Methods for identifying low emissions development options for agriculture

Working Paper No. 147

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

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Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

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Abstract

Low emissions development strategies (LEDS) are national economic and social development plans that promote sustainable development while reducing GHG emissions. While LEDS programs have helped to mainstream economy-wide planning for low emissions, planning for low emissions agriculture has remained nascent. Low-emissions development (LED) in agriculture acknowledges that the primary purpose of agriculture is to produce food and other goods for human needs, and that climate change mitigation is a secondary goal that should not compromise production. This paper describes a research process and protocol to identify high potential LED options in agriculture at the United States Agency for International Development (USAID). The case study illustrates the steps for the identification and prioritization of LED options including: idea generation, concept development, and evidence building. Each stage is designed to gather and analyze data that specifically enable managers and stakeholders to make informed evaluations. The method gathers not only emission and mitigation information but also food security and income generation data, lending process legitimacy to the research. The incorporation of institutional factors and local contextual systems in the LED concept development stage improves the output credibility and salience. In the final process phase, stakeholders are given an active role in determining the criteria for prioritization and building evidence. The LED option identification and prioritization process illustrates how careful evidence-building can increase the credibility and salience of outputs and legitimacy of the overall results.

Keywords

Low emissions development; action research; priority setting; climate change; agricultural development; USAID

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The views expressed in this document cannot be taken to reflect the official opinions of CGIAR, Future Earth, or donors. CCAFS brings together the world's best researchers in agricultural science, development research, climate science, and Earth system science to identify and address the most important interactions, synergies, and tradeoffs between climate change, agriculture, and food security. www.ccafs.cgiar.org.

Contents

Acronyms

CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
EX-ACT	EX-Ante Carbon Balance Tool
FAO	Food and Agriculture Organization (United Nations)
FTF	Feed the Future
GHG	Greenhouse gas
INDCs	Intended Nationally Determined Contributions
LED	Low emissions development
LEDS	Low emissions development strategies
MCDA	Multi-Criteria Decision Analysis
USAID	United States Agency for International Development
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

Agriculture, forestry, and other land use sectors contribute 24% of anthropogenic global greenhouse gas (GHG) emissions, which is equal to 10–12 gigatons of carbon dioxide equivalents per year (Smith et al. 2014); developing countries currently account for about three-quarters of direct emissions (Smith et al. 2007). Lowering agricultural emissions and increasing carbon sequestration can play a pivotal role in reducing agriculture's overall contribution to GHG emissions (Ogle et al. 2014).

Low emissions development strategies (LEDS) are national economic and social development plans that promote sustainable development while reducing GHG emissions. The United Nations Framework Convention on Climate Change (UNFCCC) first coined the term LEDS (Clapp, Briner, and Karousakis 2010) in 2008. The Copenhagen Accord (2010) and Durban climate agreement (2011) highlighted the term to encourage countries to align climate action and other national policy goals (Martius et al. 2015). LEDS establish economy-wide, long-term mitigation goals (15–30 years) and formulate integrated strategies for climate change mitigation based on cost-effective mitigation priorities and development aims. The UNFCCC requires developed countries to prepare LEDS, but only encourages developing countries to do so. Preparing these plans can facilitate agreement within and across institutions on development and climate change priorities (Clapp, Briner, and Karousakis 2010).

LEDS help to mainstream economy-wide planning for low emissions. And although planning for low emissions agriculture has remained nascent, countries' interest in mitigation of GHG emissions in agriculture is strong. A number of recent international initiatives and agreements have catalyzed interest in agriculture development that also minimize GHG emissions. In 2014, the Global Alliance for Climate Smart Agriculture launched at the United Nations Climate Summit. Even more significant, as part of the global agreement on climate change adopted by the UNFCCC in Paris, 103 countries pledged to mitigate emissions from agriculture, as reflected in their Intended Nationally Determined Contributions (INDCs) (Richards, Gregersen, and Kuntze 2015). These pledges signify a powerful demand to define effective and practical options for low emissions development (LED) in the agriculture sector.

We define LED in agriculture to mean sustainable development in food systems that reduces

GHG emissions, while maintaining production of food and other goods at sufficient levels to satisfy human needs. LED in this context acknowledges that the primary purpose of agriculture is to produce food and other goods for human needs.

This paper describes a process that promotes evidence-based decision making by identifying and prioritizing LED options to achieve national mitigation goals. We developed this method during a CCAFS action research project with USAID to inform LED options in the Agency's future agriculture and food security investments. The case study illustrates how a series of steps can be used to identify and prioritize LED options by gathering data, facilitating stakeholder collaboration, and quantifying the GHG emissions benefits of different development options (USAID 2015b)

This paper outlines the methods used to identify LED opportunities within USAID's Feed the Future (FTF) food security activities. The first section presents a process to identify and prioritize LED options. The second section examines an application of the process in an action research project at USAID. The third section discusses lessons learned about the process. The final section explores the implications of the process for overall LED planning.

