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Info Note

Agricultural Development and Value Chain Enhancement Activity II in Ghana:

Climate change mitigation co-benefits from sustainable intensification of maize, soybean, and rice

A series analyzing low emissions agricultural practices in USAID development projects

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NOVEMBER 2016

Key messages

- An analysis of the potential climate change mitigation impact of the project entitled *Agricultural Development and Value Chain Enhancement Activity II* (ADVANCE II) in Ghana shows that an approximate reduction in greenhouse gas (GHG) emissions of 100% will be possible. When project targets are achieved, ADVANCE II will transform the project area from a low net source of GHG emissions to roughly carbon neutrality. *
- ADVANCE II is estimated to achieve moderate GHG mitigation benefits that are driven by soil management improvements (-9,223 tCO_2e/yr), crop residue burning reductions (-4,249 tCO_2e/yr), and alternate wetting and drying (AWD) of irrigated rice (-858 tCO_2e/yr).
- The moderate increase in fertilizer and pesticide use supported by the project leads to small increases in GHG emissions (1,244 tCO_2e/yr and 2,514 tCO_2e/yr respectively).
- ADVANCE II provides important benefits for low emission development (LED) by significantly reducing the crop GHG emission intensity (GHG emissions per unit of production). This is achieved mainly through strong growth in agricultural productivity and reductions in postharvest losses.

* Carbon neutrality refers to a situation where net GHG emissions are zero, which exists when GHG emissions equal the amount of carbon sequestration when measured in carbon dioxide equivalents.

About the ADVANCE II project

ADVANCE II is a 4.5-year activity funded by USAID under its Feed the Future (FTF) initiative and is implemented by ACDI/VOCA in the Upper East, Upper West, and Northern Regions of Ghana. Begun in 2014, the goal of the activity is to scale up private sector investment in the maize, rice, and soybean value chains to achieve greater food security among the rural population in northern Ghana while increasing competitiveness in domestic commodity markets. ADVANCE II focuses on three activity components: first, increasing the productivity of production systems, next, increasing access to markets and trade for smallholder farmers, and finally, strengthening and building local capacity.

ADVANCE II supports improved management practices such as agricultural conservation methods, improved seeds, and improved postharvest handling. Direct farmer training in demonstration plots, indirect knowledge transmission from out-grower businesses to smallholder farmers, and the provision of mechanized land preparation and post-harvest grain management by commercial service providers are key to promoting the adoption of improved practices. ADVANCE II aims to directly benefit 113,000 smallholders whose farms average less than five ha. ADVANCE II implements a value chain approach in which smallholder farmers are linked to output markets, financial institutions, and input and equipment dealers.

Low emission development

In the 2009 United Nations Framework Convention on Climate Change (UNFCCC) discussions, countries agreed to the Copenhagen Accord, which included recognition that “a low-emission development strategy is indispensable to sustainable development" (UNFCCC 2009). Low emission development (LED) has continued to occupy a prominent place in UNFCCC agreements. In the 2015 Paris Agreement, countries established pledges to reduce emission of GHGs that drive climate change, and many countries identified the agricultural sector as a source of intended reductions (Richards et al. 2015).

In general, LED uses information and analysis to develop strategic approaches to promote economic growth while reducing long-term GHG emission trajectories. For the agricultural sector to participate meaningfully in LED, decision makers must understand the opportunities for achieving mitigation co-benefits relevant at the scale of nations, the barriers to achieving widespread adoption of these approaches, and the methods for estimating emission reductions from interventions. When designed to yield mitigation co-benefits, agricultural development can help countries reach their development goals while contributing to the mitigation targets to which they are committed as part of the Paris Agreement, and ultimately to the global targets set forth in the Agreement.

In 2015, the USAID Office of Global Climate Change engaged the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) to examine LED options in USAID’s agriculture and food security portfolio. CCAFS conducted this analysis in collaboration with the University of Vermont’s Gund Institute for Ecological Economics and the Food and Agriculture Organization of the United Nations (FAO). The CCAFS research team partnered with USAID’s Bureau of Food Security to review projects in the FTF program. FTF works with host country governments, businesses, smallholder farmers, research institutions, and civil society organizations in 19 focus countries to promote global food security and nutrition.

