# Framework for rapid country-level analysis of AFOLU mitigation options

Working Paper No. 305

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

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## Abstract

Mitigation in the agricultural sector is critical to meeting the 2 ˚C target set by the Paris Agreement. Recent analysis indicates that land-based mitigation can potentially contribute about 30% of the reduction is needed to reach the 2030 target. However, action to reduce emissions from the agricultural sector has lagged behind other sectors. Action and investment in agriculture have been constrained by a lack of policy-relevant and science-based methods estimating GHG emissions and mitigation potential that contribute to decision making.

In this paper, we present a framework for a rapid country-level scientific assessment of emissions and mitigation potential from the agricultural, forestry and other land-use (AFOLU) sector. The framework sets targets for AFOLU mitigation based on local agro-environmental conditions, mitigation options best fitted for those conditions and stakeholder input. It relies on the use of simple models or tools to estimate emissions at the farm gate using a mix of Tier 1, Tier 2 and simple Tier 3 methods under baseline, business-as-usual (BAU) and mitigation scenarios. The mitigation potential of low-emissions agriculture options is determined relative to a baseline or BAU scenario.

The framework also enables examining the likely level of implementation of low-emission options. This includes assessing the cost and additional benefits of applying the identified low- emission options across different jurisdictions of interest. The feasibility of these options, assessment of institutional capacity for scaling and identification of barriers and risks of adoption to identify priorities are also determined. This information is used by stakeholders and experts to develop a road map for implementation. Rapid assessment of national mitigation potentials can help countries to assess their Nationally Determined Contributions' (NDC) targets and prioritize mitigation options for achieving the targets and monitor progress towards their achievement. Spatially explicit information helps countries plan implementation at subnational levels.



### Keywords

Mitigation; country-level analysis; business as usual; AFOLU; GHG emissions.

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# Why this framework?

Climate change mitigation in the AFOLU sector has been constrained by the lack of policy-relevant and science-based methods for transparent priority setting. While more than 100 countries included agriculture in the mitigation targets of their NDCs (Richards et al. 2016), most developing countries set targets that reflect top-down aggregated estimates of national technical mitigation potentials, rather than the bottom-up information needed to inform implementation planning.

Here we provide an alternative approach that sets targets for AFOLU mitigation based on local agro-environmental conditions, the mitigation options best fitted for those conditions and stakeholder input. The framework's distinguishing features include:

- Use of spatially explicit, scientifically robust estimates of mitigation potential and cost;
- Prioritization by geographic areas and packages of mitigation technologies for investment; and
- Identification of a road map of priority policy actions for implementation by 2030, and comparison with the level of ambition needed to meet the 2 ˚C target.

The method is intended to enable rapid prioritization of mitigation options, the development of meaningful targets, and guidance for implementation planning. The framework enables rapid analysis by:

- assessing emissions based on existing algorithms, background datasets and minimal data needs, all compliant with IPCC 2006 guidelines and the 2019 Refinement;
- limiting analysis to major crops, livestock, grassland and forest emission sources and sinks, capturing at least 80% of AFOLU emissions;
- Selecting jurisdictional units of analysis to enable aggregation across the livestock, forestry and crop sectors;
- using yield as a proxy for benefits;
- building on existing, publicly available large data sets;
- developing "mitigation packages" rather than assessing many practices individually; and
- eliciting expert judgment to fill data gaps and using best practice to reduce bias.

Results can be easily updated to reflect changing conditions or improved data.

## Overview of framework

The bottom-up analysis is based on identification of jurisdictional zones and the feasibility of implementing technical packages of mitigation practices relevant to them. Stakeholders review the feasibility of these options and identify priorities and a road map for their implementation. These results can be compared to what is needed nationally to contribute to the global 2 ˚C and 1.5 ˚C climate targets to determine spatially-specific priorities for mitigation (Fig 1).