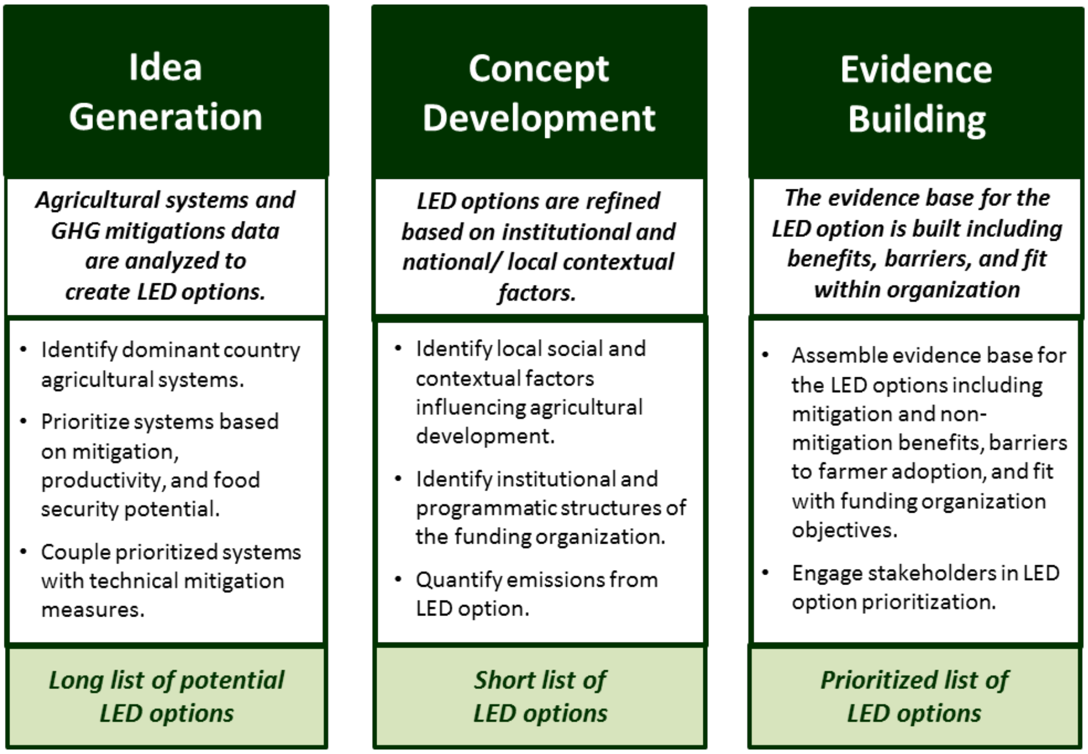
LED option identification and prioritization

The process of generating, developing, and prioritizing LED options involves multiple, sequential stages, similar to those used in stage-gate systems or phased reviews to develop consumer products. Each stage is designed to gather and analyze data that specifically enable managers and stakeholders to evaluate options (Cooper 2008, Hart et al. 2003). The development stages include idea generation, concept development, business case preparation (evidence building), product development, market testing, and market launch (Hart et al. 2003, Sumberg and Reece 2004). Although agricultural research planners have explored using stage-gate planning (Sumberg and Reece 2004), the approach is seldom used to plan agricultural research. The following sections outline three of these sequential stages (figure 1).

1. *LED idea generation*. Gather agriculture data that reflect countries' current development needs and trajectories and exhibit potential emissions impacts.
2. *LED concept development*. Refine LED options by incorporating institutional constraints and national social and contextual factors.

3. *LED evidence building.* Build robust evidence base for LED options, including benefits, barriers, and relevance within organization.

Figure 1. LED idea generation, concept development, and evidence building.



Stage 1: LED idea generation

The goal of the idea generation stage is to understand the breadth of mitigation opportunities available within a country's agricultural systems and to generate a set of technical choices for each country. Specifically, the crop and livestock systems with the greatest development impact and mitigation potential are identified and prioritized at this initial stage.

We first identified a country's dominant crop and livestock systems by gathering data from the FAO Statistical Database (FAO-Stat) on area and production: livestock production (tons), crop production (tons), and cropping extent (harvested areas). Livestock production is a large source of GHG emissions—particularly methane from enteric fermentation and manure decomposition and carbon dioxide from land use change. GHG emissions from crop production result from the use of nitrogen fertilizer and respond to crop residues management, and other agricultural practices, particularly ones that increase below-ground carbon inputs to soil via plant roots.

