LEDS GLOBAL PARTNERSHIP | Agriculture, Forestry and Land Use (AFOLU) Working Group

Role of Agriculture, Forestry and Other Land Use Mitigation in INDCs and National Policy in Asia

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Executive Summary

One hundred and seventy four countries[1] have prepared Intended Nationally Determined Contribution's (INDC) to facilitate the clarity, transparency and understanding of intended national contributions for a new climate change agreement under the United Nations Framework Convention on Climate Change (UNFCCC). Initial analysis of INDCs indicates that there is still a gap between current contributions recorded in INDCs and emission reductions needed to stay below 2°C of warming.[2] This puts pressure on all countries to consider how they can increase their level of ambition.

Agriculture, forestry and other land use (AFOLU) represents 20-24% of the global Greenhouse Gas (GHG) emissions. AFOLU is particularly important in Asia which has the largest proportion of global AFOLU emissions. Identifying opportunities for additional mitigation efforts within INDCs requires understanding the role of AFOLU in countries' emission profiles, the relationship between current treatments of AFOLU in INDCs and national planning, and the costs of AFOLU mitigation strategies and how to finance them.

This paper analyzes how AFOLU Low Emission Development Strategies (LEDS) are included in INDCs and national development plans and strategies of selected countries in Asia that have different AFOLU emission profiles and development priorities: Bangladesh, Cambodia, India, Indonesia, Lao PDR, Thailand and Vietnam. It is intended to assist national policy makers and other decision-makers who seek to understand and strengthen the connection between the current roles AFOLU LEDS is expected to play compared to the mitigation potential from AFOLU.

Key findings

The key findings are as follows:

1. **AFOLU is a key contributor to GHG emissions in the selected countries and is included in all seven countries' national socio-economic development, climate change and green growth strategies and plans**. However, national AFOLU strategies take a variety of forms and are not always directly aimed at reducing emissions. Many are designed to achieve development or adaptation objectives which may have mitigation co-benefits.
2. **INDCs do not comprehensively include AFOLU mitigation targets.** Only two countries (Indonesia and Vietnam) include both agriculture and forestry mitigation targets and measures in their INDCs. Neither sector is included in Thailand or Bangladesh's INDC mitigation commitments. However, Thailand includes a forest cover target in their adaptation strategy and Bangladesh indicates AFOLU measures as "possible further mitigation actions" that are conditional on international support. The three remaining countries, India, Cambodia and Laos include forestry targets in their INDCs while leaving out agriculture, which is covered in adaptation measures only.

[1] As of November 23, 2015. See the INDC portal: http://unfccc.int/focus/indc_portal/items/8766.php

[2] Gütschow J. et al. 2015. "INDCs lower projected warming to 2.7˚C: significant progress but still above 2°C", *Climate Action Tracker Update*, October 1st, 2015, Potsdam Institute for Climate Impact Research, Climate Analytics, New Climate Institute, Ecofys. http://climateactiontracker.org/assets/publications/CAT_global_temperature_update_October_2015.pdf.

3. In both national plans and INDCs, **agriculture emission reduction targets and measures are not as well covered as those in forestry**. In national plans quantifiable targets are much more common in the forestry sector than in the agriculture sector. In INDCs only Indonesia and Vietnam include agriculture as key mitigation priorities, while India explicitly excludes the sector from its mitigation commitments and other countries mention agriculture only in the context of adaptation.
4. Most countries indicate in their INDCs that they **require international support** in the form of finance, technology and capacity building, while some further state estimated costs and the level of support required. However, some countries including Thailand, Indonesia and Bangladesh do not provide cost estimates of AFOLU mitigation measures in their INDCs.
5. **There may be scope for increasing the mitigation contribution from AFOLU, but more work is needed** to help refine – and in some cases enhance – a number of countries' mitigation contributions from AFOLU. Increased mitigation may be expressed within domestic policy and internationally communicated contributions.

Next steps

More work should focus on collecting updated information on current emissions and removals along with completing feasibility and cost estimates to implement AFOLU mitigation and adaptation initiatives. Low Emission Development Strategies (LEDS) that target the AFOLU sector can help with this. LEDS involves an inclusive process of collecting information on current sources of emissions, identifying, analyzing and prioritizing opportunities to reduce emissions, followed by implementation and ongoing adaptive management. A number of tools and resources for developing AFOLU LEDS have already been developed[3], along with a number of example AFOLU LEDS in the region.

Going forward, integrating LEDS into national planning processes and revisions of INDCs will help improve our understanding of current mitigation contributions and establish the foundation for implementation of mitigation and adaptation efforts.

[3] See the resources section of http://ledsgp.org.

1. Introduction

In 2013 the 19th Conference of the Parties (COP19) to the UNFCCC called upon every member state to prepare an Intended Nationally Determined Contribution (INDC) to facilitate the clarity, transparency and understanding of intended contributions[4] for a new climate change agreement. The new agreement is expected to be agreed in the COP21 in Paris in 2015. INDC is a key vehicle for governments to communicate contributions towards emission reductions in ways tailored to national priorities, capabilities and responsibilities. Initial analysis of INDCs indicates that there is still a gap between current contributions recorded in INDCs and emission reductions needed to stay below 2° Celsius warming.[5]

Agriculture, forestry and other land use (AFOLU) represents 20-24% of the global Greenhouse Gas (GHG) emissions, the largest emitting sector next to energy, and is even more important in developing countries in Asia, where the largest proportion of global AFOLU emissions during 1990-2010 originated.[6] The AFOLU sector is considered unique not only because of the GHG emissions it produces, but also the potential it provides for emission reductions. A number of countries have included AFOLU within their INDCs along with national development plans and strategies. Understanding the relationship between current treatment of AFOLU in INDCs and national planning, and the amount of emissions from the AFOLU sector will help inform policy makers on the current role of AFOLU as part of the mitigation wedge needed to stay below a 2° C threshold.

This paper was commissioned by the AFOLU Working Group, part of the Low Emission Development Strategies Global Partnership (LEDS GP). The AFOLU Working Group provides technical assistance, tools, training and platforms to support low emission development across the agriculture, forestry and other land use sector.[7]

2. Objective and Methodology

The objective of this paper is to understand the current role AFOLU Low Emission Development Strategies (LEDS)[8] is expected to play in mitigation compared to potential for mitigation from AFOLU, based on case studies of selected countries from Asia.

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[4] COP Warsaw (2013: Decision 1/CP.19, Para. 2b).

[5] Gütschow J. et al. 2015. "INDCs lower projected warming to 2.7˚C: significant progress but still above 2°C", *Climate Action Tracker Update*, October 1st, 2015, Potsdam Institute for Climate Impact Research, Climate Analytics, New Climate Institute, Ecofys. http://climateactiontracker.org/assets/publications/CAT_global_temperature_update_October_2015.pdf.

[6] Smith P., M. Bustamante, H. Ahammad, H. Clark, H. Dong, E. A. Elsiddig, H. Haberl, R. Harper, J. House, M. Jafari, O. Masera,C. Mbow, N. H. Ravindranath, C. W. Rice, C. Robledo Abad, A. Romanovskaya, F. Sperling, and F. Tubiello, 2014: Agriculture, Forestry and Other Land Use (AFOLU). In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[7] For more information on the AFOLU Working Group, including how to engage, see: http://ledsgp.org/working-groups/agriculture-forestry-and-land-use/?loclang=en_gb.

[8] Low Emission Development Strategies (LEDS) are understood as a "strategic framework that articulates concrete actions, policies, programs and implementation plans to advance economic growth, improve environmental management, and meet development objectives. This framework provides a foundation for achieving long term, measurable greenhouse gas emission reductions as compared to a business-as-usual

The paper analyzes how AFOLU is included in INDCs and national development plans and strategies of Bangladesh, Cambodia, India, Indonesia, Lao PDR, Thailand and Vietnam. These seven countries were selected due to their inclusion in the USAID Lowering Emissions in Asia's Forests (LEAF) program, under which an earlier analysis for this paper was conducted, and due to their representation of different AFOLU emission profiles and development priorities. National plans[9], NAMAs and INDCs are used to produce a picture of a country's intended plans and contribution of emission reductions through its AFOLU sector. This is then compared to the countries' emission profile, which is assessed via a combination of national communications to UNFCCC and other national and global databases. Opportunities for additional mitigation efforts are then identified along with a broader discussion on costs, with third party estimates of costs and financing instruments provided where available.

3. Summary of key findings

The AFOLU sector is **a key contributor to GHG emissions** in the selected countries: AFOLU accounted for about 11% of total net emissions in India, 20-30% in Thailand and Vietnam, 50-60% in Bangladesh and Indonesia and 90% in Lao PDR.[10] For Cambodia, LULUCF was a large net carbon sink that offset almost all agricultural and other sectors' emissions in 2000.[11] In terms of absolute emissions, India had the highest emissions from agriculture (355.6 million tCO_2e in 2000), while Indonesia had the highest emissions from forestry and land use (821.3 million tCO_2e in 2000). Within the agricultural sector, rice cultivation accounted for the **largest proportion** of agricultural emissions in Cambodia (nearly 70%), Vietnam, Thailand and Indonesia (around 50%) and Lao PDR (around 38%). In India, the largest source of agricultural emissions was enteric fermentation (around 60%) while in Bangladesh this was manure management (around 40% of total agricultural emissions).

AFOLU initiatives are included in all seven countries' **national plans** such as socio-economic development, sectoral development, climate change and green growth strategies and plans. However, these initiatives take a variety of forms and **are not always directly aimed at reducing emissions**. Many are designed to achieve development and adaptation objectives and may have mitigation co-benefits. For example, sustainable agricultural intensification can improve productivity and reduces emissions. New climate-resilient crop varieties and improved cropland management can reduce the need to increase inputs such as water, fertilizers and pesticides to maintain the same level of production. Coastal mangrove protection and restoration to lessen the impacts of flooding, storm surge and sea level rise also helps increase carbon stock and sequestration.

Nevertheless, quantifiable targets (e.g., in terms of tCO_2e or areas of forests or sustainable agriculture) more clearly signify the role attributed to AFOLU in countries' climate change mitigation strategies. Table 1 (at the end of this section) summarizes the coverage of AFOLU emission reduction targets and

development pathway". LEDS Global Partnership, Stage 1: Organizing the LEDS Process, Open Energy Information, http://en.openei.org/wiki/Stage_1:_Organizing_the_LEDS_Process.

