon inventory within a Monitoring, Assessment, Reporting and Verification System (MARV), including sub-national pilot

[29] Scope 1 emissions are most crucial in the NAMA context per accepted GHG accounting protocols, as these are the emissions avoided by the project/program in a direct fashion. Scope 1 emissions are direct emissions produced on site (e.g., through the direct burning of fuel). Scope 2 emissions are indirect GHG emissions, such as those from consumption of purchased electricity, heat, or steam. Scope 3 emissions include all other indirect emissions, such as emissions included in the production and transportation of fertilizer.

implementation" for under $500,000/year for the first two years (UN-REDD 2009 p. 32). The program also allocated $300,000 the first year and $150,000 the following year to the development of a "reference emissions level," including the development and peer review of a methodology and stakeholder consultations. It must be noted that MRV requirements for REDD are more demanding than those required by a NAMA at a Tier 1 level.

Bellasen et al. (2015) found the MRV costs for CDM-offsets projects were $0.63/tCO_2e$ reduced.[30] They included the complete development and implementation of MRV systems for CDM projects, ranging from Tier 1 to 3 and scopes 1 to 3. Antinori and Sathaye (2007), in a project commissioned by the U.S. government to assess the transaction costs associated with GHG trading, found that the weighted average cost of MRV was $0.05/tCO_2e$ in 2002 ($0.07 in US 2014), including setup and ongoing operating costs.[31] Applying the Antinori and Sathaye cost figure to the MRV systems in the four focus countries in this study results in the following estimated costs:

- Bangladesh: 1.8 million tCO_2e x $0.07 = $126,000;
- Vietnam: 12.2 million tCO_2e x $0.07 = $854,000;
- India: 22.9 million tCO_2e x $0.07 = $1.6 million;
- Mexico: 0.77 million tCO_2e x $0.07 = $53,900.

It must be noted that the Antinori and Sathaye study (2007) included several energy-efficiency, fuel switching, and renewable energy projects, which use emission factors to generate emission reduction estimates as part of its MRV. These types of projects also use data centrally collected by utilities (e.g., kilowatt hour of electricity consumed, cubic meter of gas purchased), which further reduces MRV costs. As the MRV system envisaged for low emissions agriculture projects would not benefit from such easily available data, the data collection costs will be higher.

Although little information on Tier 1 MRV implementation costs is available in the public domain, the few cost estimates found for existing mitigation projects, including NAMAs, were lower than those for REDD and CDM. For instance, the first-year cost for the development of the various MRV platforms for mitigation projects in Chile were $73,412–$106,908 (GoUK 2015), whereas the NAMA for the Self-Supply Renewable Energy project in Chile had a total budget for administration and MRV of $1 million (UNFCCC 2012).

[30] Some MRV costs were at the national level, and others were at the project level.

[31] This was for 26 projects ranging from forestry, energy efficiency, fuel switching, to renewables. This covered scope 1 emissions only.

Alternatively, the NAMA for sustainable housing in Mexico allocated $800,000 toward MRV development for the first year and $241,000/year for the ongoing implementation of the MRV.[32]

6. Conclusion and recommendations

Key MRV system requirements were determined in order to develop a preliminary estimate of the implementation costs for a Tier 1 MRV system for LED projects, using agricultural NAMAs in Bangladesh, India, Mexico, and Vietnam as case studies. The most expensive cost item was found to be the distribution of cultivation logbooks to all participating farmers, as it accounts for over two-thirds of all first-year costs and can reach $2.2 million in India, where reaching one-third of farmers requires over 18.5 million logbooks. An alternative to a printed paper booklet to record key cultivation data in a standardized fashion throughout the project's life cycle could help to drive down this cost. A second important cost component is baseline generation, which could range from $50,000 to $150,000, assuming an expert is hired to generate the baselines using secondary data sources.

Annual monitoring costs could be kept low by using a random sample of 384 participating farmers to collect data on field size and sustainable development indicators (e.g., tonnes yield produced, water usage, revenues). Even if collecting this information by sending enumerators in the field with paper surveys (at a data collection and entry cost of $51 per survey), costs could be kept below $20,000/year.

Overall, the MRV system development and setup costs range between $245,000 and $2.44 million, whereas the ongoing implementation costs could be under $55,000/year in all four countries studied. To keep MRV costs low, it is advantageous to make as much use of existing data-gathering and management systems as possible. Partnerships with domestic institutions and implementing partners would therefore be crucial, as they may have systems and resources in place that LED program implementers could utilize to help drive down costs and increase the quality of the MRV system.

Finally, as LED projects (including NAMAs in the development or implementation phases) share lessons and documentation,[33] implementers will be able to compare actual and proposed

[32] This is for a NAMA that would reduce 2.1 million tCO_2e/year once fully implemented, with a total budget of $3.13 billion. See: http://www.perspectives.cc/typo3home/groups/15/Publications/NAMA_Design_Mexico_Working_Paper.pdf.

[33] For instance, through established information portals (e.g., http://www.nama-database.org, http://www.nama-facility.org/projects/portfolio.html) and on the UNFCCC NAMA Registry and http://www4.unfccc.int/sites/nama/SitePages/Home.aspx.