Once the dominant agricultural systems in a country are compiled, they are prioritized based on their potential to minimize net GHG emissions (both opportunities for emissions reduction and carbon sequestration), improve productivity, and meet agricultural development objectives. To this end, the agricultural systems were rated as High, Medium, or Low in each of the following areas:

- *Mitigation potential of an agricultural system.* The relative emissions reduction opportunity of an agricultural system is evaluated based on the direct contribution of the system to the country's agriculture GHG emissions profile. The FAO-Stat database follows the methodology of the Intergovernmental Panel on Climate Change (IPCC 1997, 2006) for assessing and reporting GHG emissions. This methodology organizes emissions according to the main sources of emissions emitted directly from agricultural production systems (e.g., enteric fermentation, manure left on pasture, manure management, fertilizer application, rice production, and burning savanna). Emissions that result from production of agricultural inputs or the transport or processing of agricultural products are not accounted for in this methodology.
- *Productivity enhancement potential of an agricultural system.* The relative productivity opportunity of the agricultural system was estimated with the current productivity gap. This criterion compares the productivity of a country's agricultural system with that of the world's most agriculturally productive country.
- *Systems importance in agricultural development (measured through staple food production or cash crop data).* If a country's agricultural system is a dominant staple or cash crop, it is deemed important for agricultural development. For staple crops, ranking depends on the metric Food Supply Crops Primary Equivalent and Livestock and Fish Primary Equivalent. For cash crops, export value determines the ranking.

Box 1. Data accessed in FAO-Stat (faostat3.fao.org) for LED idea generation (2012 Data)

1) Emissions- Agriculture: Enteric Fermentation, Manure Left on Pasture, Manure Management, Synthetic Fertilizer, Rice Production, and Burning Savanna

2) Production
   - 2.1) Crops: Area Harvested, Yield, and Production Quantity
   - 2.2) Livestock Primary: Producing Animals, Yield, and Production Quantity

3) Food Balance (assumed as Staple Food)
   - 3.1) Food Supply Crops Primary Equivalent: Food Supply Quantity (kg/capita/yr).
   - 3.2) Livestock and Fish Primary Equivalent: Food Supply Quantity (kg/capita/yr).

4) Trade (assumed as Cash Crops)
   - 4.1) Crops: Export Values (USD)
   - 4.2) Livestock Products and Live Animals: Export Values (USD)

In the final step of LED idea generation, we coupled data about the dominant agricultural systems in each country with mitigation practice data gathered from a literature review. The output of LED idea generation is a long list of potential LED ideas organized around the top food systems in the study countries.

Stage 2: LED concept development

In the LED concept development stage, institutional factors and local systems are evaluated in order to bundle technical practices into country- and crop-specific LED options. Numerous innovation studies identify the tendency for agricultural development to be channeled along set trajectories based on local social/contextual and institutional factors (Seyfang and Smith 2007). Technical mitigation practices are embedded within existing systems of agricultural development and dissemination, and the embedded nature of these practices subsequently restricts opportunities for alternatives (Jacobsson and Johnson 2000, Seyfang and Smith 2007, Van Mele 2008). In addition, existing institutional structures can play a significant role in the success of a given LED option. Research shows that an institution's organizational structure and support for specific production systems influence the technology choices made by individual firms (Jacobsson and Johnson 2000). To understand these contextual factors, it is necessary to understand the characteristics and context of successful agricultural development projects in a location, and explore barriers to adoption/scale-out of project practices. To do this, interviews should be conducted with current projects in a country and within the institution of interest. Afterward, the LED options are quantified so that they can be prioritized in the next stage.

A short list of LED options emerges from this stage of the identification process. The LED option contains a crop, geography, and bundle of technical mitigation practices that are influenced by local systems for agricultural development and institutional factors. This short list of quantified and contextually relevant LED options is then ready for evidence building.

Stage 3: LED evidence building

LED evidence building enhances the refinement of an LED option through knowledge and experience sharing, and facilitates ranking of options with stakeholders. In this stage, it is essential to engage stakeholders in discussions on evidence-based decision making. An important dimension is to understand both the sources of information the stakeholders consider credible as well as the trade-offs they want to address. This enables the team to gather additional evidence and characterize the LED options based on agreed priorities.

To gather robust evidence for LED options, the impacts of different agricultural management practices and the barriers/incentives to their adoption must be investigated. Evidence of impacts include mitigation, non-mitigation environmental, and productivity areas. To assess mitigation impacts, it is important to consider their technical feasibility and confidence level. For non-mitigation environmental impacts, consider impacts of water quality and conservation, soil fertility and structure, air quality, biodiversity, wildlife habitat, and energy conservation. Productivity impacts examine farmer productivity, evidence of labor changes, and farm profitability. LED option barriers and proven incentives should be considered across multiple scales. At the farm scale, consider financial and labor barriers to adoption and proven incentives to overcome them. At the value chain scale, take into account barriers to production systems and those of supply chain actors. Critical elements of the national- and regional-enabling environment are the business-environment context, availability of capital investment, government policy, and infrastructure challenges.

