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# Info Note

## Resilience and Economic Growth in Arid Lands – Accelerated Growth in Kenya

## Mitigation co-benefits of herd size and feed quality management

*A series analyzing low emissions agricultural practices in USAID development projects*

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**Key messages**

- The agricultural development project Resilience and Economic Growth in Arid Lands – Accelerated Growth (REGAL-AG) has promoted improved livestock management that resulted in a decrease in net emissions of 10%. Since emissions from livestock account for the majority of Kenya's agricultural emissions (95%), reduction of emissions in the livestock sector has high potential impact.
- REGAL-AG's interventions have sought to improve links between livestock producers and buyers, to boost producer access to critical inputs, and to increase availability of timely market information, which resulted in a decrease in slaughter age for all livestock types. REGAL-AG anticipated that these dynamics, coupled with the program outreach activities, could result in a 10% decrease in herd size, which drives the greater share of emission reductions.
- Increases in productivity (50–67%) and decreases in absolute emissions (-10%) that resulted from REGAL-AG's interventions decreased the emission intensity 33-40% (emissions per unit production) for all livestock types.

### About the Resilience and Economic Growth in Arid Lands – Accelerated Growth project

REGAL-AG, a 5-year project implemented by ACDI/VOCA and funded under the Feed the Future (FTF) initiative, sought to increase economic growth in rural communities by improving competitiveness and inclusiveness in the livestock value chain. The project aimed to facilitate change in actors throughout the value chain, from livestock producers to middlemen, traders, transporters, and buyers, in order to increase incomes and stimulate growth. Begun in 2013, the project focused its efforts in Marsabit and Isiolo counties (Figure 1).

REGAL-AG had four interrelated program objectives: 1) improve the enabling environment by working with pastoral communities to advocate for policy improvements to expand their access to critical services and markets; 2) create or expand end-market opportunities and catalyze commercial investments; 3) increase livestock productivity by identifying and supporting the development of market-driven solutions for improved inputs and services; and 4) increase resilience by ensuring value chain growth that includes women, youth, and local community groups.

## 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 United States Agency for International Development (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 emissions from 2.3 barrels of oil.) If the agricultural practices supported by the project lead to a decrease in net emissions through an increase in GHG removals (e.g., carbon sequestration, emission reductions) 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 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 ex-post verification of changes in GHG emissions resulting from interventions should collect field measurements needed to apply process-based models.

## Agricultural and environmental context: Kenya

Kenya (569,140 km2) has a population of over 46 million, increasing at an annual rate of about 3% (World Bank 2016). More than 45% of Kenyans live below the poverty line, and 26% of children suffer from stunting (ibid). Agriculture is a central component of the economy and accounts for approximately 33% of the gross domestic product (GDP) (ibid).

Livestock plays an important role in Kenya's economic and social fabric. The nation holds approximately 6% of the total livestock in Africa (FAOSTAT 2015). This sector (US $4.54 billion) contributes almost as much as crops and horticulture (US$5.25 billion) to Kenya's GDP (ICPALD 2013). Livestock accounts for 2% of Kenyan exports, primarily hides and leather products (Behnke 2011).

Most livestock production is concentrated in the arid and semi-arid lands, which are a sizable percentage of Kenya's total surface area (Silvestri et al. 2012). These dryland systems average less than 100 cm of precipitation per year and experience extended dry periods (AU-IBAR 2012). Characteristics of drylands include great diversity among both people and their environment and the use of common property for access and resource management (ibid). For many households in semi-arid regions, livestock provide the main source of income, milk for home consumption, manure for fertilizer, and draft power to cultivate the land (Silvestri et al. 2012).