MRV systems and better assess the resource requirements and acceptable funding requests for MRV components of LED projects.

Annex 1. Interview notes

Interviewee: William (Bill) Salas

April 14, 2015, 10:00 AM Mexico City via Skype

Rishi Basak provided with a brief overview of the CCAFS study on financing low emissions agriculture to set the context for the interview. Rishi explained that a key component of the project was to determine monitoring, reporting, and verification (MRV) requirements and corresponding costs of various greenhouse gas (GHG) mitigation technologies in paddy rice production in Bangladesh and Vietnam and nitrogen fertilizer management in India and Mexico. Rishi described the tiered approach to MRV and the project's interest is in the context of Nationally Appropriate Mitigation Action (NAMA).

Question 1: What would it take to put in place an MRV system for paddy rice in Bangladesh and Vietnam? How is the context different in each country?

Bill mentioned that there are several projects related to rice GHG monitoring, including on AWD and other technologies such as residue management. The rice GHG model he developed is being used in the U.S. for compliance markets, which require a high level of sophistication/accuracy. He described the technical aspects of the model and that it can be used at the field level or regional level. The required inputs are daily weather data, data on soil characteristics, and management practices. A GIS database underpins the model, with information stored at the regional and national level. The model can be used at various levels of detail, from "what-if" scenarios at the national level, to emissions trading.

Bill mentioned that the use of census data is not sufficient so they have employed remote sensing to complement the model. He has a pilot project underway in a province of Vietnam to help calibrate the model. In addition, he has submitted a proposal to obtain funding from NASA for remote sensing. The remote sensing is then calibrated with mobile applications, whereby pictures are taken in the field and additional field-level data are gathered and geo-tagged, including information on management practices (e.g., bailed straw on a given day). That richness of detail would be required for emissions trading, but not at lower MRV tiers.

One of the major costs is to characterize uncertainty, for which field-level data on methane and nitrous oxide are needed.

In Vietnam, Bill used various data sets, obtained through discussions with many different groups. As government ministries often do not share information among each other, this increases the costs of MRV. In addition to existing data sets, for which data quality was extremely varied, some additional data were needed. Bill mentioned monitoring work being funded by the World Bank and a workshop on measurement of GHGs in Vietnamese rice production. Bill's sense is that there is strong interest by the Ministry of Agriculture and universities in Vietnam to undertake MRV to support NAMAs and the UNFCCC process. Bill also mentioned that the BioCarbon Fund at the World Bank is evaluating the quality of GHG data for Vietnam's agriculture sector.

Bill's sense is that much less work has been done in Bangladesh, but stated that he would need to make further enquiries to determine the status in that country, as his focus has been mainly on Vietnam. He believes some data likely exist, but more work will be required than in Vietnam.

Question 2: What are the largest cost items in setting up an MRV to support a NAMA for rice GHG mitigation?

Bill mentioned that an important cost is investment in capacity building—the tech transfer component. He stated that the Ministry of Agriculture is currently hosting the system and is interfacing with the Ministry of the Environment (which liaises with the UNFCCC). He opined that a stand-alone institution should be created to coordinate GHG measurement for multiple crops (i.e., maize, soybeans, sugarcane and rice), all using the same tool, model, or remote sensing methodology.

Question 3: If you could do it over again, how would you proceed?

Bill would invest more up-front time in understanding the key institutional players and seeking their buy-in. Different institutions have different incentives, and they do not necessarily speak to each other or share data. Bill said that data collection needs to be systematic and consistent, with a measurement program that is targeted to get information for modelling and model evaluation, as opposed to gathering information as an end in itself. The model he developed is very sophisticated and can be used as a "meta-model" with key drivers for a NAMA.

7. References

Antinori C, Sathaye J. 2007. Assessing transaction costs of project-based greenhouse gas emissions trading. Berkeley, California: Lawrence Berkeley National Laboratory.

Basak R. 2016. Benefits and costs of climate change mitigation technologies in paddy rice: Cases of Bangladesh and Vietnam. CCAFS Working Paper no. 160. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: www.ccafs.cgiar.org

Buchner B, Stadelmann M, Wilkinson J, Mazza F, Rosenberg A, Abramskiehn D. 2014 The Global Landscape of Climate Finance 2014. Climate Policy Initiative. (Available from: http://climatepolicyinitiative.org/wp-content/uploads/2014/11/The-Global-Landscape-of-Climate-Finance-2014.pdf)

Dev SM. 2012. *Small farmers in India: challenges and opportunities*. Mumbai: Indira Gandhi Institute of Development Research. (Available from: http://www.igidr.ac.in/pdf/publication/WP-2012-014.pdf)

[GIZ] German Agency for International Cooperation. No date. *MRV measurement, reporting, verification: how to set up national MRV systems, draft 4.1*. (Available from: http://mitigationpartnership.net/sites/default/files/u1585/mrv-tool-20-10-2014.pdf)