As part of the broader effort to frame a strategic approach to LED in the agricultural sector, several case studies, including this one, quantify the potential climate change mitigation benefits from agricultural projects and describe the effects of low emission practices on yields and emissions. Systematic incorporation of such emission analyses into agricultural economic development initiatives could lead to meaningful reductions in GHG emissions compared to business-as-usual emissions, while continuing to meet economic development and food security objectives.

The team analyzed and estimated the project’s impacts on GHG emissions and carbon sequestration using the FAO Ex-Ante Carbon Balance Tool (EX-ACT). EX-ACT is an appraisal system developed by FAO to estimate the impact of agriculture and forestry development projects, programs, and policies on net GHG emissions and carbon sequestration. In all cases, conventional agricultural practices (those employed before project implementation) provided reference points for a GHG emission baseline. The team described results as increases or reductions in net GHG emissions attributable to changes in agricultural practices as a result of the project. Methane, nitrous oxide, and carbon dioxide emissions are expressed in metric tonnes of carbon dioxide equivalent (tCO_2e). (For reference, each tCO_2e is equivalent to the GHG emissions from 2.3 barrels of oil.) If the agricultural practices supported by the project lead to a decrease in net GHG emissions through an increase in GHG removals (e.g. carbon sequestration) and/or a decrease in GHG emissions, the overall project impact is represented as a negative (–) value. Numbers presented in this analysis have not been rounded but this does not mean all digits are significant. Non-significant digits have been retained for transparency in the data set.

This rapid assessment technique is intended for contexts where aggregate data are available on agricultural land use and management practices, but where field measurements of GHG emissions and carbon stock changes are not available. It provides an indication of the magnitude of GHG impacts and compares the strength of GHG impacts among various field activities or cropping systems. The proposed approach does not deliver plot, or season-specific estimates of GHG emissions. This method may guide future estimates of GHG impacts where data are scarce, as is characteristic of environments where organizations engage in agricultural investment planning. Actors interested in verification of changes in GHG impacts resulting from interventions should collect field measurements needed to apply process-based bio-physical models.

Photo credit: Susan Quinn USAID ADVANCE, 2011.

Agricultural and environmental context: Ghana

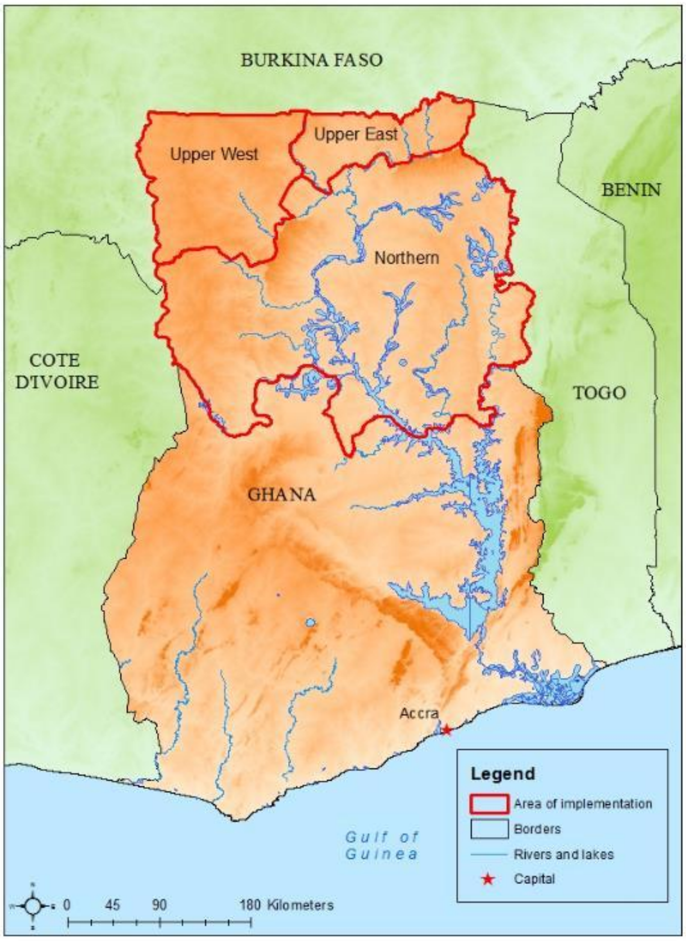
Ghana is a low-middle-income country (World Bank 2016a) with a total population of about 26 million. Approximately 24% of the population is living below the poverty line and nearly 19% of children suffer from stunting (World Bank 2016b). While poverty declined from a level of 31.9% in 2005/06 (GSS 2014), it remains a strongly sectorialized and regionalized issue: The poverty incidence is the highest in the Rural Savannah zone (55%) in the north of the country, which accounts for 40% of the overall poverty. Poverty is a predominant concern for rural and agricultural based livelihoods. While 50% of the Ghanaian population is living in rural areas, 78% percent of that population is living in poverty. Across the different employment categories, self-employment in agriculture is associated with the greatest likelihood of living under the poverty line. The average farm size is small at 1.6 ha, and farms up to 10 ha account for 95% of the cultivated land in Ghana (SRID 2011).