[9] The national plans include national development plans, national climate change strategies and green growth strategies that are publicly available in English. See **Annex 2** for a list of all national plans that were reviewed for this paper.

[10] See country-level discussion for the years of these emission data.

[11] However, due to deforestation and forest degradation Cambodia's AFOLU sector has reduced from a net sink of 64.9 million tCO_2e in 1994 to just 3.5 million tCO_2e in 2000.

measures in INDCs and national plans of the selected countries. It can be seen that **in national plans quantifiable targets are much more common in the forestry sector than in the agriculture sector** – the former is present in all countries while the latter is found in three countries only, namely Indonesia, Thailand and Vietnam.

A **comparison between national plans and INDCs** shows that while agriculture and forestry mitigation targets and measures are covered in all seven countries' national plans, only two countries (Indonesia and Vietnam) include both sectors in their INDCs. Neither agriculture nor forestry is included in Thailand and Bangladesh's INDC mitigation commitments. However, Thailand includes a forest cover target in their adaptation strategy and Bangladesh indicates AFOLU measures as "possible further mitigation actions" that are conditional on international support. The three remaining countries, India, Cambodia and Laos include forestry targets while leaving out agriculture, which is covered in adaptation measures.

As with national plans, **agriculture emission reduction targets and measures are not as well covered in INDCs as those in forestry**. Only Indonesia and Vietnam include agriculture as key mitigation priorities while India explicitly excludes the sector, stating that "India's INDC do not bind it to any sector specific mitigation obligation or action, including in agriculture". The rest of the countries mention agriculture in the context of adaptation only. India's exclusion of agriculture is particularly notable as it is one of the largest agricultural emitters in Asia and the sector is a significant contributor to the country's total national emissions (23% of total emissions without LUCF in 2000). The relatively poor coverage of agriculture shows technical potential for Asian countries in general and India in particular to consider including agriculture in future conditional and unconditional commitments, taking account of the synergies between agricultural mitigation and increased productivity and resilience.

The AFOLU **mitigation strategies** included in national plans and INDCs of the selected countries **cover a broad range of activities** as shown in Figure 1 and 2.[12] The lower coverage of AFOLU activities in INDCs compared to national plans is due to the fact that INDCs often mention broad strategies only and do not provide specific activities, instead referring to the relevant national plans for such information. Overall, reducing deforestation, forest restoration and reforestation/afforestation are the most widely cited forestry mitigation activities. Cropland management, which includes a variety of measures such as crop varieties and patterns, nutrient management (fertilizers, tillage, and residues management), water management, rice management and rewetting peatlands drained for agriculture, is the most common category of agricultural mitigation actions. This reflects the sectoral emission composition, with rice cultivation and agricultural soils accounting for a large proportion of agricultural emissions in the selected countries. Other measures such as livestock management and manure management/bio-energy are less well covered and may deserve further consideration in the future, especially given the projected increase in meat consumption in Asian countries.

[12] See **Annex 1** for detailed information on the coverage of these activities in each country's national plans and INDC.

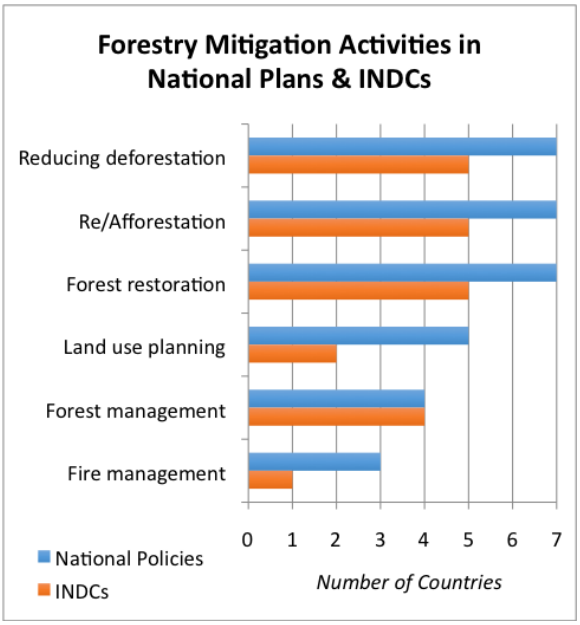

Figure 1. Types of forestry mitigation activities included in National Plans and INDCs of the selected countries.

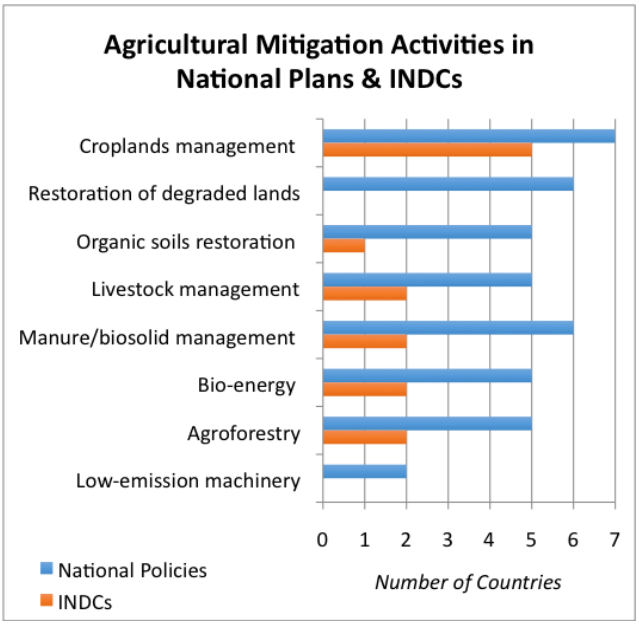

Figure 2. Types of agricultural mitigation activities included in National Plans and INDCs of the selected countries.

However, even in countries with comprehensive and ambitious targets, there can be a gap between planning and implementation. For example, Vietnam has a comprehensive program to reduce emissions in the AFOLU sector with an ambitious goal of reducing emissions by 20% by 2020, but is currently lacking financial resources to implement it. Indonesia has fallen short of achieving its fire targets in recent years (reducing forest fire spots by 95% compared to 2006 level and reducing total number of forest fire hotspots by 20% per year). This shows the importance of feedback mechanisms to evaluate countries' progress as well as international support to help countries achieve the targets and commitments set in their INDCs and national plans. Countries will also need to update INDCs over time to better reflect developments in their emission reduction efforts.

Table 1. Coverage of AFOLU emission reduction targets and measures in National Plans and INDCs of selected Asian countries.

Country	Inclusion of AFOLU Emission Reduction (ER) Targets/Measures in National Plans		INDC's Economy-wide ER Target (unconditional)	INDC's Economy-wide ER Target (conditional)	Inclusion of AFOLU Emission Reduction Targets/Measures in INDCs	
	Agriculture	FOLU / LULUCF			Agriculture	FOLU / LULUCF
Bangladesh	**Yes**	**Yes** (e.g., increase forest cover from 13% in 2010 to 15% in 2015; increase protected areas by 15% by 2015; mangrove planting along nearly 9,000 km of the shoreline by 2015)	5% below 2030 BAU (or 12 $MtCO_2e$) scenario in the power, transport and industry sectors	15% below 2030 BAU scenario (or 36 $MtCO_2e$) in the power, transport, and industry sectors	**No** (though included as "possible conditional contributions" and in Adaptation)	**No** (though included as "possible conditional contributions" and in Adaptation)
Cambodia	**Yes**	**Yes** (60% forestry cover by 2015)	None	27% below 2030 BAU scenario	**No** (though included in Adaptation)	**Yes** (60% forest cover by 2030 from about 57% in 2010 or ER contribution of 4.7 tCO_2e/ha/year, but LULUCF not included in the overall 27% target)
India	**Yes**	**Yes** (e.g., increase forest cover from 23% (current) to 33% by 2020; annual C. sequestration of 50-60 $MtCO_2e$ by 2020; improved quality of forests on 5 million ha)	Reduce emissions intensity of GDP by 33-35% by 2030 from 2005 level	None	**No** (though included in Adaptation)	**Yes** (additional carbon sink of 2,500-3,000 $MtCO_2e$ by 2030 through increased forest cover)
Indonesia	**Yes** (26-41% or 8-11 $MtCO_2e$ by 2020)	**Yes** (26-41% or 672 to 1,039 $MtCO_2e$ by 2020) (e.g., 95% reduced forest fire spots compared to 2006 level; reduce total number of forest fire hotspots by 20% p.a.)	26% below 2020 and 29% below 2030 BAU levels	41% below 2030 BAU level	**Yes** (though unclear whether the AFOLU ER target is same as economy-wide like in national plans)	**Yes** (though unclear whether the AFOLU ER target is same as economy-wide like in national plans)
Lao PDR	**Yes**	**Yes** (e.g., 70% forest cover by 2020; regeneration of natural forest in 3.9 million ha and reforestation of 200,000 ha by 2015)	None	None (though identified a number of conditional mitigation actions)	**No** (though included in Adaptation)	**Yes** (70% forest cover by 2020 and maintain this through 2030, conditional target)
Thailand	**Yes** (expand sustainable ag. areas by at least 5% p.a.)	**Yes** (e.g., 40% forest cover by 2020; increase mangrove reforestation of 800 ha p.a.; increase conservation forest area to 19% by 2015)	20% below 2030 BAU scenario (or by 111 $MtCO_2e$); inclusion of LULUCF to be considered later	25% below 2030 BAU scenario (or by 139 $MtCO_2e$); inclusion of LULUCF to be considered later	**No** (though included in Adaptation)	**No** (though included in Adaptation: 40% forest cover)
Vietnam	**Yes** (e.g., 20% by 2020)	**Yes** (e.g., reduce emissions from agriculture and rural development sector by 20% or 18.9 $MtCO_2e$ by 2020)	8% below 2030 BAU scenario (or by 62.9 $MtCO_2e$)	25% below 2030 BAU scenario (or by 196.8 $MtCO_2e$)	**Yes** (Ag & Forestry are two key mitigation sectors)	**Yes** (45% forest cover by 2030, unconditional target)

4. Country Findings

4.1. Bangladesh

A. Emissions Profile

In 2005, Bangladesh's net AFOLU emissions were 61.3 million tCO_2e, accounting for over 52% of the total net national emissions.[13] Agriculture emitted 43.1 million tCO_2e or about 35% of all emissions and 66% of AFOLU emissions, while LULUCF constituted the remaining 34% of AFOLU emissions with a net emission of 18.2 million tCO_2e. The three most important emission sources in the agriculture sector were manure management (representing 41% of agricultural emissions), enteric fermentation (24%) and rice cultivation (18%) (Figure 3).