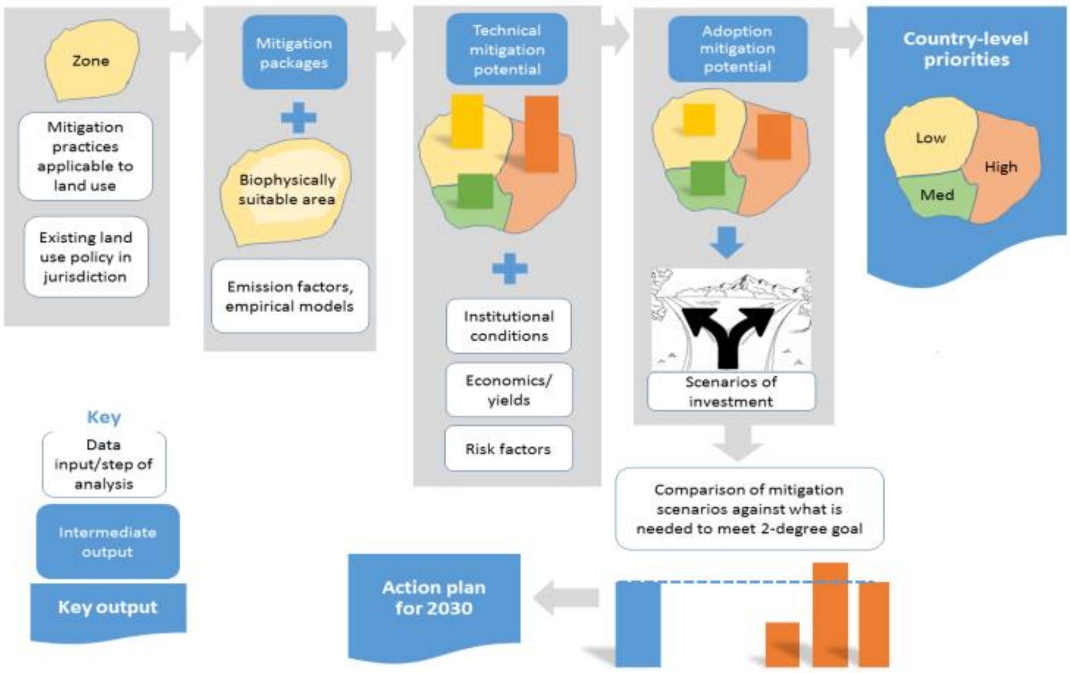


**Figure 1 Process for rapid prioritization of mitigation options.**

## Framework

### 1. Spatially referenced technical mitigation potential

A bottom-up, spatially explicit estimate of the technical mitigation potential in the AFOLU sector can be calculated based on subnational jurisdictional units and available environmental and management data for those zones. Geo-referenced soil and climate data as well as crop, livestock and forestry or agroforestry management information is needed. The data required and potential sources of data are summarized in Table 1.

Simple calculator or models for estimating emissions can be used. These should have the flexibility of using Tier 1 or Tier 2 emission factors or generating simple Tier 3 estimates of emissions.

Mitigation potential can be estimated relative to base-year emissions (Fig 2) to support rapid analysis. Base-year emissions also better reflect that emissions need to decrease to meet climate goals. In some contexts BAU projections may be preferred as the reference, for example where increases in overall emissions are necessary and the goal is to seek improved GHG efficiency in agriculture. BAU projections can require more time and resources to estimate compared to base-year emissions, but simplifying assumptions cane be made based on historical trends or anticipated policy and market conditions.

**Table 1. Data required for estimating spatially explicit GHG emission and mitigation potential and potential sources of data.**

| Categories | Data type | Possible sources of data |
|---|---|---|
| Location information | Region, state, district, longitude, latitude, etc. | Department of Agriculture, and cooperatives, department of environment, forest and climate change, state/provincial government. |
| | Regional/state-wise area under different crops | Department of Agriculture, and cooperatives, state agriculture department, land-use census |
| Soil | pH, SOC%, N%, BD, CEC, etc. | Global gridded soil information (ISRIC) Shangguan et al. (2014), country level soil database |
| Climate | Climate type, arid or not, specific climate categories for rice | worldclim.org, Agro-climatic regions of country |
| Crop management information | Tillage, residues, compost, manure, fertilizer application, irrigation, energy used etc. Rice water regimes, fertilizer production technologies, % of residue retained in the system or burned ,etc. | Department of Agriculture, state department, expert knowledge, SH consultation workshops |
| Livestock information | Livestock No according to type, breed, age, production system. Body weight, product, yield, feed/fodder consumption, etc. | Livestock census, department of livestock, universities |
| Forestry/Agroforestry | Area, management systems, reforestation, afforestation | Department of environment, forest and climate change |
| Restoration of degraded land | Degraded land area and level of degradation | Department of environment, forest and climate change |