Pastoralists on arid or semi-arid land in Kenya are facing challenges that include loss of grazing land, changes in climate, and lack of market access. Croplands are encroaching on valuable grazing land and development of national parks and forests is limiting grazing for pastoral livestock (de Jode 2010). Frequent droughts have caused significant animal mortality and harmed the livestock sector. Increasing temperatures due to climate change may decrease water availability for livestock and threaten the sustainability of grazing land (Thornton et al. 2009). Livestock producers in Kenya are hindered by lack of access to markets that could facilitate an increased off-take rate and improved feed sources (Silvestri 2012). Improvements in the livestock sector have become a focus for agricultural development in Kenya, given its economic importance both nationally and for rural livelihoods, and also because of the increasing challenges the sector faces.

Emissions from livestock account for the majority (95%) of Kenya's agricultural emissions, excluding land use change and forestry (FAOSTAT 2016). Since 1994, livestock emissions (enteric fermentation, manure management, and manure left on pastures) consistently accounted for about 95% of agricultural emissions even as total agricultural emissions increased more than 60% (FAOSTAT 2016). Kenya included agricultural emissions in its mitigation target given to the 2015 UNFCCC Paris Agreement and focused on livestock development as a priority for adaptive action (Richards et al. 2015).

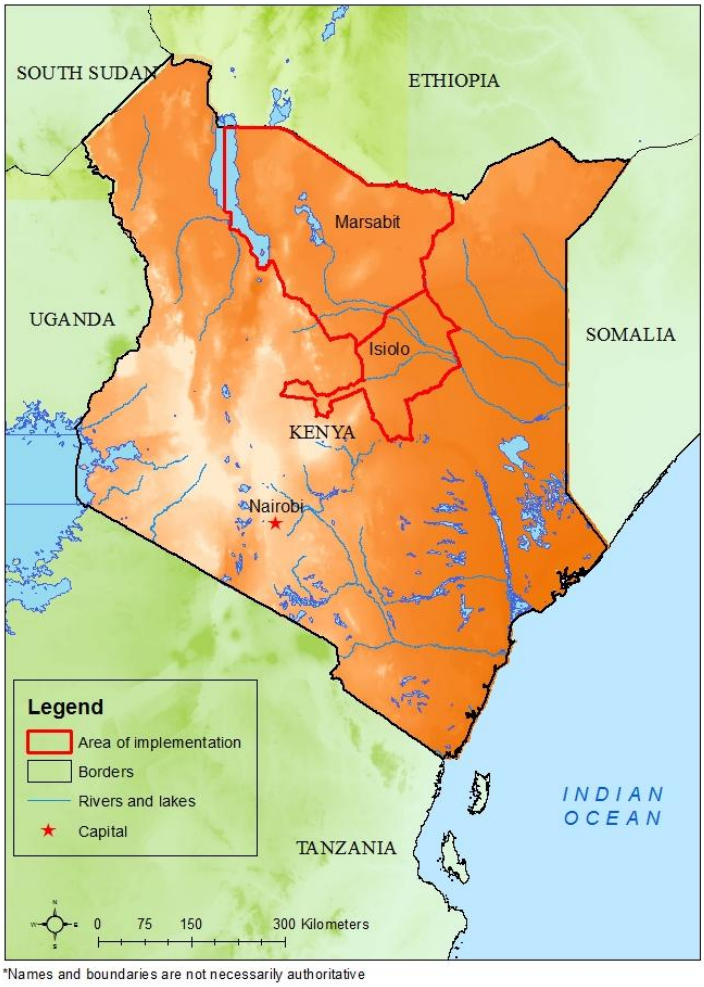


*Figure 1. Area of implementation*

*Cow in Kenya*
*Photo credit: ILRI/Stevie Mann 2012*

## Agricultural practices that impact GHG emissions and carbon sequestration

REGAL-AG focused on improved practices in the cattle, sheep, goat, and camel value chains. GHG emissions responded to feed quality improvements and herd size management (Table 1). A discussion 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. REGAL-AG—Livestock practices introduced by the project that have mitigation co-benefits by number of livestock.*

| | Cattle | Sheep | Goat | Camel |
|---|---|---|---|---|
| Herd size management | 46,252 | 34,689 | 83,254 | 9,250 |
| Feed quality improvements | 416,268 | 312,201 | na | na |