The country experienced solid rates of economic growth in the recent decade; they fluctuated between 4% to 15% for the period 2005 to 2013 (GSS 2014), while more recent rates of GDP growth were lower. The largest economic sectors that contribute to national GDP are services (49%), industry and manufacturing (29%), and agriculture (22%) (ibid.). While the agricultural sector experienced a rapid decline in its share of national GDP in recent years (ibid.), 49% of the Ghanaian population identified agricultural production as their main employment activity and depend on it for their primary income source (ibid.).

Climate change is a major concern in the ADVANCE II project implementation areas in the northern part of Ghana. The northern savannah zone frequently experiences both floods and droughts, such as those in 2007 that affected as many as 325,000 people (Stanturf et al. 2011). Climate change projections foresee an increase in future temperatures and decrease in rainfall (ibid.). These projections are expected to have negative consequences on farmers in the northern savannah zone where they are already exposed to heat stress as well as erratic and low rainfall. As an additional concern, surface waters declined in recent decades. Specifically, the White Volta and Oti river basins have been affected by reduced water inflow from upstream watersheds, increased evaporation, and possibly, increased groundwater discharge (ibid.).

In the northern regions of Ghana, periods of severe drought have resulted in reduced crop productivity and declines in livestock herds, and thus contributed to food shortages (World Bank 2016c). Land degradation and potential desertification trends in this northern savannah zone have been a critical concern for agricultural livelihoods (Mensah et al. 2015, Ciao and Sarpong 2007). Ciao and Sarpong (2007) found that land degradation significantly reduced agricultural incomes and increased poverty in this zone. Adaptation and mitigation actions in the agriculture and forestry sectors feature prominently in the Intended Nationally Determined Contribution of Ghana (Gov. of Ghana 2015) and are priorities for reducing climate change vulnerability. Besides other elements, agricultural resilience building in climate vulnerable landscapes has been identified as a priority policy action. The promotion of community-based conservation agriculture and innovations in post-harvest storage and food processing were included as specific actions.

Figure 1. Area of implementation



Agricultural practices that impact GHG emissions and carbon sequestration

As a result of ADVANCE II, the maize, soybean, and rice value chains are foreseen to benefit from one or more of the following improved agricultural practices: (A) soil management improvements; (B) crop residue burning reduction; (C) AWD; and (D) fertilizer and pesticide management.

Table 1 identifies the number of hectares that are estimated to be under improved agricultural management once the project is fully operational. A description of each practice follows, including a description of the intervention and its effects on the environment, the project plan for the intervention, and estimated impacts on emissions

Table 1. Area (ha)-supported by agricultural practices with impacts on emissions

	Maize	Soybean	Upland rice	Irrigated rice	Rainfed rice
Soil management improvements	28,200	3,239	534		
Crop residue burning reduction	28,200	3,239	534	245	1,246
Alternate wetting and drying				245	
Fertilizer and pesticide management	28,200	3,239	534	245	1,246

Soil management improvements

Soil management improvements

Background. The savanna agro-ecological zone in northern Ghana is characterized by low soil fertility and organic matter levels. Soil management improvement in smallholder farming systems in northern Ghana are an important means for crop nutrient supply, soil water retention capacity, and prevention of soil erosion (Dalton et al. 2014). The continuous export, grazing or burning of crop residues may function as a source of soil nutrient depletion. Regular supplies of organic matter added to soils, such as from animal manure, compost, or the retention of crop residues, is an important source of carbon and nitrogen, and are essential to maintain or increase soil carbon (González-Estrada et al. 2008). The low soil carbon and fertility levels in the savannah agro-ecological zone in northern Ghana is at risk of further depletion due to short fallow periods, longer intervals of bare soil, high frequency of tillage, low organic matter inputs and crop residue burning.