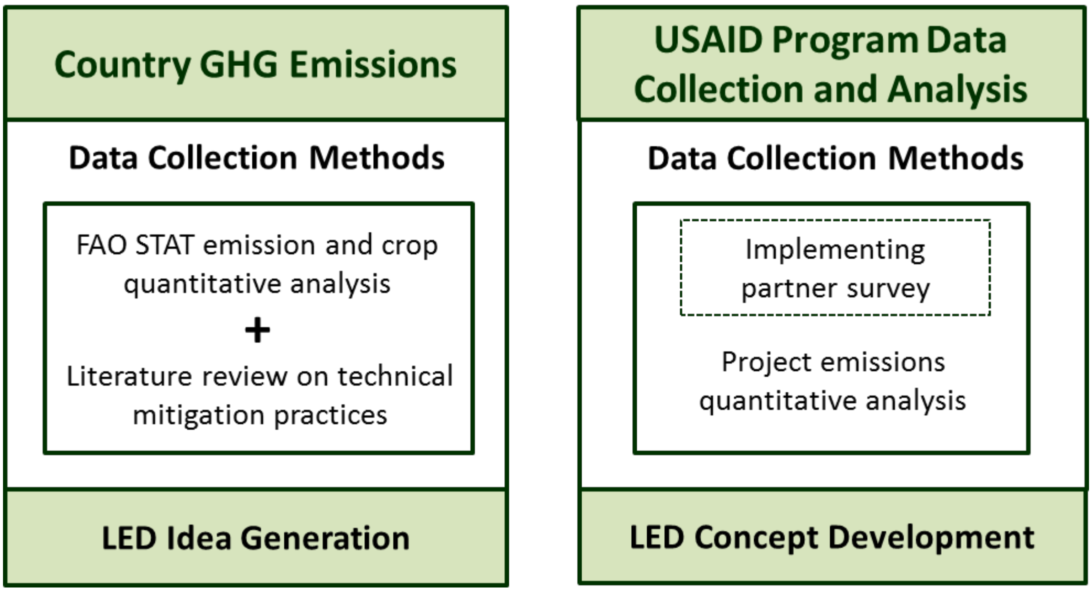
After evidence has been gathered, a wide range of stakeholders should prioritize the LED options. Multi-criteria decision analysis (MCDA) can be used as a decision support technique to balance multiple objectives and facilitate stakeholder interaction on prioritization (Scrieciu et al. 2014). MCDA has been widely applied in evaluating trade-offs of environmental management (Scrieciu et al. 2014, Tambo and Wünscher 2015). This prioritization process results in a ranked list of LED options as a basis to allocate resources for scientific evaluation and feasibility research.

Application of process in action research at USAID

USAID engaged CCAFS to help the Agency develop LED strategies for its portfolio of agriculture and food security programming. Specifically, the research team partnered with USAID's Office of Global Climate Change and Bureau of Food Security, focusing on USAID's FTF program. FTF works with host-country governments, businesses, smallholder farmers, research institutions, and civil society organizations to promote global food security and nutrition. To date it has prioritized efforts on smallholder agriculture in 19 focus countries (USAID 2015a).

An action research lens guides the overall study design. Action research is an iterative process that integrates research, reflection, and action; it balances problem-solving actions with data-driven research. The goal is to understand underlying causes in order to improve the way issues are addressed and to solve problems (Méndez, Bacon, and Cohen 2013). The highly collaborative process of stakeholder engagement extended over 12 months, and the research followed a mixed-method (qualitative and quantitative) design. Two data collection and analysis efforts (figure 2) provided inputs to the LED identification and prioritization process. USAID and qualitative data were collected concurrently, and the two data sets were compared in order to determine whether there is data convergence, differences, or some combination (Creswell 2009). In our process, the mixing of the data is defined by the identification and prioritization of LED options.

Figure 2. Data collection and analysis overview.



LED idea generation

As stated in the process section, the goal of the LED idea generation stage is to understand the breadth of mitigation opportunities available within a country's top crop and livestock systems. For the USAID case study, the team wanted to better understand the GHG mitigation opportunities outside of FTF current programming. To do this, data were collected on the top agricultural activities in the FTF countries and prioritized. Potential mitigation practices were then aligned with these agricultural activities.