### Herd size management

Herd size management

**Background**. Livestock emissions include methane ($CH_4$) that is released through livestock digestion (enteric fermentation) and the decomposition of manure, which can release nitrous oxide ($N_2O$) as well. ($CH_4$ and $N_2O$ are heat-trapping gases with global warming potentials of 34 and 298 times that of $CO_2$.) Emissions from livestock are primarily a function of herd size, animal weight, and feed consumption. In most instances, the larger and heavier the herd, the higher the emissions. In Kenya and many sub-Saharan African countries inadequate feed and nutrition limit animal growth, thereby increasing time for meat animals to reach slaughter weight, and reducing milk production (Gerber 2013; Ojango et al. 2016). Livestock practices that increase herd productivity, such as decreasing herd age at slaughter, can reduce GHG emissions through reduced numbers of animals in the herd. Targeting a small but efficient herd increases productivity per animal and results in lower net GHG emissions (Herrero et al 2013).

**Project plan.** REGAL-AG's interventions aim to improve links between livestock producers and buyers, boost producer access to critical inputs (feed and veterinary services), and increase availability of timely market information. These interventions were projected to result in a decrease in slaughter age by one year for all livestock types, a reduction from the typical age of 3 years for cattle and camels and 2.5 years for goats and sheep. REGAL-AG anticipated these market linkage dynamics, coupled with the program outreach activities, would result in a 10% decrease in herd size.

**Impact on emissions.** Reduction of herd size resulted in lower net GHG emissions across all livestock types. Scaled to the full project size (based on targeted livestock producing households and average livestock ownership), REGAL-AG activities reduce net GHG emissions (–185,952 tCO2e/year) (Figure 2).

### Feed quality improvements

Feed quality improvements

**Background.** Improving feed quality increases animal productivity and reduces GHG emissions. Low-digestibility feeds, such as in low productivity pastures, result in higher enteric emissions per unit of meat or milk (Herrero et al. 2016). Unmet animal protein intake requirements also increase emissions. Producers can reduce livestock emissions by changing forage mix and by greater use of feed supplements (Gerber et al. 2013). Feeds composed of corn or legume silages, starch, or soy decrease methane production compared with grass silages.

**Project plan.** REGAL-AG promoted increased fodder production and improved links to groups that produce it. The project anticipated that these interventions would improve the feed composition of an estimate of over 416,000 cattle and 312,000 sheep.

**Impact on emissions.** Analysis shows that REGAL-AG's feed quality improvements reduce GHG emissions. The FAO team used the method of Smith et al. (2007), which provides estimates for emission reductions following feed improvement in sub-Saharan Africa. The method does not require input data on changes in feed composition or digestibility. Smith et al. (ibid.) conservatively estimate a 1% reduction in methane emissions from enteric fermentation based on currently available improved feed practices in common use. In the absence of Tier 2 data (feed composition and digestibility), the conservative approach by Smith et al. (2007) estimates an annual GHG mitigation benefit from feed quality improvements for cattle (-0.02 $tCO_2e$/head) and sheep (-0.002 $tCO_2e$/head) (Figure 2). The net change in emissions by the full herd due to feed quality improvements in cattle and sheep totals –9,053 $tCO_2e$/year (Figure 3). If feed composition and digestibility data were available and FAO used the mechanistic Tier 2 approach outlined in IPCC (2006), GHG mitigation benefits would likely be higher.

## Summary of projected GHG emission and carbon sequestration co-benefits

The reductions in emissions due to REGAL-AG interventions were approximately 10% per year (-195,006 $tCO_2e$/year) due to improved feed quality (for cattle and goats) and herd size management. The reduced cattle and camel herd sizes provide the strongest GHG mitigation benefit per head (-2.65 $tCO_2e$/head and -2.03 $tCO_2e$/head, respectively) (Figure 2). At the project level, reduced livestock herd size accounted for 95% of all mitigation benefits (-185,952 $tCO_2e$) (Figure 3).