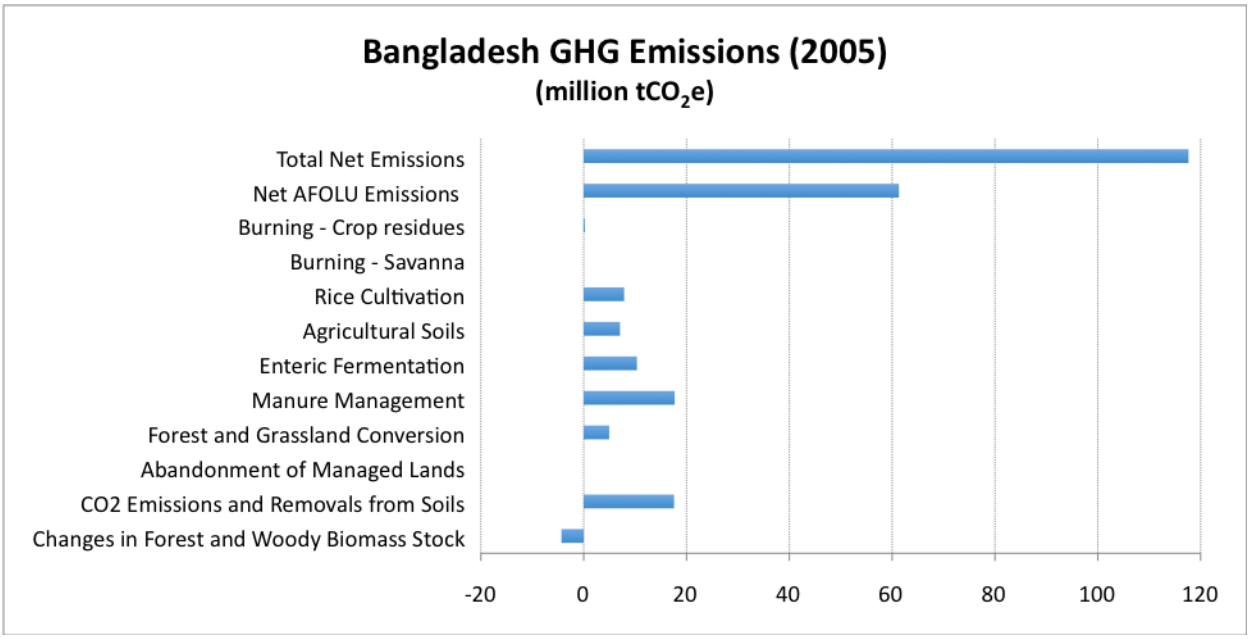

Figure 3. Distribution of Bangladesh's emission by AFOLU subsector (2005).

B. National Plans, Programs and Commitments on AFOLU

Bangladesh is considered the world's most vulnerable country to the negative impacts of climate change, facing particularly high risks from tropical cyclones and floods. In response, the country has prioritized adaptation and has invested over US$ 10 billion of its own resources to increase its climate resilience.[14] Nonetheless, Bangladesh has also implemented mitigation activities, including in the AFOLU sector. Current and planned AFOLU mitigation activities include afforestation/reforestation, REDD+, climate resilient agriculture, lowering methane emissions in agricultural production, crop diversification,

[13] MOEF. 2012. Government of the People's Democratic Republic of Bangladesh. Second National Communication to the UNFCCC. Ministry of Environment and Forests. http://unfccc.int/resource/docs/natc/bgdnc2.pdf.

[14] MOEF. 2009. Government of the People's Republic of Bangladesh. Bangladesh Climate Change Strategy and Action Plan (BCCSAP) for 2009-2018. Ministry of Environment and Forests. https://cmsdata.iucn.org/downloads/bangladesh_climate_change_strategy_and_action_plan_2009.pdf.

fertilizer management and improved livestock management. The country has several NAMAs under development in the industry and waste sectors and is exploring potential in other sectors.[15]

Bangladesh's INDC proposes an unconditional target of reducing emissions by 5% or 12 million tCO_2e and a conditional target of 15% or 36 million tCO_2e by 2030 in the power, transport and industry sectors.[16] The INDC prioritizes these sectors as they are projected to represent about 69% of the country's emissions in 2030.[17] The INDC lists a few AFOLU related measures as potential mitigation activities that the country intends to achieve by 2030, which are conditional on the availability of international support. A mix of quantified targets from agriculture and unquantified targets from LULUCF are indicated, including increased mechanization to lower draft cattle by 50% (thereby reducing associated methane emissions), increased share of organic fertilizer by 30%, scale-up of alternative wetting and drying irrigation by 20% of all rice fields, and promotion of afforestation/reforestation and mangrove plantation. Additionally, the INDC prioritizes ecosystem-based adaptation, including forestry co-management and community-based conservation of wetlands and coastal areas.

Implementation of the mitigation measures included in the INDC is estimated to cost about US$ 27 billion; however, this estimate covers activities in the power, transport and industry sectors only. The INDC acknowledges the need for further study to identify the mitigation potential, costs and co-benefits of AFOLU emission reduction measures, particularly those in the LULUCF sector.

C. Analysis

Bangladesh's INDC is built upon key national strategies and plans, such as the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) among others. Similar to the national plans, the INDC identifies AFOLU mitigation measures and recognizes the importance of creating synergies between adaptation and mitigation in the AFOLU sector. Given the government's interest in pursuing AFOLU mitigation activities, further analysis to quantify the mitigation potential along with adaptation links should be seen as a priority going forward.

4.2. Cambodia

A. Emissions Profile

In 2000, Cambodia's agricultural sector emitted about 21.1 million tCO_2e while LULUCF was a net sink of about 24.6 million tCO_2e, resulting in a net AFOLU removal of 3.5 million tCO_2e. Such removal offset most of the emissions from other sectors, leading to a net total national emission of only 0.2 million tCO_2e.[18] Within agriculture, the most important emission sources were rice cultivation (accounting for 68% of total agricultural emissions), enteric fermentation (16%) and agricultural soils (11%) (Figure 4).[19]

[15] Anita, Wahida Musara. Status of Climate Finance and NAMA in Bangladesh. Ministry of Environment and Forest. Regional Workshop on NAMA. http://unfccc.int/files/focus/mitigation/application/pdf/bangladesh_regional_workshop_on_nama.pptx-_revised.pdf.

[16] MOEF. 2015. Government of the People's Democratic Republic of Bangladesh. Intended Nationally Determined Contributions. http://www4.unfccc.int/submissions/INDC/Published%20Documents/Bangladesh/1/INDC_2015_of_Bangladesh.pdf.

[17] Bangladesh recognizes that in order to meet the 2° Celsius objective all countries will need to undertake mitigation.

[18] Kamal, Uy. 2011. Cambodia: Current status of GHG inventory and Second National Communication. GHG inventory and Mitigation Office. Presentation given on 10 January 2011. Sunway Hotel, Phnom Penh, Cambodia. http://lcs-rnet.org/pdf/locarnet_meetings/2011/P1_3_Uy.pdf.

[19] Although Cambodia's AFOLU sector is a net sink, it is worth noting that AFOLU removals have decreased by 94% between 1994 and 2000, from 64.8 to 3.5 million tCO_2e. Meanwhile, agricultural emissions have more than doubled for the same period, reflecting the increased deforestation and forest degradation in the country.

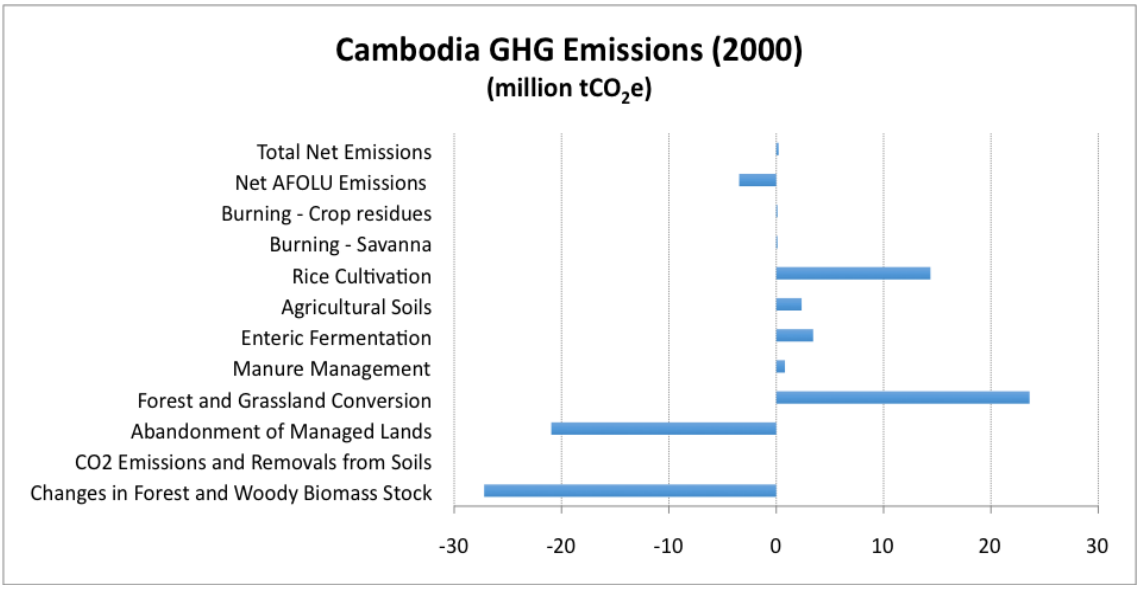

Figure 4. Distribution of Cambodia's emission by AFOLU subsector (2000).

B. National Plans, Programs and Commitments on AFOLU

Cambodia is considered one of the world's top ten countries most vulnerable to climate change due to its subsistence agriculture and low climate adaptive capacity. Cambodia's AFOLU mitigation measures are outlined in the Climate Change Strategic Plan (CCCSP)[20], which builds on the national socio-economic development and green growth plans.[21] The CCCSP puts forward 8 strategic objectives, including several AFOLU related plans such as watershed and ecosystem management, promotion of payment for ecosystem services including REDD+, promotion of participatory land use planning and increased agricultural productivity through crop and livestock diversification. Additionally, Cambodia's NAMAs include an intention to pilot REDD+ as a framework for reducing emissions.