Practice plan. ADVANCE II promotes different practices of improved soil management on the entire area of annual crops that are to benefit, 31,973 hectares. The largest area, 23,333 ha of maize, soybean and upland rice crops, is improved through the use of improved seeds and other improved plant management practices. This area of concern benefits from higher crop residue quantities that can be returned to soils. The remaining maize areas (5,640 ha) benefits from improved plant nutrient management and increased quantities of residue retention in combination with reduced tillage (3,000 ha).

Impact on emissions. In the absence of specific field measurement data, the FAO team used estimates by Smith et al. (2007) to estimate GHG mitigation benefits. On average, soil management improvements were estimated to provide carbon sequestration benefits of -0.29 tCO_2e per ha (Figure 1) and total benefits of -9.223 tCO_2e per year (Figure 2) when scaled to the full area of implementation.

GHG benefits per hectare of improved soil management are estimated to be comparably small and have a high level of uncertainty. While it can be safely stated that soil carbon sequestration will *on average* be achieved, a small number of locations may experience constant or reduced soil carbon levels even with improved soil management practices.

Crop residue burning reduction

Crop residue burning reduction

Background. The burning of crop residues left over after harvest leads to GHG emissions and air pollution (Smil 1999, Turmel et al. 2015, WHO 2014). In addition, this practice removes a valuable on-farm resource that could be used for animal feed, composting, or soil amendment (Rusinamhodzi et al. 2016, Turmel et al. 2015).

Practice plan. Since the opportunity costs involved in adopting reduced crop residue burning, together with implementation of targeted training measures for improved crop residues management are assessed as low, ADVANCE II estimates that the larger cropland area of 33,500 ha will discontinue burning residues.

Impact on emissions. Reductions in burning crop residues increase the return of organic materials to the soil. FAO estimated crop residue biomass from reported crop grain yields (IPCC 2006). Crop residue burning reduction resulted in an average net change in annual GHG emissions of -0.22 tCO_2e/ha (Figure 1), or -0.14 tCO_2e/ha for upland and rainfed rice, -0.60 tCO_2e/ha for irrigated rice, -0.13 tCO_2e/ha for maize, and -0.08 tCO_2e/ha for soybeans. When scaled to the full area of implementation, crop residue burning resulted in a change in annual GHG emissions of -4,249 tCO_2e (Figure 2). These reductions are associated with a low level of uncertainty, due to the availability of location specific data on crop yields.

Alternate wetting and drying

Background. AWD is a management practice in irrigated lowland rice characterized by periodic drying and reflooding of fields. Submergence of soil and organic residual material in rice paddies leads to anaerobic decomposition of organic matter that releases methane. Periodic drying events interrupt the duration of this process and reduce methane emissions up to half compared to continuous flooding (Richards and Sander 2014). Methane is a heat-trapping gas 34 times more potent than carbon dioxide on a 100-year time horizon (used in this study) and 86 times on a 20-year time horizon (Myhre et al. 2013). AWD reduces irrigation and associated fuel consumption while maintaining or increasing yields (Richards and Sander 2014). Because AWD depends on controlling water levels, it can only be practiced in the limited rice growing area in Northern Ghana that has access to irrigation infrastructure.

Alternate wetting and drying

Project plan. ADVANCE II projected that AWD would be adopted on 245 ha where a comparably short cycle of 90 days of flooding is practiced. Since water management of the irrigation system is centrally controlled, there is a high level of confidence in the estimate of reached rice area. In northern Ghana only a limited area of irrigated perimeters have been established, which limits the scaling potential of AWD.

Impact on emissions. The adoption of AW is estimated to reduce annual GHG emissions by an average of -3.50 tCO_2e/ha (Figure 1). Over the full area of implementation AWD reduces annual GHG emissions by an estimated -858 tCO_2e/ha (Figure 2). While AWD reduces GHG emissions with high certainty, the magnitude of the GHG emission reduction was associated with an intermediate to high level of uncertainty due to the lack of GHG field measurement data from northern Ghana.