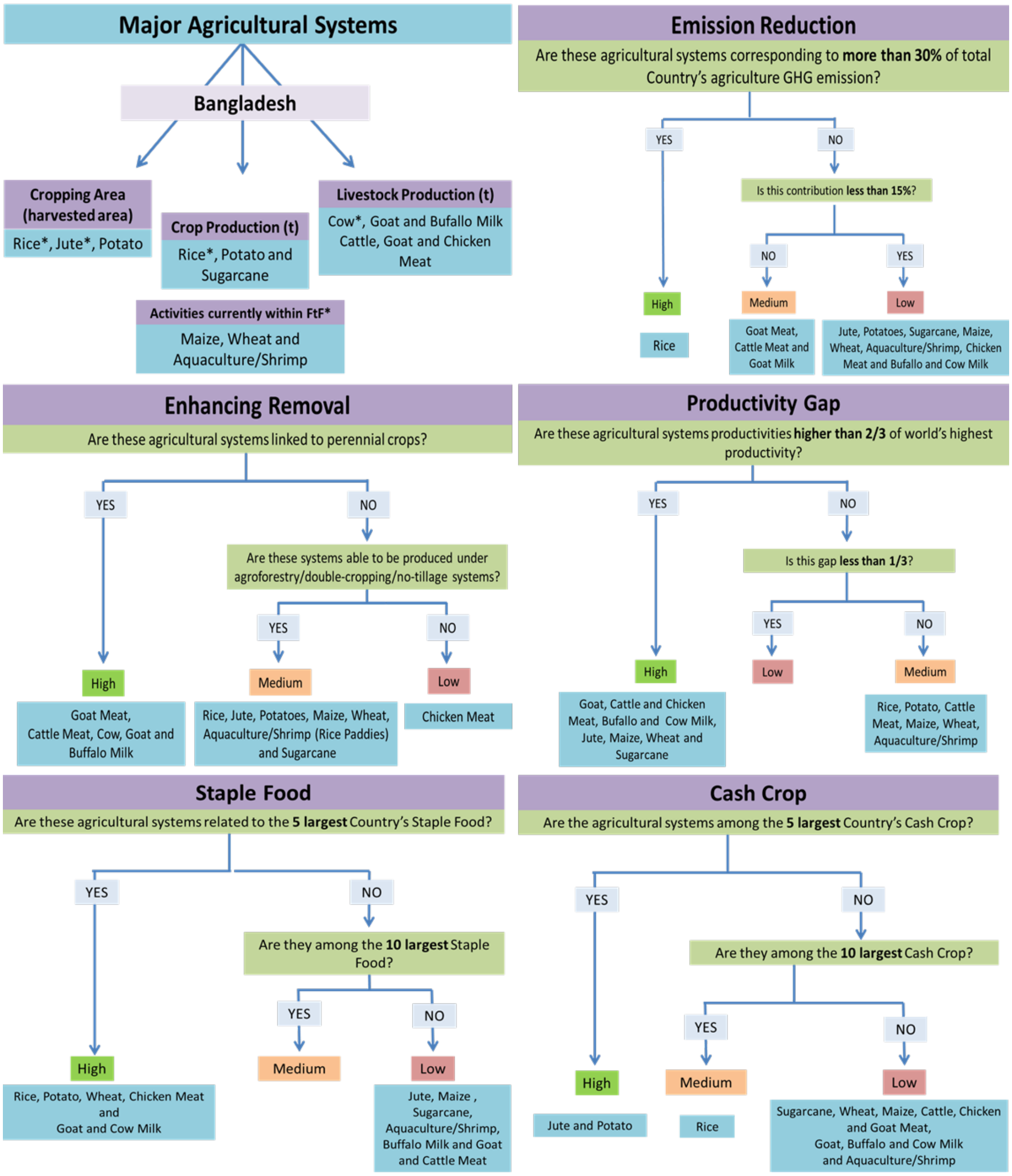
As outlined earlier in the paper, FAO-Stat is used to identify the most important agricultural systems in the 19 FTF countries. First, the top three agriculture activities were selected in terms of cropping area (hectare), cropping production (tons), and livestock production for milk and meat (tons) for 2012 (to keep uniformity with the last GHG emissions data updated by FAO-Stat.) Agricultural systems currently within FTF were also added and analyzed using the same process.

Next, agricultural food systems were prioritized based on the mitigation potential (both opportunities for emissions reduction and carbon sequestration), productivity improvement potential, and importance of the system in meeting agricultural development objectives. The following set of criteria was used to prioritize these options:

1. *Emissions reduction potential.* This criterion evaluates the agricultural system's importance to the country's GHG emissions profile. The ranking is broken down as follows: contributions up to 15% = Low, between 15% and 30% = Medium, and > 30% = High.
2. *Enhancing removal of carbon.* This criterion covers the agriculture system's potential to sequester carbon above- or/and below-ground. For this exercise, all annual cropping systems are ranked as Medium and perennial crops (including grasses in pasturelands) are ranked as High.
3. *Productivity enhancement potential.* This criterion estimates the potential to decrease the intensity of GHG emissions of a particular agriculture system. For this exercise, the current agricultural system's productivity is compared with the world's highest productivity. The ranking is broken down as follows: productivity up to 33% = High, from 33% to 66% = Medium, and > 66% = Low.
4. *Systems importance in agricultural development.* This criterion assesses the agriculture system's importance in a country's development as measured by staple food or cash crop data. If selected agricultural activities were related to (i) one of the country's first 5 largest staple food or cash crop/livestock, they are ranked as High; (ii) 5–10 of the country's largest staple food or cash crop/livestock, they are ranked as Medium; and (iii) others, they are ranked as Low.