## 2. Identification of mitigation technology packages

The analysis should focus on land uses contributing to at least 80% of emissions, as well as opportunities to sequester carbon in soils and biomass (e.g. agroforestry). For each mitigation zone, existing land use and a corresponding package of mitigation practices suitable to farming systems in the country should be identified. Mitigation technology packages together with their mitigation potential (location-specific where possible) can be obtained from the published literature, countries' communications to UNFCCC or biennial reports and through expert consultation (Table 2).

The mitigation potential of technical packages may vary by agroecosystem. For example, mitigation potential of better fertilizer management may be different for irrigated and rainfed production system or different in high-input and low input production system. Similarly, the mitigation potential of tillage systems may be different in soil with different organic matter content.

Per-hectare and per-animal mitigation potentials should be multiplied by the extent of area (or livestock population) biophysically suitable for the practice in each mitigation zone (estimated using soil and climatic data or expert judgment) to yield the technical mitigation potential.

The potential of mitigation practices for different sub-sectors may overlap and care should be given to avoid double accounting.

**Table 2. Examples of mitigation options in crops, livestock, forest and other land use systems**

| Categories | Mitigation options | Sources of information |
|---|---|---|
| Cropland | Land-use change, tillage and residue management, fertilizer management, water management together with their mitigation potential, adoption rate, yield elasticity due to adoption of improved practices, and cost of adoption | Literature, expert opinion, WOCAT database |
| Livestock | Improved feed/fodder/diet management, manure management, feed additives together with their adoption rate, yield elasticity due to adoption of improved practices, and cost of adoption | Literature, expert opinion, feed databases |
| Forestry/ agroforestry | Agroforestry (use of trees in or on agricultural land), tree plantations, forest management, rehabilitation of degraded land. | Literature, expert opinion, REDD+ experiences |

## 2. Farmers' use of mitigation packages

The mitigation potential should reflect the extent of innovation or adoption of mitigation practices in each mitigation zone based on the economics of the mitigation technical package, barriers to adoption, institutional enabling conditions, and risk of not achieving expected levels of mitigation. Average conditions can be calculated or estimated for each mitigation zone to simplify the analysis.

### 2.1 Economics

The economics of the innovation or adoption of the mitigation package can be determined by assessing whether the new technical package provides an incentive for the farmer to take up the technology, for example because it provides net benefits or involves no additional costs. The mitigation practices should provide positive incentives compared to farmers' current practices.

Examples of economic thresholds are:

- Zero cost to transition to new practice
- Net benefits
- Yield improvements
- Marginal abatement costs (cost per ton of $CO_2e$ reduced)

This step involves estimating the average cost or benefits of applying the identified mitigation package in each jurisdictional unit. Practices or mitigation packages that deliver a net incentive are likely to be adopted in that unit. Economic data can be determined based on existing data (e.g. Rosenstock et al. 2016, market prices or rates published by the respective government), key informants or expert opinion.

Costs can be important indicators for informing public policy budget allocations and priorities. The cost of adopting mitigation options can include the cost of establishing new practices (technical advisory services, infrastructure, initial capital investments) or maintaining practices, such as the cost of production inputs, including: labour, tillage, planting, seed, fertilizer, biocides, irrigation, harvesting, residue management, feed, feed additives or manure management.

Mitigation practices can be ranked from most cost-effective to most cost-prohibitive or classified as cost-neutral, cost-effective or cost-prohibitive to identify priority practices in each jurisdictional area. In combination with information about the mitigation impacts of the practices, marginal abatement cost curves (MACC) can also be constructed from this data to indicate the cost per ton of $CO_2e$ reduced.