Cambodia's INDC proposes a conditional 27% emission reduction by 2030 from the energy, industry, transport and waste sectors. In addition, Cambodia intends to undertake voluntary and conditional actions to increase forest cover to 60% of the national land area[22] from an estimate of 57% in 2010.[23] The specific list of activities the country intends to implement along with their GHG impacts will be updated once the national REDD+ strategy is finalized. Agriculture is only mentioned under adaptation activities being planned by the government.

The INDC estimates a total cost of US$ 1.27 billion for prioritized climate change action plans up to 2018. About 40% of this is expected to be sourced from international finance, while the government plans to

[20] The Royal Government of Cambodia. 2013. Cambodia Climate Change Strategic Plan 2014-2023. National Climate Change Committee. http://www.camclimate.org.kh/en/policies/nccc-news/197-cccsp-2014-2023-kh-en-final.html.
[21] The Royal Government of Cambodia. 2014. Ministry of Planning. Cambodia National Strategic Development Plan 2014-2018. http://www.mop.gov.kh/Home/NSDP/NSDP20142018/tabid/216/Default.aspx.
[22] The Royal Government of Cambodia. 2015. Cambodia's Intended Nationally Determined Contributions. http://www4.unfccc.int/submissions/INDC/Published%20Documents/Cambodia/1/Cambodia's%20INDC%20to%20the%20UNFCCC.pdf.
[23] Ibid.

increase its national climate expenditure from 1.39% of GDP in 2015 to 1.5% in 2018. Details on how these funds will be spent are not included in the INDC.

C. Analysis

Cambodia's AFOLU sector was a net sink in 2000. However, AFOLU removals have decreased by 94% between 1994 and 2000, from 64.9 to 3.5 million tCO_2e due to increased deforestation along with increased agricultural emissions. Cambodia's national plans outline a number of natural resource management activities, including increased agricultural diversification and productivity. National mitigation contributions however focus on LULUCF only, with agriculture only mentioned in the context of adaptation. Including mitigation from agriculture that does not reduce overall productivity could help further reduce emissions from AFOLU. Given the growing trend in forest loss and increased agricultural emissions, Cambodia may be able to do more to counter this trend.

4.3. India

A. Emissions Profile

India is the world's fourth largest economy and fifth largest global GHG emitter.[24] Based on the 2000 GHG inventory, India's net AFOLU emissions were 146.7 million tCO_2e, accounting for about 11% of the total net national emissions.[25] Although AFOLU is not the largest emitting sector in India, Forestry and Other Land Use (FOLU or previously LULUCF) has its importance as a net sink with removals of 236 million tCO_2e in 2000. Meanwhile, for the same period, India's agricultural emissions were 355.6 million tCO_2e, accounting for 23% of gross national emissions and 96% of gross AFOLU emissions. Emissions from agriculture primarily came from enteric fermentation, rice cultivation and agricultural soil (Figure 5).

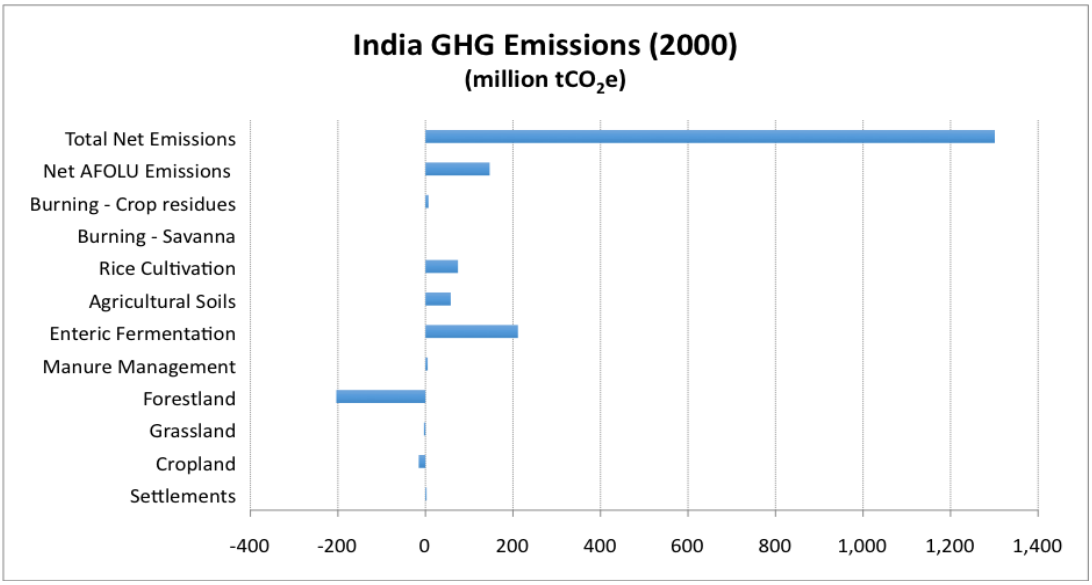

Figure 5. Distribution of India's emission by AFOLU subsector (2000).

[24] CCAFS. Agro-economic analysis of all climate change mitigation options in India. CGIAR's Research Program on Climate Change Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/fr/agro-economic-analysis-all-climate-change-mitigation-options-india#.VkzFz_mrR1g.
[25] MoEF. 2012. India's Second National Communication to the UNFCCC, Ministry of Environment and Forests, Government of India, New Delhi.

B. National Plans, Programs and Commitments on AFOLU

India has two core national mitigation missions focused on AFOLU, namely creation of a 'Green India' through increasing forest cover to 33% by adding 20 million hectares of forests by 2020[26] and implementing sustainable agriculture through the promotion of micro irrigation on 40 million hectares of land. [27] Other specific AFOLU related mitigation actions include improved crop varieties, crop insurance, sustainable forest management, afforestation and reforestation, REDD+ and ecosystem and biodiversity conservation through wetland restoration and agroforestry practices.

India pledged under the Copenhagen Accord to reduce its emissions intensity per GDP by 20 to 25% by 2020 compared to 2005 level, but excluded emissions from the agricultural sector.[28] The pledge is aligned to what the country considered as voluntary emissions reductions under its NAMAs.[29] India communicated in its INDC a goal to reduce emission intensity of its GDP by 33-35% by 2030 from 2005 level.[30] The INDC indicates increased forest area through afforestation[31] as one of key climate actions, with a target of creating additional carbon sink of 2.5-3 billion tCO_2e by 2030. India's INDC also emphasizes promoting a sustainable way of living based on traditions and values of conservation and moderation while adopting a climate friendly path. India indicates that its INDC will cost at least US$ 2.5 trillion to implement. However, the INDC does not explicitly state how it arrives at that estimate. There is also no indication on how much of that cost is expected to come from international sources and how much from domestic budget.

C. Analysis

Agriculture in India is vulnerable to climate change and is a significant source of emissions. Development plans include agricultural programs with adaptation outcomes, but agriculture is explicitly excluded from national mitigation contributions. The main sources of agricultural emissions include enteric fermentation from livestock, methane emissions from irrigated rice production, nitrous oxide from the use of nitrogenous fertilizers, and the release of carbon dioxide from energy sources used to pump groundwater for irrigation. There appears to be mitigation potential in India's agriculture sector that can go hand in hand with increased productivity, including opportunities to reduce nitrous oxide emissions from over-fertilization and methane emissions from rice.[32] If current emissions from agriculture were reduced by 33% this would generate approximately 117 million tCO_2e in additional reductions.

[26] Government India. 2008. National Action Plan on Climate Change. Government of India, Prime Minister's Council on Climate Change. New Delhi.
[27] Ibid.
[28] Information on India's pledge: https://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/indiacphaccord_app2.pdf.
[29] UNFCCC, AWG-LCA. 2011. Compilation of information on nationally appropriate mitigation actions to be implemented by Parties not included in Annex I to the Convention. http://unfccc.int/resource/docs/2011/awglca14/eng/inf01.pdf.
[30] Government of India. 2015. India's Intended Nationally Determined Contribution: Working towards climate justice. http://www4.unfccc.int/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf.
[31] As per India's State of Forest Report 2013, the country's forest comprises over a fifth or 21% of the country's geographical area, with 69.8 million hectares. http://fsi.nic.in/cover_2013/sfr_forest_cover.pdf. There was a net increase of 0.59 million hectares of forest cover compared to the 2011 India's State of Forest Report.
[32] For example the USAID Vietnam Forests and Deltas Program has helped farmers increase yields by 25% and increased income while reducing fertilizer use. See "Climate-Smart Rice Increases Yields and Profits in Vietnam", July 2015, available at: https://www.usaid.gov/results-data/success-stories/climate-smart-rice-practices-win-win-win-vietnam.

4.4. Indonesia

A. Emissions Profile

According to CAIT data, Indonesia was the world's sixth largest GHG emitter in 2011 (total GHG emissions including LULUCF). Indonesia's deforestation contributes to a large share of global deforestation emissions at around 30-40% for the period 2000-2010.[33] In 2000, Indonesia's total emissions were 1,375 million tCO_2e, a large portion of which (60%) came from LULUCF, particularly land use change and peat and forest fires. In comparison, agriculture constituted a relatively small portion of Indonesia's total emissions at around 5% in 2000 (Figure 6).[34] However, it should be noted that conversion of forests into agricultural production areas is the leading cause of deforestation in the country.