Fertilizer and pesticide management

Fertilizer and pesticide management

Background. Nutrient inputs from organic sources and synthetic fertilizers balance the nutrients removed by crop harvesting and other factors, in order to maintain soil fertility. Fertilizers can significantly contribute to increased crop yield but they are also a major source of GHG emissions because of their energy-intensive production and field related emissions of N_2O (Lal 2004; IFA 2009, Butterbach-Bahl et al. 2013), a GHG 298 times more potent than CO_2 (Myhre et al. 2013).

Project plan. ADVANCE II promotes the increase of fertilizer application rates in maize, soybeans, and both rainfed and upland rice. Fertilization rates are foreseen to increase from 40 to 75 kg/ha of NPK on maize, from 0 to 50 kg/ha of triple superphosphate on soybeans, and from 50 kg/ha of NPK to 67.5 kg/ha of NPK and 22.5 kg/ha of urea on rainfed and upland rice. Fertilizer application rates on irrigated rice remain unchanged.

ADVANCE II also estimated that implementation of the project will increase pesticide application rates moderately. The integrated pest management plans advised only targeted application, so average rates were expected to remain very low. Fertilizer and pesticide improvements were applied over 33,219 ha.

Impact on emissions. Increased fertilizer application is estimated to lead to an average increase in annual GHG emissions of 0.08 tCO_2e/ha across all crops (Figure 1). The increased GHG emissions by crop are estimated at 0.08 tCO_2e/ha on maize, 0.02 tCO_2e/ha on soybean, 0.14 tCO_2e/ha on upland rice, and 0.09 tCO_2e/ha on deepwater rice. Over the full area of implementation, the increases in fertilizer use lead jointly to additional GHG emissions of 2,514 tCO_2e/ha (Figure 2).

Increases in pesticide use, on average, lead to annual GHG emissions of 0.04 tCO_2e/ha (figure 1). Over the full area of implementation, the annual increase accounts for 1,244 tCO_2e/ha (Figure 2). The magnitude of GHG emission increases is rated to have an intermediate to high level of uncertainty.

Summary of projected GHG emission and carbon sequestration co-benefits

Total estimated reductions in GHG emissions due to ADVANCE II's interventions are approximately 102% per year when compared to their initial level. This means that ADVANCE II transforms the project area to a roughly neutral carbon situation, that is, the GHG emissions equal carbon sequestration when compared in carbon dioxide equivalents.

Figures 1 and 2 summarize GHG emissions per hectare and for the entire area of implementation. The two figures allow the comparison of the GHG benefits provided by different practices. AWD provide the greatest annual GHG mitigation benefits per hectare (estimated at -3.50 tCO_2e/ha, Figure 1). Improved soil management and reduced crop residue burning provide low but relevant annual mitigation benefits of -0.29 tCO_2e/ha and -0.22 tCO_2e/ha, respectively. Increasing use of fertilizer (0.08 tCO_2e/ha) and pesticides (0.04 tCO_2e/ha) lead to small increases in GHG emission on a per hectare basis.

When comparing the total GHG mitigation impacts that are delivered over the full area of implementation, soil management improvements and crop residue burning reduction have the highest co-benefits: -9,223 tCO_2e/yr and -4,249 tCO_2e/yr, respectively. Increases in pesticide and fertilizer usage resulted in moderate increases in GHG emissions (1,244 tCO_2e/yr and 2,514 tCO_2e/yr, respectively), which is a function of the very large area of implementation. AWD, in contrast, produces only a low contribution to reduced GHG emissions (-858 tCO_2e/yr), a reflection of the small area to which it is applied. Juxtaposition of the two figures shows that the scale of implementation of the agricultural practices over the activity area drive the total GHG emission impact of ADVANCE II, rather than per area impact.

Figure 1. Impact of agricultural practices: Net GHG emissions on an area basis
(tCO_2e/ha/yr)