[GIZ] German Agency for International Cooperation. 2013. Measurement, reporting and verification (MRV) of NAMAs. Proceedings of the regional workshop on promoting international collaboration to facilitate preparation, submission and implementation of NAMAs held in Maseru, Lesotho 16–19 April 2013. (Available from: https://unfccc.int/files/cooperation_support/nama/application/pdf/mrv_of_namas_-_giz.pdf)

[GoP] Government of the Philippines Department of Environment and Natural Resources. 2014. *Design of an adaptation oriented NAMA option for the rice sector in the Philippines*. (Available from: http://procurement-notices.undp.org/view_file.cfm?doc_id=34218)

[GoUK] Government of the United Kingdom Foreign and Commonwealth Office and British Embassy Santiago. 2015. *Mitigating climate change with Chile.* (Available from: https://www.gov.uk/government/priority/mitigating-climate-change-with-chile)

[IPCC] International Panel on Climate Change**.** 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Prepared by the National Greenhouse Gas Inventories Programme. Eggleston HS, Buendia L, Miwa K, Ngara T, Tanabe K, eds. Hayama, Japan: IGES.

Leisher C. 2014. A Comparison of tablet-based and paper-based survey data collection in conservation projects. *Social Sciences* 3(2): 264–271.

Lipper L, Neves B, Wilkes A, Tennigkeit T, Gerber P, Henderson B, Branca G, Mann W. 2011. Climate change mitigation finance for smallholder agriculture: a guide book to harvesting soil carbon sequestration benefits. Rome: Food and Agriculture Organization of the United Nations.

Nguyen K. 2010. Country Presentation: Vietnam. Presentation by Khiem Nguyen, Faculty of Economics, An Giang University. Cash Crop Conference, May 9–13, 2010, Perth, Australia. (Available from: http://www.agribenchmark.org/fileadmin/Dateiablage/B-Cash-Crop/Conferences/2010/Presentations/Vietnam_Nguyen.pdf)

Puyana A, Romero J. 2008. Diez años con el TLC: Las experiencias del sector agropecuario mexicano. México, DF: Colegio de México/FLACSO.

Salinas Álvarez S. 2006. *Demanda educativa de la población jornalera migrante: Estadísticas y conceptos.* México, DF: Secretaría de Educación Pública, Coordinación General De Educación Intercultural y Bilingüe.

Sawyer D, Dion J, Murphy D, Harris M, Stiebert S. 2013. Developing financeable NAMAs: a practitioner's guide. Winnipeg: IISD.

Thapa G, Gaiha R. 2011. Smallholder farming in Asia and the Pacific: Challenges and opportunities. Presentation at IFAD Conference on New Directions for Smallholder Agriculture (vol. 24, p. 25). (Available from: https://www.ifad.org/documents/10180/1055d470-65d1-48d0-815e-02d62ea87d86)

[UNFCCC] United Nations Framework Convention on Climate Change. 2007. Bali Climate Change Conference – Decisions. (Available from: http://unfccc.int/meetings/bali_dec_2007/meeting/6319/php/view/decisions.php)

[UNFCCC] United Nations Framework Convention on Climate Change. 2009. Cost of implementing methodologies and monitoring systems relating to estimates of emissions from deforestation and forest degradation, the assessment of carbon stocks and greenhouse gas emissions from changes in forest cover and the enhancement of forest carbon stocks. UNFCCC Technical paper. (Available from: http://unfccc.int/resource/docs/2009/tp/01.pdf)

[UNFCCC] United Nations Framework Convention on Climate Change. 2012. *NAMA seeking support for implementation: Expanding self-supply renewable energy systems (SSRES) in Chile.* (Available from: https://unfccc.int/files/cooperation_support/nama/application/pdf/nama-seeking-support-for-implementation-re-chile-dic-2012.pdf)

[UNFCCC] United Nations Framework Convention on Climate Change. 2013. Views on the general guidelines for domestic measurement, reporting and verification of domestically supported nationally appropriate mitigation actions by developing country Parties. p. 3–6. (Available from: http://unfccc.int/resource/docs/2013/sbsta/eng/misc07.pdf)

[UN-REDD] United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation. 2009. Standard joint program document: Indonesia. (Available from: http://www.un-redd.org/Portals/15/documents/events/20090309Panama/Documents/UN-REDD%20Indonesia%20NJPD.pdf)

[UN-REDD] United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation, Program Indonesia. 2011. REDD+ in Indonesia information, monitoring & measurement, reporting and verification (MRV). (Available from: http://www.unredd.net/index.php?option=com_docman&task=doc_download&gid=8862&Itemid=53)

[USAID] United States Agency for International Development. 2013. Feed the Future Agricultural Indicators Guide. (Available from: http://www.usaid.gov/opengov/developer/datasets/ftf_handbook_indicators_sept2013_2_0.pdf)

Winkelman S, Helme N, Davis S, Houdashelt M, Kooshian C, Movius D, Vanamali A. 2011. MRV for NAMAs: tracking progress while promoting sustainable development. Discussion Draft. Centre for Clean Air Policy. (Available from: http://ccap.org/assets/MRV-for-NAMAs-Tracking-Progress-while-Promoting-Sustainable-Development_CCAP-November-2011.pdf)

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