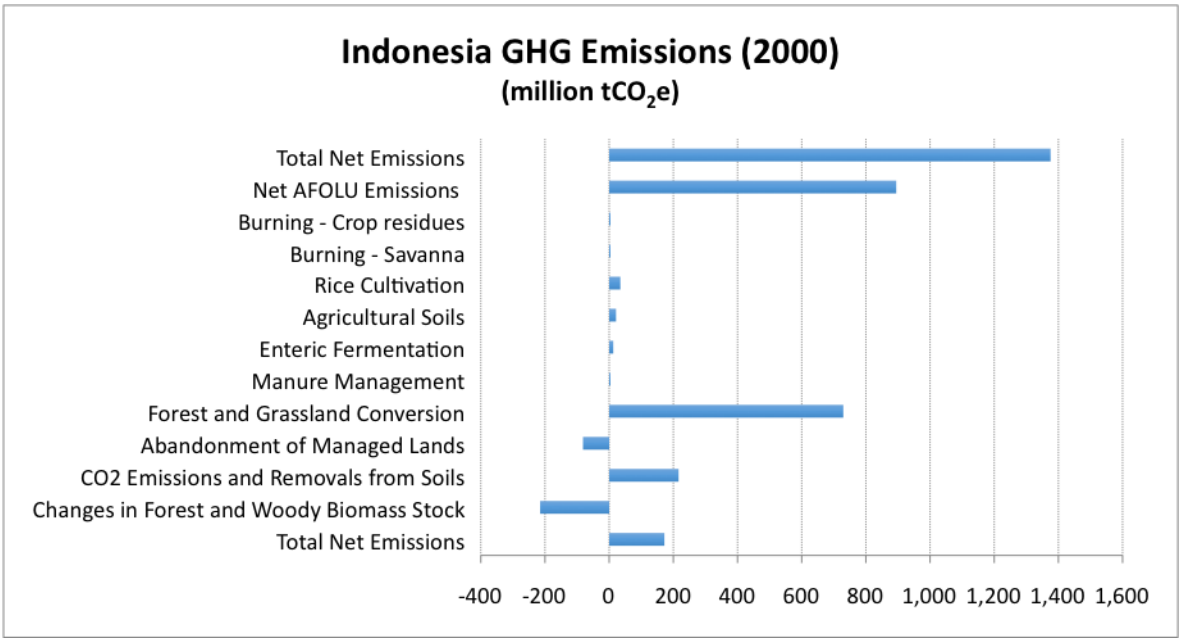

Figure 6. Distribution of Indonesia's emission by AFOLU subsector (2000).

B. National Plans, Programs and Commitments on AFOLU

AFOLU emission reduction targets and activities are emphasized in all major national climate change policies.[35] Most recently, the National Action Plan Addressing Climate Change (RAN-GRK) (2011) commits to reducing economy-wide and each sector's emissions unconditionally by 26% and conditionally by 41% by 2020. This translates to an emission reduction target of 8 to 11 million tCO_2e for the agriculture sector and 672 to 1,039 million tCO_2e for the forestry and peat land sector.

Key forestry mitigation strategies include peat management, REDD, sustainable forest management, land and water resources optimization, increase and improved quality of conservation areas, forest

[33] Climate Action Tracker – Indonesia. 2015. http://climateactiontracker.org/countries/indonesia.html.
[34] Ministry of Environment. 2011. Indonesia's Second National Communication under the UNFCCC. Government of Indonesia, Jakarta.
[35] Second National Medium Term Development Plan (2010-2014), Third National Medium Term Development Plan (2015-2019), Climate Change Sectoral Roadmap (2010), National Action Plan Addressing Climate Change (RAN-MAPI) (2007) and National Action Plan Addressing Climate Change (RAN-GRK) (2011).

planting, and application of land management and farming technologies that have lowest GHG emissions and can absorb CO_2 optimally. In the agricultural sector, priority emission reduction strategies include development of plantations (oil palm, rubber, cacao) on non-forest/abandoned/degraded/other use areas, climate-resilient crop production, use of organic fertilizers and bio-pesticides and use of livestock and agricultural waste for biogas. Additionally, one of Indonesia's NAMAs is related to AFOLU and focuses on community forest partnership for wood biomass based energy.[36]

Reflecting the commitments in RAN-GRK, Indonesia's INDC sets an unconditional emission reduction target of 26% by 2020 and 29% by 2030, along with a conditional target of 41% by 2030. The INDC identifies agriculture and forestry as two of the five key mitigation sectors. It indicates that AFOLU emission reduction targets will be met through effective land use and spatial planning, sustainable forest management including social forestry, restoration of functions of degraded ecosystems, and improved agricultural and fisheries productivity. Indonesia does not provide cost estimates in its INDC.

C. Analysis

AFOLU is well covered in both national climate change policies and INDC of Indonesia. The emission reduction targets and measures cover the entire AFOLU emission profile of the country, with emphasis on land use change and peat and forest fires as the largest emission sources.[37] However, some independent scientific sources have reported higher historical deforestation data and emissions than those in national data, suggesting that Indonesian INDC's BAU level may potentially be underestimated and that the country may be able to do more to reduce emissions in the AFOLU sector.

4.5. Lao People's Democratic Republic

A. Emissions Profile

Lao PDR's net AFOLU emissions were 49.5 million tCO_2e for the base year 2000, accounting for over 97% of the total net emission. LULUCF and agriculture comprised approximately 83% and 15% of the total net emissions, respectively.[38] Conversion of forest and grassland was the most important source of emissions under LULUCF, while rice cultivation (representing 38% of agricultural emissions), agricultural soils (30%), and enteric fermentation (28%) were the most important sources of emissions in the agriculture sector (Figure 7).

[36] Indonesia's NAMAs. NAMA Database. http://www.nama-database.org/index.php/Indonesia.

[37] Indonesia's national data show emissions from LULUCF since 2000 suddenly moving within a stable range, yet other sources including satellite imageries and FAO data show a strong increase in deforestation over the same time period, despite the government's moratorium on the clearing of primary forests and conversion of peat lands from 2010-2016 (Climate Action Tracker 2015).

[38] MONRE. 2013. Lao People's Democratic Republic's Second National Communication to the UNFCCC. Ministry of Natural Resources and Environment. http://unfccc.int/resource/docs/natc/laonc2.pdf.

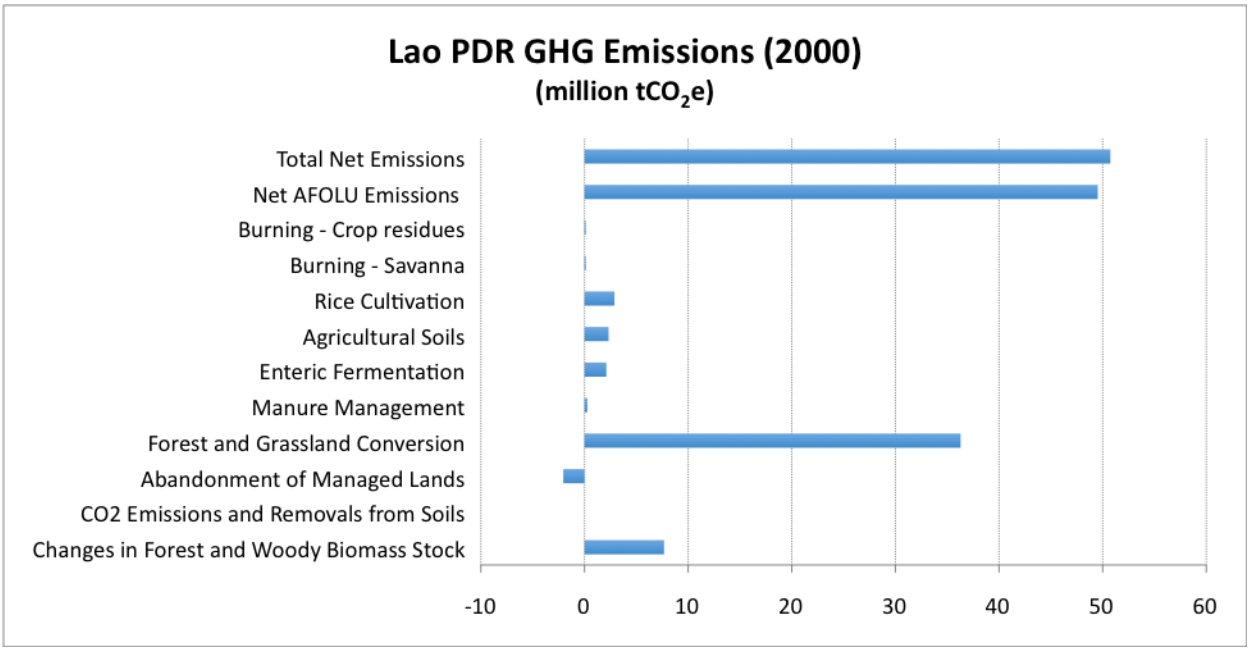

Figure 7. Distribution of Lao PDR's Emissions by AFOLU subsector (2000).

B. National Plans, Programs and Commitments on AFOLU

Lao PDR's long-term national development plan sets the vision to achieve middle-income status by 2030. The country also establishes the overarching national strategy for tackling climate change with a goal of increasing forest cover to 70% of total land area by 2020, among other targets.[39] Additionally, the national agricultural policies promote agricultural and food security programs with mitigation objectives, including climate smart land use planning[40], mobilization of new climate-related finance mechanisms such as CDM and REDD+, and piloting community-based forest management and forest co-management.[41] While Laos is yet to submit its list of NAMAs to the UNFCCC, NAMAs in the energy sector are under development and feasibility studies are underway for NAMAs in the transport sector. There is however currently no NAMA in the AFOLU sector.

Lao PDR's INDC identifies a number of emission reduction actions the country intends to undertake by 2030 that are conditional on the availability of international support. AFOLU, especially the forestry sector, is strongly represented in these target activities. As in national plans, the INDC sets a target of increasing forest cover to 70% of land area (i.e., to 16.58 million hectares) by 2020,[42] from an estimated level of 40% in 2010.[43] The INDC also highlights a preliminary estimate of emission reductions in the

[39] Lao People's Democratic Republic. 2010. National Strategy on Climate Change.
[40] MAF. 2010. Lao PDR's Strategy for Agricultural Development 2011-2020. Ministry of Agriculture and Forestry. http://theredddesk.org/sites/default/files/strategy_for_agricultural_development_2011_to_2020_1.pdf.
[41] MAF. 2010. Lao PDR's Agricultural Master Plan 2011-2015. Ministry of Agriculture and Forestry. http://asialeds.org/sites/default/files/resource/file/3.-Agricultural-Master-Plan-2011-2015.pdf.
[42] Lao People's Democratic Republic. 2015. Intended Nationally Determined Contribution. http://www4.unfccc.int/submissions/INDC/Published%20Documents/Laos/1/Lao%20PDR%20INDC.pdf.
[43] According to The Department of Forest (DOF), in 2010, forest cover in Lao PDR was estimated at 9.5 million hectares or 40.29% of the total land area. http://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/Lao%20FIP%20Presentation%20Pilot%20Country%207%20Nov.pdf.

range of 0.06 to 0.07 million tCO_2e[44] that will occur as a result of the mitigation measures (i.e., once the target has been met post-2020). The INDC also includes adaptation measures to promote climate resilience in farming systems and agriculture infrastructure, including technologies for climate change adaptation.