Figure 3 shows this LED idea generation scheme applied to Bangladeshi agriculture; a discussion of the scheme follows the figure.

Figure 3. LED idea generation scheme applied to identify Bangladesh's top agriculture systems.



1. *Emissions reduction*. As figure 3 shows, rice production in Bangladesh is responsible for 31% of the emissions from the agricultural sector in 2012, with meat from goat and cattle responsible for 16% and 18% of total emissions, respectively. All other crops and livestock systems are less than 15%. Therefore, these agriculture systems have High, Medium, and Low potential for emissions reduction, respectively.
2. *Enhancing removal*. Under adequate management practices, annual cropping systems (rice, jute, potatoes, wheat, maize, and sugarcane) have Medium potential for enhancing

removal, compared with pasture-based livestock system with perennial grasslands systems (goat, cattle, buffalo), which have High potential.

3. *Productivity enhancement potential of the agriculture system*. The livestock systems and the crop systems of jute, maize, wheat, and sugarcane are rated as having High productivity potential. All other agricultural systems have Medium productivity potential.
4. *Systems importance in agricultural development*. Almost half of the agriculture systems are rated as having High relevance as staple foods. Only jute and potato are rated as having High significance as an export product

However, it is important to highlight that emissions from application of synthetic fertilizer to agricultural soils in Bangladesh (9% of total emissions) could not be attributed to any single crop or pasture system, nor could the share of GHG emissions related to some livestock systems (i.e., goat and buffalo raised for milk or beef production). Moreover, there is no information related to agricultural soil management (i.e., tillage system and inputs) and conditions (i.e., size of degraded land) needed to assess soil carbon emissions and removal (IPCC 2006). The absence of this information prevents a more refined evaluation of the country's GHG emission sources. These are limitations of the data collection systems and methodology used by FAO-Stat. In spite of these data issues, the results identify agriculture systems related to most of the country's GHG emissions and, consequently, support prioritization for LED implementation. Suggested enhancements to this LED idea generation process are outlined in the discussion section of this paper.

On the basis of a literature review, potential agricultural management practices able to mitigate GHG emissions and/or enhance carbon sequestration were coupled with each selected agriculture system (see box 2 for references). Table 1 shows the look-up table generated at the end of the LED idea generation process for Bangladesh.

Box 2. Data accessed in FAO-Stat (faostat3.fao.org/) for LED idea generation

Agriculture System	Reference
Livestock Systems	Herrero et al. 2009, Herrero & Thornton 2009
Crop Systems	FAO 2002, Scopel et al. 2013, van Asten et al. 2011, Kassam et al. 2009, Omont et al. 2006, Thierfelder et al. 2013, Richards & Mendez 2014
Rice Systems	Richards & Sander 2014, Sander, Samson & Buresh 2014, Searchinger et al. 2014, De Laulanié 2011, Savant & Stangel 1990

Table 1. Look-up table of potential opportunities for LED development and implementation in Bangladesh

Agricultural Activity	Current Product within FTF*	Emission Reduction[1]	Enhancing Removals[2]	Productivity Gap[3]	Staple Food[4]	Cash Crops[4]	Main Technical Mitigation Practices
Rice (paddy)	yes	High	Medium	Medium	High	Medium	Improve crop rotation / Fertilizer and water input and efficiency
Jute	yes	Low	Medium	High	Low	High	Improve crop rotation / Fertilizer input and efficiency
Potatoes		Low	Medium	Medium	High	High	Improve crop rotation / Fertilizer input and efficiency
Wheat	yes	Low	Medium	High	High	Low	Improve crop rotation / Fertilizer input and efficiency
Maize	yes	Low	Medium	High	Low	Low	Improve crop rotation / Fertilizer input and efficiency
Sugarcane		Low	Medium	High	Low	Low	Improve crop rotation / Fertilizer input and efficiency
Cow milk	yes	Low	High	High	High	Low	Animal, pasture and manure management
Goat milk		Low	High	High	High	Low	Animal, pasture and manure management
Buffalo milk		Low	High	High	Low	Low	Animal, pasture and manure management
Goat meat		Medium	High	High	Low	Low	Animal and pasture management
Cattle meat		Medium	High	High	Low	Low	Animal and pasture management
Chicken meat		Low	Low	High	High	Low	Animal, pasture and manure management
Aqua-culture (shrimp)	yes	Low	Medium	Medium	Low	Low	Water Control / Fertilizer input and efficiency

[1]Agriculture system's potential for decreasing a country's GHG emissions.