Economic criteria can be used together with the other factors in section 2.2 to adjust the mitigation potential to reflect what is socioeconomically feasible.

## 2.2 Constraints, barriers and institutional context

Farmers' use of mitigation practices also depends on the constraints, barriers and institutional context for taking up new practices. Typical constraints and barriers include lack of environmental suitability, inappropriate match to farming system, low availability of capital for investment, lack of labour or time, weak technical advisory services or insufficient infrastructure. Certain kinds of attitudes, cultural norms, habits and gender roles may also hinder changes in behaviour.

Institutional conditions can drive large-scale uptake and innovation of new practices, often helping to overcome constraints and barriers. Common institutional measures supportive of mitigation include:

- A climate change strategy for agriculture at national and subnational levels, indicating priorities. This may include NDCs to the Paris Agreement.
- Information platforms and technical advisory services for improved agriculture practices.
- Improved access for farmers to farm inputs, markets and finance necessary to support implementation of new practices.
- Incentive programs such as carbon markets, subsidies, payment schemes, certification or conditional lending.
- An information system for monitoring impacts and accounting for mitigation.

A review of key policy documents and strategic plans, and interviews of key informants from local mitigation and agricultural development projects can be a good source of information to identify common barriers and the institutional and market context for uptake of mitigation options.

As the factors affecting uptake can be complex and difficult to quantify, it is recommended that practices in each jurisdiction be rated with a simple system such as “high, medium or low” likelihood of use based on expert judgement, focus group discussions or stakeholder consultations. This assessment can be used together with the other factors in this section to prioritize practices and adjust the mitigation potential.

### 2.3 Risk

Natural and social risks may affect the rate of adoption of practices or the effectiveness of those options in reducing GHG emissions or sequestering carbon. Risks include: uncertainty of mitigation estimates, dis-adoption, reversibility of mitigation (e.g. soil carbon or biomass loss), environmental disaster (flood, drought), leakage effects, governance failure, conflict and global economic factors (e.g. recession).

The impacts of risk can be estimated using secondary data and models, guidance such as IPCC uncertainty ranges (mitigation estimate, reversibility), predictions of future climate, grey and peer-reviewed literature, and key respondent interviews, focus groups or expert judgement.

Risk factors can be applied on a jurisdictional or country level as appropriate and weighed together with other factors to prioritize practices and adjust the mitigation potential.

### 2.4 Development of scenarios

Mitigation potential can be determined relative to base year emission or relative to BAU emission (Fig 2). The approach would be to quantify emissions from all sub-sectors for the baseline scenario or BAU scenario considering set of growth assumptions in AFOLU sectors. Mitigation scenario can be developed by including all abatement options that are available now will be available by the target years and apply them in a realistic scale. For example, scenarios can include:

1. Business as usual: This scenario assumes no specific policies and programmes are in-place designed for GHG emission reduction. In this scenario, emissions are projected based on certain growth assumption such as increase in crop area, livestock number,

increased consumption of production inputs and clearance clearing forest/pastureland for additional crop production needed to meet the future food security. These expected changes in natural resources, technological advances and production intensification can be validated through key respondent interviews or stakeholder workshop.

2. Minimal investment (economically beneficial packages fit for specific jurisdictions): This scenario is built upon BAU scenario and considers those mitigation options that are technically available now or will be available by the target year. This scenario includes the adoption of identified mitigation options to the most feasible scale given the socio-political and agro-ecological conditions of the jurisdiction. This scenario also considers government policies and schemes towards agriculture, climate change and sustainable natural resources management and assumes their implementation to the most feasible extent including some financial mechanisms.
3. 100% implementation: Widespread adoption of mitigation bundles in all jurisdictions supported by policies, investment and incentives to enable scaling, such as sustainability consortia, certification, innovative implementation models, carbon markets, removal of subsidies, etc.