The INDC estimates that the country will require international financial support of about US$ 1.4 billion for mitigation and US$ 0.97 billion for adaptation, which may include market-based international climate finance, particularly for REDD+.

C. Analysis

Lao PDR intends to implement policies that support the long-term goal of limiting its GHG emissions. AFOLU is the most important source of GHG emissions in the country, covering almost all national emissions. The national strategies on climate change and agricultural development explicitly highlight mitigation measures in the AFOLU sector, which adequately covered both agriculture and forestry sectors. The INDC however focuses on mitigation in the forestry sector and mentions agriculture under adaptation measures only. Furthermore, while the INDC proposes to increase forest cover to 70% by 2020 compared to a level of 40% in 2010, the preliminary estimates of projected emissions do not appear to reflect this target. Given that AFOLU emissions cover over 97% of the total national emissions, and assuming the proposed increase in forest cover that will be achieved by 2020, the estimated emission reductions would be higher than what is stated in the INDC. Additionally, the INDC has not explicitly described the analytical method used to calculate the post-2020 projected emission reductions.

4.6. Thailand

A. Emissions Profile

Thailand's net AFOLU emissions were about 44 million tCO_2e or 19% of total net emissions in 2000. Agricultural emissions totaled nearly 52 million tCO_2e, of which rice cultivation was the largest source (accounting for 58% of agricultural emissions), followed by enteric fermentation (16%), agricultural soils (15%) and manure management (10%). LULUCF on the other hand was a net carbon sink of about 7.8 million tCO_2e (Figure 8).[45]

[44] Originally reported as 60,000-69,000 Kt CO_2e.

[45] MONRE. 2011. Thailand's Second National Communication to the UNFCCC. Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment, Government of Thailand, Bangkok.

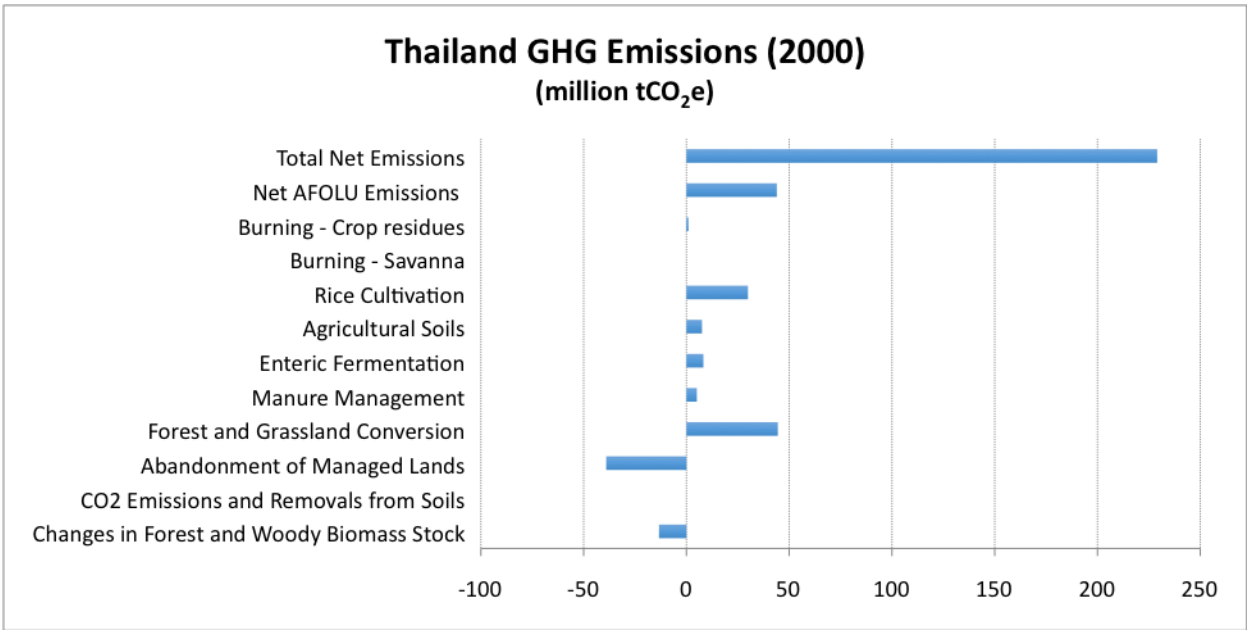

Figure 8. Distribution of Thailand's emission by AFOLU subsector (2000).

B. National Plans, Programs and Commitments on AFOLU

Thailand sets several targets related to mitigation in the AFOLU sector, including increasing forest cover to 40% by 2020, increasing conservation forest area to 19% of total area by 2015, attaining at least 5,000 rai (or 800 hectares) per year of mangrove coastal reforestation and expanding sustainable agriculture areas by at least 5% per year.[46] From forestry sector, mitigation measures include forest protection and sustainable utilization, reforestation/ afforestation, and development and promotion of financial mechanisms such as PES, REDD+ and forest bonds. Mitigation measures in the agricultural sector include zero-waste agriculture[47], agricultural intensification, soil conservation and restoration, land use zoning, fertilizer management, climate-resilient crops and crop insurance.

Thailand's INDC sets an unconditional emission reduction target of 20% (or 111 million tCO_2e) and a conditional target of 25% (or 139 million tonnes of CO_2e) below 2030 BAU level. Emission reduction strategies in the INDC focus on energy, transportation, industry and waste. Agriculture and forestry are mentioned in the context of adaptation only,[48] including a target to increase national forest cover to 40%.[49] However, the INDC indicates that Thailand will consider including LULUCF at a later date. Thailand does not provide cost estimates in its INDC. In addition, none of the country's submitted NAMAs is related to AFOLU.

[46] National Economic and Social Development Plan (2012-2016), the National Master Plan on Climate Change (2013-2050) and the Draft National Green Growth Strategy (2015).
[47] Generating energy from agricultural and agro-industrial wastes and byproducts.
[48] These include climate-resilient agriculture, sustainable management of community forests to promote food security, and biodiversity conservation and restoration of ecological integrity in protected areas and other important landscapes from the adverse impacts of climate change.
[49] FAO's Forest Resources Assessment for 2015 puts forest cover in Thailand at 32.1%. Thailand's Royal Forest Department reports forest cover of 31.57% in 2013 (Emmanoch 2015).

C. Analysis

Thailand's national plans include AFOLU as mitigation measures with a few quantified targets. The sector however is reflected rather as adaptation measures in the INDC, although the protection and expansion of forest areas is included. There may be potential for reducing emissions in agriculture, particularly rice cultivation, which accounts for about half of Thailand's agricultural emissions.

4.7. Vietnam

A. Emissions Profile

Vietnam's net AFOLU emissions were about 69 million tCO_2e or 28% of total net emissions in 2010. Agriculture emitted 88.4 million tCO_2e in 2010, of which the main sources were rice cultivation (representing 50% of total sector emissions), agricultural soils (27%), enteric fermentation (11%), and manure management (9.7%). The LULUCF sector changed from an emission source in 2000 to a sink of 19.2 million tCO_2e in 2010, mainly due to decreased deforestation and increased reforestation and afforestation (Figure 9).[50]

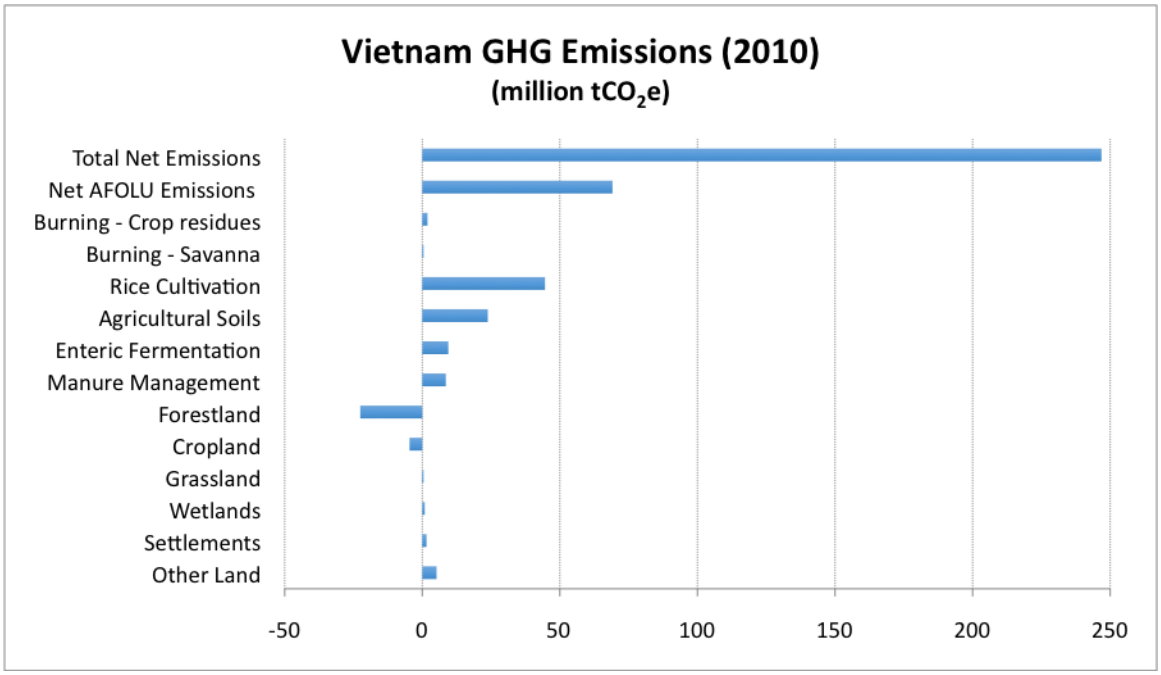

Figure 9. Distribution of Vietnam's emission by AFOLU subsector (2010).

B. National Plans, Programs and Commitments on AFOLU

Vietnam has issued a number of national climate change policies and plans[51], all of which include AFOLU as a key sector in both mitigation and adaptation. The country aims to reduce GHG emissions from the sector by 20% (or 18.87 million tCO_2e) by 2020, while simultaneously ensuring the growth rate and

[50] MONRE. 2014. The Initial Biennial Updated Report of Vietnam to the UNFCCCC. Ministry of Natural Resources and Environment, Government of Vietnam, Hanoi.