[2]Agriculture system's potential for sequestering carbon within a country.

[3]Productivity enhancement potential of agricultural system.

[4]Agricultural system's importance in agricultural development (measured through staple food production or cash crop data).

LED concept development

In the LED concept development stage, institutional factors and local systems are evaluated in order to bundle technical practices into country- and crop- specific LED options. To accomplish this, USAID program data were collected to identify and synthesize information on USAID's current investments in agricultural development (location, type, and context information).

CCAFS created an inventory of current, active agricultural programs and a multi-stakeholder process to select projects for analysis. First, CCAFS developed a project list of agriculture and food security development projects within USAID from multiple information sources, including Bureau of Food Security databases and externally available documents. Diverse stakeholders completed a MCDA to select projects for GHG emissions analysis. Projects were selected based on their potential mitigation impact, insights into LED options, and programming strength. The objective was to sample for insights across a broad range of geographies and interventions.

The project collected data through two tools, the EX-Ante Carbon Balance Tool (EX-ACT) and the implementing partner qualitative survey:

- *EX-ACT emissions tool.* The EX-ACT appraisal tool was developed by FAO to provide ex-ante estimates of the impact of agriculture and forestry development projects, programs, and policies on GHG emissions. EX-ACT applies to development projects in the areas of crop management, sustainable land management, agroforestry, grassland restoration, production intensification, and livestock management. Ex-ante project evaluation compares impacts of a planned intervention to a business-as-usual scenario (Bernoux et al. 2011).
- *Implementing partner qualitative survey*. The qualitative survey was designed to gather characteristics and context on projects, to provide a basis for cross-case comparisons (intervention mechanisms, target audience, project goals) and explore barriers to adoption/scale-out for practices covered in the calculation of GHG emissions.

Through implementing partner interviews, the qualitative survey and quantitative emissions data were collected concurrently and integrated into a single database. Three outputs resulted from this data: a list of USAID agricultural programs and practices, survey data from 40 implementing partner interviews, and 31 quantitative emissions case studies. All three elements were used to analyze the existing systems of agricultural development and dissemination. In addition, program dynamics within the institutional system (such as complexity of crop/livestock systems, beneficiaries targeted, value chain integration) were analyzed. This information was used to group mitigation practices into technical practice bundles (see table 2).

Table 2. Technical practice grouping example—Bangladesh

Technical practice grouping	Description	FTF projects using the technical practice (USAID)
Improved Crop Management (Improved Seeds, Spacing, Transplanting, Tillage, Residue Management)	A host of improved crop management practices are shown to reduce emissions including early maturing varieties of rice, reducing tillage intensity, proper spacing, residue management, and transplanting techniques.	• Bangladesh - Project A • Cambodia - Project C • Ghana - Project D • Liberia - Project E • Nigeria - Project G
Alternate Wetting and Drying	The production of rice in flooded paddies produces methane because the water blocks oxygen from penetrating the soil, creating conditions conducive for methane-producing bacteria. Shorter flooding intervals and more frequent interruptions of flooding lower bacterial methane production and thus methane emissions.	• Bangladesh - Project A • Bangladesh - Project B • Cambodia - Project C • Nigeria - Project G
Fertilizer Deep Placement	Increase fertilizer efficiency through fertilizer deep placement reduces nutrients waste and avoids unnecessary N_2O emissions.	• Bangladesh- Project A • Ghana- Project D • Liberia- Project E • Mali- Project F • Nigeria- Project G

Next, the team used available data to estimate the size of the LED opportunities. Cropping area and livestock heads for key agricultural systems were analyzed to approximate the size of the LED opportunities. For example, the main GHG emissions source from agriculture in Bangladesh is the cultivation of paddy rice. In addition, this country accounts for 60% of the rice paddy area of FTF projects, suggesting that the impact of LED opportunities addressing this crop can be very effective at reducing emissions within the country. Regional evaluations were also carried out to scale up LED options for a given geographical area. For instance, the same LED practices in rice can also be potentially applied in Cambodia and Nepal (Asia).

A short list of LED options can be drawn up from this stage of the LED option identification and prioritization process. The LED options consist of an agriculture system (crop or livestock), geography (national or regional), and a bundle of technical mitigation practices. These options are influenced by the research findings into local systems for agricultural development and institutional factors. Three LED options are shown in figure 4.

Figure 4. Low emissions agriculture options in rice in Asia.