**Figure 2. Impact of agricultural practices: Net GHG emissions on an animal basis**

*($tCO_2e$/head/yr)*

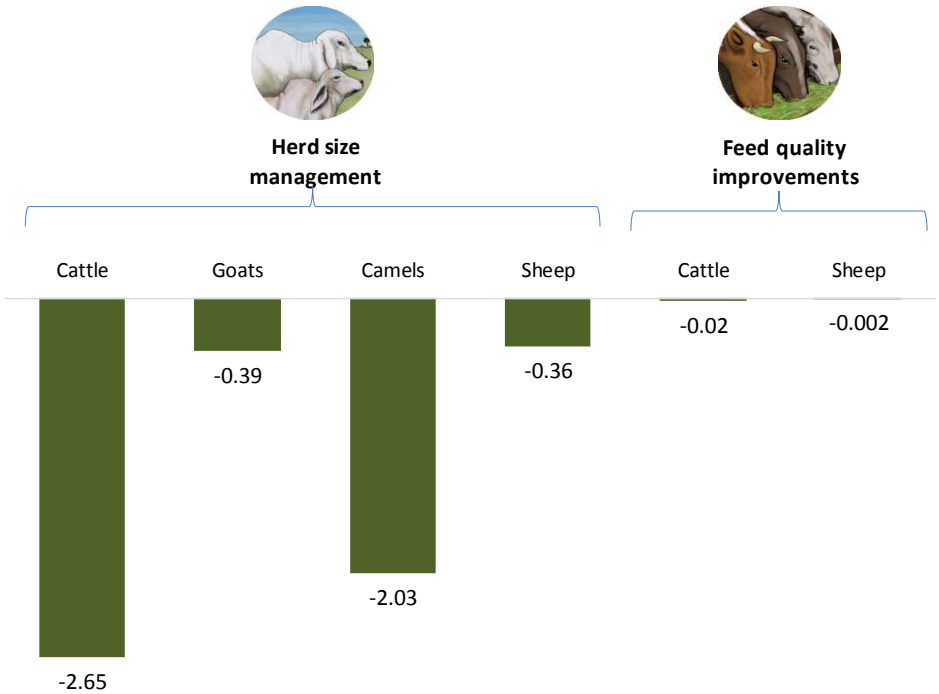


**Figure 3. Impact of agricultural practices: Net GHG emissions on total animals**

*($tCO_2e$/yr)*

## GHG emission intensity

Emission intensity (GHG emissions per unit of output) is a useful indicator of LED in the agricultural sector. Agricultural practices supported by REGAL-AG reduced emission intensities for cattle, sheep, goats, and camels (Table 2).

**Livestock productivity.** Due to improvements in market access, livestock feed, and animal health, REGAL-AG anticipated a decrease in slaughter age by one year across all livestock types. For cattle, the project estimated that the animals would reach target commercialization weight (300 kg) in two years, which translates to an increase in annual output of 50%. These slaughter age and off-take dynamics resulted in annual increases in output for sheep (67%), goats (67%), and camels (50%).

**Post-production loss.** REGAL-AG had no information on changes in post-production losses; therefore, this is not included in emission intensity estimates.

**Emission intensity**. Changes in agricultural practices lowered absolute emissions and increased productivity, leading to less emission intensity for cattle (–34%), sheep (–40%), goats (–40%), and camels (–33%).