[51] National Target Programme to Respond to Climate Change (2008), National Climate Change Strategy (2011), National Socio-Economic Development Strategy (2011-2020) and National Green Growth Strategy (2012).

poverty reduction targets according to sectoral development strategy (by 20% every 10 years).[52] Vietnam has also specified AFOLU sub-sector emission reduction targets and activities, including in crop production, livestock, forestry, fisheries, irrigation, and rural activities such as waste and cooking fuels. Additionally, Vietnam has a NAMA on biogas from medium-sized pig farms that is undergoing feasibility studies.[53]

Specific forestry emission reduction strategies in national plans include REDD, PES, afforestation/reforestation, fire management, agroforestry, and sustainable forest management to enhance carbon stock and sequestration. Mitigation strategies in the agriculture sector include crop management (e.g., reducing emissions from rice cultivation, enhancing effectiveness of nitrogen fertilizers, applying minimum tillage), livestock management (e.g., changing feed portions and composition) and manure management (e.g., waste collection and treatment, composting and biogas).

Vietnam's INDC sets an unconditional economy-wide emission reduction target of 8% (or 63 million tCO_2e) and a conditional target of 25% (or 197 million tCO_2e) below 2030 BAU level. Although the INDC does not provide specific emission reduction target for the AFOLU sector, it unconditionally commits to increasing forest cover to 45% by 2030.[54] Agriculture and forestry are two of the five key mitigation sectors in the INDC. Additionally, an adaptation target is to increase the area of coastal protection forests to 380,000 hectares, including 20,000 to 50,000 hectares of additional mangrove planting by 2030.

Vietnam's INDC does not provide any cost estimates. However, the AFOLU sectoral climate change strategy estimates that implementation of the program to reduce emissions from the sector will require a total budget of 2,740 billion VND (US$ 120 million), of which 540 billion VND (US$ 20 million) is expected from state budget and 2,200 billion VND (US$ 100 million) from ODA.

C. Analysis

AFOLU is a priority sector in both Vietnam's INDC and national climate change policies, whose mitigation targets and activities cover the country's entire AFOLU emission profile. While the sector is well covered in Vietnam's mitigation strategies, addressing the financing challenge will be critical for Vietnam to meet its AFOLU mitigation objectives.

5. Funding and Costs

5.1. Estimating mitigation cost of AFOLU activities

Mitigation cost estimates vary greatly depending on country contexts, underlying assumptions regarding emission scenarios, time horizons, cost parameters, the type of technology employed and the type of commodity, among other factors. Given such challenges, this section is meant to give only rough order-of-magnitude estimates of the costs of selected AFOLU mitigation activities, including in rice cultivation,

[52] Decision 3119 of the Ministry of Agriculture and Rural Development dated 16 December 2011 on approving The Programme of GHG Emission Reduction in the Agriculture and Rural Development sector up to 2020.
[53] Biogas NAMA in Vietnam. NAMA Database. http://www.nama-database.org/index.php/Biogas_NAMA_in_Vietnam.
[54] According to the FAO's 2015 Forest Resources Assessment, Vietnam forest cover is 47.6%. However, the Vietnam Ministry of Agriculture and Rural Development (MARD)'s reported forest cover is usually lower than that of FAO. Based on MARD data, forest cover in Vietnam was 39.7% in 2013 (Do 2015).

fertilizer management, enteric fermentation and agricultural soils. The prioritization of these activities are partly informed by discussion outcomes from a regional workshop organized by the Asia LEDS Partnership in October 2015 on "Mobilizing investment on low-emissions development in Asia's agriculture sector."[55]

The Asia region is reported to have the largest technical and economic mitigation potential in the AFOLU sector.[56] Particularly, Southeast Asia is estimated to present the highest technical mitigation potential to reduce GHG emissions from agriculture than any other region, owing to the significance of the sector in the countries' economic and emission profiles and vast area of croplands. The potential for emission reductions from using all technically feasible practices and covering all GHG gases is estimated to range from 550 to 1,300 million tCO_2e per year by 2030. In particular, the region provides almost all of the global mitigation potential for rice cultivation, including the largest potential for restoration of organic soils (due to cultivated Southeast Asian peats). By 2030 the global economic potential for agricultural GHG reduction could reach 28% of its total technical potential at a carbon price of up to $\$20/tCO_2e$ and 46% at a carbon price of up to $\$50/tCO_2e$.[57] Roughly applying the global proportions to Southeast Asia, by 2030 the region's economic potential for GHG mitigation in agriculture would be about 152 million tCO_2e/year at a carbon price of up to $\$20/tCO_2e$ and about 414 million tCO_2e per year at a carbon price of up to $\$50/tCO_2e$.[58] A study for India puts marginal abatement costs for almost all AFOLU related mitigation activities at below US$ 107[59] per tCO_2e.[60]

Table 2 summarizes the cost estimates of three agriculture mitigation options with selected case studies. As stated above, cost estimates of mitigation potential in the AFOLU sector vary greatly depending on a number of factors, including limitations on empirical estimates of mitigation potential in the agriculture sector. More detailed and evidence-based research will be needed to guide decision making on the best fit mitigation activities.

Going forward, most countries will face both mitigation and adaptation challenges. It is important to assign high priority to mitigation actions that improve (or do not reduce) productivity and have strong adaptation benefits. Lower priority could be assigned to mitigation activities that have no adaptation benefits or reduce food productivity. Financing preferences should go to the former, and a top-up based on the adaptation asset value could be considered.

[55] Mobilizing Investment on Low-Emission Development in Asia's Agriculture Sector. Regional Workshop organized by Asia LEDS Partnership, October 28-30, 2015, Ho Chi Minh City, Vietnam.
[56] Smith P., M. Bustamante, H. Ahammad, H. Clark, H. Dong, E. A. Elsiddig, H. Haberl, R. Harper, J. House, M. Jafari, O. Masera, C. Mbow, N. H. Ravindranath, C. W. Rice, C. Robledo Abad, A. Romanovskaya, F. Sperling, and F. Tubiello, 2014: Agriculture, Forestry and Other Land Use (AFOLU). In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[57] Smith, P., D. Martino, Z. Cai, D. Gwary, H. H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, R. J. Scholes, O. Sirotenko. 2007. "Mitigation." In B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer, eds. Contribution of Working Group III to the Fourth Assessment Report of the Integrated Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[58] Asian Development Bank (ADB). 2009. The economics of climate change in Southeast Asia: a regional review. Manila, Philippines.
[59] Original study reported in Euro (Euro 100 per tCO_2e). Currency converted to USD based on current rates of 1EURO=1.07USD.
[60] Environmental and Energy Sustainability: An approach for India. 2009. McKinsey & Company, Inc., Mumbai, India.

Table 2. Mitigation options in Agriculture in the Asian region and few selected countries

Mitigation Option	Relative Mitigation potential	Opportunities (Cost effectiveness, feasibility, synergy with adaptation)	Specific Country case studies	Challenges/Barriers
Rice Cultivation	In continuously flooded rice fields, reduce methane emission by 7-63% (with organic amendment) and 9-80% (with no organic amendment). **Note:** Methane emission in rice fields vary over a wide range (5-634 kg CH_4/ha)[61] depending on the season (i.e. Spring, fall or winter) and management practices: ((I) field drying at mid-tillering (i.e.mid-season drainage); or (II) continuous flooding); or (III) alternate flooding and drying).	More effective rice straw management to reduce CH_4 emissions (e.g., as a biofuel).	**Vietnam** • Alternate wetting and drying (AWD) leads to emissions reductions of 6-6.9 tCO_2e/season/ha.[62] • Reduction in methane emissions of 40kg/ha/year with an increase in rice yield of 0.3 ton/ha through an innovative water management.[63] **Philippines** • The use of ammonium sulfate as nitrogen fertilizer in place of Urea resulted in a 25-36% reduction in methane emissions **Bangladesh** • AWD offers largest GHG abatement potential in 2020 with a reasonable marginal abatement cost of \$15.72/tCO_2e abated.[64] • Total cost of production of a hectare of paddy rice under AWD increased by 3-4% from the conventional price range of \$1091-\$1184.[65] **India** • With one midseason drying, net revenue drops less than 5%, while GHG emissions drop by almost 75 million tCO_2e. Opportunity cost is US\$1.20/tCO_2e[66]	• The benefit in reducing emissions from methane may be offset by increase in nitrous oxide emission from application of nitrogen fertilizer. • Practice may be constrained by water supply • Measures such as rice residue management and AWD may incur additional costs to farmers in the short run, which in turn may impact adoption of such practices.

[61] Wassmann, R., et.al. 2000. "Characterization of Methane Emissions from Rice Fields in Asia. III. Mitigation Options and Future Research Needs." Nutrient Cycling Agroecosystems 58: 23–36.
[62] Narayan, Tulika, and Anna Belova. 2014. "Achieving Low Emissions Growth for Rice Cultivation in Vietnam: A Role for Behavioral Constraints." In *Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota*, no. 170185. Agricultural and Applied Economics Association.
[63] Asian Development Bank (ADB). 2009. The economics of climate change in Southeast Asia: a regional review. Manila, Philippines.
[64] Shrestha, R.M., M. Ahmed, S. Suphachalasai, and R.D. Lasco. 2013. Economics of reducing greenhouse gas emissions in South Asia: Options and costs. Mandaluyong City, Philippines: Asian Development Bank.
[65] Basak, Rishi. 2015. Benefits and costs of Climate Change Mitigation Technologies in Paddy rice. CCAFS study on Financing low emissions agriculture.