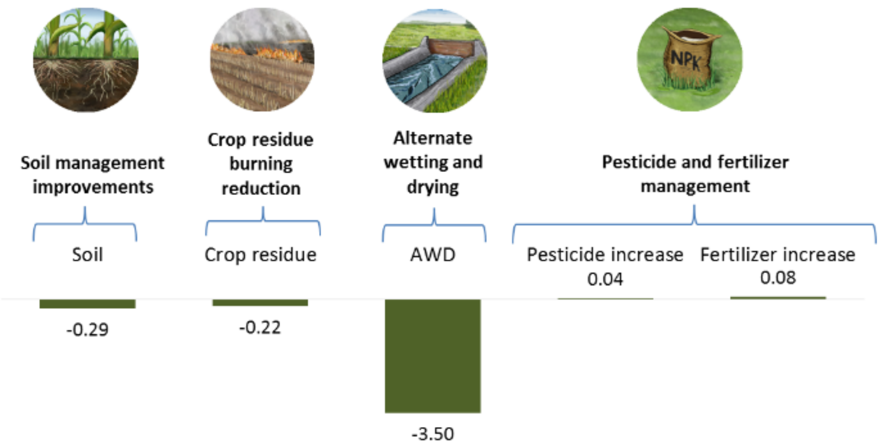
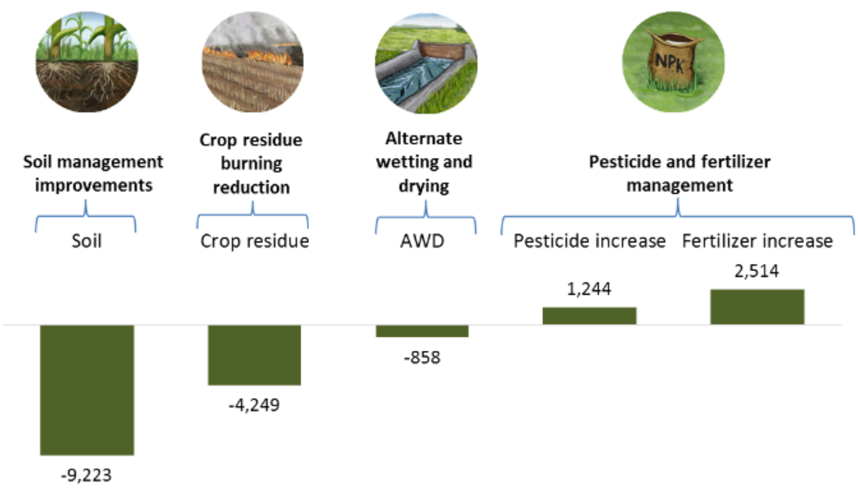


Figure 2. Impact of agricultural practices: Net GHG emissions on total area of impact
(tCO_2e/yr)



GHG emission intensity

Emission intensity (GHG emissions per unit of output) is a useful indicator of LED in the agricultural sector. Table 2 summarizes emissions intensity for the targeted value chains without and with agricultural practices supported by the activity.

Annual yield. Yields of all cropping systems were foreseen to strongly increase due to ADVANCE II improvements. Strongest yield increases are expected on maize (149%), while yields of rainfed and upland rice increase sizably (86%) as did soybeans (79%). Yield increases on irrigated rice are estimated at 51%. Improvements are mainly due to improved fertilizer use,better seeds, and integrated pest management, as well as regular plant spacing and additional good cultivation practices.

Postharvest loss. Project interventions to reduce postharvest loss included improvements in handling for the maize and rice value chains. For soybeans, no improvements with regard to postharvest losses are made. Postharvest loss rates decreased from 10% to 20% for rice, and from 30% to 10% on maize.

Emission intensity. The value chain intervention by ADVANCE II resulted in reduced emission intensity (Table 2) due to the combination of GHG emission reductions per hectare (Figure 1), increased crop yield, and reduced postharvest loss. As a result of ADVANCE II, emission intensity per year decreased in all value chains: by 53% in rainfed rice, by 66% in irrigated rice, by 100% in upland rice, by 117% and 107% for the two maize systems, and by 267% for soybeans. The agricultural production systems in the project area were already characterized by low emission intensities prior to project implementation.

The strongest net reduction in estimated GHG emission intensity are achieved for irrigated rice after the adoption of AWD. In this case, the GHG emission intensity from production is reduced by -1.14 tCO2e per tonne of rice produced.