*Table 2. Emission intensity by product*

| | Activity agricultural practices | Total GHG emissions per head ($tCO_2e$/head) (1) | Annual meat output (t meat/head) (2) | Emission intensity ($tCO_2e$/t meat) (3) |
|---|---|---|---|---|
| **Cattle** (feed quality, herd size management) | No project | 2.65 | 0.10 | 26.51 |
| | Project | 2.63 | 0.15 | 17.54 |
| | Difference (%) | –0.02 (–1%) | 0.05 (50%) | –-8.97 (–34%) |
| **Sheep** (feed quality, herd size management) | No project | 0.36 | 0.01 | 27.13 |
| | Project | 0.36 | 0.02 | 16.18 |
| | Difference (%) | 0 (–1%) | 0.01 (67%) | –10.95 (–40%) |
| **Goats** (herd size management) | No project | 0.39 | 0.02 | 21.47 |
| | Project | 0.39 | 0.03 | 12.88 |
| | Difference (%) | 0 (0%) | 0.01 (67%) | –8.59 (–40%) |
| **Camels** (herd size management) | No project | 2.03 | 0.18 | 11.05 |
| | Project | 2.03 | 0.28 | 7.37 |
| | Difference (%) | 0 (0%) | 0.09 (50%) | –3.68 (–33%) |

Notes:

1. Total GHG emissions per head signifies the emissions per head of livestock.
2. Annual meat output signifies the tonnes of meat produced per average livestock head per year.
3. Emission intensity is calculated by dividing the total GHG emissions per head by the annual meat output.

## In focus: supply and demand interventions in livestock value chains result in decreased GHG emissions.

Many smallholder farmers and pastoralists do not participate in formal livestock sales markets. In smallholder and pastoral systems, animals serve multiple functions, and livestock sales are sporadic and based on immediate cash needs. Inadequate feed and nutrition often limits animal growth, resulting in a long time frame for meat animals to reach slaughter weight (Gerber 2013; Ojango et al. 2016). Ojango et al. (2016) noted that it can take an average of 4 years for a sheep or goat to grow to mature size.

These herd dynamics not only limit productivity and incomes but also increase GHG emissions. Faster growth rates reduce the age at first calving, which results in lower breeding overhead (i.e., animals contributing to herd maintenance but not to production) (Gerber et al. 2013). In addition, as the productivity of each animal increases, the livestock keeper can reduce the herd size to produce the same amount of marketable goods (Opio et al. 2013).

Livestock producers also need improved market linkages to livestock buyers, access to critical input products and services, and timely market information to improve the livestock off-take rate (percentage of sale or slaughter at the end of or during a production cycle). In addition, favorable policy environments are needed to promote investment in market infrastructure for livestock products, inputs, and service provision (Havlik 2014). Research indicates that livestock off-take rate increase only when both livestock supply and demand factors are addressed.

## 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:

- **Grazing land improvements.** Under what circumstances are grazing land improvements feasible? Are additional interventions possible to promote soil carbon sequestration, such as by establishing rotational grazing? Are there opportunities to expand dry season livestock feed or fodder to reduce grazing pressures?
- **Livestock forage quality and management.** What value chain interventions are feasible in order to improve fodder management (cultivation, conservation, mix, and processing) and feed rationing (concentrated and complete feeds)? How can programs support producers or processors to increase feed production? Which forage varieties balance increased production with farmer affordability and reduced GHG emissions?
- **Herd size dynamics.** What incentives or changes to enabling conditions (e.g., insurance, financial services) are needed to assist a livestock producer to increase productivity and reduce herd size without facing production risks?

## Methods for estimating emissions

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 emissions reductions for these cases, and the research team therefore excluded them. Next researchers from CCAFS and USAID then selected 30 activities with high potential for agricultural GHG mitigation based on expert judgment of anticipated 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, data, and estimates regarding the adoption of improved agricultural practices, annual yields, and postharvest losses. The underlying data for this GHG analysis are based on project monitoring data.

The team estimated GHG emissions and carbon sequestration associated with agricultural and forestry practices by utilizing EX-ACT, an appraisal system developed by the 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. Deriving 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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