Mitigation Option	Relative Mitigation potential	Opportunities (Cost effectiveness, feasibility, synergy with adaptation)	Specific Country case studies	Challenges/Barriers
Cropland management • Agronomy • Nutrient management • Tillage/residue management • Water management	Potential to sequester soil carbon by 0.55–1.14 tCO_2/ha/ year Potential to reduce nitrous oxide emissions by 0.02–0.07 tCO_2e/ha/year.[67] Improved nitrogen efficiency is suggested to reduce emissions of nitrous oxide while simultaneously reducing GHG emissions from nitrogen fertilizer	Use of improved varieties with reduced reliance on fertilizers and other inputs provides opportunity for better economic returns. Reduced tillage will reduce the use of fossil fuel thus lower CO2 emissions from energy use.	**India** • Use of the GreenSeeker device[68] resulted in a greater fertilizer recovery efficiency of 6-22% compared to farmers' practices, and with no rice yield loss.[69] • The estimated GHG reduction from such recovery range from 51-247kg CO_2e/ha. Fertilizer saved is estimated to represent US$ 10.03-48.97, at current market price for Urea fertilizer.[70]	• Could be costly to implement and would need considerable effort to transfer, diffuse, and deploy. • Some measures may challenge existing traditional practices.
Livestock management feeding practices	Improved feeding reduce methane emissions from enteric fermentation by 1–22% (dairy cattle); 1–14% (beef cattle); 4–10% (dairy buffalo), and 2–5% (nondairy buffalo).[71] UMMB and UTS were found to increase milk production by as much as 25% and 30%, respectively	The measure depends on soil and climatic conditions, especially when dealing with grazing animals.	**Bangladesh** • Urea treated straw (UTS) feeding has the highest marginal abatement cost/tCO_2e with an estimated range of $43.66-$45.99, while for UMMB $13.51 -$14.66.[72] **India** • Supplementing ruminant diets with urea-molasses multi-treatment blocks (UMMB) showed emission reductions by as much as 35%.[73]	• The effect varies depending on management of animals, i.e., whether confined animals or grazing animals.

Source: Adapted from ADB (2009)

[66] Wassmann R., et.al. 2009. *Reducing Methane Emissions from Irrigated Rice*. Agriculture and Climate Change: An Agenda for Negotiation in Copenhagen, Focus 16, Brief 3, 2020 for Food, Agriculture and the Environment.
[67] Asian Development Bank (ADB). 2009. The economics of climate change in Southeast Asia: a regional review. Manila, Philippines.
[68] Similar to other handheld pocket devices, GreenSeeker is an optical crop sensor enabling to diagnose crop health and nutrient needs by guiding nitrogen fertilizer applications.
[69] Basak, Rishi. 2015. Benefits and costs of Nitrogen Fertilizer Management for Climate Change Mitigation. CCAFS study on Financing low emissions agriculture.
[70] Ibid.
[71] Asian Development Bank (ADB). 2009. The economics of climate change in Southeast Asia: a regional review. Manila, Philippines.
[72] Ibid.
[73] Shrestha, R.M., M. Ahmed, S. Suphachalasai, and R.D. Lasco. 2013. Economics of reducing greenhouse gas emissions in South Asia: Options and costs. Mandaluyong City, Philippines: Asian Development Bank.

5.2. Financing INDCs: a look at AFOLU

Meeting GHG mitigation targets while adapting to climate change is a dual challenge facing the selected case countries. More than ever, the AFOLU sector is a sound platform for countries to put a concerted effort to create synergies between adaptation and mitigation measures through their INDCs. Additionally, the sector offers these countries the opportunity to articulate their need for financing and to facilitate access to continuously evolving global climate finance by harnessing cost-effective emission reductions in AFOLU.[74] Most countries indicate in their INDCs that they require international support in the form of finance, technology and capacity building, while some further state estimated costs and the level of support required. However, some countries including Thailand and Indonesia do not provide cost estimates in their INDCs. Bangladesh draws the economic assessment of its adaptation needs from various sources, while indicating the need for further study to estimate the mitigation potential and associated costs of the AFOLU sector.[75]

It is crucial for countries to pay due attention to the role of finance as it is a key factor that will bridge achievements in mitigation between what most countries have proposed as unconditional and conditional contributions. It is also crucial for countries to start developing a comprehensive sector-based climate finance strategy that articulates their financial needs to enable implementation of INDCs and AFOLU related mitigation activities. INDCs have set the trend for countries towards introducing national climate and development policies to low-emission development strategies. To capture this opportunity, developing countries in Asia may need guidance on how to effectively access international public and private climate finance to achieve their mitigation objectives as outlined in the INDCs.

6. Next steps

Current INDCs do not bring us to a 2°C warming scenario. It remains to be seen whether deeper contributions can come from COP 21. AFOLU is one area with significant mitigation potential – particularly in Asia, which is reported to have the largest technical and economic mitigation potential in the AFOLU sector. [76]

The current INDCs are a starting point to understand countries' potential contributions to climate mitigation. In many cases they are also an expression of adaptation needs. More work is needed to help refine – and in some cases enhance – a number of countries mitigation contributions from AFOLU. This may occur both within domestic policy and internationally communicated contributions. Both refining current estimates and exploring the potential for expansion can be challenging because:

[74] Hedger, M. and S. Nakhooda. 2015. Finance and Intended Nationally Determined Contributions (INDCs): Enabling Implementation. Working Paper 425. Overseas Development Institute (ODI), London, UK.
[75] Ibid.
[76] Smith P., M. Bustamante, H. Ahammad, H. Clark, H. Dong, E. A. Elsiddig, H. Haberl, R. Harper, J. House, M. Jafari, O. Masera, C. Mbow, N. H. Ravindranath, C. W. Rice, C. Robledo Abad, A. Romanovskaya, F. Sperling, and F. Tubiello, 2014: Agriculture, Forestry and Other Land Use (AFOLU). In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

1. GHG estimates are several years old in a number of countries. A lack of clarity over the starting point makes it hard to estimate emission reduction potential.
2. Cost estimates for AFOLU mitigation need to be developed further. Cost estimates need to be developed for specific activities in specific countries, and be accompanied by estimates of emission reduction and/or removal.
3. Feasibility studies and stakeholder consultation needs to be undertaken to assess whether or not it is practical to implement wide-scale mitigation and adaptation projects or programs.

Low emission development strategies (LEDS) that target the AFOLU sector can help with this. LEDS involves an inclusive process of collecting information on current sources of emissions, identifying, analyzing and prioritizing opportunities to reduce emissions, followed by implementation and ongoing adaptive management. A number of tools and resources for developing AFOLU LEDS have already been developed[77] along with a number of example AFOLU LEDS in the region.

Going forward, integrating LEDS into national planning processes and revisions of INDCs will help improve our understanding of current mitigation contributions, and establish the foundation for implementation of mitigation and adaptation efforts.

[77] See the resources section of http://ledsgp.org.

Annex 1: AFOLU mitigation activities included in countries' national plans and INDCs

✓: Included in National plans, policies or programs
▪: Included in INDC

MITIGATION ACTIVITY CATEGORY	EXAMPLES	BANGLADESH	CAMBODIA	INDIA	INDONESIA	LAO PDR	THAILAND	VIETNAM
FORESTRY								
Reducing deforestation	Conserve existing forests, increase forest reserve and protected areas, reduce illegal logging	✓	✓▪	✓	✓▪	✓▪	✓▪	✓▪
Reforestation/ Afforestation	Plant trees on non-forested lands	✓▪	✓	✓▪	✓	✓▪	✓▪	✓▪
Forest restoration	Increase carbon densities in secondary and other degraded forests through natural or artificial regeneration, rehabilitation of degraded lands, long-term fallows	✓	✓	✓▪	✓▪	✓▪	✓▪	✓▪
Land use planning	Land use classification/zoning, development of agricultural plantations on non-forest/abandoned/degraded lands		✓		✓▪	✓▪	✓	✓
Forest management	Sustainable forest management to increase stand- and landscape-level carbon density		✓▪		✓▪	✓▪		✓▪
Fire management	Reduce the frequency and intensity of forest fires, improve fire control				✓▪	✓		✓

MITIGATION ACTIVITY CATEGORY	EXAMPLES	BANGLADESH	CAMBODIA	INDIA	INDONESIA	LAO PDR	THAILAND	VIETNAM
AGRICULTURE								
Croplands management	Plant management, nutrient management including fertilizers, tillage/residues management, water management, rice management, rewetting peatlands drained for agriculture, set-aside	✓▪	✓	✓▪	✓	✓▪	✓▪	✓▪
Restoration of degraded lands	Land reclamation, afforestation, soil fertility management/erosion control, water conservation, soil nutrients enhancement, improved fallow land		✓	✓	✓	✓	✓	✓
Organic soils restoration	Soil carbon restoration on peatlands; and avoided net soil carbon emissions using improved land management			✓	✓	✓▪	✓	✓
Livestock management	Improved feeding, breeding, and other long-term management	✓▪	✓	✓		✓		✓▪
Manure/ biosolid management	Improved storage and handling, anaerobic digestion, more efficient use as nutrient source	✓▪	✓		✓	✓	✓	✓▪
Bio-energy	Energy crops, solid waste, liquid waste, biogas, residues		✓		✓	✓▪	✓	✓▪
Agroforestry	Agroforestry		✓	✓▪	✓	✓▪		✓
Low-emission machinery	Low-emission agriculture and aquaculture machinery			✓				✓

Annex 2: List of documents reviewed, including national plans, NAMAs and INDCs

Country	National Development Plan	Climate Change Strategy	Green Growth Strategy	INDC	NAMA
Bangladesh	6th Five Year Plan (2011-2015)	Climate Change Strategy and Action Plan (2009)	-	✓	✓
Cambodia	National Strategic Development Plan (2014-2018)	Climate Change Strategic Plan (2014-2023)	National Green Growth Roadmap (2009)	✓	✓
India	12th National Development Plan (2012-2017)	National Action Plan on Climate Change (2008), including National Mission for Green India, National Mission on Sustainable Agriculture	National Mission for a Green India	✓	✓
Indonesia	3rd National Medium Term Development Plan (2015-2019)	National Action Plan Addressing Climate Change (2011), Climate Sectoral Roadmap (2009), National Action Plan Addressing Climate Change (2007)	-	✓	✓
Lao PDR	7th National Socio-economic Development Plan (2011-2015)	National Climate Change Strategy (2010), National Strategy for Agricultural Development (2011-2020)	-	✓	✓
Thailand	11th National Economic and Social Development Plan (2012-2016)	National Master Plan on Climate Change 2013-2050 (2014 Draft)	Green Growth Strategy (2014 Draft)	✓	✓
Vietnam	Ten-year Socio-economic Development Strategy (2011-2020)	National Climate Change Strategy (2011), National Target Program in Response to Climate Change (2008), Decision 3119 of the Ministry of Agriculture and Rural Development (2011)	National Green Growth Strategy (2012)	✓	✓

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