Table 2. Emission intensity by product

	Activity agricultural practices	Total GHG emissions per ha (tCO_2e/ha) (1)	Annual yield (t/ha) (2)	Postharvest loss (%) (3)	Remaining annual yield (t/ha) (4)	Emission intensity (tCO_2e/t product) (5)
Upland rice (soil, pesticide and fertilizer management, crop residue burning reduction)	No activity	0.25	1.61	20%	1.29	0.20
	Activity	0.00	3.00	10%	2.70	0.00
	Difference (%)	–0.25 (–100%)	1.39 (86%)	–10% (–50%)	1.41 (110%)	–0.20 (–100%)
Rainfed rice (pesticide and fertilizer management, crop residue burning reduction)	No activity	1.19	1.61	20%	1.29	0.92
	Activity	1.18	3.00	10%	2.70	0.44
	Difference (%)	–0.01 (–1%)	1.39 (86%)	–10% (–50%)	1.41 (110%)	–0.49 (–53%)
Irrigated rice (AWD, crop residue burning reduction)	No activity	9.56	7.00	20%	5.60	1.71
	Activity	5.46	10.60	10%	9.54	0.57
	Difference (%)	–4.10 (–43%)	3.6 (51%)	–10% (–50%)	3.94 (70%)	–1.14 (–66%)
Maize (crop residue burning reduction, increased residue retention)	No activity	0.22	1.38	30%	0.97	0.23
	Activity	–0.12	3.44	10%	3.10	–0.04
	Difference (%)	–0.34 (–155%)	2.06 (149%)	–20% (–67%)	2.13 (220%)	–0.27 (–117%)
Maize (crop residue burning reduction, soil management)	No activity	0.22	1.38	30%	0.97	0.23
	Activity	–0.05	3.44	10%	3.10	–0.02
	Difference (%)	–0.27 (–123%)	2.06 (149%)	–20% (–67%)	2.13 (220%)	–0.25 (–107%)
Soybean (soil management, pesticide and fertilizer management)	No activity	0.07	0.89	15%	0.76	0.10
	Activity	–0.22	1.59	15%	1.35	–0.16
	Difference (%)	–0.30 (–398%)	0.70 (79%)	0% (0%)	0.60 (79%)	–0.26 (–267%)

Notes:
1. Total GHG emissions per hectare refers to the emissions per hectare of product harvested.
2. Annual yield refers to the tonnes of product produced per hectare harvested each year.
3. Postharvest loss is the measurable product loss during processing steps from harvest to consumption per year.
4. Remaining annual yield is calculated by subtracting postharvest loss from annual yield.
5. Emission intensity is calculated by dividing the total GHG emissions per hectare by the remaining annual yield.

Low emission program design considerations

This analysis of GHG emissions and carbon sequestration by agricultural practice raises issues that those designing or implementing other programs will need to consider in the context of low emission agriculture and food security for smallholder farmers, including:

- **Soil management**. How can the cost-effective availability of organic matter, composts and manure be ensured for smallholders in northern Ghana? Is the scale-up of cover crops that reduce bare soil periods during the dry season and increase soil organic matter inputs economically feasible? How can labor costs and bottlenecks be addressed as well as the availability of adequate machinery to apply manure and compost to fields? How can synergies between Fulani herders and crop farmers be increased in order to ensure efficient resource exchange and coordination between crop and livestock systems?
- **Fertilizer management.** How can farmers address financial constraints relative to the timely purchase of the most adequate fertilizer products? Can farm machinery help farmers address labor bottlenecks that prevent efficient distribution as well as split application of fertilizers? What are the barriers to expanding techniques such as microdosing? How can barriers to practice adoption be addressed through policy?
- **Irrigated rice improvements.** Considering surface water availability, investment costs, and alternative water uses, is the expansion of rice fields with irrigation infrastructure and AWD economically feasible? Which advantages and disadvantages do farmers perceive when they adopt short rice crop varieties? What are the impacts on seed costs, reduced expected yield, and reduced risks of crop failure?

In focus: Sustainable intensification strategies for smallholder farming in drylands

This case study is an example of how pathways to agricultural intensification of smallholder farming systems in drylands can provide benefits for GHG mitigation. The farming systems analyzed in north Ghana are generally associated with low levels of GHG emissions. However, land degradation and shrubland conversion can contribute to overall carbon stock losses. Closing the major gap between observed yields and water limited yield potential requires investments in climate-smart farming systems:

- Soil carbon losses must be minimized by reducing periods of bare fallow fields during the dry season and by ensuring sufficient organic matter inputs from manure, compost, and crop residues. Under improved soil conditions, synthetic fertilizer application will achieve higher yield benefits, while nutrient efficiency will be optimized.
- Where available, supplementary irrigation from water storage structures, groundwater sources, or streams may provide needed resilience to dry spells in critical periods of the growing season. Limiting water withdrawal to sustainable levels is an essential element of long-term system stability.
- Adequate machinery and implements to meet the technical problems cited as well as an increase in labor productivity are additional central preconditions for the scale-up of sustainable intensification strategies.