	Alternate Wetting and Drying (AWD) in irrigated rice systems in FTF Bangladesh, Cambodia, and Nepal	Facilitating transitions from irrigated rice systems in Bangladesh	Sustainable intensification of rice in Cambodia and Nepal
Technical Practice Bundle	Alternate Wetting and Drying (AWD) in irrigated rice systems in Bangladesh, Cambodia, and Nepal	Emissions impacts of promoting the adoption of alternative grain and bean crops	Improved AWD, UDP, intercropping, improved seed, reduced tillage, and residue retention
Agricultural System	Irrigated rice	Irrigated rice	Rice
Geographic Scale	Bangladesh, Cambodia and Nepal	Bangladesh	Cambodia and Nepal
Opportunity Scale	Total emission from rice cultivation in selected geography: **37.1M tCO2e**	Total emission from rice cultivation in selected geography: **23.8M tCO2e**	Total emission from rice cultivation in selected geography: **13.3M tCO2e**

LED evidence building

The LED evidence building stage enhances option refinement through knowledge and experience sharing, and facilitates ranking of options with stakeholders. In this action research project, a wide range of stakeholders from USAID and CCAFS engaged in discussions on evidence-based decision making. In addition to the original criteria outlined by CCAFS, the USAID stakeholders encouraged us to investigate a wider range of non-mitigation impacts. Specifically for productivity impacts, USAID encouraged evidence to be gathered on both aggregated farm profitability and disaggregated elements such as agriculture systems yields, resource use efficiency, and labor impacts. In addition, the Agency stressed that barriers and incentives should be considered within the value chain scale and regional-enabling environment.

Discussion

The discussion section presents the advantages of the current LED process and the areas for improvement.

Advantages of the LED identification and prioritization process

- *LED idea generation takes into account food security and income generation from the beginning.* This early focus on not only mitigation but also food security and income generation lends legitimacy to the overall prioritization process.
- *LED concepts developed within context of local socio/cultural and institutional systems.* In the LED concept development stage, institutional factors and local systems are evaluated in order to bundle technical practices into country- and crop-specific LED concepts. This research approach recognizes the complex interactions surrounding agricultural practice change. When institutional conditions are incorporated into LED options, salience of the data improves.
- *Characterization of LED options provides evidence base for prioritization decisions.* In action research, it is essential to provide evidence that is credible and legitimate in time for major decisions. In the final process phase, stakeholders play an active role in determining the criteria for prioritization and time is allowed to build evidence.

Suggested improvements to the LED identification and prioritization process

- *LED idea generation stage should formally integrate information from national agricultural growth objectives.* Many of the countries studied have national objectives for agricultural growth. These plans are developed at a national level based on governments' resource policies and strategies. Our project did not account for these stated national objectives.
- *LED quantification methods need improvement.* Quantification of opportunities is essential for weighing options for investment. Additional time and resources should be devoted to scale up of mitigation options.
- *Emissions estimation methods (FAO-Stat and EX-ACT) lack convergence.* FAO uses a method for making a country's GHG inventory (top-down approach); EX-ACT evaluates the additionality of projects for mitigating GHG emissions (bottom-up approach). Greater

convergence would be possible if somehow the two methods could be linked and estimate how much GHG emissions could be avoided by best practices or vice-versa (e.g., FAO adds information at farm-scale level). In addition, FAO-Stat should move forward and include emissions and removals by soils (even with high level of uncertainty), as most of the LED practices rely on soil carbon for reducing emissions.

- *Data collection (FAO-Stat) lack important information.* FAO-Stat does not provide transparency to the practice level of some agricultural systems. Overall, there is a need for a new data source that provides information on inputs of major agricultural activities in a given country as well as land degradation and soil management types. It would help to narrow down the impacts of single-cropping and livestock systems and consequently, increase the confidence in building LED options.

Conclusion

The INDCs indicate that countries are highly interested in mitigating climate change impacts from agricultural practices. Creating technical and policy options for development donors to invest in LED options could therefore have significant impact.

We have outlined a process to identify and prioritize LED options in agriculture to achieve food security and economic development goals, with mitigation co-benefits. This process aims to support decisions about low emissions management practices and accelerate the scale-up of project investments. The method was developed in the course of a CCAFS action research project with USAID to inform LED options in their agriculture and food security portfolio.

The identification and prioritization of LED options involved three sequential stages: idea generation, concept development, and evidence building. Each stage is designed to gather and analyze data that enable managers and stakeholders in particular to make informed evaluations. The first stage gathers data on not only mitigation potential but also food security and income generation, lending legitimacy to the idea generation process. The incorporation of institutional factors and local contextual systems in the LED concept development stage improves the concept's credibility and salience. In the final process phase, stakeholders are actively involved in determining the criteria for prioritization and building evidence.

By bringing together institution-specific evidence covering both mitigation and non-mitigation benefits of LED, this process illustrates how a careful evidence-building process can increase the quality and relevance of outputs and legitimacy of the overall results.

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