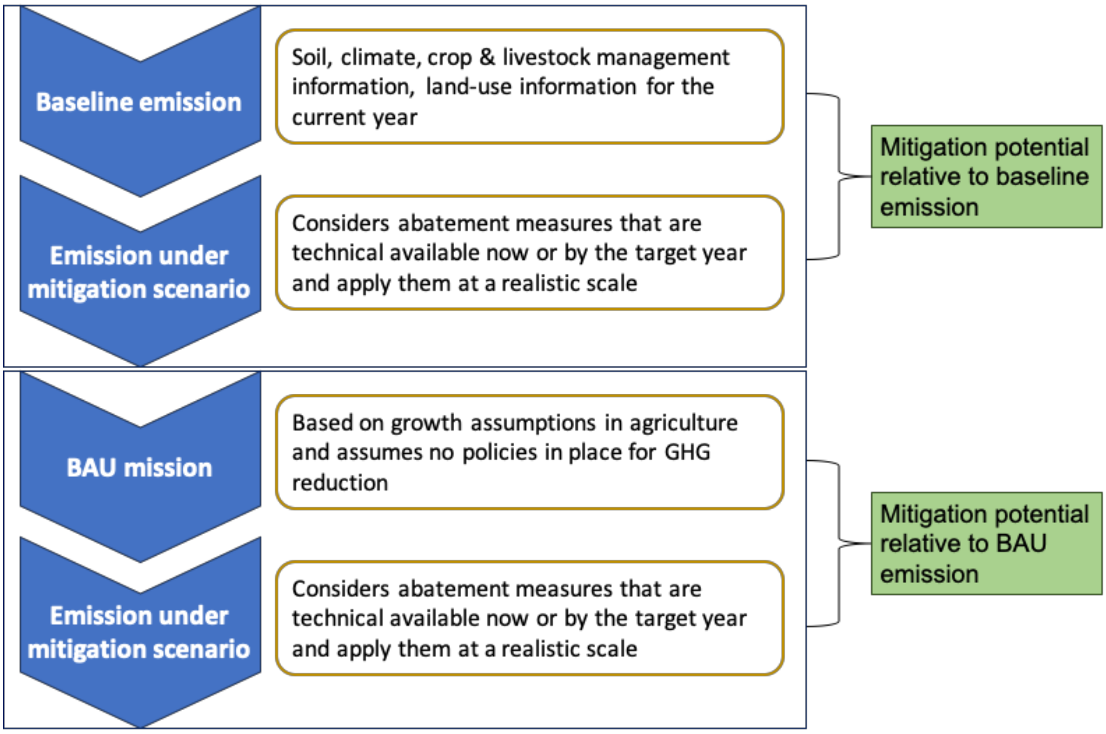


**Figure 2 Steps for quantification of mitigation potential from AFOLU sectors relative to baseline emission (upper panel) and BAU emission (lower panel).**

A stakeholder workshop or key respondent interview with the representatives from government, civil society, private sector and farmer organizations can be organized to critically review and prioritize proposed mitigation scenarios as well as identify a way forward. Comparing a set of progressively ambitious adoption scenarios can help to identify policy and incentive needs.

Priority packages of practices and geographic areas can be ranked from highest to lowest mitigation potential.

Scenarios of achievable mitigation can also be compared against the level of action needed to meet 2 ˚C targets (based on Richards et al. 2018) or with national NDC goals. This comparison can inform a roadmap for priority actions for 2030, including policy changes and enabling conditions needed.

# Conclusions

Here, we propose a framework for a rapid country-level scientific assessment of emission and mitigation potential from the agricultural, forestry and other land-use sector. The framework's distinguishing features include use of minimal and readily available data that enables countries to identify science-based mitigation hotspots; scientifically robust estimates of mitigation potential and cost; prioritization by geographic areas and packages of mitigation technologies for investment; and identification of a road map of priority policy actions for their implementation and comparison with the level of ambition needed to meet the 2-degree target. The framework presents a bottom-up approach based on identification of jurisdictional zones and the feasibility of implementing technical packages of mitigation practices relevant to them. Key informants and other relevant stakeholders review the feasibility of these options and identify priorities and a road map for their implementation. This rapid approach of estimating spatially explicit mitigation potential will help countries understand what is needed nationally to contribute to the Paris Agreement climate targets and to determine spatially-specific priorities for mitigation. It also provides a scientific, spatially explicit basis for countries to determine NDC targets, identify where to achieve targets and monitor progress.

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