While such productivity measures do not radically change the GHG emission levels per hectare, they substantially increase productivity. In consequence, low-productive agricultural systems that currently have a small resource footprint can be transformed to productive and intensified agricultural systems without an extreme increase in GHG emissions.

In the dryland ecosystem in north Ghana, conservation of soil organic carbon is an essential precondition to enable farmers to intensify their production in a sustainable way. Conversely, degraded annual cropland will increase the need to clear additional shrubland and pastures or apply synthetic fertilizer at a significantly higher rate.

In order to further scale-up sustainable land and soil management practices, stable land tenure institutions are a further major precondition. Land tenure security allows farmers to invest in costly measures of long term soil fertility management more often, since it ensures that they will harvest the benefits.

Methods for estimating GHG impacts

A comprehensive description of the methodology used for the analysis presented in this report can be found in Grewer et al. (2016); a summary of the methodology follows. The selection of projects to be analyzed consisted of two phases. First, the research team reviewed interventions in the FTF initiative and additional USAID activities with high potential for agricultural GHG mitigation to determine which activities were to be analyzed for changes in GHG emissions and carbon sequestration. CCAFS characterized agricultural interventions across a broad range of geographies and approaches. These included some that were focused on specific practices and others designed to increase production by supporting value chains.

For some activities, such as technical training, the relationship between the intervention and agricultural GHG impacts relied on multiple intermediate steps. It was beyond the scope of the study to quantify GHG emission reductions for these cases, and the research team therefore excluded them. Next, researchers from CCAFS and USAID selected 30 activities with high potential for agricultural GHG mitigation based on expert judgment of anticipated GHG emissions and strength of the intervention. The analysis focused on practices that have been documented to mitigate climate change (Smith et al. 2007) and a range of value chain interventions that influence productivity.

Researchers from FAO, USAID, and CCAFS analyzed a substantial range of project documentation for the GHG analysis. They conducted face-to-face or telephone interviews with implementing partners and followed up in writing with national project management. Implementing partners provided information, monitoring data, and estimates regarding the adoption of improved agricultural practices, annual yields, and postharvest losses. The GHG analysis is based on the provided information as input data.

The team estimated GHG emissions and carbon sequestration associated with agricultural and forestry practices by utilizing EX-ACT, an appraisal system developed by FAO (Bernoux et al. 2010; Bockel et al. 2013; Grewer et al. 2013), and other methodologies. EX-ACT was selected based on its ability to account for a number of GHGs, practices, and environments. Derivation of intensity and practice-based estimates of GHG emissions reflected in this case study required a substantial time investment that was beyond the usual effort and scope of GHG assessments of agricultural investment projects. Additional details on the methodology for deriving intensity and practice-based estimates can be found in Grewer et al. (2016).

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Info note series

USAID project	Country	Agroforestry, perennial crop expansion	Irrigated rice	Land use, inc. reforestation & avoided degradation	Livestock	Soil, fertilizer management
Accelerating Agriculture Productivity Improvement	Bangladesh		X			X
ACCESO	Honduras	X			X	X
Agricultural Development and Value Chain Enhancement Activity II	Ghana		X			X
Better Life Alliance	Zambia	X		X		X
Chanje Lavi Planté	Haiti	X	X	X		X
Pastoralist Resiliency Improvement and Market Expansion	Ethiopia				X	
Peru Cocoa Alliance	Peru	X				X
Resilience & Economic Growth in Arid Lands-Accelerated Growth	Kenya				X	
Rwanda Dairy Competitiveness Project	Rwanda				X	

All info notes are available at: https://ccafs.cgiar.org/low-emissions-opportunities-usaid-agriculture-and-food-security-initiatives

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Citation:

Grewer U, Bockel L, Nash J, Galford G. 2016. Agricultural Development and Value Chain Enhancement Activity II (ADVANCE II) in Ghana: Climate change mitigation co-benefits from sustainable intensification of maize, soybean and rice. CCAFS Info Note. Published by the International Center for Tropical Agriculture (CIAT) and the Food and Agriculture Organization of the United Nations (FAO).

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CCAFS is supported by: