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ENVIRONMENT
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WORKING
PAPER

67

NDC

REGIONAL ANALYSIS OF THE NATIONALLY DETERMINED CONTRIBUTIONS OF EASTERN AFRICA

Gaps and opportunities in the agriculture sectors



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ABBREVIATIONS AND ACRONYMS

ACCES	Climate Change Adaptation for Soil and Water Resources Conservation
AFOLU	Agriculture, Forestry and Other Land Use
AR5	Fifth Assessment Report Working Group II
BAU	Business-as-usual
BUR	Biennial Update Report
CA	Conservation Agriculture
CC	Climate Change
CO₂ eq	Carbon Dioxide Equivalent
COP	Conference of the Parties
CSA	Climate Smart Agriculture
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ETF	Enhanced Transparency Framework
EUR	Euro
EWS	Early Warning Systems
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GDP	Gross Domestic Product
GFCS	Global Framework for Climate Services
GHG	Greenhouse Gas
GIS	Geographic Information Systems
Gt	Gigatonnes
(I)NDC	(Intended) Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPDM	Integrated Pest and Disease Management

IPPU	Industrial Processes and Product Use
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry
M&E	Monitoring and Evaluation
MODIS	Moderate Resolution Imaging Spectroradiometer
MRV	Measurement, Reporting and Verification
N₂O	Nitrous Oxide
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAPA	National Adaptation Programmes of Action
NC	National Communication
NDCs	Nationally Determined Contributions
NGHGI	National Greenhouse Gas Inventories
P&M	Policy and Measure
PA	Paris Agreement
RCP	Representative Concentration Pathway
REDD+	Reducing Emissions from Deforestation and Forest Degradation and Forest Conservation
SDG	Sustainable Development Goal
SFM	Sustainable Forest Management
SLM	Sustainable Land Management
TNA	Technology Needs Assessment
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WRM	Water Resources Management

EXECUTIVE SUMMARY

The Paris Agreement constitutes a landmark achievement in the international response to climate change, as developed and developing countries alike have committed to do their part in the transition to a low-emissions and climate-resilient future. (Intended) Nationally Determined Contributions (NDCs) represent the main national policy frameworks, under the United Nations Framework Convention on Climate Change (UNFCCC), by which Parties communicate their climate commitments to the international community and report on the progress made, and support needed, toward achieving them.

FAO is proposing a series of regional-level analyses of the NDCs to identify the current commitments, gaps and opportunities in the agriculture sectors for enhancing mitigation and adaptation ambitions in the next round of NDCs. In the analysis, the agricultural sectors refer to crops, livestock, forestry, and fisheries and aquaculture as defined by FAO. This report aims to guide FAO – and other international actors – committed to providing developing countries with the support required for implementing their NDCs and ensuring future commitments are transparent, quantifiable, comparable, verifiable and ambitious.

The results of the analysis will inform the facilitative dialogue and global stocktaking process – an integrated periodic review of collective progress in achieving the long-term climate goals of the Paris Agreement.

The first of the regional series covers Eastern Africa, as defined by the FAO regional grouping, including eighteen countries: Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

1.1 REGIONAL CIRCUMSTANCES

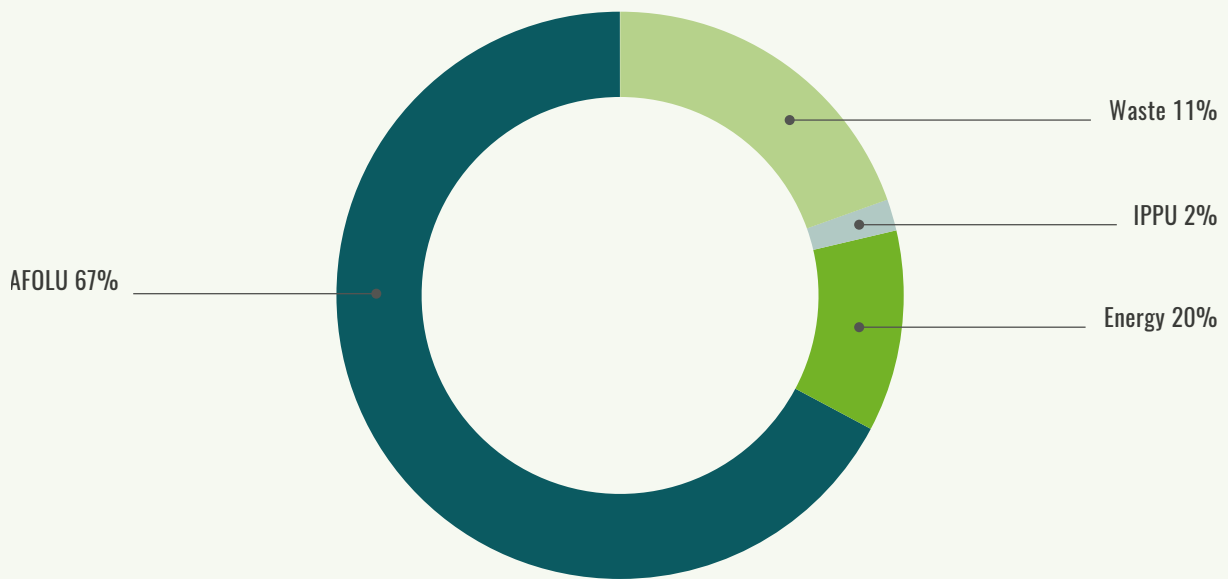
Reducing greenhouse gas (GHG) emissions while ensuring food security will be a challenge in Eastern Africa, as agriculture drives the rural economy, accounting for approximately 25 percent of gross domestic product (GDP) (WB, 2017), 70 percent of employment (ILO, 2017), and five billion USD in food export revenues every year (FAO, 2017b). Currently, around one-third of the population is undernourished, with high prevalence of food inadequacy, stunting and wasting at 41, 44, and 8 percent, respectively. Overall, poverty is widespread across the region, with more than 40 percent of the population living in households with consumption or income per person below 1.90 USD per day (WB, 2017).

According to the national GHG inventories reported in latest National Communications (NC) (**Figure 1**), the Agriculture, Forestry and Other Land Use (AFOLU) sector represents the most significant share of net emissions¹ in the region (67 percent), followed by the Energy (20 percent), Waste (11 percent) and the Industrial Processes and Product Use (IPPU) sectors (2 percent). While the agriculture sector constitutes a source of annual net emissions (0.36 Gt CO₂ eq), the LULUCF sector represents a net sink (-0.11 Gt CO₂ eq), for a combined total of 0.25 Gt CO₂ eq net emissions per year in the AFOLU sector.

¹ The result of summing all anthropogenic emissions and removals.

FIGURE 1.

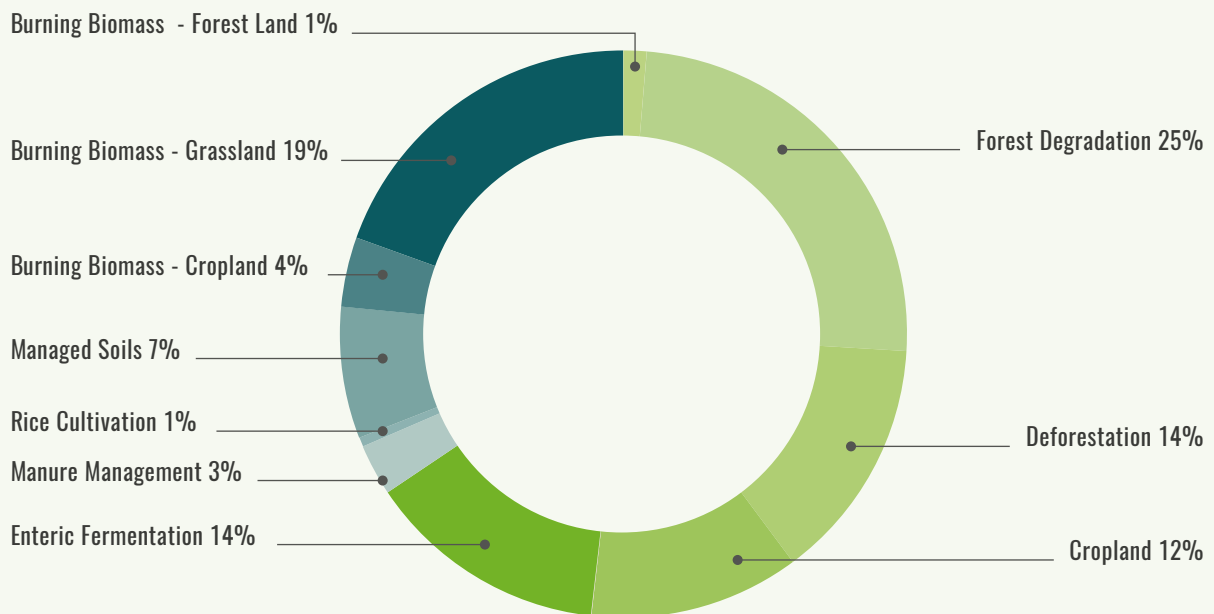
REGIONAL GHG NET EMISSIONS, PER SECTOR



Source: Countries' National Communication (NC), excluding Somalia and South Sudan whom did not submit a NC

FIGURE 2.

SHARE OF REGIONAL GHG EMISSIONS AMONGST SOURCES IN THE AFOLU SECTOR



Source: NC

Within the AFOLU sector (**Figure 2**),² the GHG sources from agriculture and Land Use, Land Use Change and Forestry (LULUCF) are almost equally distributed, with 49 and 51 percent shares each. Overall, the most significant GHG sources are forest degradation³ (25 percent) and grassland biomass burning (19 percent),⁴ with deforestation⁵ and enteric fermentation holding equal shares (14 percent).

Within the agriculture sector, the largest sources of emissions are grassland biomass burning (40 percent), enteric fermentation (29 percent) and non-CO₂ emissions from managed soils (16 percent), followed by cropland biomass burning (8 percent),⁶ manure management (6 percent) and rice cultivation (1 percent).

Overall, the LULUCF sector constitutes a net sink at the regional level, constituted mainly by forest management⁷ (65 percent) and afforestation⁸ (31 percent). However, aggregated country data suggests that forest degradation⁹ is the highest source of LULUCF emissions (48 percent), while deforestation¹⁰ and cropland account for around one-third of the total (27 and 23 percent, respectively).

1.2 OVERALL COVERAGE OF MITIGATION AND ADAPTION IN THE NDCS

In Eastern Africa, all 18 countries communicated their ambitions towards reducing GHG net emissions and increasing resilience under climate change in their respective mitigation and adaptation contributions. Representing the most significant source of net emissions, as well as the priority sector for adaptation, the agriculture sectors figure prominently in the region's commitments to a low-emissions and sustainable development pathway. Overall, 16 out of 18 countries include the agriculture and/or Land Use, Land Use Change and Forestry (LULUCF) sector in overall mitigation contributions, whereas all 18 countries include the agriculture and LULUCF sectors in the adaptation component of their NDCs (**Figure 3**).

² AFOLU-related GHG categories are aggregated in this analysis to accommodate for both the 1996 and 2006 IPCC guidelines for reporting adopted by countries in their respective NDCs. **Annex 1** illustrates the methodology for capturing national data in common GHG categories and sub-categories that link the 1996 IPCC source/sink categories to the 2006 land use categories, carbon pools and non-CO₂ gases.

³ Forest degradation refers to total GHG net emissions from 2006 IPCC land use category "Forest land remaining forest land" and 1996 GHGI category "Changes in forest and other woody biomass" when those categories are a net source at the national level.

⁴ Burning biomass on grassland refers to total GHG net emissions from 2006 IPCC land use sub-category "Biomass burning" and to 1996 GHGI category "Prescribed burning of savannas".

⁵ Deforestation refers to total GHG net emissions from 2006 land use category "Forest land converted to other use" and 1996 IPCC GHGI category "Forest and grassland conversion".

⁶ Burning biomass on cropland refers to total GHG net emissions from 2006 IPCC land use sub-category "Biomass burning" and to 1996 GHGI category "Burning of agricultural residues".

⁷ Forest management accounts for total net emissions related to 2006 IPCC land use category "Forest land remaining forest land" and 1996 GHGI category "Changes in forest and other woody biomass," when those categories are a net sink at national level.

⁸ Afforestation accounts for total net emissions related to 2006 IPCC land use category "Land converted to forest land" and 1996 GHGI category "Abandonment of managed lands".

⁹ Forest degradation refers to total GHG emissions from 2006 IPCC land use category "Forest land remaining forest land" and 1996 GHGI category "Changes in forest and other woody biomass" when a net source at the national level.

¹⁰ Deforestation refers to total GHG net emissions from 1996 IPCC GHGI category "Forest and grassland conversion" and 2006 land use category "Forest land converted to other use".

FIGURE 3.

OVERVIEW OF THE NDCS IN THE AGRICULTURE SECTORS OF EASTERN AFRICA



Source: NDC

1.3 MITIGATION IN THE AGRICULTURE SECTORS

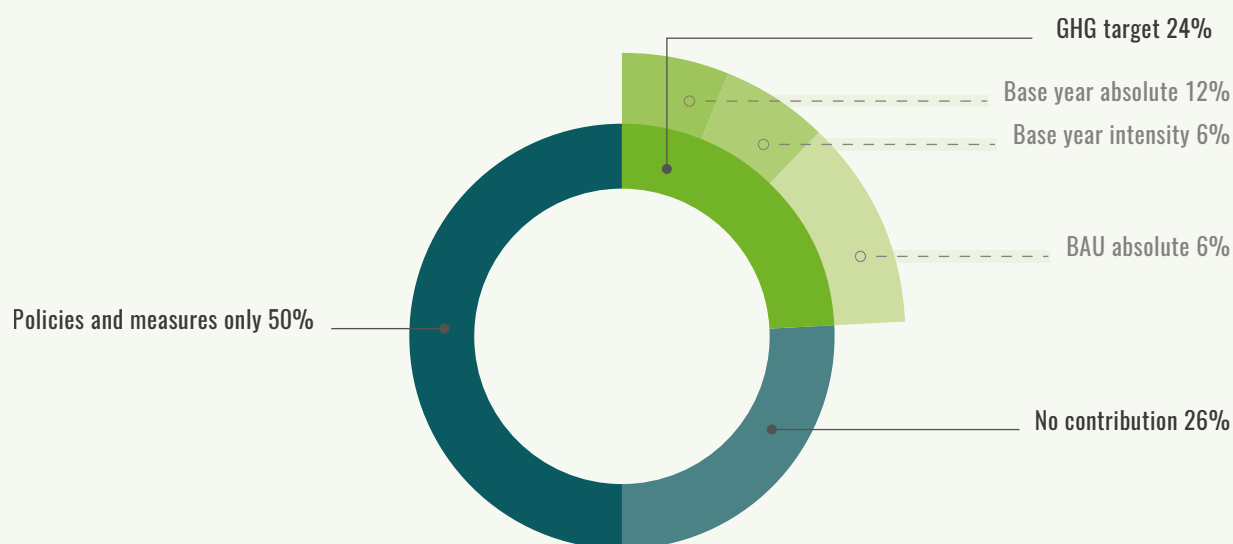
1.3.1 Targets, policies and measures

Fifteen out of 18 (83 percent) East African countries set a national economy-wide GHG

mitigation target for 2030, while the three remaining countries¹¹ base their mitigation contribution on “actions only,” with an implementation period varying from 10 to 15 years. All 15 countries that set an economy-wide GHG target project a baseline of future net emissions under a business as usual (BAU) scenario. Thirteen of those 15 countries express their GHG target as an absolute net reduction compared with the baseline, while the other two express their target as a reduction in the intensity of per capita net emissions.

FIGURE 4.

COVERAGE OF MITIGATION CONTRIBUTION IN THE AGRICULTURE SECTOR



Source: NDC

Out of the 13 countries (**Figure 4**)¹² that include agriculture in their overall mitigation contribution, four (24 percent)¹³ set a sectorial GHG target – expressed as either an absolute net emission reduction compared with a base year or BAU, or as a reduction in the intensity of net emissions per capita compared with a base year. The remaining nine countries include

policies and measures (P&Ms) for mitigation in the agriculture sector.

Out of the 15 countries (**Figure 5**)¹⁴ including the LULUCF sector in their overall contribution, five (28 percent)¹⁵ set sectorial GHG targets – expressed as an absolute net emission reduction compared with a BAU. The remaining ten countries include P&Ms for mitigation in the LULUCF sector.

¹¹ Rwanda, Somalia and South Sudan.

¹² Mozambique, Seychelles, South Sudan, United Republic of Tanzania and Zimbabwe do not include the agriculture sector in overall mitigation contribution.

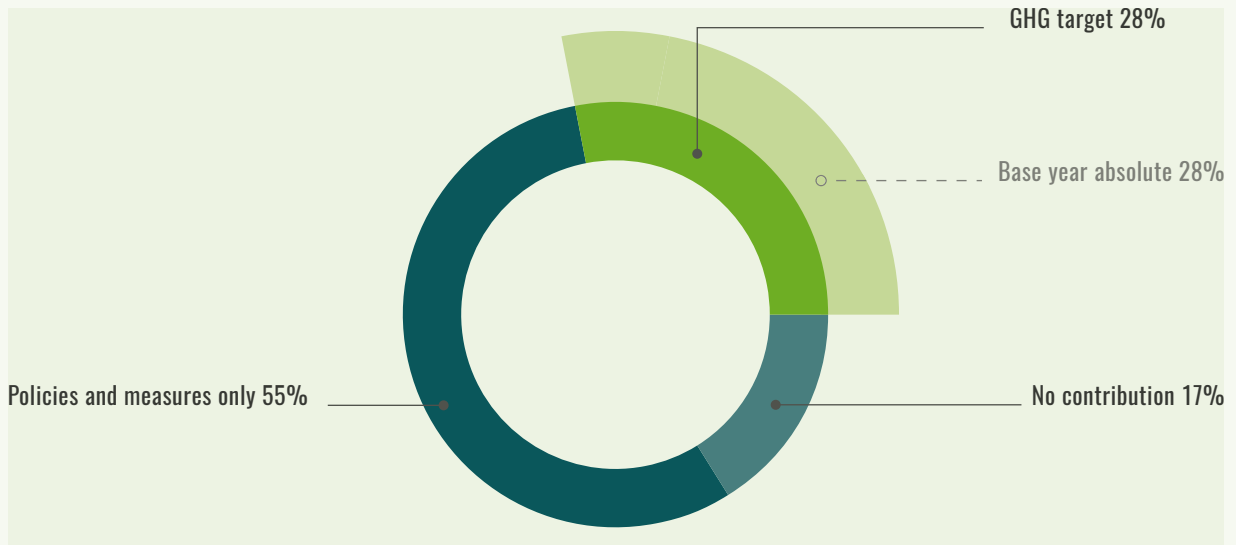
¹³ Comoros, Madagascar, Ethiopia, and Malawi.

¹⁴ Djibouti, Seychelles and Zimbabwe do not include the LULUCF sector in overall mitigation contribution.

¹⁵ Comoros, Madagascar, Ethiopia, Malawi, and Uganda.

FIGURE 5.

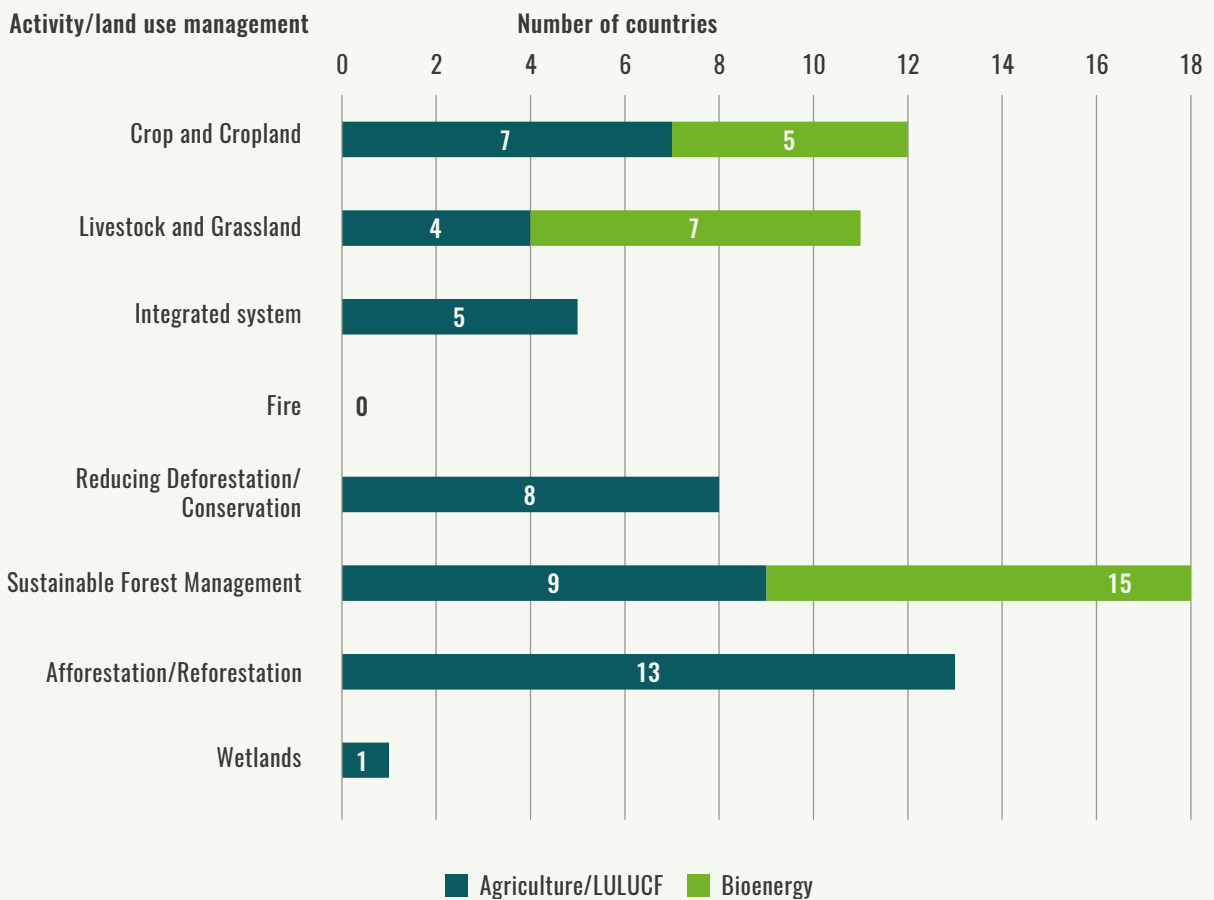
COVERAGE OF MITIGATION CONTRIBUTION IN THE LULUCF SECTOR



Source: NDC

FIGURE 6.

COUNTRIES WITH POLICIES AND MEASURES IN THE AFOLU SECTOR, PER ACTIVITY/LAND USE MANAGEMENT



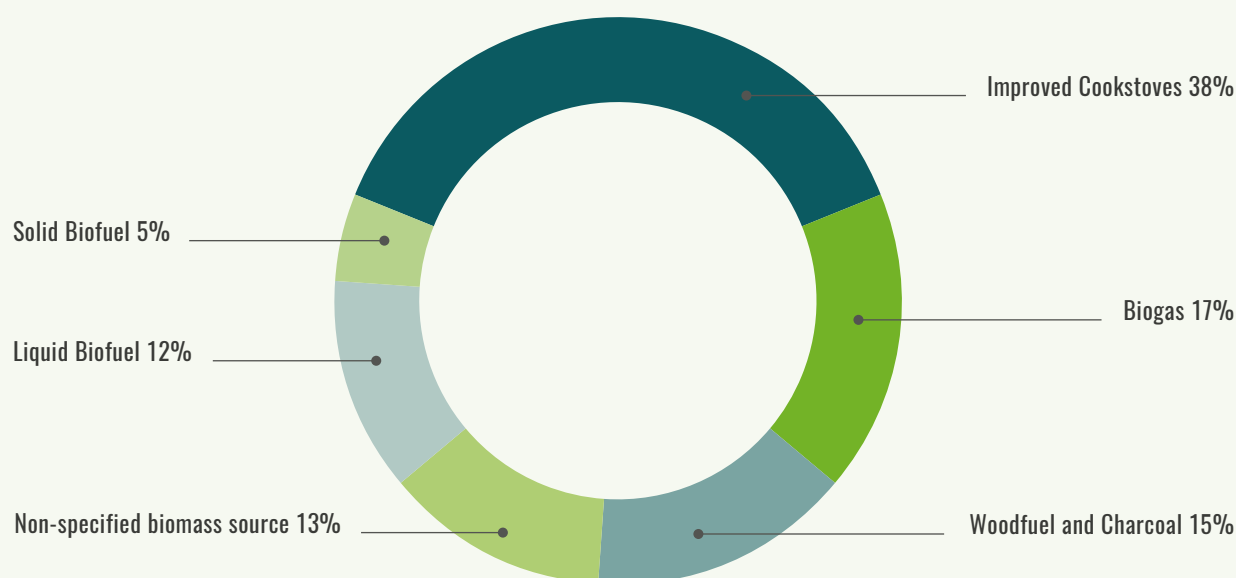
Source: NDC

In addition to the economy-wide and sectorial targets set by countries in their NDCs, the P&Ms identified range by activity and land use management, and are often cross-sectoral. In the AFOLU sector (**Figure 6**), the majority of countries aim to avoid emissions and/or enhance removals by promoting sustainable forest management, afforestation/reforestation, and improved management of crop and livestock systems. Other P&Ms, such as reducing deforestation, integrated system management and wetlands management, are also included as mitigation options. Most countries aim to reduce

emissions from forest degradation through more sustainable energy production from forest biomass, while others target agricultural emissions related to enteric fermentation and manure management through biogas production. Overall, 15 East African countries (83 percent) report either one or multiple P&Ms aiming to increase – or render more efficient – energy production from agriculture and/or forest biomass, with potential¹⁶ mitigation co-benefits in both the Energy and AFOLU sectors (**Figure 7**).

FIGURE 7.

SHARE OF COUNTRIES WITH POLICIES AND MEASURES ON ENERGY PRODUCTION AND USE FROM AGRICULTURAL/FOREST BIOMASS



Source: NDC

Lastly, cross-cutting measures, such as Climate Smart Agriculture (CSA) and Reducing Emissions from Deforestation and Forest Degradation and Conservation of Forest (REDD+), represent common strategies for enhancing agricultural productivity and

improving the sustainability of forestry practices, while avoiding emissions and/or enhancing removals. Around one-third of countries include CSA as a mitigation strategy, while over half promote REDD+ as a national mitigation framework.

¹⁶ While the substitution of fossil fuel for biofuel from the agriculture sectors may reduce emissions in the Energy sector, the mitigation impact of biofuel production on the AFOLU sector depends on the sustainability of biofuel production, which is measured as a positive or neutral impact on the long-term average carbon stock of the land on which it is produced, and/or on the associated non-CO₂ budget.

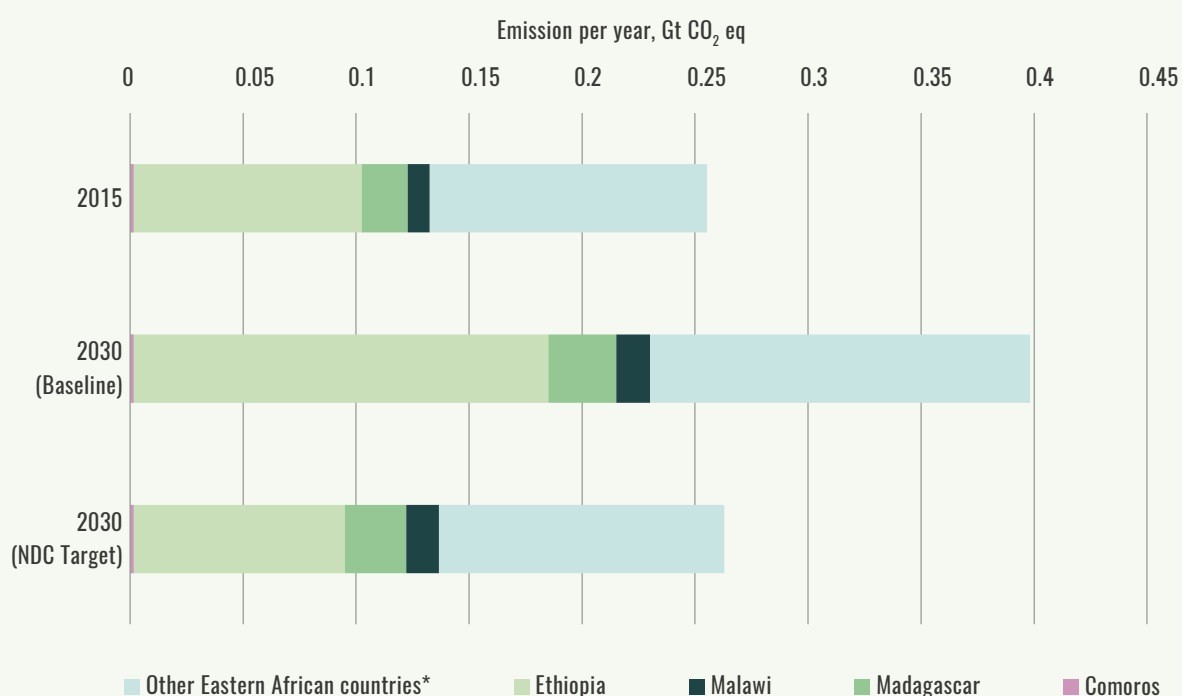
1.3.2 Regional baseline net emission and mitigation target analysis

On the aggregate level,¹⁷ economy-wide net emissions in Eastern Africa reported in the NDCs are expected to increase by 80 percent¹⁸ between 2015¹⁹ and 2030. On the other hand, full implementation of both conditional and

unconditional mitigation targets set forth in the NDCs would limit regional net emissions to roughly 40 percent below the baseline²⁰ – equivalent to a cumulated net emission reduction of 3 Gt CO₂ eq in 2030. However, despite implementation of the NDCs, regional net emissions would nevertheless increase by 6 percent in 2030 compared with the 2015 level.

FIGURE 8.

BASELINE VALUE (2030) AND NDC MITIGATION TARGET (2030), COMPARED WITH HISTORICAL EMISSIONS (2015), IN THE AGRICULTURE SECTOR FOR EASTERN AFRICA



Source: NDC, NC and author's calculation²¹

*see Footnote 24 for list of countries

¹⁷ Aggregated net emission reductions include only those countries (15) that estimated both an economy-wide GHG baseline and mitigation target (Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Seychelles, Uganda, United Republic of Tanzania, Zambia, and Zimbabwe) or only a GHG mitigation target (Mozambique). Rwanda, Somalia and South Sudan did not submit an economy-wide GHG target nor 2030 baseline in respective NDC.

¹⁸ From 0.62 Gt CO₂ eq per year in 2015 to 1.12 Gt CO₂ eq per year in 2030.

¹⁹ Historical values range from 1994 to 2013, and are adjusted to respective 2015 value based on national or regional trends.

²⁰ To 0.66 Gt CO₂ eq per year in 2030.

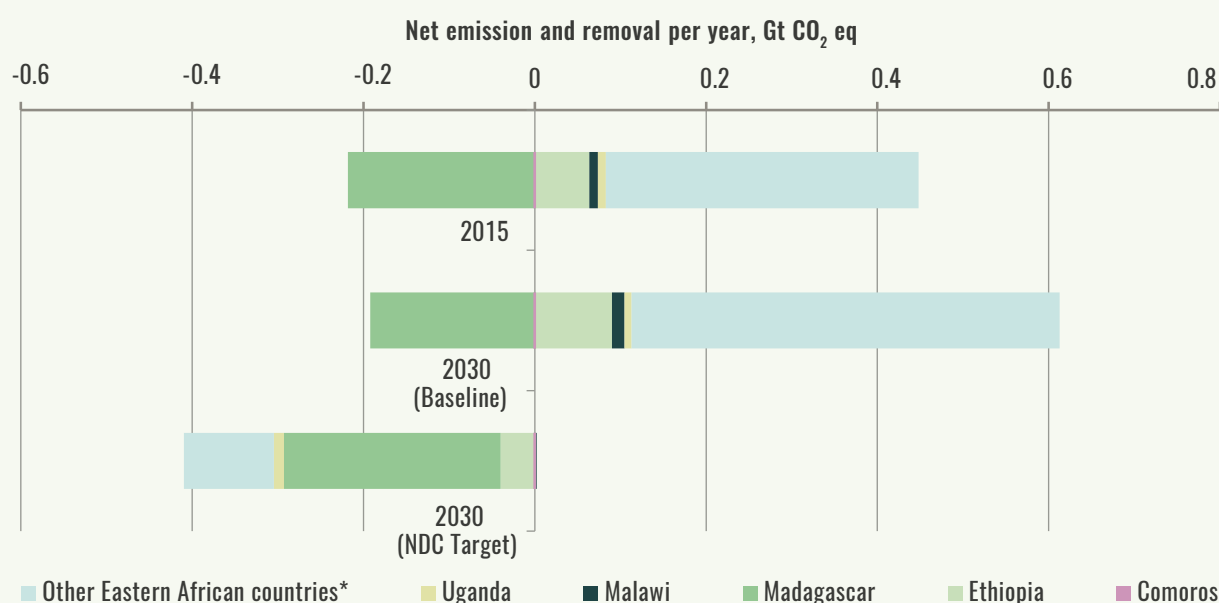
²¹ When the historical net emission value for the agriculture sector is not reported in the NDC, the value from respective NC is applied. If the latest reported value is prior to 2015, the value is projected to 2015 based on national or regional trends. The aggregated 2030 NDC target level includes values reported in the NDCs by (4) countries and extrapolated for those (7) countries pledging mitigation in the agriculture sector whom did not include quantified GHG targets. The methodology is described in Footnote 24.

In the agriculture sector (**Figure 8**), regional emissions are projected to increase by roughly 55 percent²² between 2015²³ and 2030. However, full implementation of sectorial mitigation targets scaled to the regional level²⁴

would limit net emissions to approximately one-third below²⁵ the projected baseline – equivalent to a cumulated net reduction of 0.94 Gt CO₂ eq by 2030.

FIGURE 9.

BASELINE VALUE (2030) AND NDC MITIGATION TARGET (2030), COMPARED WITH HISTORICAL NET EMISSIONS (2015), IN THE LULUCF SECTOR FOR EASTERN AFRICA



Source: NDC, NC and author's calculation²⁶

*see Footnote 29 for list of countries

²² From 0.25 Gt CO₂ eq per year in 2015 to 0.40 Gt CO₂ eq per year in 2030.

²³ Historical values range from 1994 to 2013, and are adjusted to 2015 value based on regional trend.

²⁴ Aggregated net emissions reductions include only those countries (4) that estimated both a GHG baseline and mitigation target in the agriculture sector (Comoros, Ethiopia, Madagascar and Malawi) as well as those countries (7) pledging mitigation contributions in the agriculture sector (Burundi, Djibouti, Eritrea, Kenya, Mauritius, Uganda, and Zambia) without estimating a sectorial GHG target. For the seven countries, the baseline and mitigation target, respectively, are calculated based on: a) the average change of emissions (56 percent) from the 2015 historical value and 2030 baseline value observed in the four countries; and b) the average expected change of emissions (3 percent) from the historical 2015 value to the target 2030 value observed in the four countries.

²⁵ To 0.26 Gt CO₂ eq per year in 2030.

²⁶ When the historical net emission value for the LULUCF sector is not reported in the NDC, the value from respective NC is applied. If the latest reported value is prior to 2015, the value is projected to 2015 based on national or regional trends. The aggregated 2030 NDC target level includes values reported in the NDCs by (5) countries and extrapolated for those (7) countries pledging mitigation in the LULUCF sector but did not estimate a GHG target. The methodology is described in Footnote 29.

In the LULUCF sector (**Figure 9**), regional net emissions are projected to increase by roughly 85 percent²⁷ between 2015²⁸ and 2030. On the other hand, full implementation of the mitigation targets scaled to the regional level²⁹ would enhance removals by roughly 275 percent³⁰ compared with the baseline – equivalent to a cumulated net reduction of 5.6 Gt CO₂ eq by 2030.

1.3.3 Identifying gaps and opportunities to enhance mitigation ambitions

Comparing the relative coverage of mitigation policies and measures presented in the NDCs against the GHG hotspots identified in the agriculture and LULUCF sectors, a few gaps emerge, pointing to areas for potential improvement in the next revision of the NDCs (**Figure 10**). Results from the gap analysis evidence insufficient coverage of policies and measures aiming to reduce biomass burning on grassland (i.e. savannah burning); improve soil management; and improve livestock feeding and breeding practices in the agriculture sector. In the LULUCF sector, the coverage of mitigation policies and measures targeting emissions from deforestation and cropland was also insufficient with respect to the high share of respective emissions per land use category. However, significant coverage of mitigation actions aiming to enhance forest sinks through sustainable forest management and afforestation/ reforestation illustrate an opportunity, amongst others, for additional countries to achieve net reductions in the LULUCF sector. However, gaps may be closed and opportunities seized only if appropriate incentives are established and trade-offs are reconciled.

Filling in the regional and national gaps found in the overall coverage of mitigation actions targeting AFOLU-emission sources presents a critical opportunity for enhancing climate ambitions where mitigation potential is greatest. Consequently, the mitigation potential of a set of policies and measures reported by individual countries in their NDCs and NCs in the agriculture sectors were scaled to the regional level and measured against the global marginal abatement cost³¹ to illustrate the most cost effective mitigation options for the region (**Figure 11**). Estimates indicate that agroforestry and sustainable soil management entail negative costs and high mitigation potential, while improved livestock management entails higher costs per unit of mitigation. On the other hand, sustainable forest management, afforestation and reduced deforestation constitute high mitigation potential at a relatively low cost. At the regional level, the selected management practices in the agriculture sectors could reduce economy-wide net emissions to below historical³² levels by 2030 with an estimated mitigation potential of -4.6 Gt CO₂- eq in 2030, – at a cumulated abatement cost of 13.2 billion EUR – representing approximately 140 percent of the current GHG target set forth in the NDCs for all sectors (**Annex 14**).

If the selected mitigation actions were to be implemented in full across the region, the agriculture sectors alone could reduce economy-wide net emissions to below historical³³ levels by 2030. In other words, by enhancing mitigation contributions in the agriculture sectors alone – provided that timely climate finance is received at the necessary scale – Eastern Africa could not only reach its climate objectives by 2030 but enhance its climate ambitions even more.

²⁷ From 0.23 Gt CO₂ eq per year in 2015 to 0.42 Gt CO₂ eq per year in 2030.

²⁸ Historical values range from 1994 to 2013, and are adjusted to 2015 value based on national or regional trends.

²⁹ Aggregated net emissions reductions include only those countries (5) that estimated both a baseline and mitigation target in the LULUCF sector (Comoros, Ethiopia, Madagascar, Malawi and Uganda) as well as those countries (7) pledging mitigation contributions in the LULUCF sector (Burundi, Eritrea, Kenya, Mauritius, Mozambique, United Republic of Tanzania, and Zambia) without estimating a sectorial GHG targets. For the seven countries, the baseline and mitigation target, respectively, are calculated based on: a) the average change of net emissions (83 percent) from the historical 2015 value to the 2030 baseline value observed in the five countries; and b) the average expected change of net emissions (-277 percent) from the historical 2015 value to the 2030 target value observed in the five countries.

³⁰ To -0.41 Gt CO₂ eq per year in 2030.

³¹ McKinsey & Company, 2009.

³² 2015.

³³ 2015.

FIGURE 10.

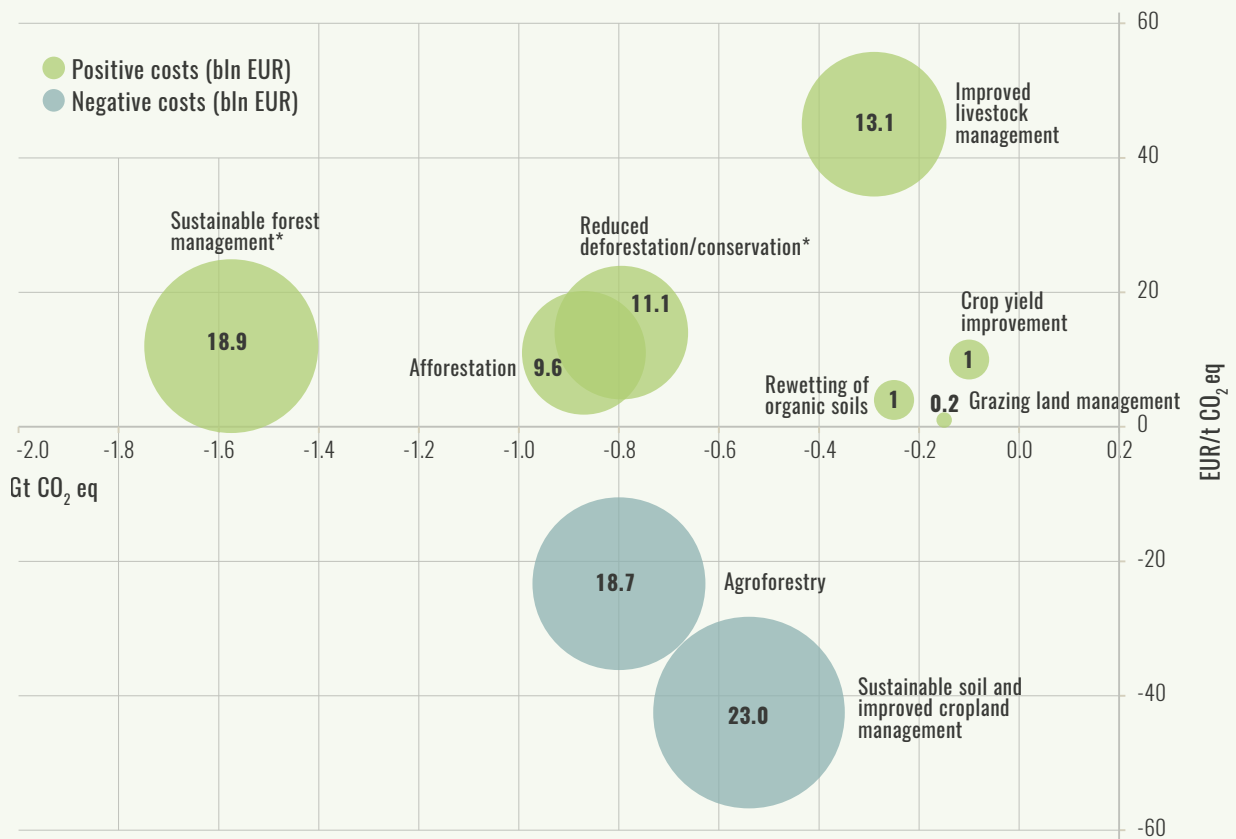
GAPS IN THE OVERALL COVERAGE OF POLICIES AND MEASURES ADDRESSING REGIONAL GHG HOTSPOTS AND OPPORTUNITIES FOR ENHANCING AMBITIONS



Note: Size of blue bubble relates to relative size of gap (when policies and measures do not address GHG hotspot, the bubble relates to share of sectoral GHG emissions). Size of green bubble relates to estimated regional mitigation potential of management practice. It should be noted that gaps are opportunities.

FIGURE 11.

ENHANCED MITIGATION POTENTIAL AND COST IN THE AGRICULTURE SECTORS, 2016-2030



Source: Author's calculation based on national data reported in NC, NDC, national policy and Global GHG Abatement Cost Curve v2.0

* Some mitigation actions may have overlapping impacts

1.4 ADAPTATION IN THE AGRICULTURE SECTORS

1.4.1 Priority actions and cross-sectoral measures

All 18 countries in Eastern Africa highlight the key climate related hazards, impacts, vulnerabilities and the adaptation measures and actions relevant to the agriculture and LULUCF sector.

Most countries report on observed and projected changes in meteorological variables, namely fluctuations in mean annual and seasonal land surface air temperature, changes in precipitation intensity and variability of rainfall regimes. Droughts and floods are referred to as major observed and projected climate related hazards. Countries further report on how climate change exacerbates already existing vulnerabilities, such as economic dependence on agriculture sectors, poverty and low human development. Countries report on observed effects of past and recent climate trends, as well as projected impacts mainly on human health and life incidence, agriculture productive assets and livelihoods and human settlements and infrastructure.

Countries stress that adaptation in the agricultural sector is a national priority, and put forward their strong commitment towards mainstreaming adaptation into sectorial, national and regional development planning processes. **Figure 12** illustrates the overall coverage of ongoing and planned adaptation measures in the agriculture sectors. Countries aim to increase agricultural production and productivity, as well as create sustainable production systems than can re-establish food

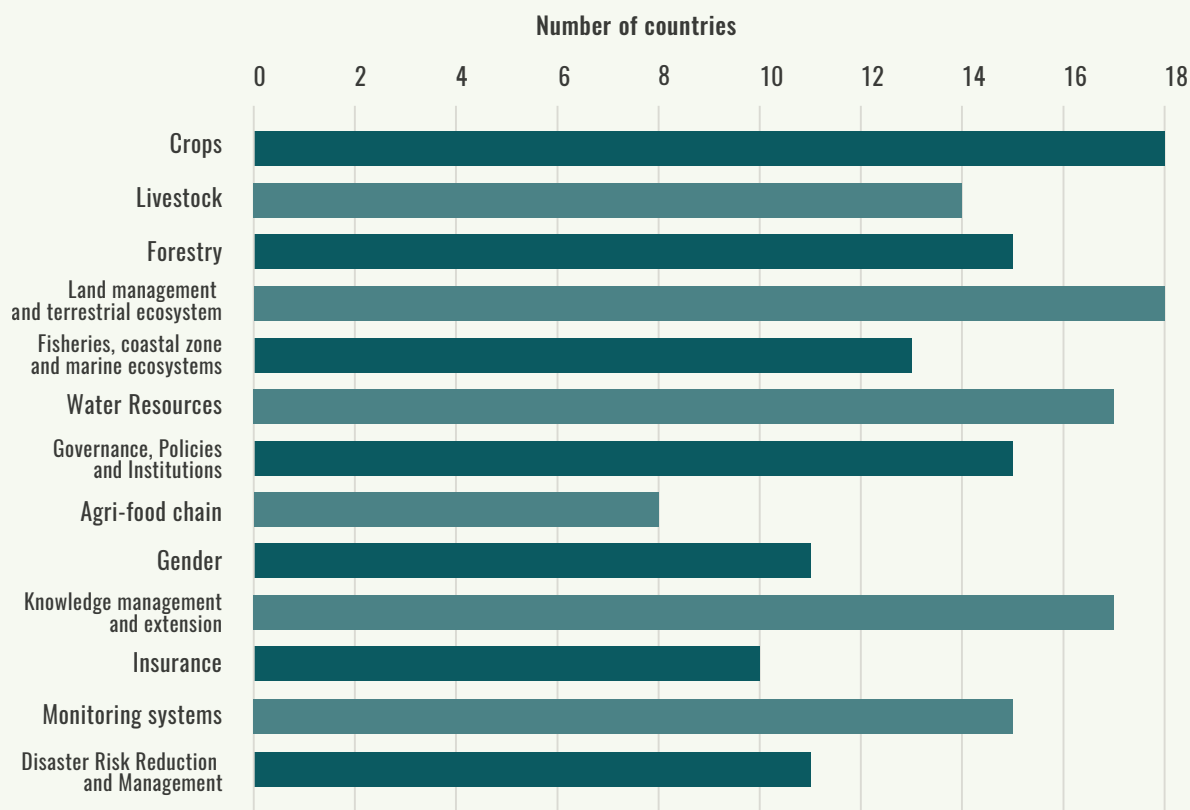
self-sufficiency in the short and medium-term. Priority adaptation measures for the crop, livestock and water resource management sectors include breeding and promotion of stress tolerant crop varieties; conservation and use of germplasm of crop land species and their wild relatives; animal breeding; pasture and range management; irrigation and water storage and harvesting. All countries refer to cross-cutting crop management practices that range from CSA, conservation agriculture (CA) and agroforestry. A strategic focus is given to food production supply and agriculture value chains, not only to reduce post-harvest losses, store food and feed in productive years and secure food supply in case of extreme weather events, but also to add value to agricultural products and transform subsistence farming into profitable market agriculture while meeting the national market demand for food.

Investments for land management and protection, land rehabilitation and restoration are strongly linked to the goal of maintaining the natural resource base and ecosystem services to increase the resilience of the agriculturally productive areas. Forest-based adaptation is also a priority given the reliance of the rural population in the region on forest resources. Several countries stress the importance of protecting, conserving and restoring terrestrial and freshwater ecosystems and their biodiversity, such as wetlands and mangroves. Coastal countries express the need to foster adaptation actions for the protection and sustainable exploitation of the region's fisheries, coastal zones and marine ecosystems.

Lastly, cross-sectoral adaptation measures relevant to the agriculture sectors, such as disaster risk reduction and management (DRR/M), establishment of monitoring systems, gender sensitive adaptation responses and investment in research are referred to in the region's NDCs.

FIGURE 12.

COVERAGE OF THE ONGOING AND PLANNED ADAPTATION MEASURES IN THE AGRICULTURE SECTORS



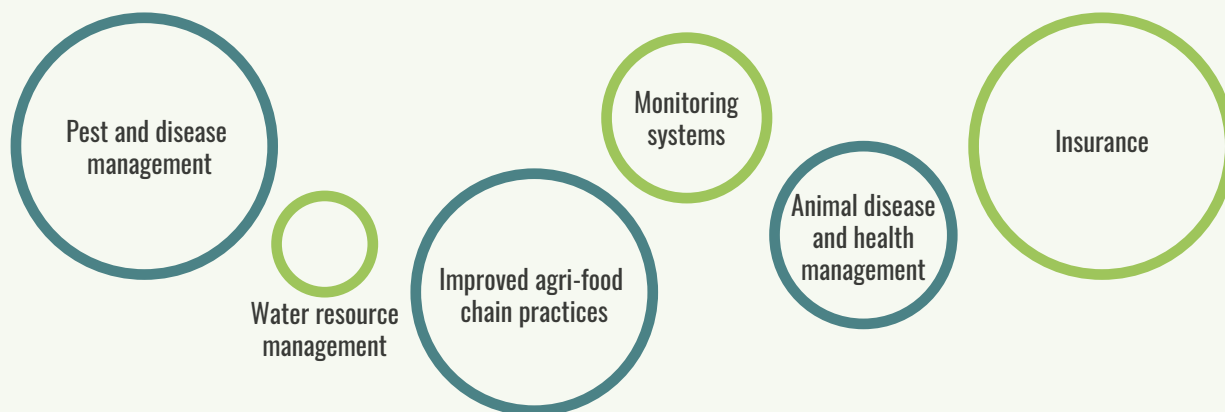
Source: NDC

1.4.2 Identifying gaps and opportunities to enhance adaptation ambitions

Assessing proposed and ongoing adaptation actions in the NDCs against projected hazards and vulnerabilities is essential for understanding gaps and opportunities in the coverage of adaptation in the agricultural sectors (Figure 13). Adaptation actions that have been identified by the countries as priorities in line with evidence-based research present opportunities for agricultural adaptation to climate change. Such opportunities in Eastern Africa include crop and cropland management proposed by all 18 countries (including climate smart agriculture and adapted crop varieties); water resource management (including irrigation and water storage/harvesting); land management and protection; and monitoring systems to assess the results of adaptation policies and actions in the agricultural sectors, as well as assess the impact of climate change. These key adaptation measures present opportunities for additional

countries to address the literature-supported projections of climate-related hazards with appropriate adaptation measures.

There are areas of adaptation that are not broadly developed in the NDCs but are associated with hazards projected to greatly impact the region, presenting gaps in the proposed adaptation measures. Gaps highlighted by the analysis include pest and disease management mentioned by less than one-third of the countries. This is considered a gap in adaptation potential due to the expected increase in crop pests as a result of regional warming. Secondly, animal disease and health management were mentioned by few countries. Finally, the importance of food post-harvest handling and processing is expected to increase with a changing climate due to increased temperature and the potential for increased flooding. Improvements in food transport and storage need to be considered in further adaptation planning and activities.

FIGURE 13.**GAPS IN THE OVERALL COVERAGE OF ADAPTATION ACTIONS ADDRESSING REGIONAL HAZARDS AND VULNERABILITIES, AND OPPORTUNITIES FOR ENHANCING AMBITIONS**

Note: Size of blue bubble relates to relative size of gap (number of countries not including policy and measure addressing regional hazard and vulnerability). Size of green bubble relates to relative size of opportunity (number of countries with potential to include additional good practices). It should be noted that gaps are opportunities.

1.5 SYNERGIES

It is widely recognized that adaptation and mitigation in the agriculture sectors go hand and hand (FAO, 2016b), as optimizing the use of natural resources and regulating carbon and nitrogen cycles through sustainable agricultural production can enhance the long-term stability and resilience of farming systems under climate variability (FAO, 2011; 2013). However, only a few countries explicitly identified synergies between mitigation and adaptation in their NDCs (56 percent). On the other hand, many potentially synergistic actions were promoted separately in the respective mitigation and adaptation components, such as CSA and REDD+

being mentioned as either a mitigation and/or adaptation strategy by seven and ten countries (39 and 56 percent, respectively) in the region, reinforcing the need to scale up selected actions across the region to leverage their synergistic potential.

In addition, many countries recognize the environmental, economic and socio-economic co-benefits generated by more sustainable and resilient agricultural production systems. For instance, Zambia associates sustainable forest management with increased rural household income, biodiversity conservation and rural poverty reduction, particularly amongst women and youth groups.

1.6 PRIORITY AREAS FOR SCALING UP INTERNATIONAL SUPPORT

Transformation to more sustainable and resilient agricultural production systems in Eastern Africa is clearly dependent on international support, as all countries in the region express support needs in the form of either technology transfer (18 countries); technical and/or institutional capacity development (17 and 18, respectively); and finance (18) for implementation of their respective NDCs.

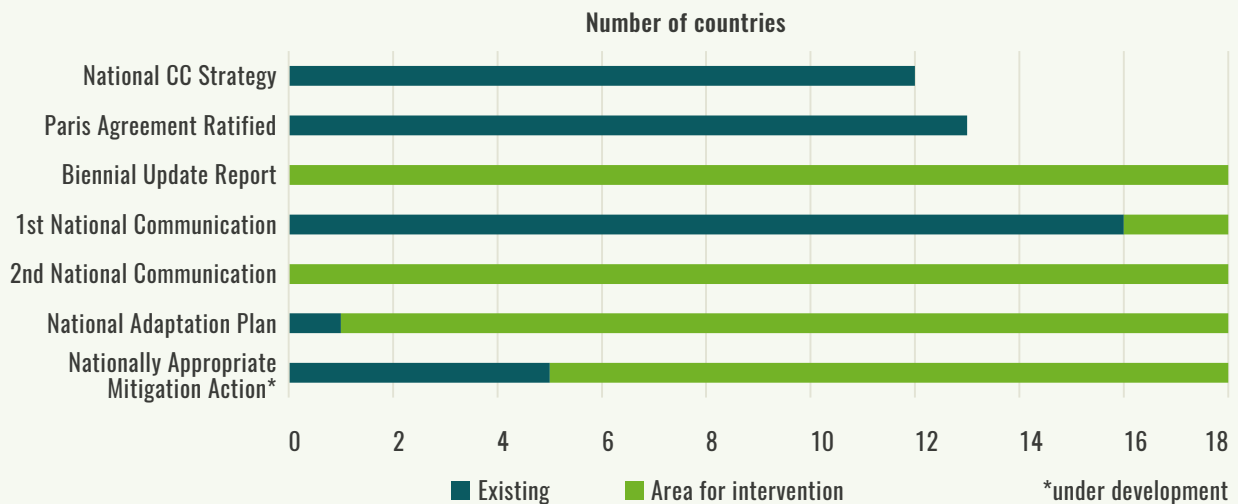
The cumulated costs for implementation of economy-wide mitigation and adaptation priority actions set forth in the NDCs correspond to

a reported 515.7 billion USD, or 35.2 billion USD per year. While seven countries set their contributions as contingent upon international support, the other 11 plan to allocate domestic resources as well. Amongst those countries that reported costs disaggregated by mitigation and adaptation actions,³⁴ the average share of mitigation and adaptation costs is estimated to be approximately 50 percent each.

The capacity gaps and needs identified by the East African countries for achieving their respective NDC point to a set of five intervention areas that should be prioritized for international support, including institutional and technical capacity building for tracking and reporting mitigation and adaptation priority actions in the agriculture sectors in line with the Enhanced Transparency Framework (ETF), as well as national planning (Figure 14) and leveraging climate finance for NDC implementation.

FIGURE 14.

NATIONAL PLANNING FOR NDC IMPLEMENTATION



Source: NDC, UNFCCC, NAMA and NAP/NAPA Registry

³⁴ 11 out of 18 countries.

1.7 CONCLUSION

The agriculture sectors in Eastern Africa represent a pivotal opportunity for simultaneously leveraging the mitigation potential of the region, while enhancing adaptive capacity and food security outcomes through a transition to more sustainable agriculture and land use. However, change will only come about if supported by appropriate policies, institutional

arrangements, capacity development and finance mechanisms. By highlighting the gaps in the coverage of mitigation and adaptation actions in the agriculture sector, as well as illustrating opportunities for enhancing climate ambitions in the next round of NDCs, this analysis can serve as an important roadmap for directing future investment and international support toward low-emission, climate-resilient and inclusive agriculture systems in the region.

INTRODUCTION

BACKGROUND

The Paris Agreement constitutes a landmark achievement in the international response to climate change, as developed and developing countries alike have committed to do their part in the transition to a low-emissions and climate-resilient future. (Intended) Nationally Determined Contributions (INDCs) represent the main national policy frameworks under the United Nations Framework Convention on Climate Change (UNFCCC) by which Parties communicate their climate commitments to the international community and report on the progress made, and support needed and received, toward achieving them. Upon submission of the instrument for ratification of the Paris Agreement, the INDC automatically becomes a Parties' NDC accordingly. The report hereafter refers collectively to the NDCs. Insofar as the agriculture sectors³⁵ feature prominently in the NDCs of developing countries, **FAO has a critical role to play in supporting countries to leverage the mitigation and adaptation potential in the agriculture sectors in their transformative response to climate change and efforts to achieve the 2030 Agenda for Sustainable Development.**

OBJECTIVE

Building on FAO's global study of the coverage of *The Agriculture Sectors in the Intended Nationally Determined Contributions (INDCs): Analysis* and policy support document on *The agricultural sectors in nationally determined contributions (NDCs): Priority areas for international support*, the Climate and Environment Division (CBC) is proposing a series of regional-level analyses of the NDCs to identify the current commitments, gaps and opportunities for enhancing regional mitigation and adaptation ambitions in the agriculture sectors. **The NDC Regional Analysis: Gaps and Opportunities in the Agriculture Sectors will inform the facilitative dialogue and global stocktaking process** – an integrated periodic review of collective progress in achieving the long-term climate goals of the Paris Agreement. This report aims to guide FAO – and other international actors – committed to providing developing countries with the support required for achieving their climate goals, complying with transparency requirements and enhancing climate ambitions in future NDC cycles. **The series will also feed into the work of the Thematic Working Group on Agriculture, Food Security and Land Use, led by FAO under the umbrella of the recently launched NDC-Partnership.** The first of the regional series covering the Eastern Africa³⁶ region is set to be launched at the 23rd session of the Conference of the Parties (COP23).

³⁵ The agricultural sectors refer to crops, livestock, forestry, and fisheries and aquaculture as defined by FAO.

³⁶ Eastern Africa refers to FAO regional grouping containing 18 countries (Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe).

METHODOLOGY

Based on a comprehensive review³⁷ of the NDCs for Eastern Africa, the regional analysis comprises three parts:

- (i) a descriptive overview of regional circumstances based on literature review and verified statistical data;³⁸
- (ii) a review of the mitigation and adaptation components, means of implementation and support needs for NDC implementation in the agriculture sectors for the region; and
- (iii) a gap analysis³⁹ of mitigation contributions and of adaptation priority actions in order to identify potential opportunities for enhancing mitigation ambitions, building resilience in the agriculture sectors, and capturing their synergies.

Depending upon the context in which agriculture – crops, livestock, forestry, and fisheries and aquaculture – is discussed, the terminology used varies. In the context of

the NDCs – as an instrument of the UNFCCC – countries often distinguish between the Agriculture and Land Use, Land-Use Change and Forestry (LULUCF) sectors when defining their respective mitigation and adaptation contributions. However, under the *2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (NGHGI)*, countries are expected to report emissions and removals to the UNFCCC for the *Agriculture, Forestry and Other Land Use (AFOLU) Sector*, which integrates the *Revised 1996 IPCC Guidelines for NGHGs in the Agriculture and LULUCF sectors* and the *2000 and 2003 IPCC Good Practice Guidance and Uncertainty Management in NGHGs*. At the same time, as the processes underlying GHG emissions and removals occur across various land uses and farming systems – and influence agricultural livelihoods and adaptive capacities – the discussion of agricultural practices and climate response options on the ground generally refers to the agriculture sectors, as defined by FAO. The report refers inter-changeably to the above terms as a consequence of context.

³⁷ The analysis is based on a global NDC database, containing countries' mitigation and adaptation contributions, means of implementation and support needs.

³⁸ Statistical databases include, but are not limited to, FAOSTAT, AQUASTAT, GAEZ, IEA, and WB.

³⁹ The annex contains methodological documents for each stage of the analysis.

PART 1

REGIONAL CIRCUMSTANCES

In Eastern Africa, all 18 countries submitted an (I)NDC, of which 13 have already ratified the Paris Agreement, with their (I)NDC accordingly becoming their NDC.⁴⁰ Representing the most significant source of net greenhouse gas (GHG) emissions, as well as the priority sector for adaptation, the agriculture sectors figure prominently in the region's commitments to a low-emissions and sustainable development pathway. Understanding the environmental, economic and socio-economic variables driving emissions and vulnerabilities in the region is critical for identifying context-specific mitigation and adaptation actions that simultaneously support – rather than limit – food security and sustainable development objectives. Indeed, most countries refer to their specific national circumstances when outlining why their NDCs are fair and ambitious. This section provides an overview of the regional

trends conditioning emission trajectories, mitigation options, adaptive capacities and food security outcomes in the region.

1.1 CLIMATE AND NATURAL RESOURCES

The region's tropical climate is differentiated by its varying topography and moisture regimes, giving way to diverse agro-ecological zones, ranging from the warm arid savannahs in the north, to the cool and sub-humid highlands in the Rift Valley, and to the warm humid zones near the coast (FAO, 2001; Garrity *et al.*, 2012; Dixon, 2014). Temperatures in Eastern Africa are

⁴⁰ Comoros, Djibouti, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Somalia, Uganda, Zambia and Zimbabwe as of 1 October 1 2017.

moderate, with an average annual mean of 23°C, reaching a maximum of 31°C in the low-latitude tropics and a minimum of 2°C in the highlands (FAO, 2017c). On average, the region receives around 1 000 mm of precipitation annually (FAO, 2017a), often following a bimodal rainfall cycle, capable of sustaining plants for 180 to 270 growing days. However, low and variable rainfall patterns characterize the arid and semi-arid zones, with less than 25 plant growing days per year in some areas, while large amounts of rainfall and long growing seasons (>270 days) characterize the eastern seaboard and portions of the highlands (FAO, 2017c). With just under 1100 m³ of total annual renewable water resources per capita – five times less than the global average – the region is considered water stressed (FAO, 2017a). The distribution of water resources per capita across the region, however, is widely uneven, ranging from very low levels in Djibouti, Kenya and Rwanda (300–900 m³ per year), to very high levels in Madagascar (16 000 m³ per year) on average, with heterogeneity within countries (FAO, 2017a). The proportion of water bodies with good ambient water quality is relatively higher than the continental average at 86 percent (FAO, 2017b).

Land cover patterns range from the bare pasture lands of Djibouti and Eritrea in the North, to the dense forestland of Zimbabwe and Madagascar in the South, cultivated lands in Malawi and Rwanda, wetlands in Zambia, and vast areas of grass- and woodlands in between. Agricultural land occupies over half of total land area while forestland covers around one-third and other land around one-fifth. Of agricultural lands, the predominant land cover is grassland (41 percent) followed by cropland (12 percent).⁴¹ Due to low soil fertility and a high degree of erosion, soil health ranges from bare to poor in the northern areas but improves towards the south, while land degradation is moderate across the region with extreme degradation in some areas (FAO, 2017b).

1.2 FARMING SYSTEMS

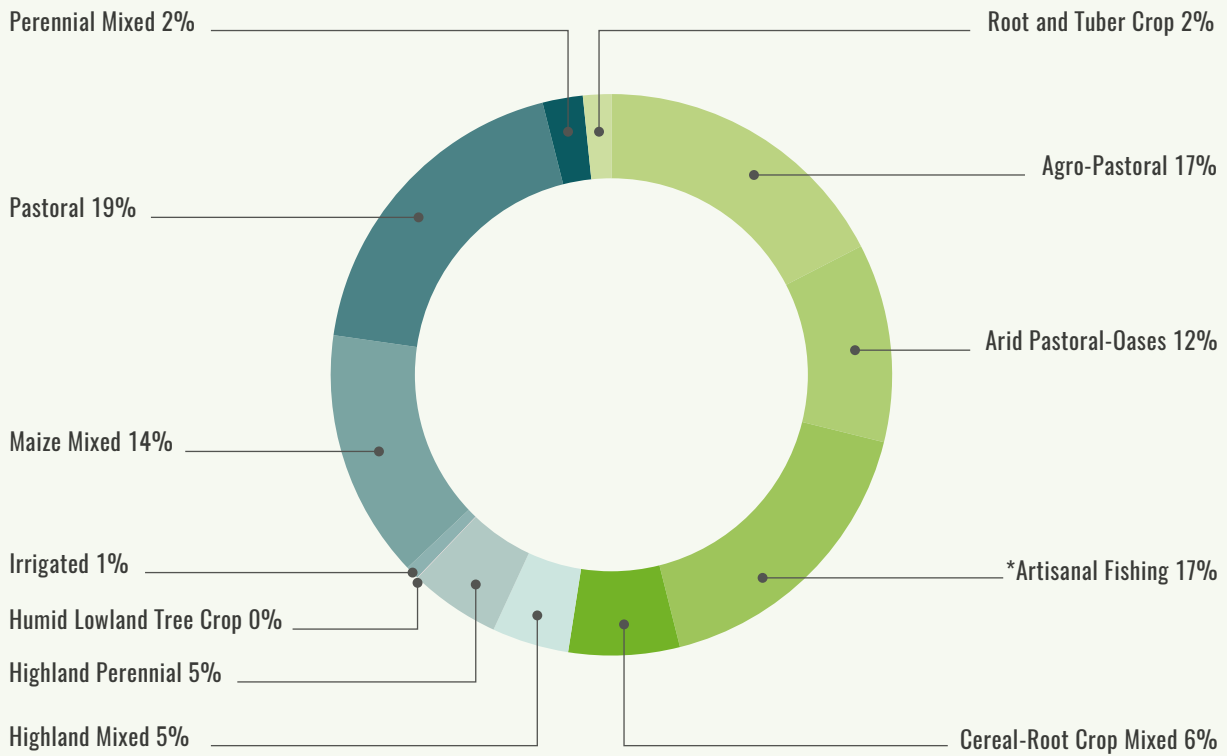
The diversity of the landscape and natural resource base across Eastern Africa gives way to varying farming activities and livelihood patterns, as inextricably linked to the biological, physical, economic and cultural environment in which rural populations live. Based on geo-spatial data of agro-ecological and socio-economic variables, 12 major farming systems were found in Eastern Africa. A farming systems approach (**Figure 15**) provides a way to aggregate farm households that have a similar resource base and livelihood pattern, and comparable constraints and opportunities for mitigating climate change and enhancing resilience (FAO, 2001; Garrity *et al.*, 2012; Dixon, 2014).

Most agricultural production relies on rainfall and spans across the humid, dry and temperate tropics and rangeland subtropics in the region. While rainfed systems in the subtropics and humid tropics are more productive than the other zones, rainfed cropping in the highland areas and dry tropics are often low-yielding and subsistence-based. Drought-resistant cereals, and goats and sheep, dominate the rainfed dry tropics, whereas wheat and cattle production characterizes the rainfed subtropics (FAO, 2011). Smallholder farming prevails across the region, with average farm sizes less than 1.2 hectares (FAO, 2017b).

⁴¹ FAO, 2017b; Land use categories are aggregated in line with IPCC 2006 land categories where cropland refers to arable land and permanent crops; and grassland refers to permanent meadows and pastures.

FIGURE 15.

MAJOR FARMING SYSTEMS IN EASTERN AFRICA, SHARE OF TOTAL AREA

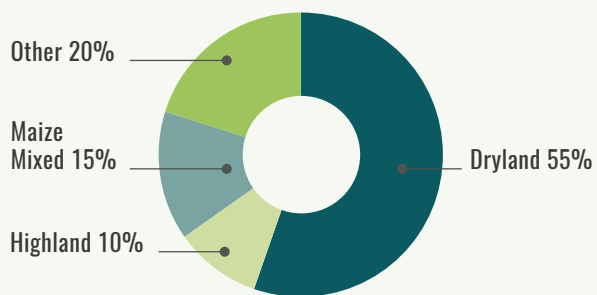


*Artisanal fishing area includes water bodies.

Source: FAO, 2001; Garrity et al. 2012; Dixon, 2014

FIGURE 16.

MAJOR FARMING SYSTEMS, PER BROAD CATEGORY

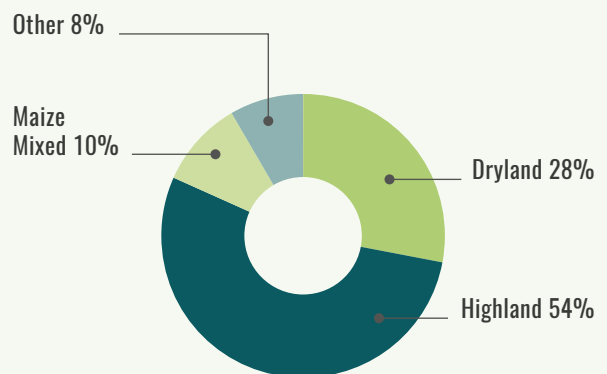


% of agricultural area

Source: FAO, 2001; Garrity et al. 2012; Dixon, 2014

FIGURE 17.

DISTRIBUTION OF CATTLE STOCK, PER MAJOR FARMING SYSTEM



% of total cattle

Source: FAO, 2014b

The major farming systems identified fall into four broad categories (**Figure 15**): Dryland, Highland, Maize Mixed and Other. The dryland farming system (including pastoral, agro-pastoral, arid-pastoral oasis and cereal-root crop mixed) constitutes the largest share of agricultural area (55 percent) (FAO, 2017b) and accounts for roughly half the rural population (47 percent) (GIST, 2017), yet holds less than one-third of total cattle stocks (28 percent) (FAO, 2014b). In the arid and semi-arid regions extending across South Sudan, Somalia, Eritrea, Kenya and Uganda, where the potential for crop growth is limited, extensive livestock grazing systems can transform low productivity vegetation into a source of protein in pastoral systems. The main driver of vulnerability is climatic variability and high incidence of drought (Dixon, 2014). In the semi-arid zones, agro-pastoral systems are characterized by rainfed sorghum, millet and livestock production, where drought, declining soil fertility and animal mortality represent sources of vulnerability (Garrity *et al.*, 2012).

In humid and sub-humid areas, maize mixed farming is the most important food production system, extending across plateau and highland areas from Ethiopia, Kenya and Tanzania to Zambia, Malawi, Zimbabwe, and Madagascar. This system accounts for 15 percent of agricultural area (FAO, 2017b), 17 percent of the rural population (GIST, 2017) and only ten percent of total cattle (FAO, 2014b) in the region, ranging from the more fertile, high population density areas in the highlands to the less fertile areas in Zambia, Mozambique and Tanzania (FAO, 2014b). With declining biomass productivity, monomodal rainfall patterns, and low input use, this system however holds high agricultural growth and poverty reduction potential (Dixon, 2014).

The highland farming system (including perennial and mixed) occupies only ten percent of agricultural area in the region (FAO, 2017b), yet supports 18 percent of the rural population (GIST, 2017) and accounts for the highest share of cattle (**Figure 16**) in the region (54 percent) (FAO, 2014b). Mixed highland systems are mostly found in Ethiopia, where livelihoods

depend on wheat, barley and livestock products, while the perennial crop system is located in Ethiopia, Rwanda, Burundi and Uganda, where banana or enset, coffee, and plantains dominate. While the highland areas host favorable climate and soils, high soil erosion rates are degrading land, and high population densities are reducing farm size, to an average of 0.5 ha per household (Garrity *et al.*, 2012).

1.3 POPULATION AND RURAL ECONOMY

Achieving a sustainable transition to a low-emissions economy will be a challenge in Eastern Africa, as population is projected to increase from nearly 400 million today, to around 550 million in 2030, and up to 1.5 billion in 2100 (UNDESA, 2017). Rapid population growth (2.8 percent per year) (WB, 2017) will likely exacerbate the competition for and degradation of the natural resource base, contribute to an increase in anthropogenic-induced emissions, and as vulnerability to climate change is often linked to the distribution and density of the population, intensify vulnerability to climate-related impacts.

Agriculture drives the rural economy in Eastern Africa, accounting for approximately 25 percent of gross domestic product (GDP) (WB, 2017), 70 percent of employment (ILO, 2017), and five billion USD in food export revenues every year (FAO, 2017b). The share of women in agricultural employment is the highest amongst all other regions in Africa, averaging 73 percent⁴². Within the agriculture sectors, crops offer the highest share of value added to agricultural-GDP (58 percent), followed by livestock (23 percent), cereals (14 percent) and non-food production (5 percent) (FAO, 2017b). Overall, annual GDP growth in Eastern Africa is accelerating compared with global averages (3.4 to 2.6 percent, respectively), yet long-term trends point to the decline in the relative share of agriculture in GDP over time. GDP per capita is much lower than the global

⁴² ILO, 2017; Employment status includes paid and self-employed workers, excluding informal contracts.

average, and slightly higher than averages in least-developed countries, with significant differences between countries (WB, 2017).

1.4 FOOD SECURITY AND NUTRITION

The direct and indirect impacts of climate change on agriculture production systems and forests will most likely exacerbate the current food security and nutrition challenges affecting the most vulnerable and poor populations of Eastern Africa. Understanding the channels by which climate shocks are transmitted will be crucial for reducing vulnerabilities and enhancing coping capacities under climate change. First, in terms of food availability, the average share of energy supply derived from cereals, roots and tubers represents 62 percent, while the average protein supply from animal origin of total protein supply is 21 percent. While animal protein sources are only half of global averages, and slightly below the average for Africa, the role of livestock lies beyond diet, as a productive asset and source of economic security. Second, food access is hindered by high domestic food price volatility, which is greater than the continental average. According to the Global Hunger Index, the region falls within the alarming category and the average prevalence of undernourishment is around one-third of the population (IFPRI, 2017). In terms of food utilization, and as proxies of nutrition deficit, the prevalence of food inadequacy, stunting and wasting average 41, 44, and 8 percent, respectively. Around 65 percent of the rural population enjoys access to improved water resources. Despite relatively low cereal import

dependency, per capita food supply variability is twice that of Africa, contributing to low levels of food stability (FAO, 2017b). Overall, poverty is widespread across the region, with more than 40 percent of the population living in households with consumption or income per person below 1.90 USD per day (WB, 2017).

1.5 GHG EMISSIONS PROFILE

Sixteen out of 18 Eastern Africa countries⁴³ reported national GHG inventories in their National Communications (NC) submitted to the UNFCCC between 1994 and 2013. According to the latest reported inventories, the AFOLU sector represents the most significant share of net emission⁴⁴ in the region (67 percent), followed by the Energy (20 percent), Waste (11 percent) and the Industrial Processes and Product Use (IPPU) sector (2 percent) (**Figure 18**). While the agriculture sector constitutes a source of net annual emissions (0.36 Gt CO₂ eq), the LULUCF sector represents a net sink (-0.11 Gt CO₂ eq), for a combined total of 0.25 Gt CO₂ eq net emissions per year in the AFOLU sector.

Within the AFOLU sector (**Figure 19**),⁴⁵ the GHG sources from agriculture and Land Use, Land Use Change and Forestry (LULUCF) are almost equally distributed, with 49 and 51 percent shares each. Overall, the most significant GHG sources are forest degradation⁴⁶ (25 percent) and grassland biomass burning (19 percent),⁴⁷ with deforestation⁴⁸ and enteric fermentation holding equal shares (14 percent).

⁴³ Somalia and South Sudan did not report a National Communication (NC).

⁴⁴ The result of summing all anthropogenic emission and removals.

⁴⁵ AFOLU-related GHG categories are aggregated in this analysis to accommodate for both the 1996 and 2006 *IPCC guidelines* for reporting adopted by countries in their respective NCs. **Annex 1** illustrates the methodology for capturing national data in common GHG categories and sub-categories that link the 1996 IPCC source/sink categories to the 2006 land use categories, carbon pools and non-CO₂ gases.

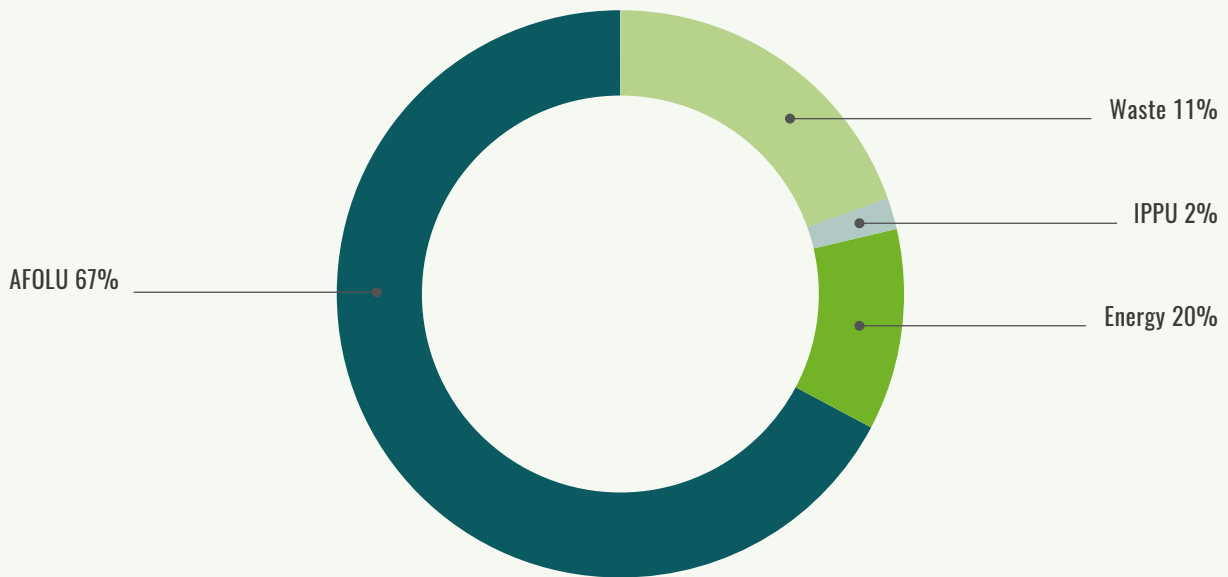
⁴⁶ Forest degradation refers to total GHG net emissions from 2006 IPCC land use category "Forest land remaining forest land" and 1996 GHGI category "Changes in forest and other woody biomass" when those categories are a net source at the national level.

⁴⁷ Burning biomass on grassland refers to total GHG net emissions from 2006 IPCC land use sub-category "Biomass burning" and to 1996 GHGI category "Prescribed burning of savannas".

⁴⁸ Deforestation refers to total GHG net emissions from 2006 land use category "Forest land converted to other use" and 1996 IPCC GHGI category "Forest and grassland conversion".

FIGURE 18.

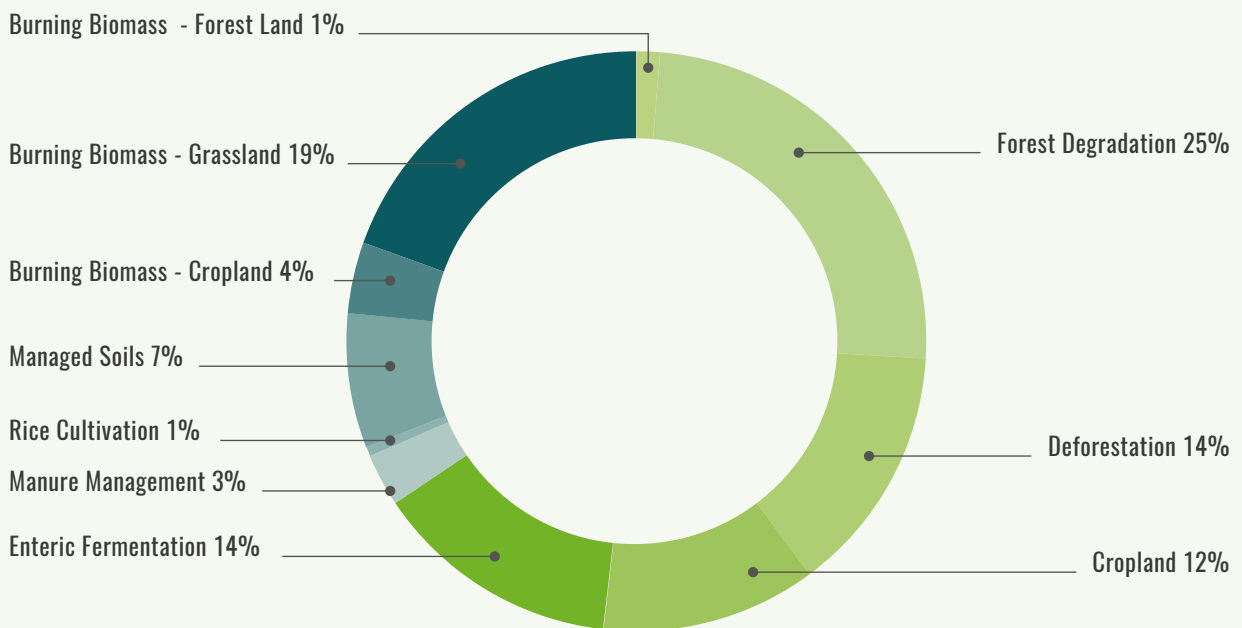
REGIONAL GHG NET EMISSIONS, PER SECTOR



Source: Countries' National Communication (NC), excluding Somalia and South Sudan whom did not report a NC

FIGURE 19.

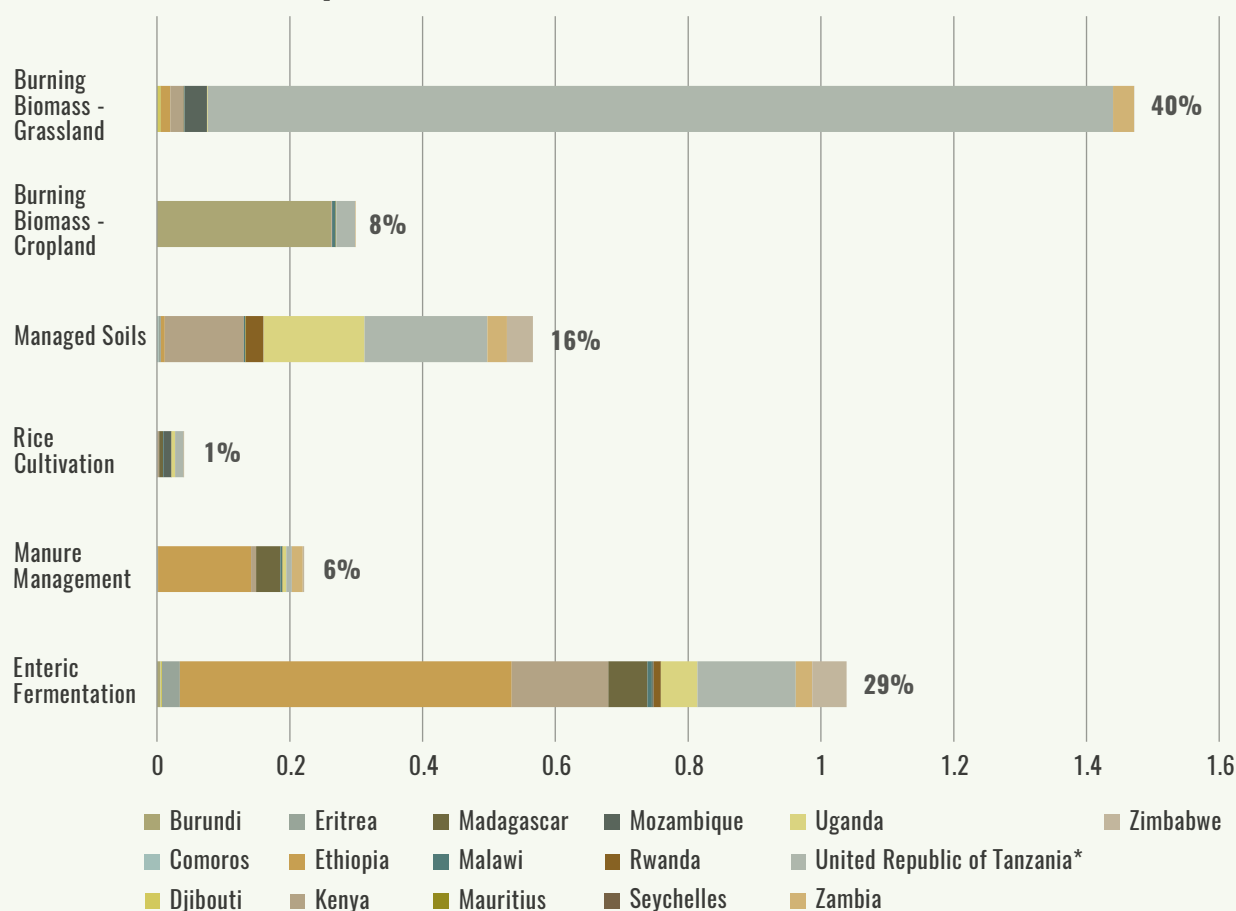
SHARE OF REGIONAL EMISSIONS AMONGST SOURCES IN THE AFOLU SECTOR



Source: NC

FIGURE 20.

NATIONAL EMISSIONS AMONGST SOURCE CATEGORIES IN THE AGRICULTURE SECTOR

Net emissions per year, Gt CO₂ eq

*Activity data value under burning grassland in the NC of United Republic of Tanzania contains high uncertainty.

Source: NC

Within the agriculture sector (Figure 20), the largest sources of emissions are grassland biomass burning (40 percent),⁴⁹ enteric fermentation (29 percent) and non-CO₂ emissions from managed soils (16 percent), followed by cropland biomass burning (8 percent), manure management (6 percent) and rice cultivation (1 percent). At the national level, however, the distribution of emission sources (Annex 2) varies. For instance, in Ethiopia,

enteric fermentation constitutes 76 percent of total emissions, while in Uganda, managed soils hold a 69 percent share of total agricultural emissions.

Overall, the LULUCF sector constitutes a net sink at the regional level, constituted mainly by forest management⁵⁰ (65 percent) and afforestation⁵¹ (31 percent). However, aggregated country data suggests that forest degradation⁵² is the highest source of LULUCF emissions (48

⁴⁹ Burning biomass on grassland refers to total GHG net emissions from 2006 IPCC land use sub-category "Biomass burning" under land use category "Grassland" and to 1996 NGHGI category "Prescribed burning of savannas".

⁵⁰ Forest management accounts for total net emissions related to 2006 IPCC land use category "Forest land remaining forest land" and 1996 GHGI category "Changes in forest and other woody biomass," when those categories are a net sink at national level.

⁵¹ Afforestation accounts for total net emissions related to 2006 IPCC land use category "Land converted to forest land" and 1996 GHGI category "Abandonment of managed lands".

⁵² Forest degradation refers to total GHG emissions from 2006 IPCC land use category "Forest land remaining forest land" and 1996 GHGI category "Changes in forest and other woody biomass" when a net source at the national level.

percent), while deforestation⁵³ and cropland account for around one-third of the total (27 and 23 percent, respectively).

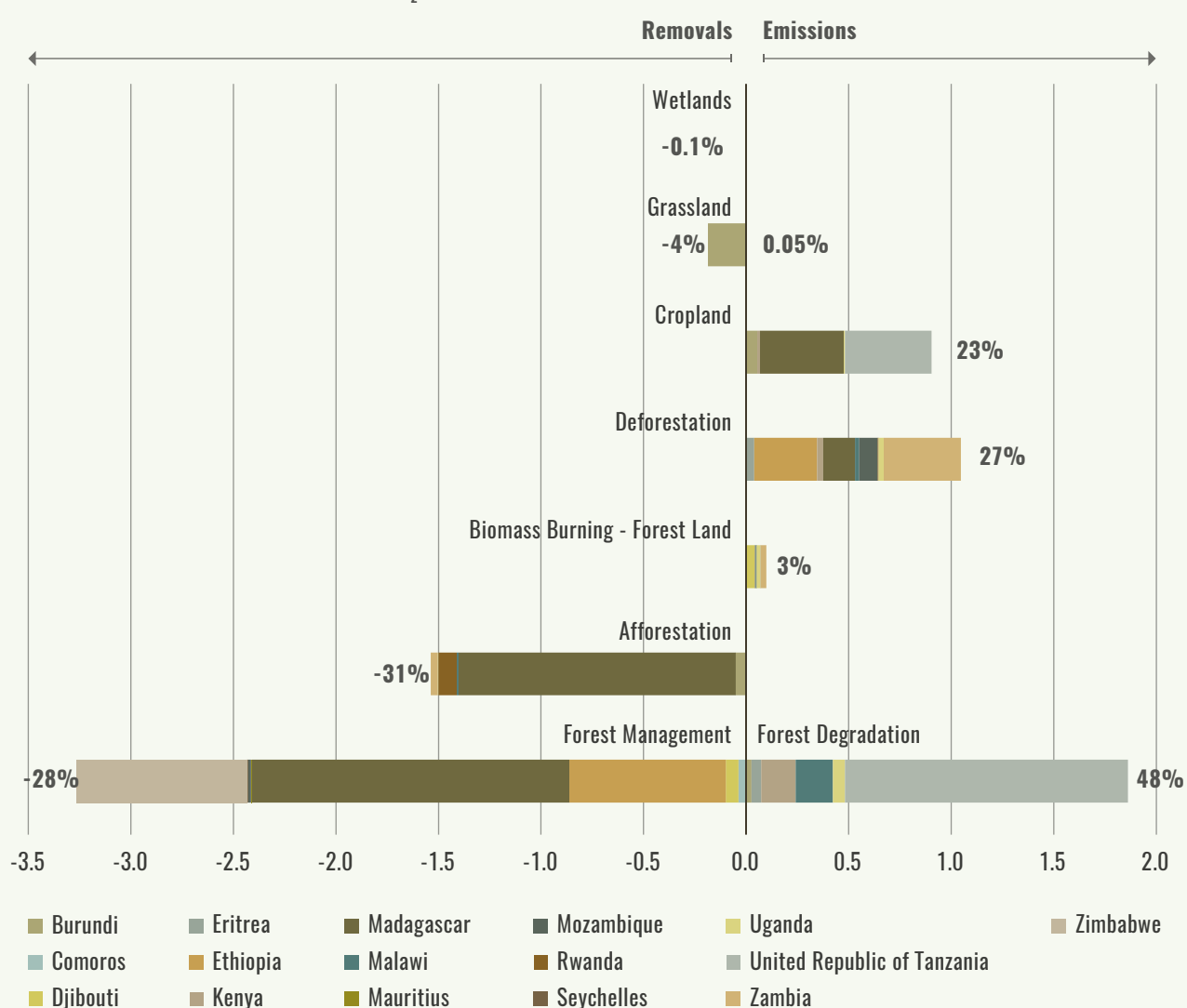
At the national level, however, sources of net emissions and sinks (Annex 3-4) vary according to forest cover and energy consumption trends. For example, deforestation constitutes all sectoral net emissions in Comoros, Ethiopia,

Mozambique and Rwanda, whereas forest degradation practices are responsible for almost 90 percent of emissions in Malawi. On the other hand, forest management contributes to all removals in Zimbabwe, while afforestation accounts for all removals in Malawi, Uganda and Zambia.

FIGURE 21.

NATIONAL EMISSIONS AND REMOVALS FROM THE LULUCF SECTOR

Emissions and removals per year, Gt CO₂ eq



Source: NC

⁵³ Deforestation refers to total GHG net emissions from 1996 IPCC GHGI category "Forest and grassland conversion" and 2006 land use category "Forest land converted to other use".

PART 2

REGIONAL MITIGATION AND ADAPTATION CONTRIBUTIONS IN THE AGRICULTURE SECTORS

In Eastern Africa, all 18 countries of the region communicated their contributions towards GHG net emission reductions through their respective NDC. Although the adaptation component was not a mandatory part of the NDC, all countries also seized the opportunity to highlight national circumstances, goals and visions towards adaptation. The following section provides a synthesis of the mitigation and adaptation contributions of the East African countries in the agriculture sectors. Based entirely on the countries' NDCs, it reflects the heterogeneous nature of these commitments but also tries to identify regional trends. Indeed, while the format and specific content of the initial NDCs was left largely for countries to decide, these documents lay out a country's vision that will guide climate action for the coming years. It is widely recognized, however, that many of the mitigation options and adaptation scenarios

identified by countries have significant barriers to adoption and scalability.

2.1 MITIGATION CONTRIBUTION

2.1.1 Economy-wide mitigation contribution

Fifteen out of 18 (83 percent) East African countries set a national economy-wide GHG mitigation target for 2030, while the three remaining countries⁵⁴ base their mitigation contribution on “actions only,” with an implementation period varying from 10 to 15 years (**Figure 22**). All 15 countries that set an economy-wide GHG target project a baseline of future net emissions under a business as usual

⁵⁴ Rwanda, Somalia and South Sudan.

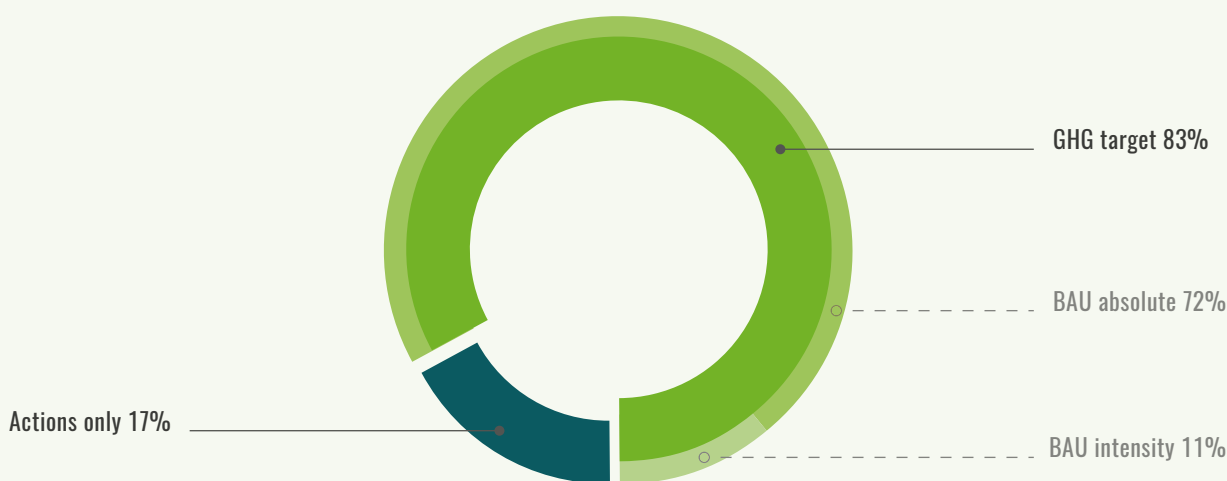
(BAU) scenario. Thirteen of those 15 countries express their target as an absolute net reduction compared with the baseline, while the other two express their target as a reduction in the intensity of per capita net emissions.

The mitigation contributions pledged by the East African countries in their NDCs cover

the Energy, LULUCF, Waste, Agriculture and Industrial Processes and Product Use (IPPU) sectors (**Figure 23**). Thirteen⁵⁵ and 15⁵⁶ countries include the agriculture and/or LULUCF sectors in their overall mitigation contribution.

FIGURE 22.

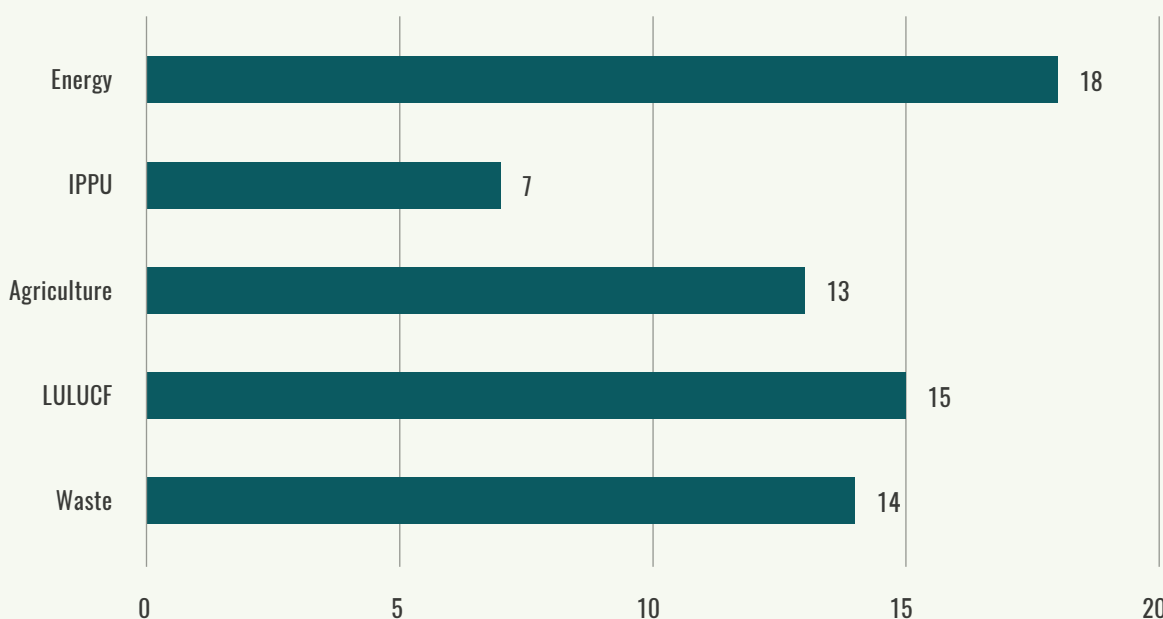
COVERAGE OF ECONOMY-WIDE MITIGATION CONTRIBUTION



Source: NDC

FIGURE 23.

SECTORS COVERED IN OVERALL MITIGATION CONTRIBUTION



Source: NDC

⁵⁵ Mozambique, Seychelles, South Sudan, United Republic of Tanzania and Zimbabwe do not include the agriculture sector in overall mitigation contribution.

⁵⁶ Djibouti, Seychelles and Zimbabwe do not include the LULUCF sector in overall mitigation contribution.

The cumulated mitigation costs reported by the region⁵⁷ for NDC implementation is estimated to be approximately 163 billion USD,⁵⁸ and the average cost per unit of economy-wide emission reduction, as compared with the baseline value, is roughly 95 USD per CO₂ eq.⁵⁹

2.1.2 Mitigation contribution in the agriculture sectors

Out of the 13 countries (Figure 24)⁶⁰ that include agriculture in their overall mitigation contribution, four (24 percent)⁶¹ set a sectorial GHG target – expressed as either an absolute net emission reduction compared with a base year or BAU, or as a reduction in the intensity of net emissions per capita compared with a base year.

The remaining nine countries include policies and measures (P&Ms) for mitigation in the agriculture sector.

Out of the 15 countries (Figure 25)⁶² including the LULUCF sector in their overall contribution, five (28 percent)⁶³ set sectorial GHG targets – expressed as an absolute net emission reduction compared with a BAU. The remaining ten countries include P&Ms for mitigation in the LULUCF sector. Table 1 illustrates the quantified GHG targets, expressed as a cumulated net reduction in 2030, in the agriculture and LULUCF sectors associated with mitigation actions, including combinations of conservation agriculture, reforestation, forest protection and agroforestry.

TABLE 1.

CUMULATED NET REDUCTION FROM GHG SECTORIAL TARGETS FOR AGRICULTURE AND LULUCF

	AGRICULTURE	LULUCF
	kt CO ₂ eq	
COMOROS	-85	-298
MADAGASCAR	-12,708	-415,816
ETHIOPIA	-620,108	-392,588
MALAWI	-2,868	-90,287
UGANDA	--	-165,568

⁵⁷ All countries excluding Malawi, Mozambique and Rwanda whom did not report costs.

⁵⁸ Mitigation costs account for an average 50 percent share of total costs reported in NDCs.

⁵⁹ Value corresponds to the highest end of the global marginal abatement cost (Global GHG Abatement Cost Curve v2.0, McKinsey and Company, 2009).

⁶⁰ Mozambique, Seychelles, South Sudan, United Republic of Tanzania and Zimbabwe do not include the agriculture sector in overall mitigation contribution.

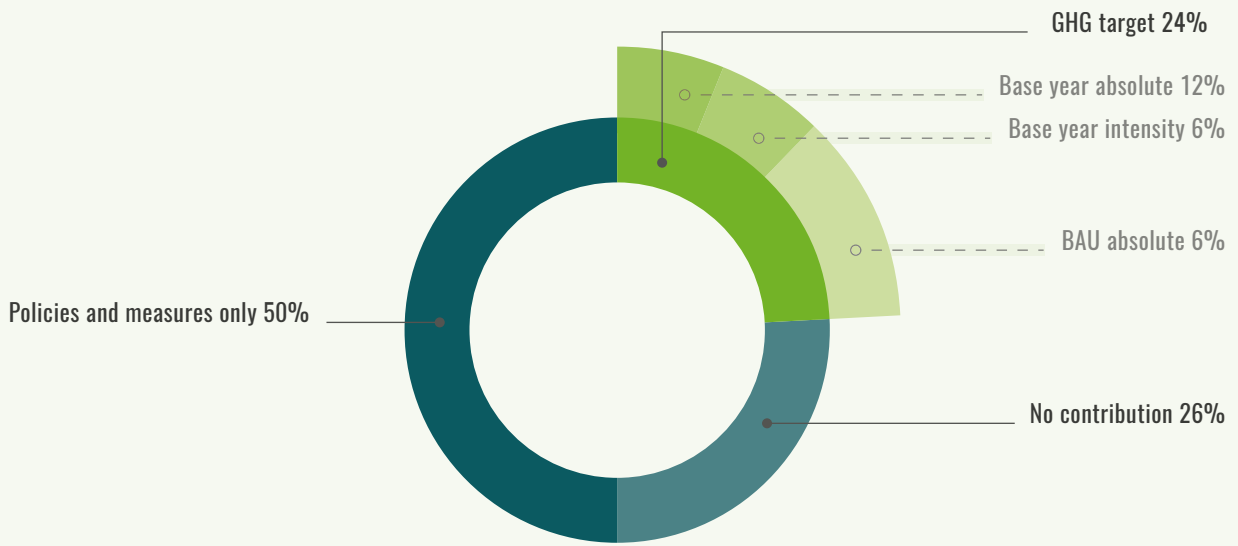
⁶¹ Comoros, Madagascar, Ethiopia, and Malawi.

⁶² Djibouti, Seychelles and Zimbabwe do not include the LULUCF sector in overall mitigation contribution.

⁶³ Comoros, Madagascar, Ethiopia, Malawi, and Uganda

FIGURE 24.

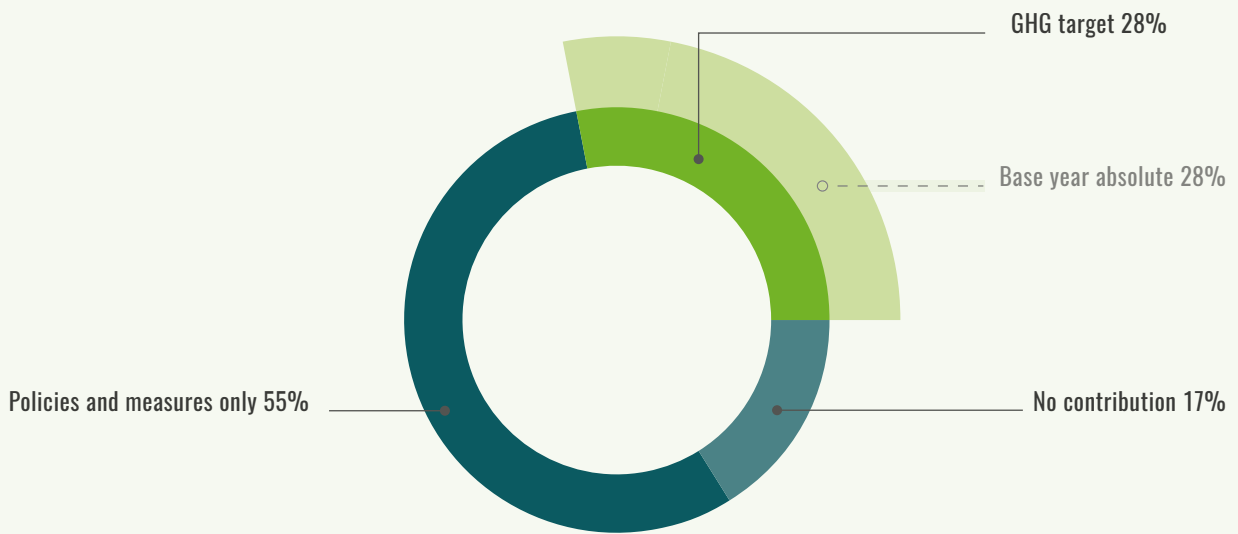
COVERAGE OF MITIGATION CONTRIBUTION IN THE AGRICULTURE SECTOR



Source: NDC

FIGURE 25.

COVERAGE OF MITIGATION CONTRIBUTION IN THE LULUCF SECTOR



Source: NDC

2.1.3 Policies and measures in the agriculture sectors

In addition to the economy-wide and sectorial targets set by countries in their NDCs, the P&Ms identified range by type of activity and land use management, and are often cross-sectoral. This section provides an overview of the P&Ms included by countries to either avoid emission and/or enhance removals in the Agriculture and LULUCF sectors, further sorted by activity or land use management.⁶⁴ The methodological matrix for how the P&Ms are categorized in relation to GHG source and sink categories can be found in [Annex 5](#).

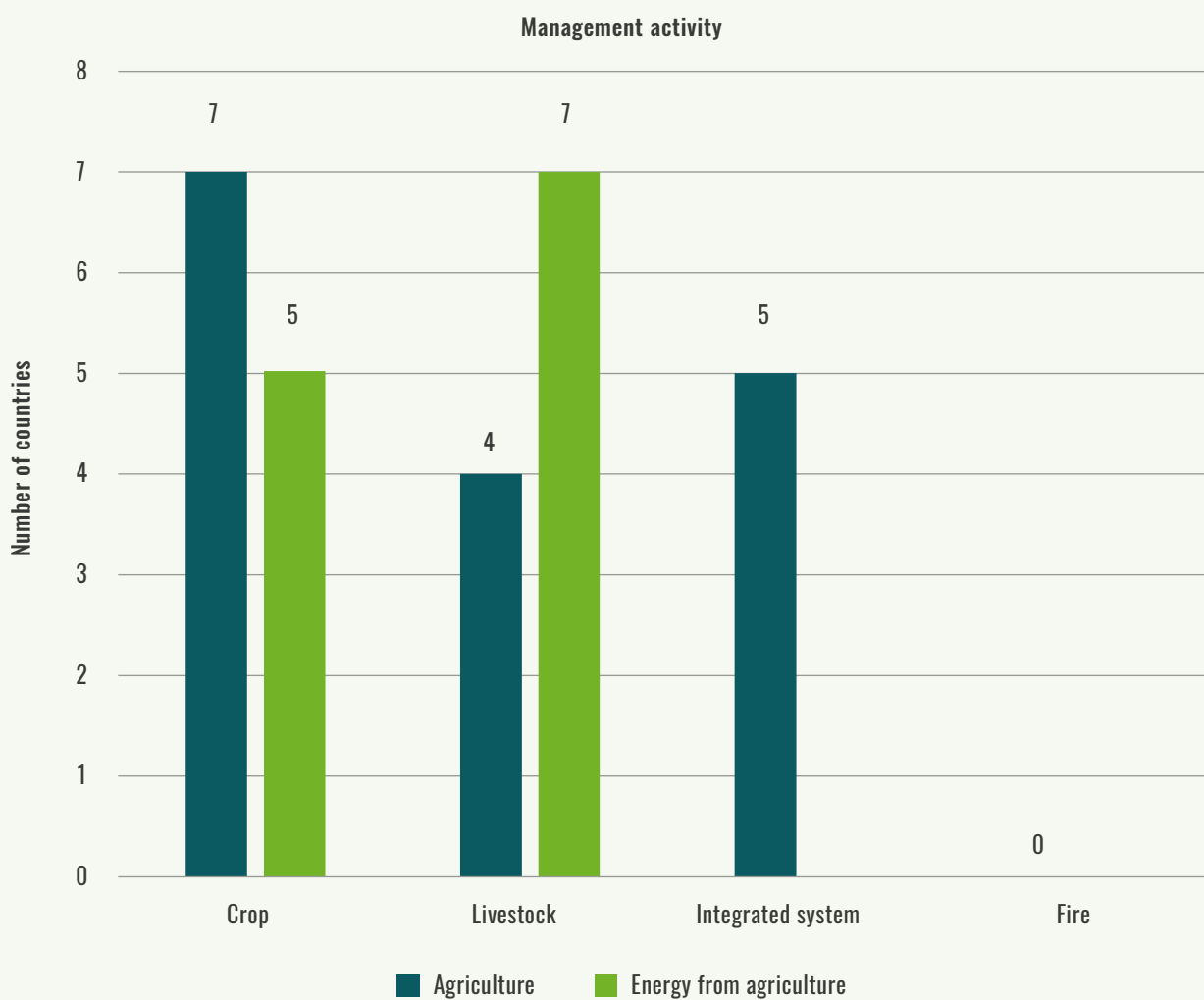
2.1.3.1 Policies and measures in the agricultur sector

P&Ms identified by countries in the agriculture sector illustrated in [Figure 26](#) are aggregated into the following four main management activities: 1) crop; 2) livestock; 3) integrated system; and 4) fire.⁶⁵

In addition to the P&Ms compiled below, around one-third⁶⁶ of countries include CSA as a mitigation strategy.

FIGURE 26.

COUNTRIES WITH POLICIES AND MEASURES IN THE AGRICULTURE SECTOR, PER MANAGEMENT ACTIVITY



⁶⁴ Categories contain similar management practices aiming to reduce net emissions from respective GHG source and sink categories, in line with 1996 and 2006 IPCC GHG source and sink categories.

⁶⁵ Fire management includes reduced biomass burning on crop and grassland.

⁶⁶ Kenya, Madagascar, Malawi, Mauritius, Uganda and Zambia

CROP MANAGEMENT

Seven countries⁶⁷ refer to crop management to reduce their GHG emissions in the agriculture sector, mainly in addressing soil management on cropland,⁶⁸ fertilizer use,⁶⁹ and rice cultivation.⁷⁰

For instance, Ethiopia commits to improving crop production practices in general for greater food security and higher farmer incomes while reducing agricultural emissions. Other countries, such as Comoros and Madagascar, target emissions from managed soils and cropland through conservation agriculture.

Uganda more precisely notes that agricultural soils represent the source of 36 percent of its agricultural GHG profile, setting a baseline and target, aiming to reduce emissions from managed soils by approximately 2 700 kt CO₂ eq per year by 2030.

Malawi plans to upscale the dissemination of climate resilient agronomic practices to cover over 10 percent of current cropland area, including application of organic amendments to enhance soil organic carbon levels; planting nitrogen-fixing plants to reduce fertilizer usage; optimize fertilizer application; and reduce or implement no tillage. As a result, reduced synthetic fertilizer application is estimated to contribute to a net emission reduction of 100 kt CO₂ eq by 2030. Burundi

also provides a non-GHG target, calling for the progressive substitution of mineral for organic fertilizers by 2030.

Finally, Burundi and Madagascar promote intermittent drainage in rice cultivation and the large-scale dissemination of intensive and/or improved rice farming techniques, respectively.

LIVESTOCK MANAGEMENT

Four countries⁷¹ include mitigation options to reduce the emissions associated with livestock production through improved feeding and breeding, other long-term animal management, and manure management practices.

Ethiopia aims to reduce emissions from enteric fermentation through improved feeding and breeding practices, while Malawi also includes veterinary practices and sustainable livestock intensification. On the other hand, Djibouti more generally recognizes the importance of addressing enteric fermentation sources. Uganda, instead, underlines the need for livestock breeding research.

While Djibouti, Malawi and Uganda generically aim to improve their manure management practices, seven countries⁷² target manure management emissions through the promotion of biogas production.

⁶⁷ Burundi, Comoros, Djibouti, Ethiopia, Madagascar, Malawi and Uganda.

⁶⁸ Comoros, Ethiopia, Madagascar, Malawi, Djibouti and Uganda.

⁶⁹ Burundi and Malawi.

⁷⁰ Burundi and Madagascar.

⁷¹ Djibouti, Ethiopia, Malawi and Uganda.

⁷² Burundi, Comoros, Eritrea, Rwanda, Somalia, Zambia and Zimbabwe.

BOX 1: ENERGY FROM AGRICULTURE

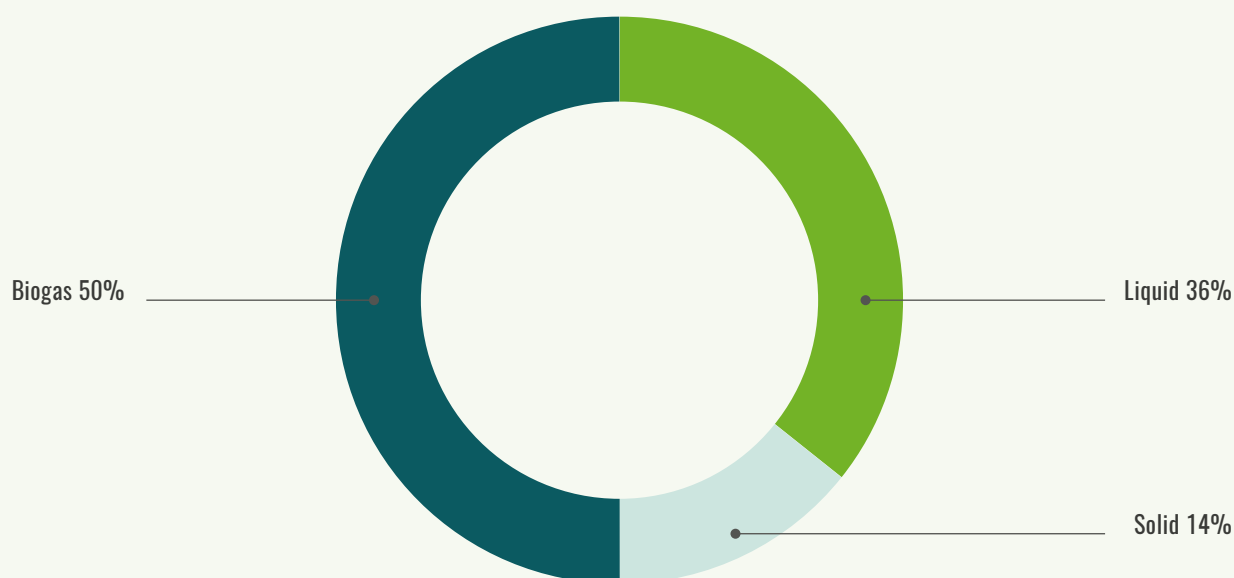
The box presents the share of countries with P&Ms aiming to increase energy production from agricultural biomass, with potential mitigation co-benefits in the agriculture and energy sector. While the mitigation potential of bioenergy production in the agriculture sector depends on the potential increase of carbon stock mainly in above- and below-ground biomass and/or avoided emissions from manure through biogas production, the mitigation benefits of bioenergy use are more significant in the energy sector via displacement of fossil fuel use for biomass. On the other hand, increased biofuel production may drive AFOLU-related emissions through the conversion of vegetation types from higher to lower long-term average carbon stock and

increased fertilizer input use. While biogas production may reduce manure inputs to agricultural soils, the consequent reduction of soil organic carbon may drive increased use of synthetic fertilizers. The present analysis does not assess the full impact of bioenergy use on the net balance of economy-wide emissions nor on sectorial emissions. Lastly, potential food security and nutrition costs of increased biofuel production were not acknowledged in the NDCs of the region.

Overall, ten East African countries⁷³ report P&Ms that aim to promote energy production from agriculture in their NDCs through either one or multiple measures (**Figure 27**).

FIGURE 27.

SHARE OF COUNTRIES WITH POLICIES AND MEASURES ON ENERGY PRODUCTION FROM AGRICULTURAL BIOMASS, BY FUEL TYPE



Seven countries promote biogas production, as either a non-GHG or GHG target. For instance, Rwanda aims to install 35 000 household biogas digesters and 15 institutional biogas digesters annually, while Zimbabwe calls for 1 250 institutional biogas digesters by 2030. On the other hand, Eritrea and Comoros set emissions reduction targets for 2030: -45.10 kt CO₂ eq per year from biogas on rural farm respectively and -5.5 kt CO₂ eq per year by from composting and biogas production.

Five countries refer to a liquid biofuel blending mandate for transport, electricity generation, lighting and cooking purposes. For example, Malawi aims to produce

2 (unconditional) to 20 (conditional) million litres (ML) of biodiesel annually and 18 (unconditional) to 40 ML (conditional) of ethanol by 2030. Mozambique intends to implement its biofuel policy, producing biofuel from cassava, *jatropha*, sugar cane, coconut and beet root. Seychelles plans to increase biofuels through import regulation; Zambia aims to introduce and increase blending of bio-fuels with fossil fuels, and switch from diesel to biodiesel. Zimbabwe plans to reduce its emissions by 0.2Mt CO₂-eq per year in 2030, by blending ethanol into conventional gasoline for a cost of 100 million USD.

⁷³ Burundi, Comoros, Eritrea, Malawi, Mozambique, Rwanda, Somalia, Seychelles, Zambia and Zimbabwe.

Five countries support the development of bioenergy but do not specify the type of feedstock.⁷⁴

Finally, two countries⁷⁵ also include P&Ms that target the production of energy from solid biofuel from agricultural biomass, such as briquettes, pellets and carbonization.

However, since the biomass source for bioenergy is an alternative to fuel wood, solid biofuel P&Ms are accounted for as mitigation actions on forest land, as per the substitution effect.

INTEGRATED SYSTEMS MANAGEMENT

Five countries⁷⁶ aim to optimize land use by diversifying agriculture production systems. Burundi aims to establish agroforestry on sloped land, while Malawi promotes agroforestry in targeted locations for enhancing soil organic carbon. Djibouti, Comoros and Madagascar allocate a specific number of hectares to be dedicated to agroforestry systems, while Comoros also includes an associated GHG target.

FIRE MANAGEMENT

Fire management practices aiming to reduce biomass burning of crop residues and/or savannas are not included in any of the mitigation contributions of the Eastern Africa region.

2.1.3.2 Policies and measures in the LULUCF sector

All 18 countries of the East African region identify mitigation P&Ms in the LULUCF sector. P&Ms identified by countries in the LULUCF sector illustrated in **Figure 28** are aggregated into the following six areas of land use management: 1) reducing deforestation/ forest conservation; 2) sustainable forest management (SFM)/reducing degradation; 3) afforestation/ reforestation; 4) cropland; 5) grassland; and 6) wetlands. In addition, ten countries⁷⁷ also refer specifically to Reducing Emissions from Deforestation and Forest Degradation and Conservation of Forest (REDD+) either as a framework for NDC implementation, monitoring emissions or accessing climate finance.

REDUCING DEFORESTATION/ FOREST CONSERVATION

Eight countries⁷⁸ plan to reduce deforestation and/or conserve forests to reduce net emissions in the LULUCF sector.

In general, countries aim to reduce deforestation by setting aside forest land for conservation or as an indirect consequence of another policy or measure, such as more sustainable forest management.

For instance, the United Republic of Tanzania, Uganda, Ethiopia and Malawi promote conservation through non-GHG targets, pledging to protect and conserve existing forests and catchments, as well as to promote non-extractive livelihoods. For instance, South Sudan aims to increase the area of conservation for natural forests by 20 percent.

Few countries include GHG targets aiming to enhance forest conservation. Malawi proposes to unconditionally increase protected areas with an estimated mitigation potential of -4 800 kt CO₂ eq by 2030, while Comoros calls to establish 5 000 hectares of protected areas by 2030, equating to a conditional cumulated net emissions reduction of 45.8 kt CO₂eq in 2030

SUSTAINABLE FOREST MANAGEMENT/REDUCING DEGRADATION

While the majority of P&Ms aim to reduce forest degradation through more sustainable bioenergy production and use, nine countries⁷⁹ include general commitments to enhance SFM practices. Only Zambia and Madagascar include P&Ms aiming to reduce forest degradation by controlling forest fire in their NDCs.

⁷⁴ Burundi, Mauritius, United Republic of Tanzania, Uganda and Zambia.

⁷⁵ Burundi and Malawi.

⁷⁶ Burundi, Comoros, Djibouti, Madagascar and Malawi.

⁷⁷ Burundi, Madagascar, Malawi, Mozambique, Rwanda, South Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

⁷⁸ Comoros, Ethiopia, Madagascar, Malawi, Somalia, South Sudan, Uganda and United Republic of Tanzania

⁷⁹ Burundi, Ethiopia, Madagascar, Malawi, Somalia, Uganda, United Republic of Tanzania, Zambia and Zimbabwe.

FIGURE 28.

NUMBER OF COUNTRIES WITH POLICIES AND MEASURES IN THE LULUCF SECTOR, PER LAND USE MANAGEMENT



Source: NDC

BOX 2: ENERGY FROM FORESTS

The box presents the distribution of policies and measures aiming to increase the sustainable production and use of bioenergy from forest biomass, with potential mitigation co-benefits in the LULUCF and energy sector. While the substitution of fossil fuels with forest biomass may offset emissions in the energy sector, the increased demand of biomass can reduce carbon stocks on forest land. On the other hand, an increase in the efficiency of charcoal production, as well as in the use of woodfuel and charcoal, may preserve forest stocks and sinks. However, the present analysis does not assess the impact of bioenergy use on the net balance of economy-wide emissions nor the net impact of fuelwood production on forest land-related emissions.

Overall, 15 East African countries (Figure 29)⁸⁰ aim to simultaneously reduce emissions from forest degradation while increasing the efficiency of traditional biomass use.

Mitigation actions proposed include sustainable woodfuel plantations, efficient charcoal production and energy-efficient cook-stoves.

Fifteen countries aim to improve the efficiency of either wood or charcoal cookstoves. Djibouti, Rwanda, Somalia, Zambia, Madagascar and Uganda set non-GHG targets aiming to improve the efficiency and distribution of wood and charcoal stoves. Rwanda, for instance, commits to covering 100 percent of household needs with efficient cookstoves, while Madagascar targets 50 percent.

On the other hand, Eritrea and Ethiopia include both GHG targets associated with more efficient cookstoves initiatives, with estimated net emission reductions in the order of 500 kt CO₂ eq per year and 35 000 kt CO₂ eq by 2030, respectively.

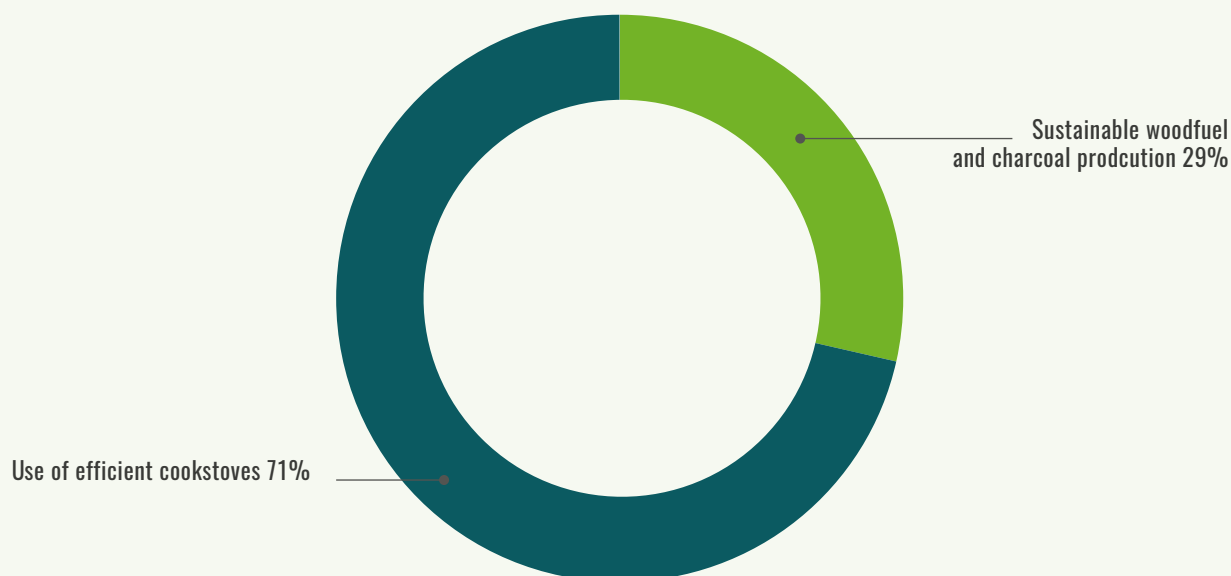
⁸⁰ Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Rwanda, Somalia, South Sudan, Uganda, Zambia.

More specifically, Burundi, Eritrea and Zambia aim to improve the efficiency of charcoal kilns. Rwanda aims to increase average charcoal yields by 50 percent as well as reduce GHG emissions by 5 700 kt CO₂ eq through the sustainable intensification of the charcoal value chain by

2030. Somalia, too, aims to reduce unsustainable charcoal production through a mix of legal instruments, energy plantations, alternative livelihood options, reforestation and afforestation for land rehabilitation, as well as production of charcoal from the invasive species *Prosopis juliflora*.

FIGURE 29.

SHARE OF COUNTRIES WITH POLICIES AND MEASURES ON ENERGY PRODUCTION AND USE FROM FOREST BIOMASS



Source: NDC

AFFORESTATION/REFORESTATION

Thirteen countries⁸¹ include afforestation/ reforestation P&Ms aiming to increase removals by sinks in the LULUCF sector. In general, mitigation options build upon existing national policies, while some countries set forth new targets in terms of hectares to be reforested, kt CO₂ eq to be removed or trees to be planted. For instance, Uganda aims to increase forest cover to 21 percent by 2030, while Comoros estimates a GHG target of -78 kt CO₂ eq associated with an increase of 12 000 hectares of forest cover.

CROPLAND MANAGEMENT

Overall, cropland management practices are not included by any of the East African countries as a mitigation option.

GRASSLAND MANAGEMENT

Overall, grassland management practices are not included by any of the East African countries as a mitigation option.

WETLANDS MANAGEMENT

Only Uganda includes a P&M addressing wetlands, aiming to expand current wetland area by 2 percent by 2030 through demarcation, gazettement and restoration of degraded wetlands.

⁸¹ Burundi, Comoros, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Somalia, South Sudan, Uganda, United Republic of Tanzania and Zambia.

2.2 ADAPTATION CONTRIBUTION

This chapter presents a synthesis of the adaptation contributions relevant to the agriculture and LULUCF sectors in Eastern Africa as featured in the adaptation component of NDCs submitted to the UNFCCC by 18 countries. The number of countries referring to a given practice is cited in parentheses. All countries in the region include adaptation in their NDC and cover adaptation priorities⁸² in the agriculture and LULUCF sectors.

2.2.1 Climate-related hazards, impacts and associated vulnerabilities in the agriculture sectors

2.2.1.1 Climate vulnerability assessment

Eleven countries make reference to existing climate vulnerability assessments to inform the NDCs, of which some of these were conducted by national and international institutions, often as part of the initial and subsequent NC to the UNFCCC, National Adaptation Plan (NAP) or international development support programs. For instance, the Mozambican *Instituto Nacional de Gestão das Calamidades* and the Zimbabwe Vulnerability Assessment Committee played a key role in the elaboration of climate change impact studies. Another example is evidenced by the climate vulnerability analysis conducted by Burundi, which was conducted as part of the Climate Change Adaptation for Soil and Water Resources Conservation (ACCES) project.

2.2.1.2 Climate-related hazards

Most of the East African countries report observed and projected changes in climate variables, namely variations in mean annual and seasonal land surface air temperature (14 countries) and precipitation intensity and variability of rainfall regimes (15) (**Table 2**). The delay and unpredictability of rainfall onset and subsequent extension of the dry season, dry

spells frequencies, and rainfall intensity are reported to have worsened.

For instance, reference is made to meteorological observations and climate modelling that confirm changes in climate parameters over the last 40 to 50 years, while providing future projections for the next century. For instance, Uganda reports that mean annual temperatures have risen by 1.3 °C and annual and seasonal rainfall has decreased significantly since 1960. Climate projections developed for the country using the models of the IPCC Fifth Assessment Report (IPCC AR5) indicate an increase in near-surface temperature for the country in the order of +2 °C in the next 50 years under Representative Concentration Pathway (RCP) 4.5; and in the order of +2.5 °C for the same time period, under RCP 8.5. These models also predict a slight decrease in total annual rainfall in most of the country. In Zambia, recent climate trends based on records from 1960 to 2003 indicate that mean annual temperature has increased by 1.3 °C, since 1960, an average rate of 0.34 °C per decade; while mean rainfall over the country has decreased by an average rate of 1.9 mm per month (2.3 percent) per decade since 1960. Future trends point towards a higher average temperature, a possible decrease in total rainfall, and some indication of heavy events of rainfall. Similarly, Rwanda has experienced a temperature increase of 1.4 °C since 1970, and expects an increase in temperature of up to 2.0 °C by the 2030s compared with the 1970s average. In Madagascar, the trend of temperature rise continues to be that observed from the 1950s in the south while gradually shifting towards the northern part of the island. Temperature projections for the next 50 years foresee this upward trend to continue. Seventeen countries of Eastern Africa expressed their concern with regard to the impacts and frequency in the occurrence of droughts and floods.

All the Small Island Developing States in the Region (Seychelles, Mauritius and Comoros) underscore the challenges deriving from sea level rise and associated receding of the

⁸² **Annex 6-7** contains definitions and coverage of of adaptation priorities in the NDCs.

shoreline and coastal erosion (3 countries), and flooding of low lying coastal lands, estuaries, deltas, and salt marshes are also mentioned (2). Increasing sea surface temperature (2) is a risk, which is likely to result in dinoflagellate algae blooms and higher fish mortality rates.

Ocean acidification (2) and the negative impact on marine ecosystems are reported. These climate-related risks and slow onset events threaten other coastal countries (Djibouti, Eritrea, Madagascar, Mozambique and Somalia).

TABLE 2.

CLIMATE-RELATED HAZARDS AND RISKS

	CLIMATE-RELATED HAZARDS AND RISKS	NUMBER OF COUNTRIES	PROPORTION OF COUNTRIES
OBSERVED/PROJECTED CHANGES IN METEOROLOGICAL VARIABLES	CHANGES IN TEMPERATURE	14	78%
	CHANGES IN PRECIPITATION INTENSITY AND PATTERN	15	83%
OBSERVED/PROJECTED CLIMATOLOGICAL, HYDROLOGICAL AND CLIMATE-RELATED HAZARDS	STORMS (HAILSTORMS, RAINSTORMS)	7	39%
	CYCLONE	6	33%
	DROUGHTS	17	94%
	FLOODS	17	94%
	WILD FIRE	1	6%
	PESTS AND DISEASES	5	28%
OBSERVED/PROJECTED CLIMATE-RELATED RISKS AND SLOW ONSET EVENT	DESERTIFICATION	3	17%
	SOIL EROSION	7	39%
	SEA-LEVEL RISE*	7	64%
	INCREASE SEA SURFACE T*	5	45%
	OCEAN ACIDIFICATION*	2	18%
	COASTAL EROSION*	5	28%
	ICE-MELTING	0	0%

Source: NDC Note: The categories with the asterisks exclude land-locked countries, therefore the proportion is calculated over 11 countries.

2.2.1.3 Drivers of economic, social, environmental vulnerability in agriculture systems and rural livelihoods

Eleven countries underscore that climate change vulnerabilities can be exacerbated by economic dependence on agriculture sectors, particularly reliance on climate sensitive natural resources and environmental goods and services. In addition, countries stress the sensitivity of current crop production systems that are dominated by rain-fed, subsistence agriculture. In addition, rural populations have a high dependence on the exploitation of natural resources, including forests, for the extraction

of non-wood forest products and fuelwood as the main source of energy. Poverty and low human development (9 countries) is also one of the main drivers of climate vulnerability. In addition, climate change is expected to interact with other pre-existing non-climatic stress factors, such as geographical characteristics and location, topography and land use (8). The degree of exposure of people, livelihoods, ecosystems, natural resources, infrastructure, or economic and social assets to climate change is an issue of concern. For instance, Seychelles, Mauritius and Djibouti highlight that coastal communities and their livelihoods are concentrated in low lying coastal lands, estuaries and deltas that are

at high risk of flooding from heavy rainfall by sea level rise and storm surges. In Rwanda, an average of 90 percent of the cropland is located on slopes, which range from 5 to 50 percent, making the farming systems vulnerable to soil erosion and permanent fertility loss. Concerns are raised over the increased occurrence and severity of natural disasters that exacerbate environmental and natural resource management challenges, where agricultural systems are already under threat from poor land management; degraded natural resources; presence of large number of livestock; inability of land to capture and retain rainfall; and unregulated, uncontrolled and illegal fishing (6).

2.2.1.4 Observed and projected vulnerabilities in the agriculture sectors

VULNERABILITIES IN CROPS AND LIVESTOCK SYSTEMS

Fifteen countries report on observed effects of past and recent climate trends, as well as projected impacts on the crop and livestock productive assets and traditional rural livelihoods systems, whose stability is often highly dependent on climate in most countries. Some countries quantify the decrease in crop production for selected crops. In Zimbabwe, the availability of its staple crop, maize, is expected to be significantly impacted, as yields are expected to decrease by up to 30 percent in 2030. The area suitable for maize production is projected to further decrease by 2080. Climate change also threatens the existence of livestock, as well as the livelihoods of pastoralist communities due to the loss of pasture lands and reduced access to water resources. South Sudan, for example, has the among the largest livestock populations in Africa and therefore suffers increased vulnerability under climate change.

VULNERABILITIES IN FORESTRY, TERRESTRIAL, FRESHWATER AND MARINE AGRO-ECOSYSTEMS

Thirteen countries discuss observed and projected climate-related impacts on ground and shallow water reservoirs, rivers and lakes, depletion and drying of water bodies, deterioration of water quality and siltation of waterways.

Countries express their concerns related to climate-related effects on land use, land use change and forest resources (9 countries), impinging on soil erosion and loss of fertility, degradation of cultivated areas and pastureland, reduction of net primary productivity and carrying capacity. Climate change is also likely to affect ecosystems and biodiversity (10), which provide critical services to rural, periurban and communities. Countries expressed the concern that environmental degradation associated with climate-related risks are likely to affect both marine and terrestrial ecosystems, their habitats, structure and functions; as well as the shift in geographical range of species, genetic erosion and extinction of endemic species. Furthermore, the damaging consequences on fish nesting and fishing grounds are likely to distress fisheries and aquaculture production (7).

ECONOMIC AND SOCIO-ECONOMIC VULNERABILITY

As expressed in the NDCs, it is likely that climate change will exacerbate already present vulnerabilities concerning poverty and inequality (8 countries), food insecurity and malnutrition (9), while result in negative outcomes for human health due to outbreak of diseases, particularly malaria and toll on human lives (15). Countries report on recently recorded and projected damage to settlement and socio-economic infrastructures (13). Current climate variability has already led to economic costs and losses of a magnitude that affected the developing and least developed countries' GDP. It is stated that financial losses from climate variability combined with longer-term impacts from climate change and extreme weather events can reduce the medium- and long-term economic growth and national welfare of countries. For instance, an empirical economic assessment of impacts of climate change on agriculture in Zambia (Jain, 2007) estimated GDP loss in the range of 2.2–3.13 billion USD over a 10–20 year mid-term time horizon due to low agriculture productivity and its associated effects on poverty levels.

TABLE 3.

OBSERVED AND PROJECTED CLIMATE CHANGE IMPACTS AND VULNERABLE SECTORS

	DRIVERS AND IMPACTS	NUMBER OF COUNTRIES	PROPORTION OF COUNTRIES
DRIVERS OF CC VULNERABILITY (SOCIAL, ECONOMIC AND ENVIRONMENTAL)	ECONOMIC DEPENDENCE ON AGRICULTURE SECTORS	11	61%
	POPULATION DENSITY OR GROWTH	5	28%
	POVERTY AND LOW HUMAN DEVELOPMENT	9	50%
	TOPOGRAPHY, LAND USE	8	44%
	ENVIRONMENTAL MANAGEMENT, NRM	6	33%
OBSERVED/PROJECTED VULNERABILITIES	POVERTY AND INEQUALITY	8	44%
	FOOD INSECURITY /MALNUTRITION	9	50%
	HUMAN HEALTH & LIFE INCIDENCE	15	83%
	SOCIAL AND POLITICAL CONFLICTS	3	17%
	MIGRATION, DISPLACEMENT	4	22%
	HUMAN SETTLEMENT AND INFRASTRUCTURE	13	72%
	CROP AND LIVESTOCK PRODUCTIVE ASSETS AND LIVELIHOODS	15	83%
	LULUCF/ FOREST RESOURCES	9	50%
	FISHERIES AND AQUACULTURE	7	39%
	WATER RESOURCES	13	72%
	BIODIVERSITY, MARINE AND TERRESTRIAL ECOSYSTEMS AND THEIR SERVICES	10	56%
	GENDER IN RELATION TO VULNERABILITIES	2	11%

Source: NDC

2.2.2 Adaptation goals, policies and plans

While countries stress that adaptation in the agricultural sectors is a national priority, their commitments towards resilience are in general intertwined with the Sustainable Development Goals (SDGs), and in particular Goal 2, end hunger, achieve food security and improved nutrition and promote sustainable agriculture, as well as Goal 13, take urgent action to combat climate change and its impacts. All countries reiterate their political will and aims towards adaptation, which are enshrined in their existing national and sectorial adaptation strategies, action plans and policies. There is a strong commitment towards mainstreaming adaptation into sectorial, national and regional development planning processes. The national determined adaptation actions and contributions to respond to climate change are those identified as part

of the previous and ongoing adaptation-related mechanisms and processes under the Convention. Countries stress that the National Adaptation Plan of Action (NAPA), latest UNFCCC National Communications, NAP, and Technology Needs Assessment (TNA) provide a more exhaustive status of their adaptation current and intended adaptation interventions and associated needs.

2.2.3 Adaptation priorities and actions in the agriculture sectors

All countries promote investment and planning to enhance the resilience of crop and livestock production systems to observed and expected climatological, hydrological hazards, risks and slow onset events. Countries aim to increase agricultural production and productivity as well as develop sustainable production systems than

can re-establish food self-sufficiency in the short- and medium-term.

2.2.3.1 Sectorial and post-harvest adaptation measures

CROP AND CROPLAND MANAGEMENT

Priority adaptation measures that emerge from the NDCs include breeding and promotion of stress tolerant crop varieties, conservation and use of germplasm for crop land races and their wild relatives with traits that allow sustaining plant growth during extreme weather events (9 countries) (**Figure 30-31**). In Zambia, the promotion of crop land races of cassava, maize, sorghum, finger millet, beans, cowpea and their wild relatives is a key strategy for improved agricultural production and diversification. The approach is associated with practices for efficient use of fertilizer, increased soil fertility and conservation, and improved agro-biodiversity conservation. In Ethiopia, the focus is on making available improved crop varieties, agroforestry, harvesting adjustments and distribution of disease resistant crop varieties to deal with crop and plant diseases and pests. Uganda expresses the importance of expanding research on climate resilient crops and their diversification. Improved pest (4), nutrient (5) and on-farm soil management (7) allow a shift towards sustainable and climate resilient systems that can feed the rural population notwithstanding climate change challenges. Mauritius communicates strong commitment towards the

development of an integrated strategy and policy to foster the adoption of Integrated Pest and Disease Management (IPDM) practices, including the review of policy and regulatory framework to facilitate the upscaling of IPDM technology and regulate the use and disposal of pesticides. All countries refer to cross-cutting crop management practices that range from CSA and conservation agriculture (CA) to agroforestry. These practices are either to be promoted over the short and medium-terms or recognized to already be largely fostered.

Nine countries refer specifically to CSA,⁸³ three to CA⁸⁴ and three to agro-ecology.⁸⁵ Regarding agro-ecology, Burundi aims to develop an agro-ecological approach (soil fertility management practices, use of manure and compost, development of agroforestry, and water and soil conservation), while Rwanda plans to mainstream agro-ecological techniques using spatial plant stacking as in agroforestry, kitchen gardens, nutrient recycling, and water conservation to maximize sustainable food production. Other references to cross-cutting crop management practices include: ecological farming and the increase in vegetation cover (Ethiopia); the development of ecosystem-based adaptation (Madagascar); the development of climate resilient agronomic practices (Malawi); crop diversification (Uganda); sustainable agro-forest-based adaptation; and management practices and sustainable intensification (Zimbabwe).

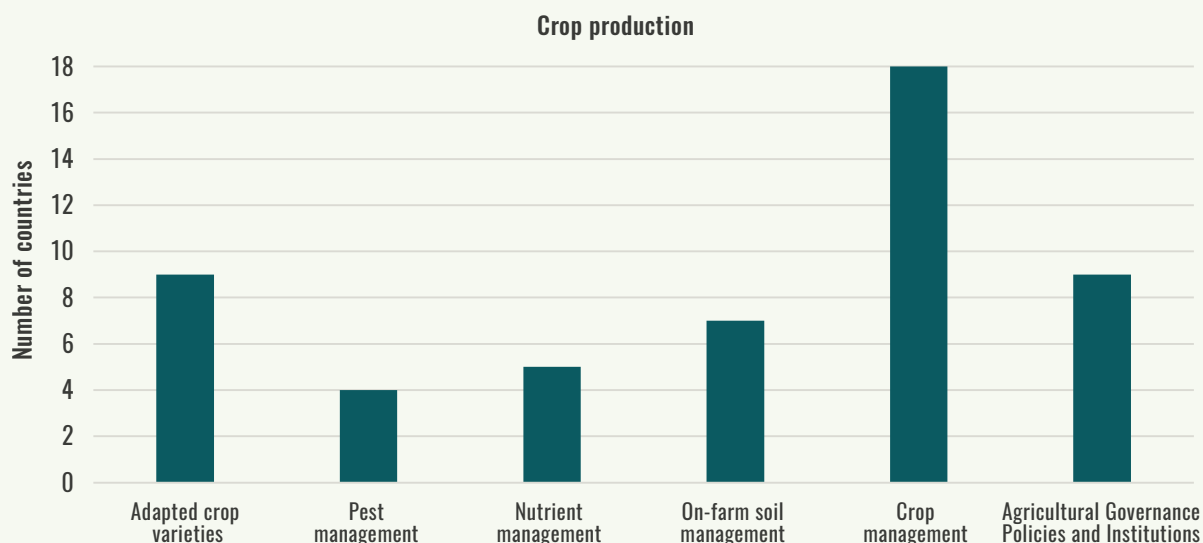
⁸³ Eritrea, Kenya, Mauritius, Seychelles, South Sudan, Uganda, Tanzania, Zambia, and Zimbabwe.

⁸⁴ Eritrea, Comoros and Malawi.

⁸⁵ Burundi, Comoros and Rwanda.

FIGURE 30.

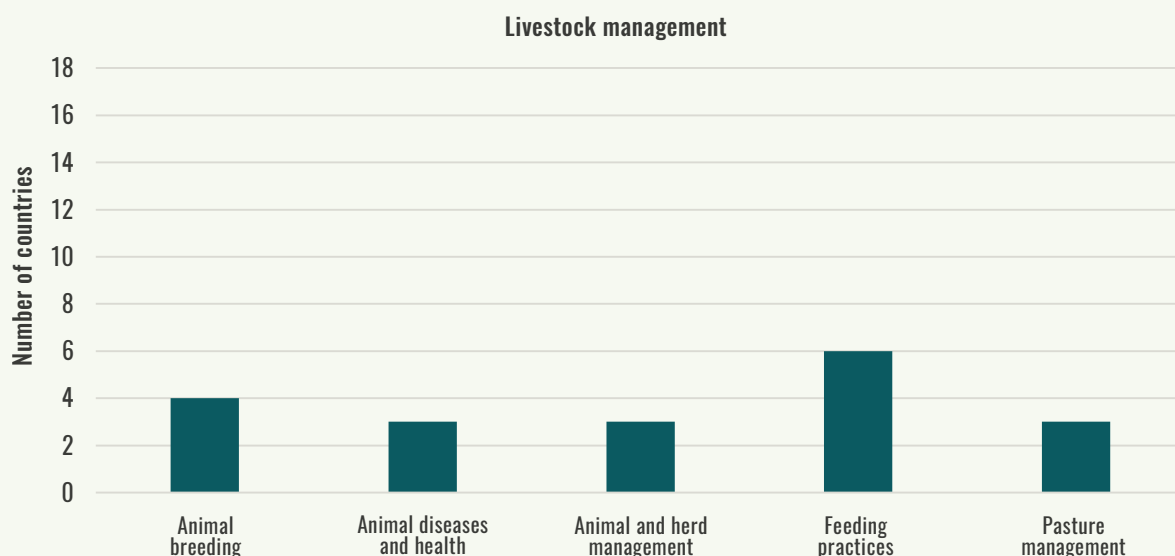
MAIN ONGOING AND PLANNED ADAPTATION ACTIONS FOR THE CROP SECTOR



Source: NDC

FIGURE 31.

ADAPTATION ACTIONS IN THE LIVESTOCK SECTOR



Source: NDC

LIVESTOCK AND PASTURE MANAGEMENT

The most common actions for increased livestock productivity and adaptive capacity of pastoralists and their systems are: animal breeding (9 countries), including the use of drought-tolerant breeds; animal feeding (3 countries) and pasture and range management (6 countries). In Djibouti, strengthened resilience of pastoral populations in the coastal areas is based on investment in animal health,

development of agro-pastoral perimeters, increased security of pastoral systems and reinforcement of pastoral communities' livelihoods through income diversification. Zambia aims to increase livestock productivity and system resilience through improved feed management, improved animal health and use of drought-tolerant breeds. In Ethiopia, animal breeding and distribution of disease resistant fodder varieties are promoted to deal with the

emergence and expansion of diseases and pests. Eritrea specifies that over 750 000 hectares should be dedicated to the creation of newly enclosed areas for grass regeneration.

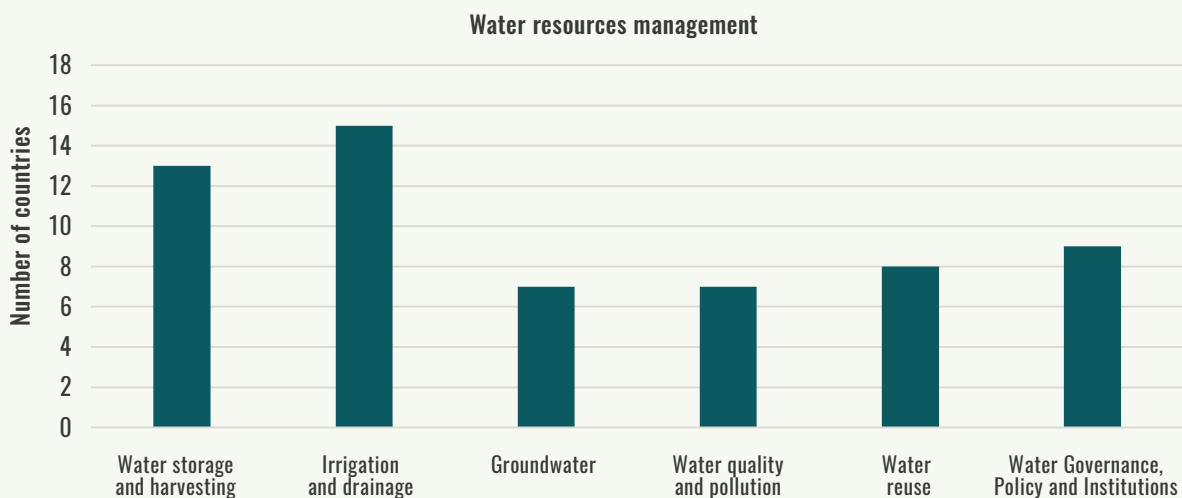
WATER RESOURCE MANAGEMENT

Water can be a scarce and critical resource in the region, thus sustaining agricultural production requires investment to protect water bodies (rivers, springs, aquifers) and to provide access to safe water supply during climate change extreme events. Water resources protection, harvesting and storage is often needed to reduce vulnerability during dry season water shortages. This can often be a matter of survival, as for the case of pastoralist communities in Somalia, where water sources reduce significantly during the dry season and force communities to travel far to reach alternative sources. Several

countries indicate that the provision of water for agricultural and domestic use can be guaranteed through the construction and rehabilitation of small to large-scale water harvesting, capture and storage infrastructures (13 countries), irrigation and drainage systems (15), including check-dams to protect flood-prone areas and restock water. Management of existing systems or expanding and development of new ones are accompanied by water efficiency and conservation practices.⁸⁶ Groundwater development and management facilities, such as dug wells, boreholes, watering points are also mentioned by seven countries. There is recognition that deep and shallow water aquifers should be accessed on the basis of ad-hoc understanding of downstream hydrological impacts (Somalia).

FIGURE 32.

MAIN ONGOING AND PLANNED ADAPTATION ACTIONS FOR THE WATER RESOURCE MANAGEMENT



Source: NDC

Priority adaptation measures that emerge from the NDCs include practices for water treatment, reuse and recycling (8 countries), maintain water quality and reduce water pollution (7). Most countries intends to develop and implement a comprehensive water governance approach (9), often using participatory and community based decision making for the management of water at farm, watershed and river basin levels.

Also institutional strengthening for formulation and implementation of national, regional and community level climate resilient water resources management (WRM) policies, strategies and plans are prioritized. Equitable distribution and access systems are important to reduce conflicts over scarce resources through coordinated oversight and understanding of water availability and quality at national and international levels.

⁸⁶ Rwanda, Uganda, Ethiopia, Burundi, Malawi and Zimbabwe.

LAND, FOREST AND OTHER LAND-BASED ECOSYSTEM MANAGEMENT

Investments for land management and protection (15 countries) land rehabilitation and restoration (7) are significantly linked to the goal of maintaining a strong natural resource base and ecosystem services (**Figure 33–34**). The shift towards a sustainable land management (SLM) approach of rangelands, forests and areas with agricultural potential allow providing the rural population with sustainable grazing, forestry products and agriculturally productive areas while increasing resilience to climate change. In some cases, this is performed at watershed level.⁸⁷ Countries mention a broad range of practices under the SLM approach aimed at reducing soil erosion, biomass burning, decreasing encroachment on sensitive areas, preventing and reversing land degradation.

Forest-based adaptation is a priority given the reliance of the rural population on forest resources and ecosystem services. There is recognition of the importance of adjusting forest management practices to maintain and enhance the full range of productive capacity, social, environmental and economic benefits (9 countries); maintaining forest health and vitality to withstand disturbance and reduce the incidence and impact of pests and epidemics (2); preventing and managing fire (4); engaging in forest restoration (6 countries); and afforestation and reforestation (11) by using drought tolerant and fast growing tree species, indigenous and introduced suitable tree species.

Several countries mention the importance of protecting, conserving and restoring

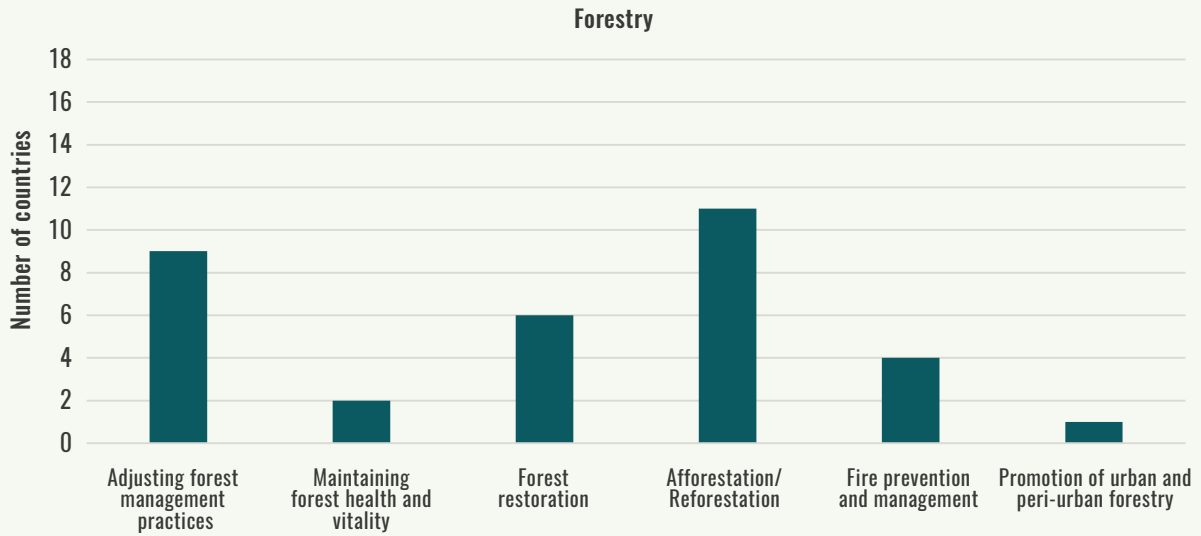
other important terrestrial and freshwater ecosystems (13 countries) and their biodiversity (14), including wetlands (4), mangroves (5), rangelands and grasslands (5). Actions include the expansion and improved management of protected areas, animal and plant corridors, climate refuge areas, habitat connectivity and maintenance of optimal wildlife population sizes based on reserve carrying capacity. In the Sudd of South Sudan, the largest designated Ramsar wetland, is pivotal in regulating the weather patterns in the Sahel, the Horn of Africa and the greater Eastern Africa region. The Sudd acts as a barrier to the southward encroachment of the Sahara desert and its preservation and management is expected to be South Sudan's most significant contribution toward buffering against the impacts of climate change at the regional level.

In 11 countries, forest and land governance is part of an integrated adaptation strategy to build foresters, farmers and pastoralists adaptive capacity. It consists of different practices such as communities engagement in the formulation of local and district land use management and spatial planning (Mozambique, Seychelles, Somalia, Rwanda), land registration and land tenure reform (Rwanda), enforcement of environmental regulations (South Sudan), and establishment of mechanisms to ensure equitable sharing of benefits accrued from the forest and wildlife resources (South Sudan, Zambia).

⁸⁷ Eritrea, Burundi, Somalia, Zambia, Uganda, South Sudan and Djibouti.

FIGURE 33.

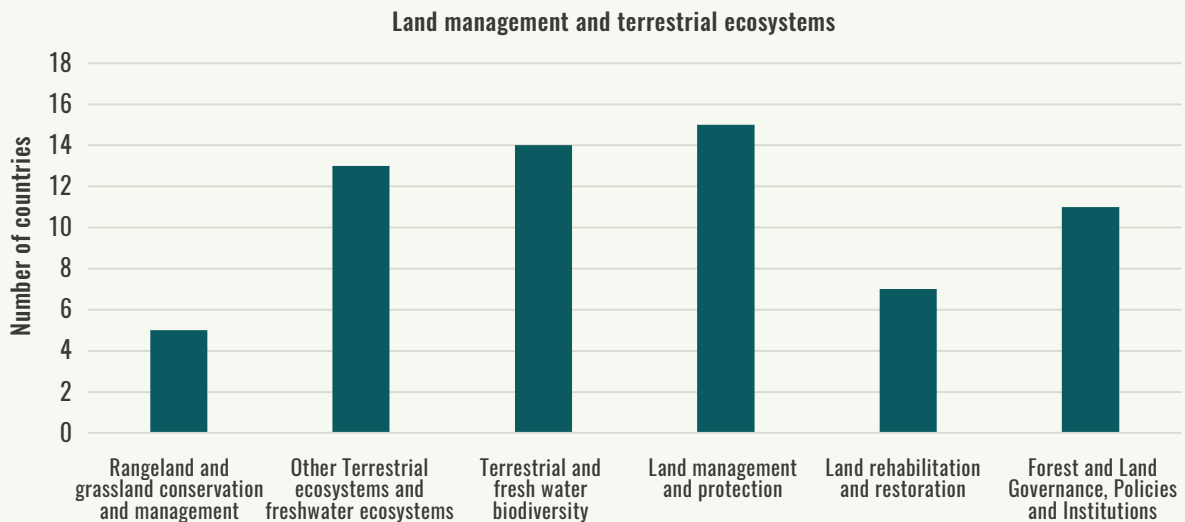
MAIN ONGOING AND PLANNED ADAPTATION ACTIONS FOR MANAGEMENT OF FORESTS



Source: NDC

FIGURE 34.

MAIN ONGOING AND PLANNED ADAPTATION ACTIONS FOR MANAGEMENT OF THE LAND AND OTHER ECOSYSTEMS



Source: NDC

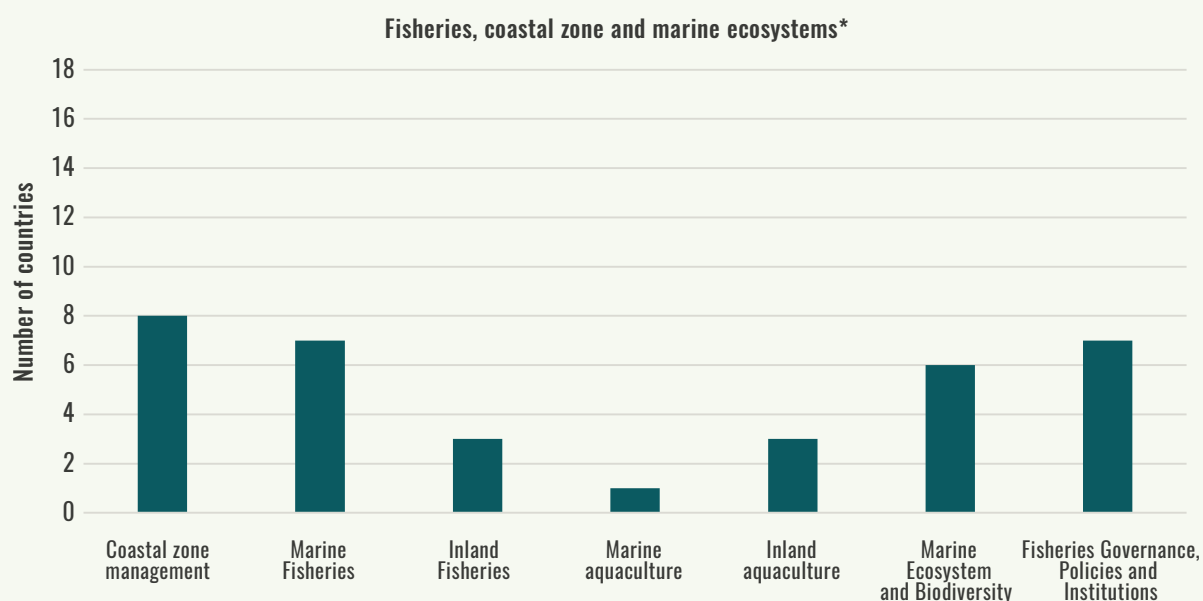
FISHERIES, COASTAL ZONE AND MARINE ECOSYSTEM MANAGEMENT

Mainstreaming of adaptation into development policies and initiatives while fostering the protection and sustainable exploitation of Eastern Africa’s marine ecosystems and biodiversity (6 countries), coastal resources (8), marine (7) and inland fisheries (3) aim at building resilience (Figure 35). Priority adaptation measures that emerge from the

NDCs include: scientific research on the impacts of climate change on industrial and artisanal fisheries to guide adaptation strategies (Seychelles); expansion of protected area network for the rehabilitation of sea-grass and coral reef (Mauritius), as well as generation of revenue through the development of ecotourism activities (Djibouti); protection of fish spawning and breeding sites (Malawi); and aquaculture and fish farming to buffer food security and improve

the climate resilience of fishing-dependent communities (Malawi). Some of the coastal countries expressed specific needs to enhance coastal zone management, as for the case of mangrove and shoreline restoration, sea level rise control systems, saltwater inundation and intrusion control (Tanzania), or rehabilitation

of mangroves for coastal protection against tides and erosion (Djibouti). Development and enforcement of policy measures and legal frameworks for integrated coastal and fisheries resources management is also a priority for seven countries.

FIGURE 35.
MAIN ONGOING AND PLANNED ADAPTATION ACTIONS FOR THE MANAGEMENT OF FISHERIES, COASTAL ZONES AND MARINE ECOSYSTEMS


Source: NDC

*Coastal zone management, marine fisheries, marine aquaculture and marine ecosystem and biodiversity adaptation measures are not relevant to the seven land-locked countries.

POST-HARVEST HANDLING, PROCESSING AND MARKETING

The focus on food production supply and agriculture value chains is strategic, not only to reduce post-harvest losses, store food and feed in productive years and secure food supply in case of extreme weather events, but also to add value to agricultural products and transform subsistence farming into profitable market agriculture and meet the national market demand for food, while reducing regionally and internationally imported food products (7 countries). Burundi, Comoros, Ethiopia and Seychelles are interested in receiving technical support in the field of food processing and the improvement of traditional methods of

food and feed storage, whereas Uganda cites post-harvest handling and storage and access to markets, as a priority adaptation action in its NDC. Zimbabwe recognizes its insufficient capacity for grain storage facilities as a barrier to adaptation. Furthermore, Rwanda intends to expand local markets by constructing climate-proofed market facilities, road and transport networks, and decentralized village-based agricultural processing centers with biogas-digesters, compost plants, warehouse powered by solar energy and solar driers. The country aims to strengthen local markets and group based organizations involved in agriculture production and agro-processing facilities with the objective of tripling their actual production

capacity of 400 000 tonnes. Another target is to grant all farmers access to post-harvest services and storage of food crops to reduce current post-harvest losses of maize, beans and rice from 10 percent, 28 percent and 8 percent, respectively, to at least 1 percent by 2030.

2.2.3.2 Cross-sectorial adaptation measures

This section covers adaptation measures that are relevant to all the agricultural sectors, and often also to other sectors.

DISASTER RISK REDUCTION AND MANAGEMENT

Considering disaster risk reduction (DRR) and management (DRM) as an integral part of climate change adaptation, all East African countries refer to measures that contribute to DRR/DRM efforts. The section below presents an overview of the DRM/DRR measures for the agricultural sectors (10 countries), as put forward by the countries in the adaptation component of their NDCs. For the purpose of clarity, the analysis is structured along the four priorities for action defined by the Sendai Framework for Disaster Risk Reduction 2015–2030.

Sendai Framework Priority 1: Understanding disaster risk

Fourteen countries mention activities that contribute to the understanding of disaster risk. For instance, both Rwanda and Seychelles, recognize that specific risk and vulnerability assessments are key to understanding climate change impacts and to improve planning and implementation of relevant adaptation actions. Hazard zone and vulnerability mapping for natural hazards is one of the priorities for Rwanda, Somalia and Uganda. Comoros underlines the need for capacity building and technology transfers in the area of Geographic Information Systems (GIS) and satellite imagery for risk assessments.

Sendai Framework Priority 2: Strengthening disaster risk governance to manage disaster risk

Twelve countries refer to activities and policies, plans or strategies that strengthen DRR/M governance. Detailed capacity building needs for disaster risk governance are put forward in

Somalia's NDC, including awareness raising for senior officials and policy makers in key sectors for linkages between DRM and climate related risks; developing government strategies in responding to drought and flash flood events; and building capacities at regional and district levels to enable building community level awareness, disaster preparedness and response. Mozambique, Somalia, Zimbabwe and Uganda specifically mention the need to mainstream climate change adaptation and disaster risk reduction into sectorial policies. Rwanda plans to more closely coordinate the work of the different ministries, including the Ministry of Disaster Management and Refugee Affairs.

Sendai Framework Priority 3: Investing in disaster risk reduction for resilience

All countries directly or indirectly mention investments in disaster risk prevention and reduction measures in the agriculture sectors. Measures mentioned include intensification and diversification of agricultural production, integrated water resource management, coastal management, enhanced irrigation systems and integrated pest and disease management, among others. Madagascar, for example, emphasizes its commitment to climate proofing of hydrological and agricultural infrastructures through the implementation and definition of policies to respond to flood and cyclone risks. Nine countries present the option of index-based insurance against meteorological risks for smallholder farmers, pastoralists and entrepreneurs in order to reduce the financial impact of climate-related disasters.

Sendai Framework Priority 4: Enhancing disaster preparedness for effective response

Fifteen countries refer to disaster risk preparedness measures in order to strengthen more effective response and recovery. South Sudan, for example, aims to increase investments in disaster prevention mechanisms, rather than disaster response mechanisms. Other countries refer to more general disaster preparedness and response efforts: Uganda, for example, plans to improve emergency-related institutions and to establish a contingency fund to take care of emergency needs following an

extreme climate event. Rwanda commits to improving its capacity in disaster preparedness and mobilization and distribution of relief to populations affected by specific disaster events. Climate information services and early warning systems are important tools for enhanced disaster preparedness and have been recognized as such in many of the NDCs. These tools are discussed in the next section.

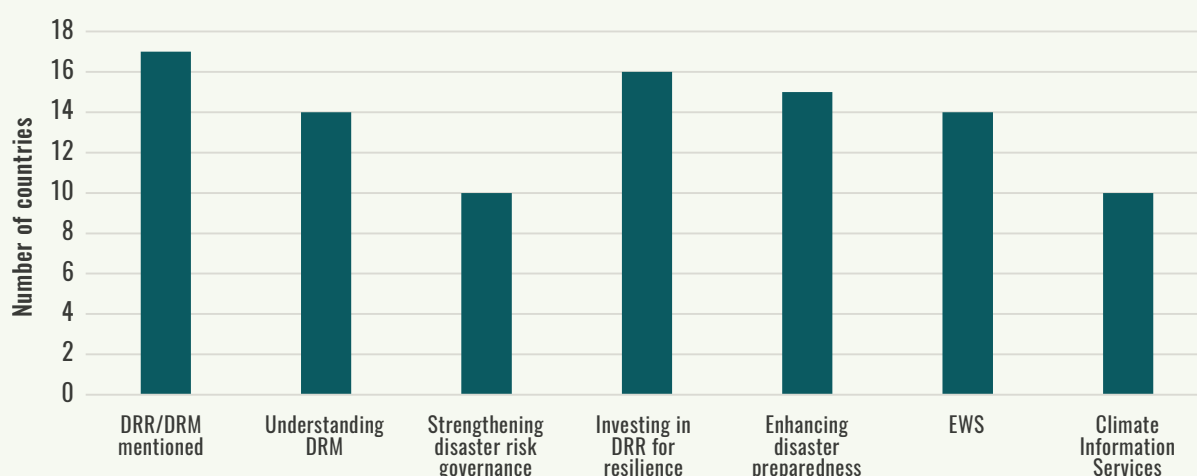
CLIMATE INFORMATION AND EARLY WARNING SYSTEMS

Climate information and early warning systems play an integral part for understanding disaster risk and better disaster preparedness. Countries refer to the importance of enhancing climate information services (11 countries) and developing early warning systems (EWS) (14) to support decision making in the process of building adaptive capacity, and plan disaster preparedness. For instance, Madagascar has committed to finalize the national framework for meteorological services by 2020 for effective implementation of multi-hazard EWS; while South Sudan is dedicated to assembling, analysing, predicting and disseminating climate information through improved climate monitoring and data management systems to

develop EWS and inform appropriate responses to extreme climatic events. Furthermore, Somalia will invest in the provision of seasonal EWS and weather forecasting for pastoralist and farmers livelihood and food security; while Comoros aims at establishing an EWS to intervene through the country in case of the emergence of bovine and caprine diseases associated with climate events. In Zambia and Zimbabwe, the focus of a decentralized climate information services for early warning and long-term projections on the effects of climate change is aimed at supporting sustainable agricultural production systems and reduce risk of losses in crops and livestock. The Seychelles Department of Risk and Disaster Management will be upgrading its coordination with the Meteorological Service to improve emergency response system; while Madagascar foresees to finalize the National Framework for Meteorological Services as part of its commitments for the Global Framework for Climate Services (GFCS) of the World Meteorological Organization. South Sudan spells out capacity building and technology transfer needs for climate information services to monitor hydro-meteorological events in real time and establish EWS.

FIGURE 36.

MAIN ONGOING AND PLANNED DDR/DRM ACTIONS



Source: NDC

2.2.3.3 Monitoring systems

Thirteen countries underscore the importance of investing in monitoring systems to keep track of climate change trends and assess the impact on the AFOLU sector. The principal scope is the acquisition of knowledge and understanding of environmental and land resources spatial and temporal changes to develop vulnerability risk mapping at sectorial and regional levels. The ultimate goal is the identification of pasture degradation processes, areas ravaged by diseases or affected by sea inundation. Monitoring systems are key to planning relevant adaptation actions, as proposed actions include: development of climate scenarios for different agro-ecological regions (Zambia); and the establishment and rehabilitation of hydro-meteorological monitoring networks and stations to collect weather and climate data, while enhancing meteorological services, climate and hydro-related information systems (South Sudan, Kenya, Burundi, Rwanda and Zimbabwe). Some countries have assigned the monitoring role to ad-hoc institutions, as the University of Seychelles Blue Economy Research Institute, or have developed specific systems, as the Mozambican National System to Monitor and Evaluate Climate Change. Monitoring and assessing the effectiveness and efficiency of national and sectorial adaptation policies, plans and program implementation can potentially play an important role in the process. Eleven countries indicate that they intend to take or have already taken action for adaptation monitoring at national level. Several countries report having set up different bodies and operationalized institutional arrangements with the ultimate aim of building resilience in the agricultural sector through reiterative monitoring and evaluation of short-, medium- and long-term results and subsequent revisions of adaptation interventions.

2.2.3.4 Gender sensitive adaptation responses

Eleven countries mention mainstreaming gender responsive approaches in policies and strategies, addressing gender concerns in

national and sectorial plans and enhancing gender inclusiveness in adaptation programs and interventions to lead to more resilient development. A common approach is the incorporation of a gender and human rights approach into capacity building, research and education, as well as to emphasize special efforts to strengthen the adaptive capacity of vulnerable groups (women, youth and children) and communities on all socio-economic levels. The main aim is to prioritize the most vulnerable sectors and regions to build social empowerment and to reduce social inequality and the gap between women and men rights. For instance, Zimbabwe is mainstreaming gender responsive climate policies and emphasizes its special efforts to support vulnerable groups (women, youth and children) in adaptation efforts within all sectors of the economy. In addition, Malawi recognizes that vulnerable and disadvantaged groups carry the burden of the impacts of climate change. In rural areas, women and girls are particularly impacted, as they have to walk further in search of basic commodities for the family, such as firewood and water. Yet, women may not have the authority to decide on alternatives and climate-resilient solutions for the household. To address these challenges, Malawi indicates that the adaptation interventions proposed in the NDC are meant to enhance gender inclusiveness in adaptation programmes and projects. Furthermore, gender issues are enshrined in the Malawi Constitution, and the country is committed to the implementation of its Gender Policy, by promoting the mainstreaming of gender in all government sectors.

2.2.3.5 Research, knowledge management and extension

Enhancing scientific knowledge on climate change impacts and responses through research (14 countries), while promoting education, raising awareness on climate risks and capacity development and skills on climate resilient responses in the crop, livestock, forestry and fisheries sectors (16) are also a priority in the region.

PART 3

GAPS AND OPPORTUNITIES IN THE AGRICULTURE SECTORS

The agriculture sectors are at the centre of economic development and rural livelihoods of Eastern Africa, and thus key in the region's efforts to mitigate GHG emissions while promoting production systems that are sustainable and resilient under climate change. This section aims to review the overall coverage of mitigation targets and adaptation priorities in light of the region-specific vulnerabilities and agricultural emission trends, as well as identify gaps in and opportunities beyond current climate commitments in order to enhance countries' ambitions in the next round of NDCs.

3.1 MITIGATION ANALYSIS

3.1.1 Baseline net emissions and mitigation targets

In the NDCs, 15 countries include economy-wide GHG mitigation targets, while 14 also include

projected 2030 baselines (**Figure 37**). On the aggregate level,⁸⁸ economy-wide net emissions in Eastern Africa are expected to increase from 0.62 Gt CO₂ eq per year in 2015⁸⁹ to 1.12 Gt CO₂ eq per year in 2030 – or by 80 percent. On the other hand, full implementation of both conditional and unconditional mitigation targets set forth in the NDCs would limit regional net emissions to 0.66 Gt CO₂ eq per year by 2030 – or by roughly 40 percent below the baseline. This would lead

⁸⁸ Aggregated net emission reductions include only those countries (15) that included both an economy-wide GHG baseline and mitigation target (Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Seychelles, Uganda, United Republic of Tanzania, Zambia, and Zimbabwe) or only a GHG mitigation target (Mozambique). Rwanda, Somalia and South Sudan did not submit an economy-wide GHG targets nor 2030 baselines in its respective NDC.

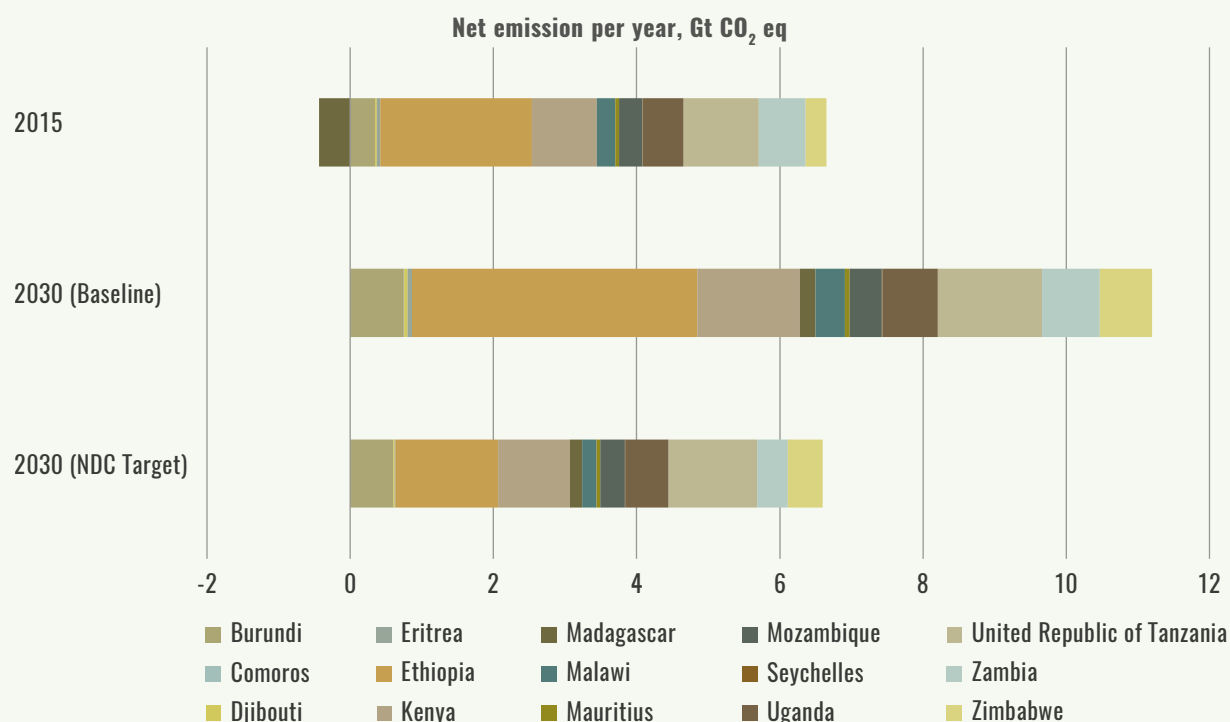
⁸⁹ Historical values range from 1994 to 2013, and are adjusted to respective 2015 value based on national or regional trend.

to a cumulated net emission reduction of 3 Gt CO₂ eq between 2016 and 2030.⁹⁰ However, when compared with the 2015 level, NDC

implementation would nevertheless lead to a 6 percent increase in regional net emissions – an increase of 0.23 Gt CO₂ eq by 2030.

FIGURE 37.

ECONOMY-WIDE BASELINE VALUE (2030) AND NDC MITIGATION TARGET (2030) IN 2030, COMPARED WITH HISTORICAL NET EMISSIONS (2015), IN EASTERN AFRICA



Source: NDC, NC and author's calculation⁹¹

In the agriculture sector, only four countries⁹² project a 2030 baseline and provide a GHG mitigation target in their respective NDC. However, an additional seven countries⁹³ pledge mitigation contributions in the agriculture sector but do not estimate sectorial GHG targets. Based on the average annual change

of emissions in the baseline and mitigation target reported by the four countries, the baseline and mitigation targets are scaled up to the regional level to include those additional seven countries (Figure 38). On the aggregate level,⁹⁴ agricultural emissions are projected to increase from 0.25 Gt CO₂ eq per year in 2015⁹⁵ to

⁹⁰ However, the implementation period for Madagascar, Seychelles and Zimbabwe is set for 2021–2030.

⁹¹ When the historical net emission value is not reported in the NDC, the value from respective NC is applied. If the latest reported value is prior to 2015, the value is projected to 2015 based on the national trend (i.e. average annual increase in emissions). In the case of Mozambique, the 2030 BAU value is projected based on regional trend (i.e. 80 percent increase).

⁹² Comoros, Ethiopia, Madagascar and Malawi.

⁹³ Burundi, Djibouti, Eritrea, Kenya, Mauritius, Uganda, and Zambia.

⁹⁴ Aggregated net emissions reductions include only those countries (4) that estimated both a GHG baseline and mitigation target in the agriculture sector (Comoros, Ethiopia, Madagascar and Malawi) as well as those countries (7) pledging mitigation contributions in the agriculture sector (Burundi, Djibouti, Eritrea, Kenya, Mauritius, Uganda, and Zambia) without estimating a sectorial GHG target. For the seven countries, the baseline and mitigation target, respectively, are calculated based on: a) the average change of emissions (56 percent) from the 2015 historical value and 2030 baseline value observed in the four countries; and b) the average expected change of emissions (3 percent) from the historical 2015 value to the target 2030 value observed in the four countries.

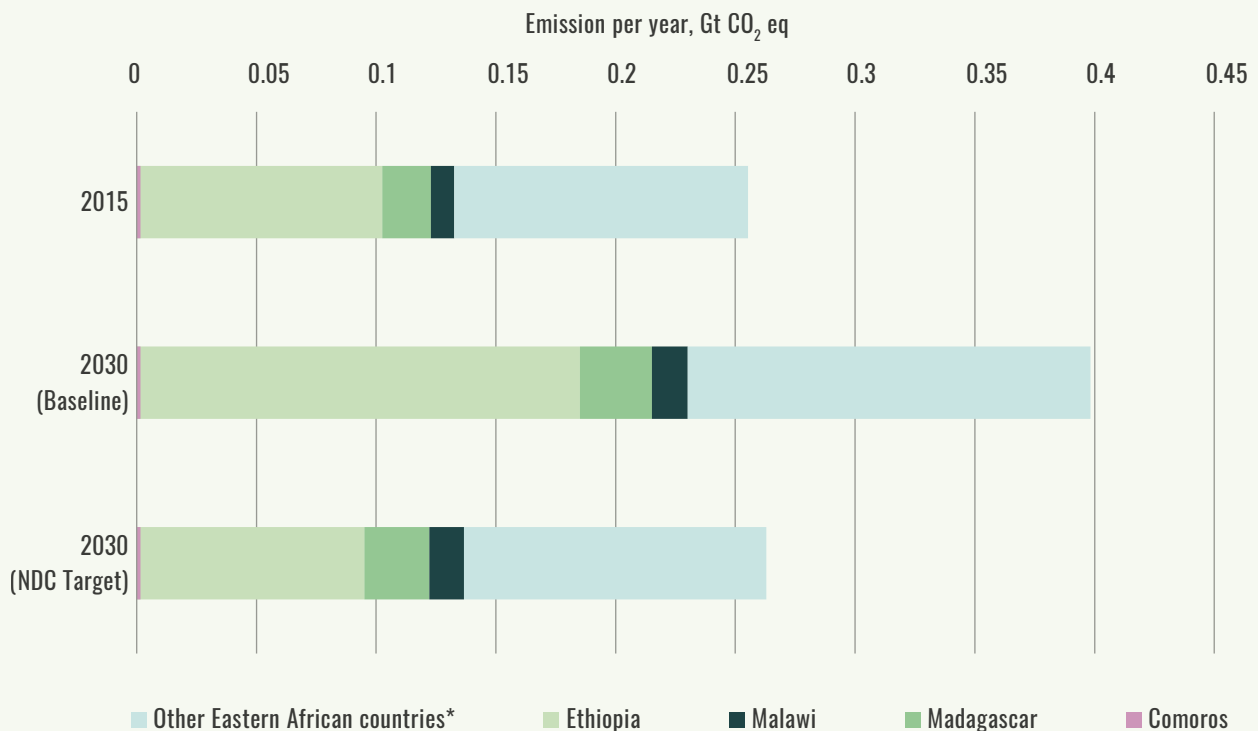
⁹⁵ Historical values range from 1994 to 2013, and are adjusted to 2015 value based on national or regional trends.

0.40 Gt CO₂ eq per year in 2030 – or by roughly 55 percent. However, full implementation of the regional mitigation target would limit emissions to 0.26 Gt CO₂ eq per year by 2030, or approximately one-third below the baseline.

This would lead to a cumulated net reduction of 0.94 Gt CO₂ eq between 2016 and 2030.⁹⁶ However, despite implementation of the regional target, sectorial emissions would nevertheless increase by 3 percent⁹⁷ above 2015 levels.⁹⁸

FIGURE 38.

BASELINE VALUE (2030) AND NDC MITIGATION TARGET (2030), COMPARED WITH HISTORICAL EMISSIONS (2015), IN THE AGRICULTURE SECTOR FOR EASTERN AFRICA



Source: NDC, NC and author's calculation⁹⁹

⁹⁹see Footnote 93 for list of countries

In the LULUCF sector, only five countries¹⁰⁰ project a 2030 baseline and report a GHG mitigation target in their respective NDC. However, an additional seven countries¹⁰¹ pledge mitigation contributions in the LULUCF sector

but do not estimate sectorial GHG targets. Based on the average annual change in LULUCF emissions in the baseline and mitigation target reported by the five countries, the baseline and mitigation targets are scaled up to the

⁹⁶ However, the implementation period for Madagascar, Seychelles and Zimbabwe is set for 2021–2030.

⁹⁷ 0.20 Gt CO₂ eq in 2030.

⁹⁸ Historical values range from 1994 to 2013.

⁹⁹ When the historical net emission value for the agriculture sector is not reported in the NDC, the value from respective NC is applied. If the latest reported value is prior to 2015, the value is projected to 2015 based on national or regional trends. The aggregated 2030 NDC target level includes values reported in the NDCs by (4) countries and extrapolated for those (7) countries pledging mitigation in the agriculture sector whom did not include quantified GHG targets. The methodology is described in Footnote 93.

¹⁰⁰ Comoros, Ethiopia, Madagascar, Malawi and Uganda.

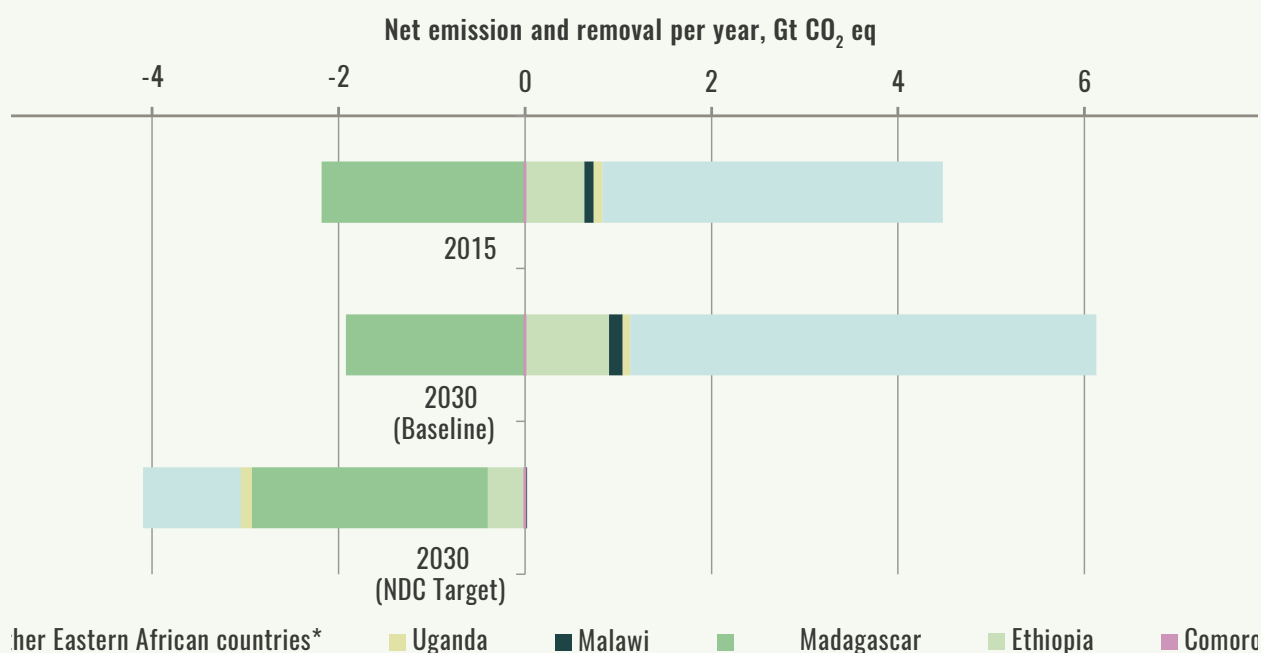
¹⁰¹ Burundi, Eritrea, Kenya, Mauritius, Mozambique, United Republic of Tanzania, and Zambia.

regional level to include those additional seven countries (Figure 39). On the aggregate level,¹⁰² net LULUCF emissions are projected to increase from 0.23 Gt CO₂ eq per year in 2015¹⁰³ to 0.42 Gt CO₂ eq per year in 2030 – or by roughly 85 percent. On the other hand, full implementation

of the regional mitigation target would enhance removals to around –0.41 Gt CO₂ eq per year by 2030 – or by roughly 275 percent¹⁰⁴ compared with the baseline. This would lead to a cumulated net reduction of 5.6 Gt CO₂ eq between 2016 and 2030.¹⁰⁵

FIGURE 39.

BASELINE VALUE (2030) AND NDC MITIGATION TARGET (2030), COMPARED WITH HISTORICAL NET EMISSIONS (2015), IN THE LULUCF SECTOR FOR EASTERN AFRICA



Source: NDC, NC and author's calculation¹⁰⁶

*see Footnote 101 for list of countries

3.1.2 Gap analysis

In order to achieve mitigation targets in the NDCs, countries set forth a series of actions (i.e. policies and measures) to either reduce sources of emissions or enhance sinks in the agriculture

sectors. Analysis of these actions, in light of regional and national GHG “hotspots”, indicate a series of gaps – and therefore opportunities – to be considered for enhancing mitigation ambitions in the next round of NDCs.

¹⁰² Aggregated net emissions reductions include only those countries (5) that estimated both a baseline and mitigation target in the LULUCF sector (Comoros, Ethiopia, Madagascar, Malawi and Uganda) as well as those countries (7) pledging mitigation contributions in the LULUCF sector (Burundi, Eritrea, Kenya, Mauritius, Mozambique, United Republic of Tanzania, and Zambia) without estimating a sectorial GHG targets. For the seven countries, the baseline and mitigation target, respectively, are calculated based on: a) the average change of net emissions (83 percent) from the historical 2015 value to the 2030 baseline value observed in the five countries; and b) the average expected change of net emissions (-277 percent) from the historical 2015 value to the 2030 target value observed in the five countries.

¹⁰³ Historical values range from 1994 to 2013, and are adjusted to 2015 value based on national or regional trends.

¹⁰⁴ However, when compared with the 2015 level, the LULUCF sink would increase by 200 percent (4.1 Gt CO₂ eq) in 2030.

¹⁰⁵ However, the implementation period for Madagascar, Seychelles and Zimbabwe is set for 2021–2030.

¹⁰⁶ When the historical net emission value for the LULUCF sector is not reported in the NDC, the value from respective NC is applied. If the latest reported value is prior to 2015, the value is projected to 2015 based on national or regional trends. The aggregated 2030 NDC target level includes values reported in the NDCs by (5) countries and extrapolated for those (7) countries pledging mitigation in the LULUCF sector but did not estimate a GHG target. The methodology is described in Footnote 101.

3.1.2.1 Regional GHG hotspots

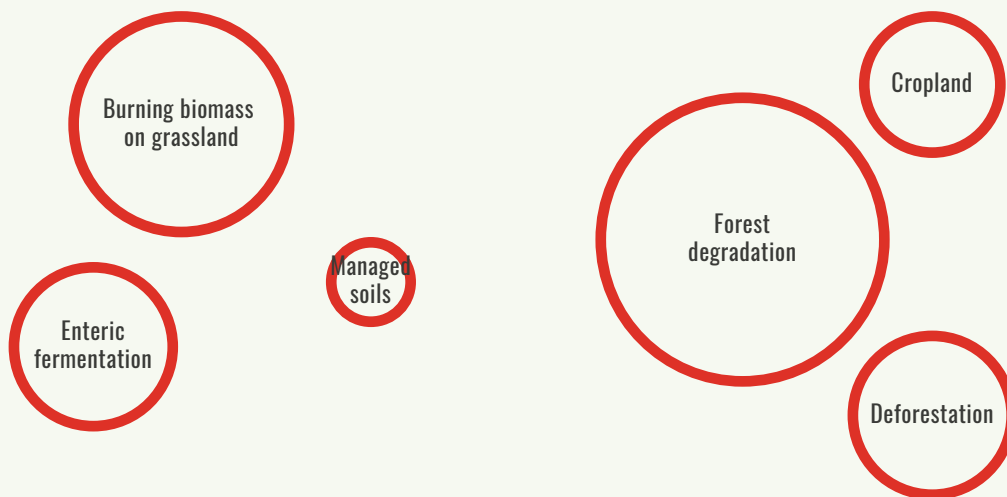
As indicated in regional GHG emissions profile, the top three sources – or GHG “hotspots” (**Figure 40**) – of agriculture-related emissions are grassland biomass burning, enteric fermentation and managed soils with 40, 29 and 16 percent shares, respectively. In the LULUCF sector, the top three sources of LULUCF-related emissions are forest degradation,¹⁰⁷ deforestation,¹⁰⁸ and cropland with 48, 27, and 23 percent shares, respectively. On the other hand, the largest sinks – and therefore opportunities – in the region are forest management¹⁰⁹ and afforestation/reforestation¹¹⁰ with 65 and 31 percent shares, respectively.

As this analysis is conducted on the regional-level, significant national-level trends can be overlooked when data is aggregated, leading to an incomplete picture of GHG

hotspots in the region. Analysis of national GHG inventories in the agriculture sector (**Annex 8**) confirms that burning biomass on grassland, enteric fermentation and managed soils account for over 50 percent of total agricultural emissions (ranging from 50 to 98 percent) for at least five countries. At the same time, analysis of national GHG inventories in the LULUCF sector (**Annex 9**) indicates that forest degradation and deforestation account for over 50 percent (ranging from 54 to 100 percent) of net LULUCF emissions for at least five countries. However, several countries exhibit national GHG hotspots that differ from the regional trend. For instance, cropland emissions constitute 72 percent share in total agriculture emissions in Madagascar while forest burning biomass accounts for a 100 percent share of total LULUCF emissions in Djibouti.

FIGURE 40.

GHG HOTSPOTS IN THE AFOLU SECTOR



Source: NC

Note: Size of red bubble relates to the respective share of sectoral GHG emissions.

¹⁰⁷ Forest degradation refers to total GHG net emissions from 2006 IPCC land use category “Forest land remaining forest land” and 1996 GHGI category “Changes in forest and other woody biomass” when those categories are a net source at the national level.

¹⁰⁸ Deforestation refers to total GHG net emissions from 2006 land use category “Forest land converted to other use” and 1996 IPCC GHGI category “Forest and grassland conversion”.

¹⁰⁹ Forest management accounts for total net emissions related to 2006 IPCC land use category “Forest land remaining forest land” and 1996 GHGI category “Changes in forest and other woody biomass,” when those categories are a net sink at national level.

¹¹⁰ Afforestation accounts for total net emissions related to 2006 IPCC land use category “Land converted to forest land” and 1996 GHGI category “Abandonment of managed lands”.

3.1.2.2 Regional gaps in mitigation coverage

Comparing the relative coverage of mitigation policies and measures presented in the NDCs (**Annex 10–11**) against the GHG hotspots identified in the agriculture and LULUCF sectors, a few gaps emerge (**Figure 41**) pointing to areas for potential improvement in the next revision of the NDCs. Results from the gap analysis (**Annex 12–13**) evidence insufficient coverage of policies and measures aiming to reduce biomass burning on grassland (i.e. reduce savanna burning); improve soil management; and improve livestock feeding and breeding practices in the agriculture sector. In the LULUCF sector, the coverage of mitigation policies and measures targeting emissions from deforestation and cropland was also insufficient with respect to the high share of respective emissions per land use category.

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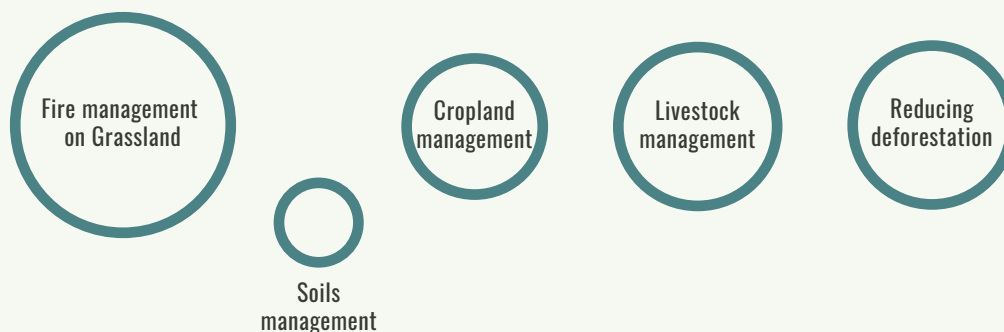
However, significant coverage of mitigation actions aiming to enhance forest sinks through sustainable forest management and afforestation illustrates an opportunity, amongst others, for additional countries to achieve net reductions in the LULUCF sector. However, gaps may be closed and opportunities seized only if appropriate incentives are established and trade-offs are reconciled.

To complete this exercise at the national level, a complete list of national GHG hotspots in the agriculture sectors and relative coverage of the policies and measures in the NDCs can be found in **Annex 8–11**.

Filling in the regional and national gaps found in the overall coverage of mitigation actions targeting AFOLU-emission sources presents a critical opportunity for enhancing climate ambitions where mitigation potential is greatest. The following section estimates the feasibility of pursuing the mitigation potential in Eastern Africa.

FIGURE 41.

GAPS IN THE OVERALL COVERAGE OF POLICIES AND MEASURES ADDRESSING REGIONAL GHG HOTSPOTS



Source: Author's analysis

Note: Size of blue bubble relates to relative size of gap (when policies and measures do not address GHG hotspot, the bubble relates to share of sectoral GHG emissions).

3.1.3 Identifying opportunities to enhance regional mitigation ambitions

This section summarizes a selection of feasible, supply-side¹¹¹ mitigation options that exist for decoupling production from emissions and enhancing terrestrial carbon stocks in the agriculture sectors. While the biophysical and technical mitigation potential of Eastern Africa can be calculated based on soil, climate land availability (i.e. biophysical factors) and management options, technical skills and input availability (i.e. technical factors),¹¹² actual mitigation on the ground depends on economics, socio-economics and institutions.

Estimating practical mitigation potential on the ground is a challenge, as labour availability, land tenure, market access and transaction costs are difficult to account for in an open economy and changing socio-economic environment. In order to estimate feasible mitigation options in Eastern Africa, a set of unconditional management activities set forth in national policies, NCs and NDCs of the region was collected, as testament to their practicality in light of the national circumstances conditioning countries' respective mitigation capacity on the ground. Based on a series of proxies, mitigation potential was scaled up to the regional level¹¹³ for several management activities, assuming a constant rate and uniform implementation of

the activity across all agricultural and forest area that result in a linear and cumulated impact on GHG net emissions by 2030. The estimated mitigation potential was then measured against the global marginal abatement cost¹¹⁴ per management activity to illustrate the most cost effective mitigation options for the region (**Figure 4.2**). Estimates indicate that agroforestry and sustainable soil management entail negative costs and high mitigation potential, while improved livestock management entails higher costs per unit of mitigation. On the other hand, sustainable forest management, afforestation and reduced deforestation constitute high mitigation potential at a relatively low cost. At the regional level, the selected management practices in the agriculture sectors could reduce economy-wide net emissions to below historical¹¹⁵ levels by 2030 with an estimated mitigation potential of -4.6 Gt CO₂-eq in 2030, – at a cumulated abatement cost of 13.2 billion EUR – representing approximately 140 percent of the current GHG target set forth in the NDCs for all sectors (**Annex 14**). In other words, by enhancing mitigation commitments in the agriculture sectors alone – provided that timely climate finance is received at the necessary scale – Eastern Africa could not only reach its climate objectives by 2030 but enhance its climate ambitions even more.

¹¹¹ While significant mitigation potential in the food system lies in supply- and demand-side options, including reduced food loss and waste, as well as decreased consumption of wood products, lifecycle analysis falls outside the scope of the present analysis. However, avoided waste or reduced demand of agricultural and forest products equates to a one-to-one mitigation of embodied emissions. On the other hand, the substitution of biomass-sourced energy for fossil fuel presents mitigation opportunities in the energy sector, but require landscape approaches to account for the potential environmental and socio-economic trade-offs of increased bioenergy production.

¹¹² Technical mitigation potential for all practices in Eastern Africa is estimated to be 434 Mt CO₂ eq per year by 2030 (Smith *et al.* 2008).

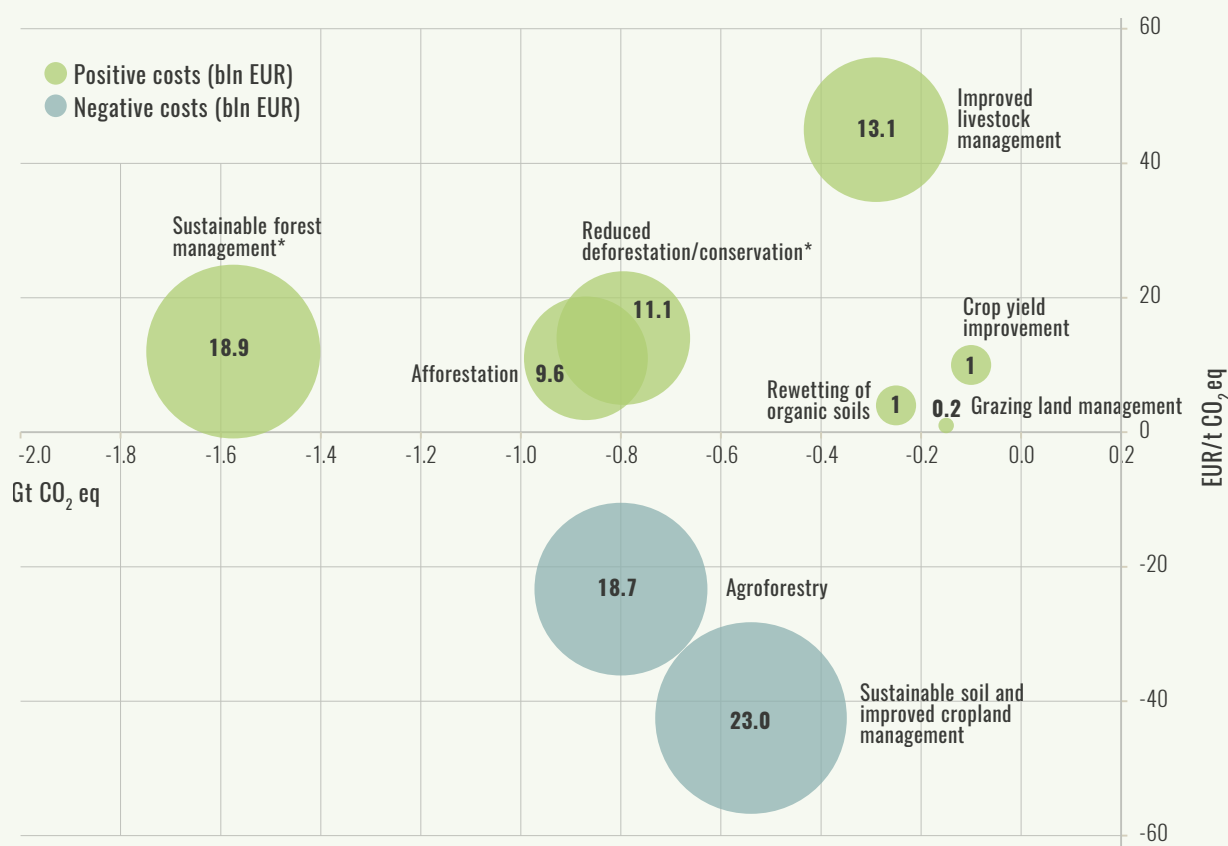
¹¹³ Scaled estimates include all 18 countries.

¹¹⁴ McKinsey & Company, 2009.

¹¹⁵ 2015.

FIGURE 42.

ENHANCED MITIGATION POTENTIAL AND COST IN THE AGRICULTURE SECTORS, 2016-2030



Source: Author's calculation based on national data reported in NC, NDC, national policy and Global GHG Abatement Cost Curve v2.0

* Some mitigation actions may have overlapping impacts

3.1.3.1 Restore degraded soils

GAP

Soils hold the largest terrestrial carbon pool and play a critical role in regulating carbon and nitrogen cycles and the exchange of GHGs with the atmosphere (IPCC, 2014a). The Status of the World's Soil Resources report established that 40 percent of African soils are subject to moderate to severe degradation, and identified major production systems at risk of degradation and desertification in Eastern Africa, including

rained cropping and agro-pastoral systems in the savannah regions and Sahel, irrigated rice-based systems in Madagascar and the highlands of the Ethiopian plateau and Great Lakes area (FAO and ITPS, 2015). Poor land use management combined with the exacerbating impacts of climate change contribute to high soil erosion,¹¹⁶ soil loss,¹¹⁷ deteriorating soil organic carbon content¹¹⁸ and severe nutrient depletion rates,¹¹⁹ resulting in the oxidation of soil organic matter (Oldeman *et al.*, 1991), soil mineralization and nitrification/denitrification

¹¹⁶ Around 77 percent of SSA is affected by erosion, of which Kenya, Ethiopia, Somalia, Uganda, and Zimbabwe, among others, are most severe (FAO and ITPS, 2015).

¹¹⁷ For example, the national soil loss rates in Malawi averaged 29 tonnes per hectare per year in 2014 (FAO and ITPS, 2015).

¹¹⁸ In semi-arid environments, soil carbon stocks can decrease by 30 percent in less than five years when native vegetation or pastures are converted to cropland. Cultivation of tropical forest soils leads to more than a 60 percent loss of original soil organic carbon stocks in just a few years (FAO and ITPS, 2015).

¹¹⁹ Soil fertility trends reveal a downward trend in N, P and K balances by land use system in all Eastern Africa countries, except Mauritius. Countries with high nutrient depletion rates include Kenya, Ethiopia, Burundi, Malawi, Rwanda, and Uganda, Burundi, Malawi, and Rwanda (Stoorvogel, J. and Smaling, E., 1990; IFPRI, 1999; Roy *et al.*, 2003).

(IPCC, 2006; 2013), as well as reduced agricultural productivity.¹²⁰ While biophysical carbon sequestration potential is higher in the humid temperate than in semi-arid and tropical areas (Lal *et al.*, 1998), land use, vegetation cover and management practices largely influence the capacity of soils to provide ecosystem goods and services, such as carbon storage and nutrient cycling. Current levels of land degradation range from moderate to severe¹²¹ and soil organic carbon content is poor on average, with a 1 percent median carbon content in topsoil as a percent in weight (indicative of poor agricultural value) (FAO, 2017b).

Sustainable soil management practices can contribute to climate change mitigation both directly – by increasing and stabilizing soil organic carbon stock in the soil and regulating elemental cycling – and indirectly – through increases in agriculture productivity (Lal *et al.*, 2004; Branca *et al.*, 2013). Agricultural soil management plays an integral role in cropland and grassland management, as plant growth is determined by the availability and quality of soil, water, nutrients and climatic resources. The mitigation benefit of sustainable soil management combined with improved cropland management is estimated below.

3.1.3.2 Improve crop and cropland management



With severe nutrient depletion, weak soil structure and poor soil management practices, rainfed crop yields in Eastern Africa have stagnated at 16 percent of potential and increases in production have come almost entirely from land conversion, relying on expansion of area for increasing production output (Figure 43) (FAO, 2011; FAO, 2017b). As only 0.2 percent of cultivated land is equipped for irrigation, the majority of smallholder production depends on low-input, rainfed systems. While yield improvement rates are relatively higher in Eastern Africa than Africa as a whole for cereals, rice, oil crops, pulses, roots and tubers, and fibres, vegetable

and fruit improvement rates are lower, and overall net cereal yields amount to only half of global ten-year averages (FAO, 2017b). Closing the yield gap (see potential in Figure 44) through improved cropland management practices, therefore, presents an opportunity for intensifying production on current land area and reducing GHG intensities per unit of product. Improved cropland management practices include soil fertility management, minimum soil disturbance, soil erosion control, vegetation management, water management and pest and disease control (Branca *et al.*, 2013; Sanz *et al.*, 2017), varying in suitability based on agro-climatic and agro-edaphic conditions. Recent evidence suggests that adaptive changes in crop management have the potential to increase yields by about 7 to 15 percent on average, with scalable mitigation benefits (Elliot *et al.* 2015).

The channels by which improved cropland management practices mitigate agriculture and land use emissions are multiple. For instance, as more nutrients are removed with crop harvests than applied in Eastern Africa – and nitrogen is the most important determinant of crop yields – integrated nutrient management represent a critical opportunity to enhance nutrient uptake efficiency and boost crop yields, while substantially reducing reactive nitrogen losses and GHG emissions (by 20 to 30 percent) (Snyder *et al.*, 2014; Wu and Ma, 2015). Models suggest that combining nitrogen management together with a set of improved practices can yield up to three times greater output than that generated from a single practice (IFPRI, 2014). Reversing soil nutrient depletion in Eastern Africa requires a mix of better timing of fertilizer application and the introduction of nitrogen-fixing legumes and nitrogen-efficient crop varieties, as well as raising farmer awareness (Kassam *et al.*, 2012).

Second, as soil disturbance tends to stimulate soil carbon losses through enhanced decomposition and erosion, reduced- or no-till agriculture often provides carbon sequestration benefits, particularly when combined with residue retention, though the impact on N₂O emissions is still inconclusive (Sanz *et al.*,

¹²⁰ Yield reduction in Africa due to past soil erosion ranges from 2 to 40 percent, with a mean loss of 8.2 percent for the continent (Eswaran *et al.* 2001).

¹²¹ 2.5 GLASOD erosion degree (FAO, 2017b).

2017). Positive effects of no-tillage practices on crop yields are widely reported,¹²² especially in semi-arid and dry sub-humid areas of sub-Saharan Africa, and on severely degraded soils (Branca *et al.*, 2011).

Third, vegetation management practices (e.g. improved crop varieties, crop rotation, inter-cropping) that conserve soil quality and increase harvest frequency without requiring additional land conversion provide mitigation benefits through avoided land use change emissions and increased above- and below-ground carbon biomass (IPCC, 2007). Global models suggest that the adoption of heat tolerant crop varieties hold the highest projected yield increase for maize in 2050 (IPCC, 2007), while widespread adoption of cover crops mitigate 10 percent of agricultural emissions (Kaye and Quemada, 2017). Additionally, crop rotations and inter-cropping with nitrogen-fixing and nitrogen-efficient crops can exploit symbiotic microbes to fix nitrogen in the soil and enhance nutrient supply to crops, increasing yields and reducing nitrogen loss (Kassam *et al.*, 2012). Crop rotation and intercropping with nitrogen-fixing beans enhanced soil fertility, generating significant maize yield increases in Kenya (Branca *et al.*, 2011). Global crop models indicate that nitrogen-fixing rice varieties hold the greatest yield improvement potential of all crops (IFPRI, 2014).

Last, as rainfed systems account for 99 percent of farmland in Eastern Africa (FAO, 2017a), better management of rainwater and soil moisture is key to raising productivity and reducing yield loss in periods of increased rainfall variability under climate change

(HLPE, 2015). The scope for mitigation through improved water management lies in enhanced biomass production (i.e. increased above and below ground biomass); efficiency gains; and avoided conversion to rainfed cropland (Branca *et al.*, 2011; FAO, 2011). Water conservation techniques along with agronomic practices that enhance soil water retention are essential to improving agricultural productivity. Evidence suggests that better water management, coupled with improved soil and crop management, can more than double agricultural productivity in rainfed areas with currently low yields (FAO, 2008). Increases in land and water productivity through small-scale irrigation can also contribute to mitigation through efficiency gains – greater output per unit of water consumed – provided that intensive energy use is offset by GHG savings through yield gains. As technical carbon sequestration potential under irrigation schemes increases in tropical conditions (FAO, 2008), the significant scope for expansion of irrigation in Eastern Africa should be considered (only 0.2 percent of the 11 percent of irrigation potential is actually irrigated) (FAO, 2017a), particularly in the Ethiopian highlands where high volumes of runoff are lost due to low levels of water infrastructure (FAO, 2011).

The mitigation potential of sustainable soil management practices and improved cropland management for Eastern Africa as a whole is projected to be in the order of $-0.54 \text{ Gt CO}_2\text{-eq}^{123}$ by 2030. Lastly, crop productivity gains resulting from improved soil conservation practices constitute an indirect channel, by which the region would benefit from an additional $-0.1 \text{ Gt CO}_2\text{-eq}$ (15–100 range) of avoided emissions.¹²⁴

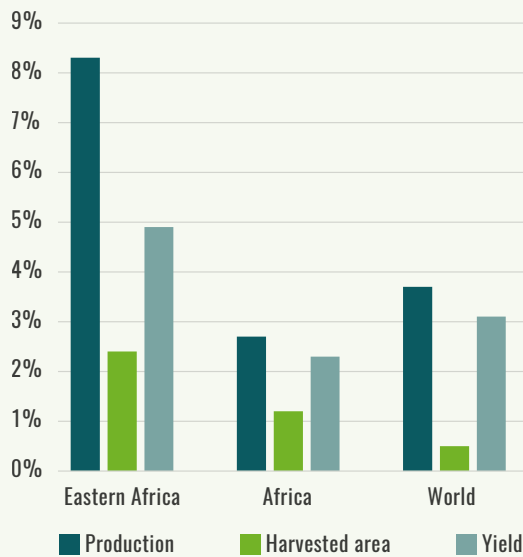
¹²² For example, maize yields (monoculture) increased by 9 percent in Zimbabwe in 2004–2010. In Zambia, on average, hand-hoe conservation agriculture in smallholder maize-based farming systems in Zambia attained higher maize yields (1.1 tonnes per hectare more) than conventional hand-hoe or animal draft system (Branca *et al.* 2011).

¹²³ Mitigation potential in 2030 based on national data reported in the NDCs and NCs of 6 countries (Burundi, Ethiopia, Kenya, Malawi, Mauritius and Uganda) on soils conservation, efficient use of synthetic fertilizers, improved use of crop residues and reduced water-coverage in riziculture, scaled up to the regional level as a function of agricultural area.

¹²⁴ Estimates based on observed data in America, Africa and Asia (Derpsch, R., T. *et al.*, 2010). The GHG reduction is calculated based on average increment in additional productivity (35 percent), excluding mitigation potential of Somalia and South Sudan whom did not submit NCs.

FIGURE 43.

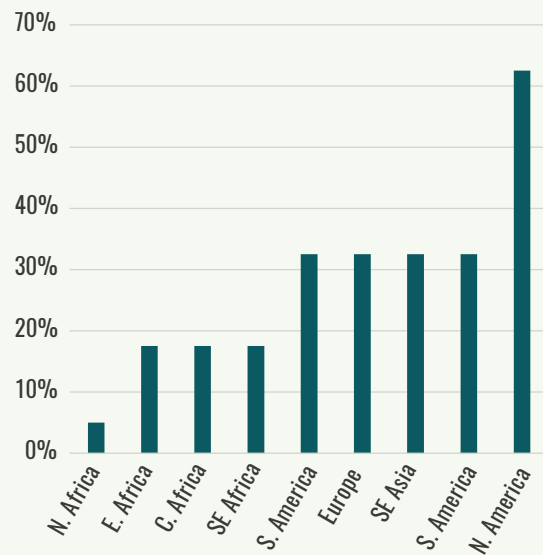
GROWTH IN CEREAL PRODUCTION (2005–2014)



Source: FAO, 2017b

FIGURE 44.

RATIO OF ACTUAL TO POTENTIAL YIELD IN RAINFED MAIZE FARMING SYSTEMS



Source: FAO, 2017c

3.1.3.3 Enhance grassland carbon pools

OPPORTUNITY

Transforming extensive rangelands into carbon sinks could contribute to carbon accumulation and storage in the arid- and semi-arid

pastoral systems in Eastern Africa, mostly as a consequence of the large land area¹²⁵ opposed to the amount of potential sequestration per unit of land (Lipper *et al.*, 2014; Smith *et al.*, 2008). While warmer temperatures are expected to improve pasture quality and enhance productivity in mid-latitudes of Eastern Africa under climate change, productivity gains will be discounted by additional heat stress (FAO, 2016b). Improving grazing lands and pastures through species introduction, reduced grazing intensity, and nutrient management, such as sowing legumes, represent high technical potential for simultaneously increasing animal productivity and enhancing grassland carbon stocks, particularly in the East African drylands (FAO and ITPS, 2015). The estimated mitigation potential of improved grazing land management constitutes cumulated GHG savings of -0.15 Gt CO₂ eq¹²⁶ in 2030.

¹²⁵ 40 percent of total land cover (FAO, 2017b).

¹²⁶ Refer to Footnote 127 for data source and methodology.

3.1.3.4 Improve livestock management

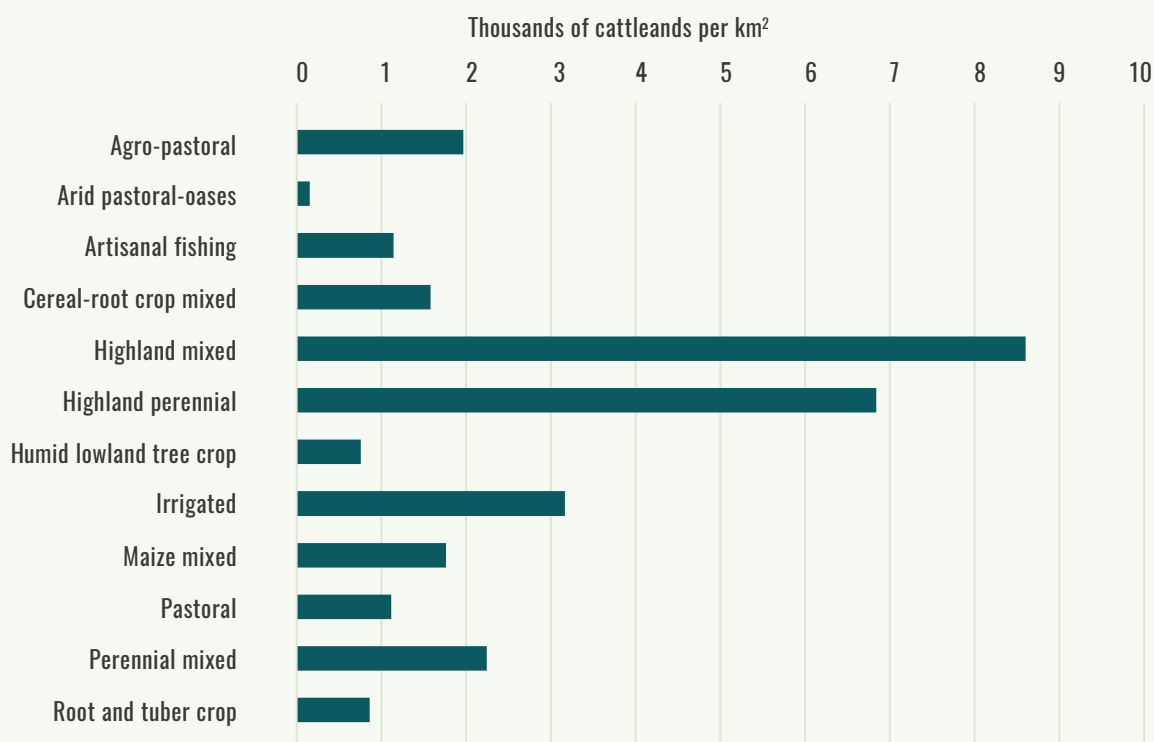
GAP

Due to low animal productivity, poor animal health and low quality feeds, the emissions intensity from ruminant production is generally high

in Eastern Africa, representing substantial potential for emission reduction per unit of protein where volumes of production are high (highland, pastoral, agro-pastoral and cereal root-crop mixed farming systems), such as in the highland perennial, highland mixed, and perennial mixed where stocking densities are high (Figure 45) (Herrero *et al.*, 2013). As climate change impacts increasingly affect livestock production both directly and indirectly through heat stress, animal mortality, increased incidence of pests and diseases, and the provision of quality feed, targeted mitigation action can improve feed conversion efficiency and reduce enteric emission intensity, while increasing production and promoting climate resilience (FAO 2016b; c).

FIGURE 45.

CATTLE DENSITY PER FARMING SYSTEM



Source: FAO, 2014b. Garrity *et al.* 2012

In both ruminants and monogastrics, improved feeding practices, animal husbandry and the selection of high efficiency breeds can increase the amount of output produced for a given level of emissions and reduce the amount of animals required to produce a fixed level of output, while improved manure management can reduce methane emissions from high concentrations of manure. Consensus amongst the available literatures suggests that improving the overall digestibility of feed rations and balancing their nutritional quality is the first level intervention, which yields most mitigation benefits (Gerber *et al.*, 2013). As ruminant feed in most mixed dryland systems are of low digestibility and deficient in crude protein, minerals and vitamins (between 2–12 percent of feed energy is lost on average in the form of methane under imbalanced feeding

scenarios) (Gerber *et al.*, 2013), increasing the digestibility of feed rations by improving the quality of crop residues, or supplementing diets with concentrates, reduces methane emissions (Herrero *et al.*, 2008). A study estimates that emissions generated by livestock production could be technically reduced by between 18–30 percent if the practices used by the 25 percent of producers with the lowest GHG emission intensity were widely adopted in each farming system (Gerber *et al.*, 2013). In Eastern Africa, the combined implementation of improved animal breeding techniques and manure management practices across Eastern Africa could generate cumulated GHG savings in the order of -0.29 Gt CO₂ eq.¹²⁷ Overall, the mitigation potential of improved livestock management systems across Eastern Africa, including land management,

¹²⁷ Mitigation potential in 2030 based on data reported in NDCs and NCs by four countries (Burundi, Ethiopia, Malawi and Uganda) on breeding, feeding and manure management, scaled up to the regional level as a function of the projected emissions at 2030 from enteric fermentation and manure (projections built on a 88 percent expected increase in emissions associated to livestock, as per Burundi NC).

constitute cumulated GHG savings of -0.44 Gt CO₂-eq¹²⁸ in 2030.

On the other hand, using lifecycle analysis, global studies indicate that sustainable practices would lead to reductions of between 14 and 41 percent in livestock GHG emissions with increases in food production, with particularly high mitigation potential in the ruminant and pig farming systems in Africa (Mottet *et al.*, 2017). Indeed, the negative correlation observed between productivity and emission intensity in ruminant production (Gerber *et al.*, 2013) evidences a win-win opportunity for mitigation and food security in Eastern Africa.

3.1.3.5 Diversify farming systems

OPPORTUNITY

The diversification and integration of agricultural production into complex agro-ecosystems that provide nitrogen-rich residues and enhances soil organic matter presents an optimal mitigation opportunity. In agroforestry systems, mitigation opportunities are cross-cutting, ranging from greater efficiency of natural resource capture and utilization over single-species (Nair, 1993); increased above-ground carbon stock; reduced soil carbon losses from erosion (FAO, 2013); reduced pressure on forests due to land productivity gains and reduced fertilizer use (FAO, 2011). By integrating nitrogen-fixing trees into cropping systems, farmers in Zambia and Malawi successfully restored exhausted soils and increased yields by up to 400 percent under *Faidherbia* canopy (FAO, 2011). Overall, the mitigation potential of an increase in agroforestry area, across Eastern Africa is estimated to be in the order of -0.8 Gt CO₂-eq by 2030.¹²⁹ In the long-term, wood products can also act as carbon reservoirs.

Similarly, agro-pastoral systems optimize the use of the biomass and nutrient cycles, as the waste of one system is a resource for the other (FAO, 2013). Mixed farming systems for example

provide around 15 percent of the nitrogen inputs used in crop production via manure, which reduces input costs and achieves an emission intensity substantially lower than that of many grazing systems (Liu *et al.*, 2010; Herrero *et al.*, 2013). Evidence suggests that diversification and crop-livestock-tree integration in temperate and tropical regions would increase farm-scale efficiency and reduce GHG emission intensity (Soussana *et al.*, 2015). Examples in Ethiopia and United Republic of Tanzania illustrate how drought-tolerant mixed farming systems, which include nitrogen-fixing leguminous trees that provide palatable pods for livestock and leaves for fertilizer generate higher soil fertility and yields, representing examples that could be expanded in comparable areas of Eastern Africa (FAO, 2016b).

3.1.3.6 Protect forests

GAP

Decoupling agricultural production from forest conversion has the largest and most immediate carbon stock impact in the short-term per hectare and per year globally (IPCC, 2014a), particularly in the tropics where the opportunity cost of reduced yields is minimal (FAO, 2008). In Eastern Africa, forests currently account for approximately 31 percent of current land cover, though 11 percent of total forest area was lost to extensive deforestation between 2006 and 2015, reaching up to 93 percent in some countries (FAO, 2017b). Although the net annual forest conversion rates for Eastern Africa is decreasing (-1 percent), it is doing so at a slower rate than Africa as a whole (-10 percent) (FAO, 2017d). A FAO elaboration of MODIS data and IPCC Tier 1 methodology that captures forest fire as an indicator of slash-and burn agriculture reveals high levels of deforestation associated with maize mixed, cereal-root crop mixed and agro-pastoral farming systems. However, a 20 percent reduction of net deforestation in

¹²⁸ Mitigation potential in 2030 based on data reported by Ethiopia in its NC on pasture and rangeland management, scaled up to the regional level as a function of grassland area.

¹²⁹ Mitigation potential in 2030 based on data reported in the NDCs and NCs by four countries (Burundi, Comoros, Kenya and Malawi) on the expansion of agroforestry areas, scaled up to the regional level as a function of the agricultural area. The projection assumes a linear rate of implementation of the mitigation actions across the region, taking into consideration the projected increase of agricultural emissions under expected population growth (UNDESA, 2017). The estimate does not include Somalia and South Sudan.

Eastern Africa could mitigate -0.5^{130} to -1.06 Gt CO₂ in 2030.¹³¹ Expanding the current 19 percent of forest land under conservation (FAO, 2017d) would contribute to mitigation targets. In an open economy, however, maintaining forest cover depends on the drivers of conversion, the returns from non-forest and potential alternative land uses and the associated compensation for changing land use practices (IPCC, 2014a). A recent study finds that reducing or avoiding emissions from deforestation provides high or moderate impacts on land degradation, mitigation and adaptation, with strong biodiversity conservation co-benefits (Sanz *et al.*, 2017).

3.1.3.7 Expand forests

OPPORTUNITY

Increasing forest area through planting, seeding, assisted natural regeneration, and natural succession, afforestation leads to increases in the carbon stocks held in biomass, dead organic matter and soil (FAO, 2016b). One of the most effective methods for reducing emissions is the conversion of abandoned lands to forest land (Lal *et al.*, 2004). Based on aggregated national data, the average mitigation potential of afforesting approximately 3.3 million hectares could sequester up to a cumulated -0.87 Gt CO₂ by 2030.¹³² Reconciling potential trade-offs, such as the hydrological consequences of upper catchment afforestation with downstream use, however requires an integrated landscape approach to afforestation (FAO, 2008).

3.1.3.8 Sustainably manage forests

OPPORTUNITY

Sustainable forest management practices that increase productivity show significant potential for land-based climate change mitigation by addressing emissions related to forest degradation. The three main pathways by which improved forest management can mitigate land use emissions area through improved biomass extraction, solid biofuel production efficiency, and sustainable use of solid biofuels for energy. For example, planned harvests using appropriate technologies and at sustainable frequencies can counter ongoing degradation trends of forest carbon stocks. If combined with controls for illegal harvesting, planned harvest represents a cumulated mitigation potential of -0.04 ,¹³³ unconditionally, to -0.7 Gt CO₂ in 2030, provided international support is received.¹³⁴

Second, as charcoal and woodfuel represent the primary energy sources in Eastern Africa,¹³⁵ increasing the efficiency of biofuel production can minimize forest degradation and reduce net demand, ultimately reducing the high share of emissions resulting from unsustainable forest management. For example, a transition from traditional to more efficient kilns for charcoal production presents a significant opportunity to reduce GHG emissions with a zero or positive income impact on producers. Scaled national data illustrates that charcoal production efficiency gains in Eastern Africa could achieve an unconditional reduction of -0.12 Gt CO₂ by

¹³⁰ Assuming a 50 percent overlap with other mitigation actions in forest land.

¹³¹ Based on national forest data (FAO, 2017d).

¹³² Mitigation potential in 2030 based on data reported by ten countries (Burundi, Comoros, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, South Sudan, Uganda) in respective NDCs and by two countries (Mauritius and Zimbabwe) in respective NDCs for achieving net GHG removals through afforestation/reforestation. Estimated potential is scaled to the regional level as a function of pressure on agricultural lands and available land for conversion.

¹³³ Assuming a 50 percent overlap with other mitigation actions in forest land.

¹³⁴ Mitigation potential in 2030 based on data reported by four countries (Eritrea, Ethiopia, Malawi and Zimbabwe) in respective NDCs to ensure sustainable forest management of national forest land, scaled up to the regional level as a function of the total forest area of the region expected at 2030 according to current trends.

¹³⁵ The region accounts for 4.2 and 4.3 percent of total charcoal and wood fuel production in Africa, respectively (FAO, 2017b).

2030, reaching up to -0.47 Gt CO₂, provided climate finance is received.¹³⁶

Third, transitioning from traditional three stone stoves to more combustion efficient cookstoves presents an opportunity to reduce emissions associated with household cooking in the extensive rural areas of Eastern Africa.¹³⁷ The actual abatement potential of this transition lies in the accounting of fuel type and quantity; compared efficiency between traditional and new stoves; the fraction of renewable and non-renewable biomass used; and household cooking practices (GACCS, 2017). Within the literature, fuelwood-efficient stoves are estimated to be half as efficient as biogas, electric, and liquefied petroleum gas (LPG) stoves (CRGE, 2011). However, considering the high costs and relatively short lifetime of electric, LPG and biogas stoves, large-scale distribution of fuelwood efficient stoves across the rural households in Eastern Africa presents a more likely scenario for achieving mitigation. The cumulated mitigation potential of large-scale distribution of fuelwood efficient stoves across the rural population of the region is estimated to be a conditional -0.93 Gt CO₂, in 2030.¹³⁸

Current fuelwood shortages in the maize mixed, highland mixed and highland perennial systems (Garrity *et al.*, 2012) most likely exacerbate poor forest management-related emissions, yet represent opportunities for increasing the efficiency of solid biofuel production and use as a means of ensuring energy security to the rural population.

3.2.1.1 Rewet organic soils drained for agriculture



Drained organic soils¹³⁹ represent a global emissions hotspot given the high emission factor per unit of area, on one hand, and the long lasting emitting effect on the other (i.e. a drained organic soil emits CO₂ and N₂O from the onset of drainage until most of the organic matter is oxidized). However, their rewetting immediately halts the emissions and reactivates the accumulation process of organic matter. Since organic soils are often among the most productive soils (also because they occur in areas rich of water) their rewetting is unlikely to occur without the provision of international financial support to compensate for lower returns to farm production. While only one out of 18 countries proposed wetland management as a mitigation action in their NDCs,¹⁴⁰ a 1 percent expansion of current wetland area¹⁴¹ in Eastern Africa could reduce emissions by -0.25 Gt CO₂ eq over a 15-year period.¹⁴²

Overall, the combination of feasible mitigation potential in the LULUCF¹⁴³ alone accounts for a net cumulated reduction of -2.52 to -4.01 Gt CO₂ by 2030,¹⁴⁴ depending on the degree of mitigation overlap amongst activities, while the agriculture sector holds a net reduction potential in the order of -1.88 Gt CO₂ eq by 2030.

¹³⁶ Mitigation potential in 2030 based on information reported by six countries (Burundi, Eritrea, Kenya, Madagascar, Mozambique and Rwanda) in respective NDCs to provide efficient kilns, with or without additional international support, scaled up to the regional level as a function of projected levels of charcoal production in 2030 based on population growth trends.

¹³⁷ Rural populations holds 74 percent share of total population (UNDESA, 2017).

¹³⁸ Mitigation potential in 2030 based on the mitigation capacity of ten countries (Comoros, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Rwanda, South Sudan, Tanzania) – as stated in respective NDCs – and in Ethiopia's Climate-Resilient and Green economy strategy (2011), scaled to the regional level based on rural population.

¹³⁹ Histosoils.

¹⁴⁰ Uganda.

¹⁴¹ Regional wetlands area calculated based on aggregated data from national land policies.

¹⁴² Mitigation potential in 2030 based on mitigation capacity reported by Uganda in respective NDC to expand existing wetlands area.

¹⁴³ Excluding cropland and grassland, which is estimated under agriculture mitigation potential.

¹⁴⁴ Includes both the reduction in emissions and enhancement of removals.

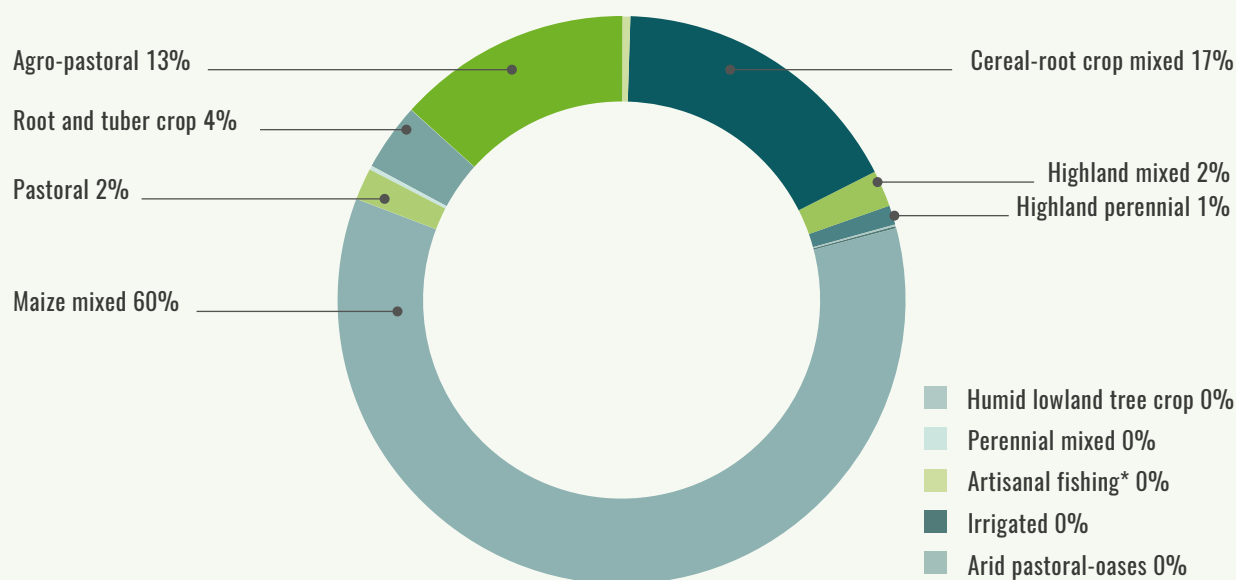
BOX 3: UNLOCKING THE MITIGATION POTENTIAL OF EASTERN AFRICA: AN ALTERNATIVE TO BIOMASS BURNING

A FAO elaboration of MODIS data and IPCC Tier 1 methodology demonstrates that fires on forest land (0.06 Gt CO₂eq), and on cropland and grazing land (0.99 Gt CO₂ eq), constitute a major source of net emissions in Eastern Africa (1.05 Gt CO₂ eq) – the highest contribution to AFOLU emissions in 2010. As smallholder farming systems often burn crop residues in order to clear the land for a new culture, or burn grassland and savannah to regenerate short-term fertility for the next season, fires represent the largest driver of long-term land degradation in the tropics (Sanz et al., 2017). In Eastern Africa, the main

farming systems associated with highest net emissions from savannah and forest fire in terms of magnitude are maize mixed, cereal-root crop mixed, and agro-pastoral (Figure 46), while the humid lowland tree crop, irrigated, root and tuber crop and perennial mixed systems exhibit the highest GHG intensity per unit of area (Figure 47). Overall, the area of savannah burned is much greater than that of forests (140 times larger). **The total area of burned area across Eastern Africa in 2015 amounts to more than three times the size of Rwanda.**

FIGURE 46.

FARMING SYSTEMS ASSOCIATED WITH SAVANNAH BURNING EMISSIONS (SHARE OF REGIONAL EMISSIONS FROM BURNING)



Source: Author's elaboration of MODIS data and IPCC Tier 1 methodology

*Land associated with artisanal fishing farming systems is captured due to coarse resolution, yet unlikely linked to savannah burning.

Alternative management options, however, such as incorporating azote into cropland and grassland vegetation management (e.g. seeding) can improve soil fertility levels and, therefore, land productivity, reducing incentives to burn residues and savannah land. While only a few countries¹⁴⁵ included mitigation actions aiming to avoid the use of fire through sustainable crop residue and grazing land management, the mitigation potential of avoided biomass burning is substantial in Eastern Africa given the magnitude of fire emissions. Under a feasible mitigation scenario (i.e. 80 percent reduction in crop residue and savannah fire activities over a 15-year period), a cumulated net reduction of 7.88 Gt CO₂ could be achieved – more than double the region's

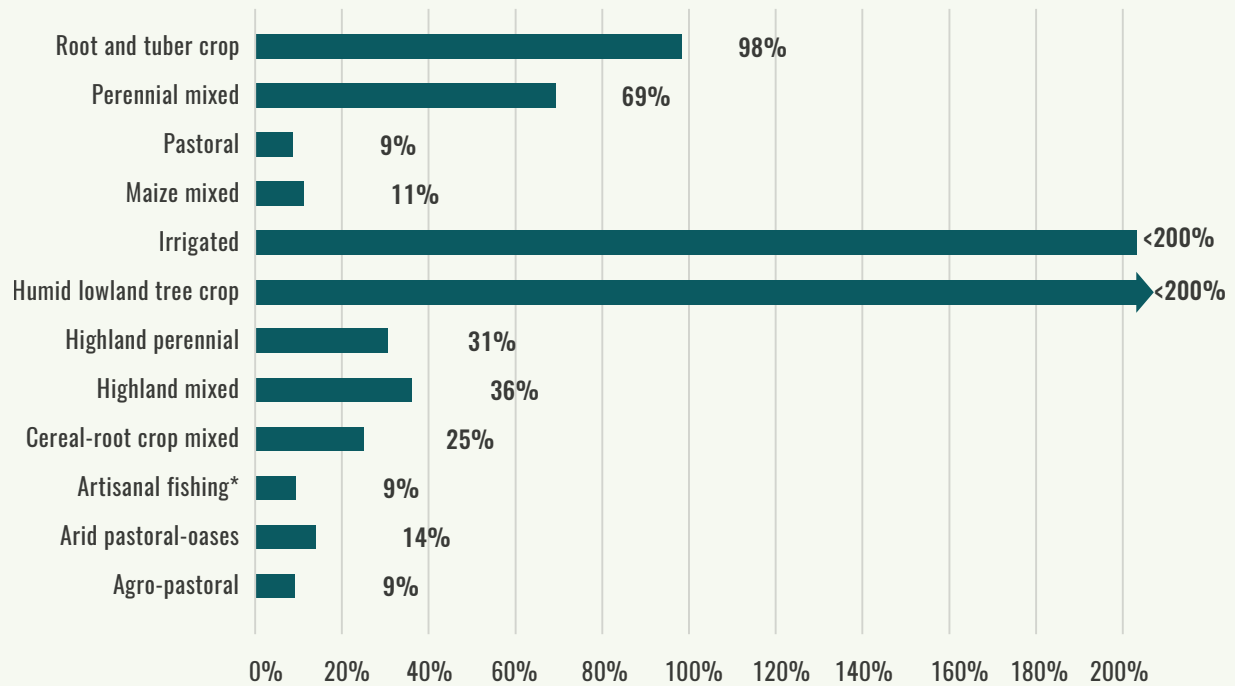
current mitigation contribution – without productivity costs and minimal technology requirements.

Currently, weak institutional arrangements and low technical capacity in developing countries to collect and report GHG data related to burning biomass often lead to the omission of such emissions in national GHG inventories and, consequently, absence in the NCs submitted to the UNFCCC. Without proper NGHGs systems in place, appropriate mitigation actions cannot be designed to counter national emission trends and achieve global climate objectives. Hence, institutional and technical capacity building initiatives are crucial for identifying emission sources and designing robust mitigation response options.

¹⁴⁵ Zambia and Kenya plan to reduce fires in forest and agricultural land, respectively.

FIGURE 47.

BURNING SAVANNAH GHG INTENSITY PER FARMING SYSTEM



Source: Author's elaboration of MODIS data and IPCC Tier 1 methodology

*Land associated with artisanal fishing farming systems is captured due to coarse resolution, yet unlikely linked to savannah burning.

3.2 ADAPTATION ANALYSIS

3.2.1 Relevance of adaptation contributions to the regional context

The aim of this section is to synthesise and analyse the adaptation component of the East African NDCs, using literature and evidence-based research from the region. The analysis to follow highlights areas of agreement and divergence between observed hazards/vulnerabilities and proposed actions presented in the NDCs.

3.2.1.1 Coverage of climate-related hazards, impacts and associated vulnerabilities

Rising temperature is a key climate related risk with observed increases of 0.5° C or more during

the last 50 to 100 years across most of the African continent. The IPCC Fifth Assessment Report Working Group II Africa Regional Chapter (IPCC AR5 WGII) indicates that projected maximum and minimum temperatures over equatorial Eastern Africa show a significant increase in the number of days warmer than 2° C above the 1981–2000 average by the middle to end of the twenty-first century under A1B and A2 scenarios (Anyah and Qiu, 2012). In line with the observed and predicted changes, 14 countries highlight the importance of temperature as a main climate-related hazards in their NDCs.

Observed precipitation in Eastern Africa over the last three decades has decreased between March and May–June (Williams and Funk, 2011). Over the last 60 years, studies show that summer monsoonal precipitation in the Great Horn of Africa has also decreased as a result of changing sea level pressure (William *et al.*, 2012). Global climate models predict a wetter climate over Eastern Africa with more intense wet seasons and less severe droughts is

projected by the end of the twenty-first century. The projected reversal of historical precipitation trends is attributed to recent cooling in the eastern equatorial Pacific which in turn offsets the equatorial Pacific warming (Conway and Schipper, 2011; IPCC, 2014b). The combination of rising temperature and changing precipitation patterns in the East African region pose great risks to agriculture in the region. Accordingly, changes in precipitation patterns are reported by 15 countries in the region.

Extreme rainfall and droughts in Eastern Africa have increased in frequency in the last 30–60 years (IPCC, 2014b). Projections in the region indicate, with high certainty, increase in heavy precipitation and number of extreme wet days by the mid-twentieth century. In accordance with these findings, all East African NDCs identify droughts and flood as a major concern. As the urban population grows, flooding in cities and urban centres is an increasing risk, as was demonstrated in Eastern Africa in 2002 when tens of thousands were forced to leave their homes in Rwanda, Kenya, Burundi, Tanzania and Uganda (IPCC, 2014b). Extreme weather events threaten food security in numerous ways including the growing cycles of crops, the life of livestock and the post-harvest transportation of food products.

Socio-economic and environmental drivers of vulnerabilities, and main observed and foreseen impacts of climate change on key natural resources, ecosystems and rural productive assets put forward in the NDCs are in line with the IPCC AR5 WGII, which stresses that climate change may adversely affect development progress, increase pressure on economic activities, such as agriculture and fishing. Most East African countries underline social and economic issues as drivers of vulnerability to climate change. Economic dependence on agriculture sectors is mentioned by 11 countries. Poverty and low human development is mentioned by nine, but fewer countries see fragile environmental management as a driver (6 countries).



While only five countries mention pests and diseases as a major variability in the region, the IPCC WGII AR5 suggests that warming could result in

a significant increase of crop pests in Eastern Africa, illustrating a gap in coverage. For example, in highland Arabic coffee producing areas (Ethiopia, Kenya, Uganda, Rwanda and Burundi), the coffee berry borer is becoming an increasing threat to coffee production. Temperature rise in eastern Africa also increases the risk of burrowing nematodes in highland banana producing regions (IPCC, 2014b). Pest-related risks and potential adaptation actions require further development in regional adaptation plans.

3.2.2 Coverage of adaptation priorities and actions in the agriculture sectors

3.2.2.1 Crop and cropland management

Crop management practices are referred to in all NDCs in accordance with the many references made to observed or projected vulnerabilities on crop and livestock assets and livelihoods (15 countries). The exact practices proposed differ significantly with most reference made to CSA-related practices (9), followed by CA (3) and agro-ecology (3).

Half of the East African reports (9 countries) highlight the importance of adapted crop varieties. This is in line with the findings of a synthesis of over 160 studies on the impacts of climate change on crops in Eastern Africa in which they estimate wheat to be the most negatively impacted crop, with yields decreasing up to 72 percent by the 2080s. Heat-resistant and drought tolerant crops, such as sorghum, millet and root crops (i.e. cassava, sweet potato and potato) have potential for increasing yields in the region (Adhikari *et al.*, 2015).

There is increased evidence that farmers are changing their production practices in response to increased climate-related food security risks, through both technical and behavioural changes. Examples include planting cereal crop varieties that are better suited to shorter and more variable growing seasons, reduced tillage practices and crop residue management to more effectively bridge dry spells, and adjusting planting dates to match shifts in the timing of rainfall. While this evidence of adapted farming practices is in line with modelled and predicted need, it is essential moving forward

that changes in crop and cropland management practices are informed and supported by evidence and suggested actions. Changes in temperature and precipitation alone are altering the suitability of agro-climatic zones in the region (IPCC, 2014b). Adaptation to this change must be strategic, sustainable and consider the entire food system.

3.2.2.2 Water resource management

The IPCC AR5 WGII concludes that although inadequate observational data is a systemic limitation for the estimation of future freshwater availability, and current poor understanding of how climate change will affect water quality, water stress in a world +2° C and +4° C degrees warmer would remain high. In Eastern Africa, a reduction of flow in the Blue Nile as a result of climate change and development upstream (irrigation and hydropower) is of particular concern due to the basin's geopolitical and socio-economic importance (IPCC, 2014b). The NDCs highlight the fact that a considerable proportion of the population do not have direct access to water for household consumption and agricultural activities and any additional reduction in surface and underground water bodies and reservoirs, or overflow of water courses would result in high water stress risks. Water resource management is emphasized in the planned adaptation actions in the majority of East African NDCs (17 countries). The following adaptation practices more specifically address the risks and vulnerabilities resulting from water availability in the region.

IRRIGATION AND DRAINAGE RELATED MEASURES

OPPORTUNITY

Due to the reliance on rainfed crop production in Eastern Africa, the region is particularly vulnerable to water shortage.

Irrigation is a crucial aspect of ensuring food security in the region. Rainfed agricultural practices are usually more vulnerable in the short-term to climate change than irrigated systems (FAO, 2011). In Eastern Africa, only 2.5 percent of the 10.5 percent potential of cultivable area is actually equipped for irrigation (FAO, 2017b). Irrigation

and drainage are referred to as an important adaptation action in 15 of the NDCs.

WATER STORAGE AND HARVESTING RELATED MEASURES

Water storage and harvesting are referred to in 13 East African NDCs as an important means to address water security in the region. The main barrier for implementation of water harvesting in Eastern Africa is the cost of the storage tank, however research to develop new technologies and finding local solutions is ongoing (Parker *et al.*, 2012).

WATER QUALITY, POLLUTION AND REUSE RELATED MEASURES

Adaptation measures related to water treatment, reuse and recycling appear in nine NDCs. Maintaining water quality and reducing water pollution are mentioned by seven countries. Wastewater treatment and the management of water quality and pollution rely on technologies that most of the East African countries have not yet developed.

3.2.2.3 Fisheries, coastal zone and marine ecosystem management

Coastal and marine ecosystems are expected to be greatly impacted by the increasing stress of climate change with impacts including habitat degradation, loss of biodiversity, salinization, pollution and coastal erosion (IPCC, 2014b). Sea-level rise is mentioned as an observed or projected climate-related slow onset risk in 7 NDCs and ten reference the overall climate change related vulnerabilities to biodiversity, marine and terrestrial ecosystems and their services. Activities related to coastal zone management, from coastal afforestation to protection of coastal areas, are mentioned in 8 East African NDCs. Marine Fisheries (7 countries) and the management, protection, conservation or restoration of marine ecosystems and their biodiversity (6) are also a priority actions for the coastal countries. Despite the high priority to marine fisheries and ecosystems, coastal erosion (5), sea level rise (7) and ocean acidification (2) are not broadly discussed.

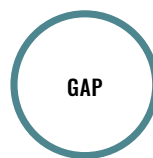
3.2.2.4 Forestry, land management and terrestrial ecosystems protection

With regard to forests management, afforestation and reforestation related measures figure the most in countries' adaptation actions (15 countries). Countries specifically refer to adjusting forest management practices (9), forest restoration (6), afforestation and reforestation (11) and fire prevention and management (4). In accordance with these proposed adaptation actions, the FAO guidelines on sustainable forest management in drylands of sub-Saharan Africa address potential forest management options based on evidence from the region. The guidelines recommend favouring forest varieties and species that are adapted or adaptable to new climate conditions, intensifying fire management systems, corridors to help species migration and forest management to reduce vulnerability (FAO, 2010).

Only one country, Uganda, highlights measures related to urban and peri-urban forestry. The urban population of Africa is projected to increase by 0.8 billion (triple in size) by 2050. Developing cities in the country are often composed of informal settlements and are largely unplanned, making them extremely susceptible to climate change impacts (Yuen and Kumssa, 2011). The relative absence of urban and peri-urban forestry highlights a major gap in Eastern Africa NDCs.

The importance of forest and land governance policies and institutions is mentioned in 11 NDCs. Land management and terrestrial ecosystem adaptation practices highlighted in the NDCs include land management and protection, including SLM, and landscape and watershed approach for land use planning (15 countries). Practices that were mentioned by less than half of the countries in the region include land rehabilitation and restoration (7) and rangeland and grassland conservation and management (5).

3.2.2.5 Livestock and pasture management



Livestock production in Africa is projected to be indirectly impacted by water scarcity through crop production. In several East African countries, maize stove availability per head of cattle is expected to decrease by 2050 (Thornton *et al.*, 2010). The literature concludes that switching from crop to mixed crop-livestock or a livestock system may be an important risk management and adaptation strategy (FAO, 2017; Jones and Thornton, 2009). Practices for the management of livestock and pastures (14 countries) are highlighted in East African NDCs. These practices include selecting more productive animals to enhance productivity, greater heat tolerance, disease resistance, fitness and reproductive traits (e.g. cross-breeding of locally adapted breeds) or switching of livestock species. Livestock and pasture management needs to be developed further as animal diseases and health responses were included by four countries and enhanced feed practices included by three.

3.2.3 Coverage of cross-sectorial adaptation measures

3.2.3.1 Research and education

The IPCC AR5 WGII emphasizes the need for increased knowledge and information sharing in Africa. The region lacks the necessary digitalized data and expertise to run climate models, exacerbated by under-resourcing of Meteorological Agencies for the collection of data. The NDCs emphasize research (14 countries) and education, awareness raising and capacity development (16). Areas of research vary significantly from one country to another: drought-resistant forest species and vulnerability and adaptation of socio-economic sectors to climate change (Burundi), ecosystem-based adaptation (Madagascar), development of vulnerability risk mapping based and better data on climate change impacts at sectorial and regional level (Uganda) and locally-specific adaptation scenarios (Zambia). The use of

local, traditional and indigenous knowledge is mentioned in seven NDCs from the region.

3.2.3.2 Monitoring systems

OPPORTUNITY

Monitoring is key to better understand, plan and review adaptation actions. While the reliability and accessibility of climate change information in

the region is essential for effective adaptation, the IPCC WGII AR5 states that at present, a national coordinating system for collating data and synthesizing actions is not in place in the region. Across the continent there is a lack of digitized climate records, under-resourcing of meteorological agencies and a lack of in-country expertise. Most of the countries plan to develop a monitoring system assessing climate change impacts (13 countries), although many refer to a system assessing the results of adaptation policies and actions in agricultural sectors (11). The definition of a clear mandate for the collection and assessment of data, as well as the timeline, as detailed by the Seychelles and Mozambique, is highly recommended to ensure a solid and operational monitoring system (IPCC, 2014b).

3.2.3.3 Disaster risk reduction and management

Disaster risk reduction/management measures for the agricultural sectors are mentioned by all East African countries. Fourteen countries plan to develop early warning systems (EWS) and 10 highlight the importance of climate information services. Other DRR/DRM measures focused on in the NDCs include investing in DRR for resilience (16 countries), enhancing disaster preparedness (15) and strengthening disaster risk governance (10) which is also discussed in monitoring section above. Initiatives in Kenya, South Africa, Swaziland, and Tanzania deploy local and traditional knowledge for disaster preparedness and risk management. The current challenges in risk reduction strategies are political and institutional translation of early warning signs into early action, conveying useful information in local languages and remote areas

and national-level mistrust in locally collected data (FAO, 2017).

3.2.3.4 Food post-harvest handling and processing

GAP

Current post-harvest losses in Africa during production, processing, transport and storage are projected to be exacerbated by climate change.

High temperatures and the potential for increased flooding in the region may increase the risk of food spoilage due to inadequate transport and storage infrastructure (IPCC, 2014b).

The importance of food post-harvest handling (6 countries) and food value-added processing and marketing (5) are measures which could be developed further in future adaptation plans by countries in the region. There is a need for increased awareness of the options for reducing post-harvest loss. Some examples mentioned in NDCs of Burundi and Rwanda include food dewatering, drying, storing and cold chain.

3.2.3.5 Insurance

OPPORTUNITY

Changes in precipitation patterns (15 countries) and drought/flooding (18) are major climate-related hazards highlighted in East African

NDCs. Storms (7) and wildfires (1) are also important climate-related hazards, but were mentioned by less than nine countries. These hazards underscore the need for insurance for agricultural practices in the region. Over half of the countries plan to develop adaptation measures related to insurance (10). Malawi's experience with index-based weather insurance to combat drought risk proved successful so far with 892 farmers purchasing the insurance in the first trial period (IPCC, 2014b). Another example in Ethiopia is the insurance for work program in which cash-poor farmers can gain insurance through engaging in disaster risk reduction products (WFP, 2011).

3.3 RECONCILING SYNERGIES AND TRADE-OFFS BETWEEN MITIGATION AND ADAPTATION

Ensuring food and nutrition security while mitigating climate change presents a major sustainability challenge in light of the multiple, and often competing pressure, on natural resources. As synergies between mitigation and adaptation are often region- and system-specific – varying according to natural resource endowments, socio-economic characteristics, political systems and stages of development – the overall challenge of climate policy will be to find the efficient mix of mitigation and adaptation solutions that increase the efficiency of resources on one hand and limit the overall impacts of climate change on agro-ecosystems and rural livelihoods on the other (FAO, 2012). The literature suggests that adaptation and mitigation in the agriculture sectors can go hand-and-hand (FAO, 2016b), as optimizing the use of natural resources and regulating carbon and nitrogen cycles through sustainable agricultural production can enhance the long-term stability and resilience of farming systems under climate variability (FAO, 2011; 2013).

However, only a few countries explicitly identified synergies (56 percent) between mitigation and adaptation in their NDCs (**Figure 48**). On the other hand, many synergistic actions were promoted separately in the respective mitigation and adaptation components, such as CSA and REDD+ being

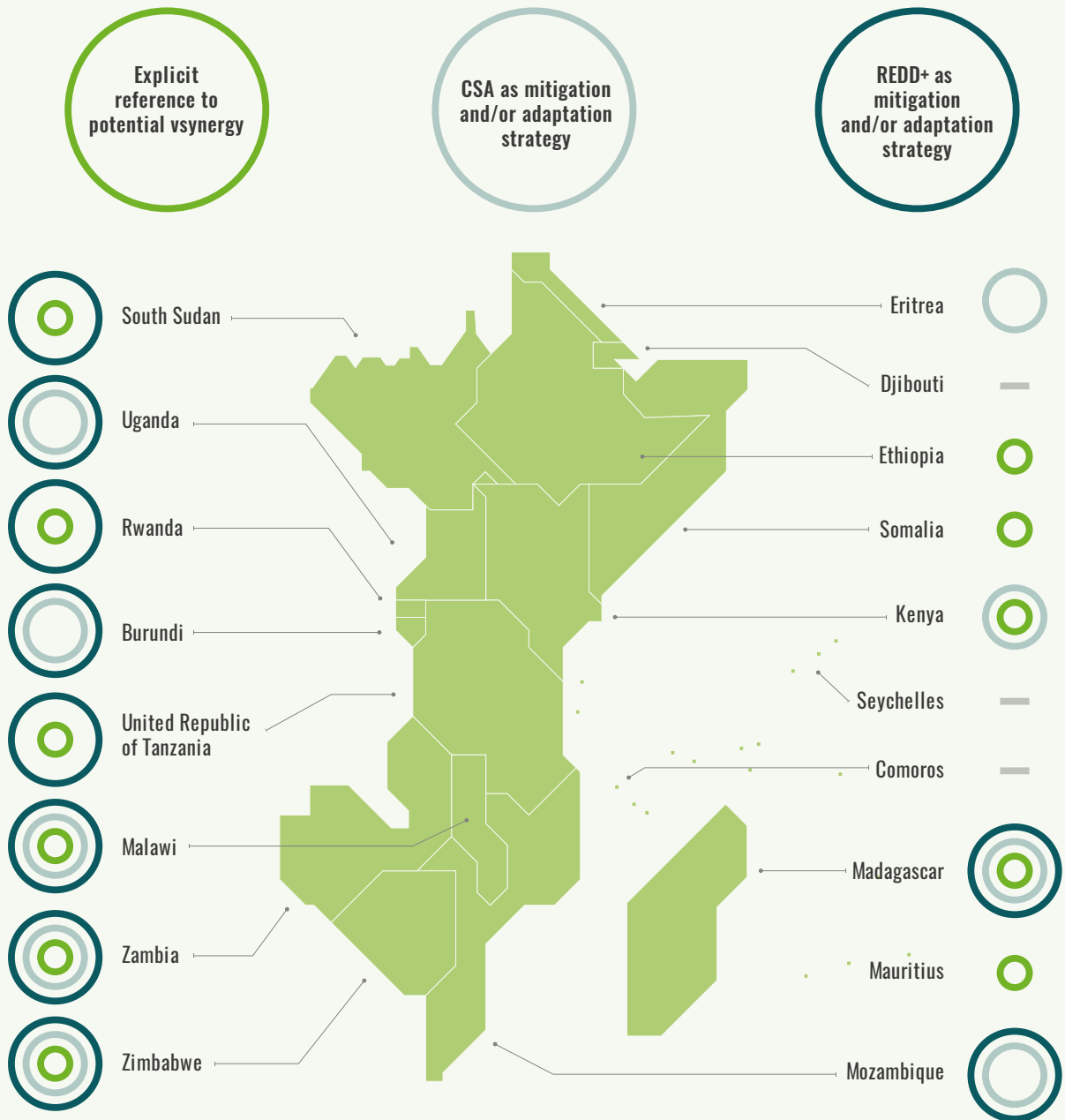
mentioned as either as mitigation and/or adaptation strategy by seven and ten out of 18 countries (39 and 56 percent, respectively) in the region, reinforcing the need to scale up such selected actions across the region to leverage their synergistic potential.

In this context, developing a framework to assess co-benefits and trade-offs could allow regulators, policy-makers and natural resource users to deliver more coherent management strategies that could improve the benefits and co-benefits at varying time and space scales. Based on a review of the established literature (Smith *et al.*, 2008; FAO, 2016c; Sanz *et al.*, 2017), and in light of the mitigation and adaptation priorities set forth in the NDCs of Eastern Africa, this section highlights a non-exhaustive set of management practices (**Table 5**) capturing synergistic adaptation and mitigation benefits of varying degree with low to moderate costs. As the appropriateness of interventions vary by local variables, including biophysical conditions, socio-economic constraints and livelihood strategies, the table below presents global evidence as a starting point for a more careful assessment of context-specific management activities that can maximize synergies between mitigation and adaptation outcomes while minimizing trade-offs amongst competing objectives. By identifying synergies in the agriculture sectors, developing countries may be able to attract more international support as an opportunity to maximize the returns on investment (FAO, 2008).

Lastly, many countries recognize the environmental, economic and socio-economic co-benefits generated by more sustainable and resilient agricultural production systems. For instance, Zambia associates sustainable forest management with increased rural household incomes, biodiversity conservation and rural poverty reduction, particularly amongst women and youth groups.

FIGURE 48.

MAPPING SYNERGIES BETWEEN MITIGATION AND ADAPTATION IN THE NDCS



Source: NDC

TABLE 4.

SYNERGISTIC MANAGEMENT PRACTICES IN LINE WITH NDC PRIORITIES

SYNERGISTIC MANAGEMENT PRACTICE	CARBON STOCK IN SOILS AND BIOMASS	NON-CO ₂ EMISSIONS	PRODUCTIVITY	WATER AVAILABILITY	
	MITIGATION		ADAPTATION		COST
SOIL MANAGEMENT					
ORGANIC FERTILIZER USE	+++	+	+	++	+
MODIFY FERTILIZER APPLICATION RATE	++	+++	++++	+++	++
NO TILLAGE	++	++	+++	++	+
BIOCHAR SOIL AMENDMENT AND MULCHING	+++	+	+++	+	++
CROPLAND MANAGEMENT					
CROP DIVERSIFICATION	+++	++	++	+++	+
MULTIPLE CROPPING, INTERCROPPING	+++	++	++	+++	+
WATER HARVESTING	++	++	+	++	+
MICRO-IRRIGATION SYSTEMS	++	++	+	++	+
GRAZING LAND MANAGEMENT					
STOCKING DENSITY	++	++	+++	++	
MANURE NUTRIENT MANAGEMENT	+++	+	+	+++	+
PERENNIAL GRASS SEED AREA	+++	++	++	+++	
IMPROVED FOODER PRODUCTION ON DEGRADED PASTURE	++	++	++	+++	+
LIVESTOCK MANAGEMENT					
IMPROVE FEED QUALITY	+	+++	+++	+	++
ANIMAL BREEDING	+	+++	++	+	+
MIXED SYSTEM MANAGEMENT					
SHEEP INTEGRATION INTO DRY GRAIN SYSTEMS	++	+	++	++	+
MULTIPURPOSE TREES ON CROPLAND	+++	++	+++	+++	+
FOREST LAND MANAGEMENT					
AFFORESTATION WITH MIXED SPECIES AT MULTIPLE SCALES	+++	++	++	++	++
WILD FIRE MANAGEMENT	++	+++	+++	++	+++
REDUCE SLASH-AND-BURN AGRICULTURE	++	+++	++	++	+
ADJUST FOREST PLANTATION ROTATION PERIOD	+++	+	++	++	+
+ = LOW OR NO IMPACT ++ = MEDIUM IMPACT +++ = HIGH IMPACT					

Source: Smith et al. 2008; FAO, 2016c; Sanz et al. 2017; and NDC

3.4 TOWARDS IMPLEMENTATION: PRIORITY AREAS FOR INTERNATIONAL SUPPORT

3.4.1 Review of support needs

Transformation to more sustainable and resilient agricultural production systems in Eastern Africa is clearly dependent on international support, as all countries in the region express support needs in the form of either technology transfer, capacity development and/or finance for implementation of their respective NDCs. A review of national capacity limits and support needs illustrates the existing gaps and barriers constraining global climate action – an informative point of reference for prioritizing areas of targeted international support.

3.4.1.1 Technology transfer

In terms of technology transfer, all 18 countries identify either a general gap or a specific need, such as the significance of improving data collection and management systems, adopting new agricultural technologies, and accessing climate information and early warning systems.

3.4.1.2 Capacity development

Overall, countries recognize how limited institutional (17 out of 18) and technical capacity (18) hinders progress towards designing, tracking and reporting mitigation and adaptation priorities, such as poor institutional arrangements (e.g. inappropriate legal frameworks) and low levels of technical

expertise (e.g. insufficient or inexistent national GHG inventories and monitoring systems).

3.4.1.3 Finance

All 18 countries make their NDCs contingent upon financial support. Seven countries¹⁴⁶ specify that their contributions are conditional to international support, while the remaining 11 plan to allocate an unconditional portion of domestic resources towards implementation (**Figure 49**). In addition, Burundi, Djibouti, Eritrea and Malawi distinguish between which contributions are conditional and unconditional, although Malawi does not report the specific cost. The cumulated costs for implementation of economy-wide mitigation and adaptation priority actions set forth in the NDCs are reported to be 515.7 billion USD, or 35.2 billion USD per year. Amongst those countries that reported costs disaggregated by mitigation and adaptation actions (**Figure 50**),¹⁴⁷ the average share of mitigation and adaptation costs is estimated to be approximately 50 percent each, ranging from less than 20 percent¹⁴⁸ in some countries to 100 percent¹⁴⁹ shares in others.¹⁵⁰

3.4.2 Areas of intervention for scaling up support

As the agriculture sectors constitute the backbone to rural economies in Eastern Africa, and the largest driver of regional GHG emissions, FAO – and other international actors – have a key role to play in supporting the transformation to more sustainable, inclusive and resilient farming systems. Addressing individual and institutional capacity gaps in the agriculture sectors, while facilitating an enabling environment for NDC implementation, is critical for ensuring robust climate action and transparent reporting of mitigation and adaptation progress under the Enhanced Transparency Framework (ETF) of the Paris Agreement.

¹⁴⁶ Mauritius, Mozambique, Rwanda, Somalia, South Sudan, United Republic of Tanzania and Zimbabwe.

¹⁴⁷ 11 out of 18 countries.

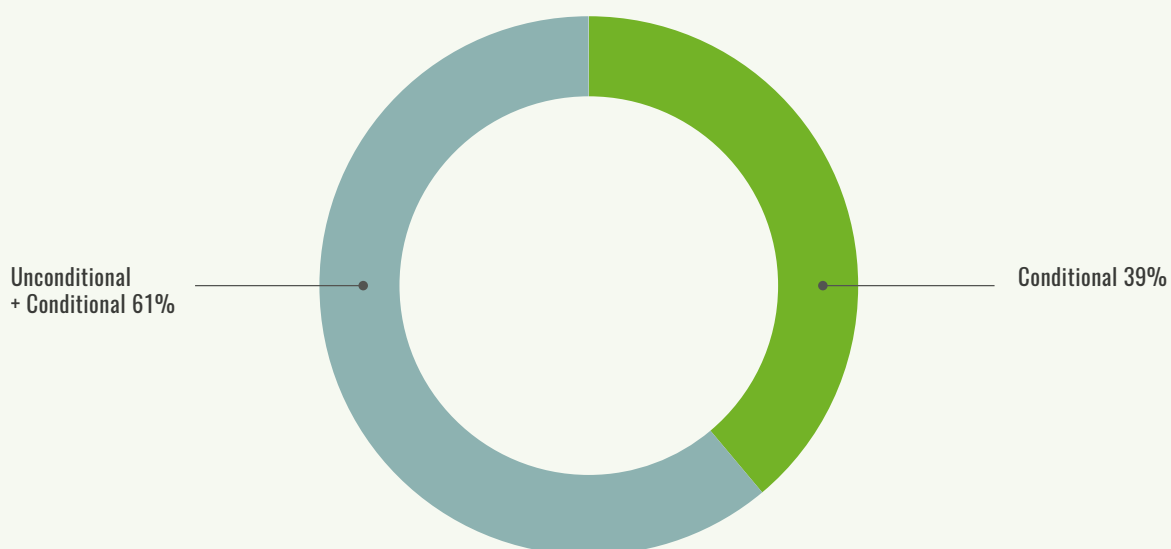
¹⁴⁸ Eritrea and Madagascar.

¹⁴⁹ Burundi.

¹⁵⁰ Country examples reflect mitigation shares.

FIGURE 49.

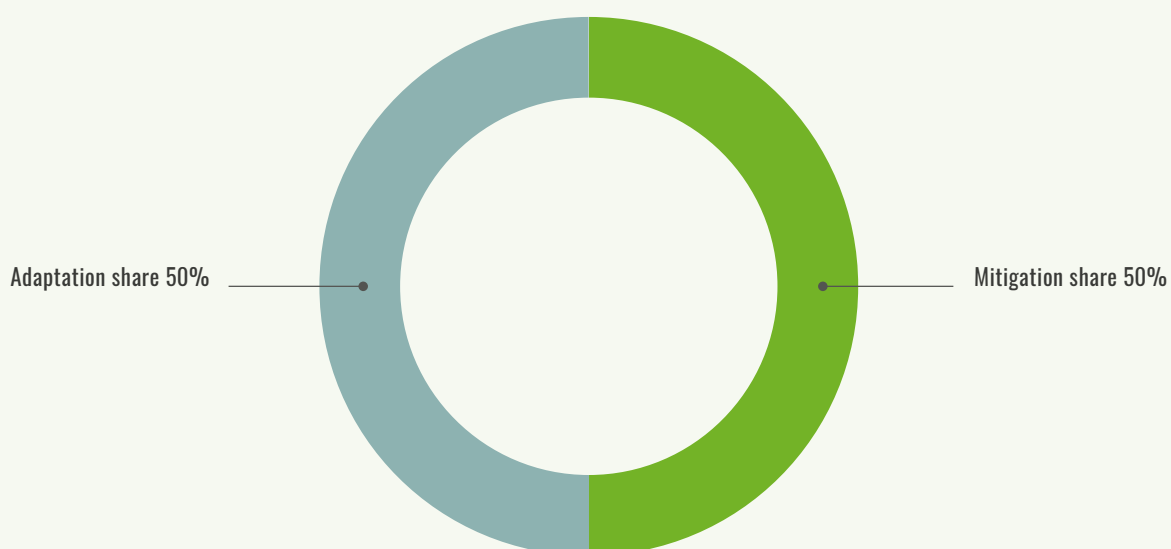
FINANCIAL CONDITION OF NDC IMPLEMENTATION, PERCENT SHARE OF COUNTRIES



Source: NDC

FIGURE 50.

SHARE OF TOTAL FINANCE NEEDS FOR NDC IMPLEMENTATION



Source: NDC

3.4.2.1 Reporting mitigation and adaptation progress under the Enhanced Transparency Framework

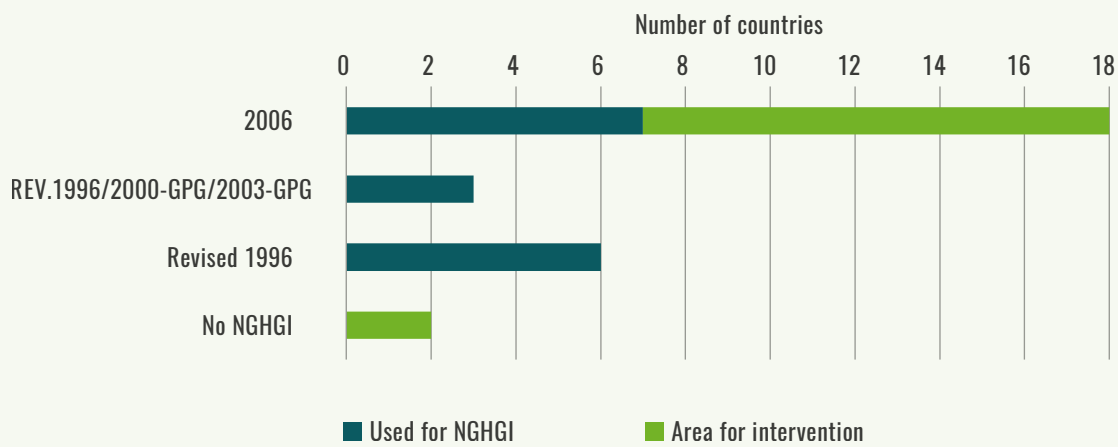
Under the Paris Agreement, Parties are to regularly track and report the progress of mitigation and adaptation priority actions towards achieving their respective NDC commitments, as provided for ETF. Specifically, the Paris Agreement requires Parties to submit:

(a) a national inventory report of anthropogenic emissions by sources and removals by sinks of GHG as part of the Biennial Update Report (BUR), prepared using *IPCC guidelines* as stipulated by Article 13; (b) information necessary to track progress made in implementing and achieving their NDCs under Article 4; and (c) information on climate change impacts and adaptation under Article 7 of the Agreement.

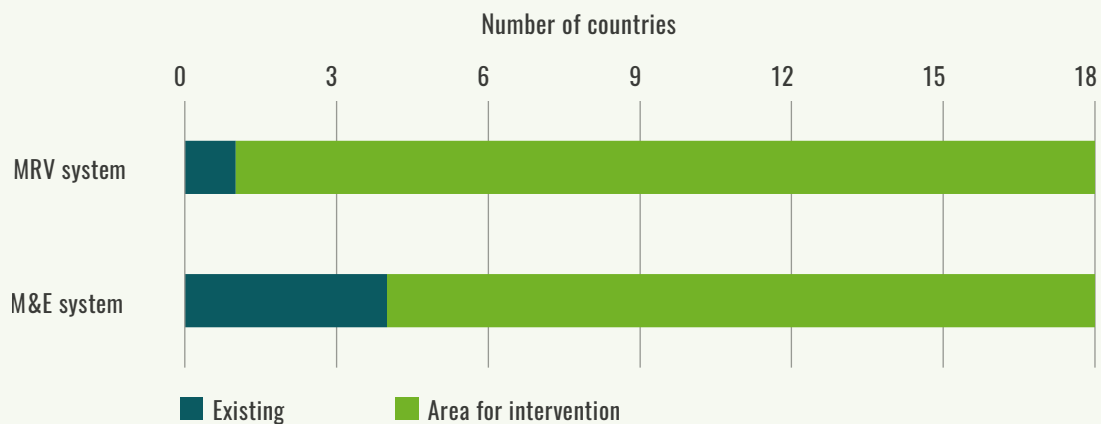
As a result, coordinated action and international support will be required to assist developing countries in their transparency-related efforts to develop NGHGs using improved data collection, management, and methodological approaches; establish domestic systems for measurement, reporting and verification (MRV) emissions and mitigation actions; enhance abilities to monitor and evaluate (M&E) adaptation measures;

and track NDC progress in the AFOLU sector.

Figure 51 illustrates that only seven out of 18 East African countries used the updated 2006 IPCC guidelines, supplement and refinement, when preparing their respective NGHGs, while **Figure 52** attests to the limited number of countries referencing domestic MRV and M&E systems in place.

FIGURE 51.**IPCC GUIDELINES USED FOR NATIONAL GREENHOUSE GAS INVENTORY**

Source: NC

FIGURE 52.**MITIGATION AND ADAPTATION REPORTING SYSTEMS IN PLACE***

Source: NDC

*As stated in NDC

3.4.2.2 Building capacity for action in the agriculture sectors

Climate action in the agriculture sectors will only be sustainable if supported by strong institutional structures and coordination mechanisms, nor will it be robust unless planned and implemented with appropriate technical expertise. All East African countries underlined capacity development needs in the agriculture sector, either in the form of institutional (94 percent) or technical capacity (100 percent) building. Therefore, strengthening the capacity of lead institutions to develop and implement NDC-related policies and programs, coordinate with sectorial line ministries, and engage stakeholders in the NDC implementation process will be critical for establishing an enabling environment (FAO, 2016f). Equally, enhancing the technical capacity of agricultural stakeholders to effectively design, implement and track NDC priority actions will require targeted support, such as interventions aiming to improve data collection practices; establish domestic monitoring systems; develop quality assessment and assurance (QA/QC) and verification processes; and design NDC improvement plans.

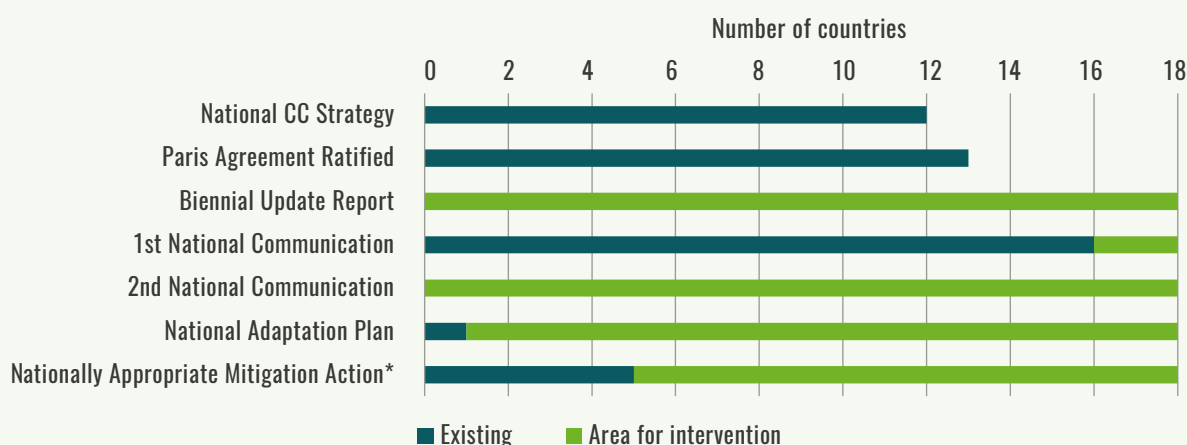
3.4.2.3 Planning for NDC implementation

With the implementation phase of the NDCs set for 2020, support for NDC planning will be key to ensuring readiness on the ground. Most countries will build on existing climate change-related plans and strategies (UNDP, 2016). Review of the region’s NDCs (Figure 53) illustrates that over two-thirds of countries have already developed a national climate change strategy or plan; 13 countries have ratified the Paris Agreement; not all countries have submitted a first NC nor have any submitted a second; and not one has submitted a BUR. On the other hand, only one out of 18 countries has submitted a NAP; while just over one-third have Nationally Appropriate Mitigation Actions (NAMA) under development in the agriculture sectors.

Mainstreaming mitigation and adaptation in national planning and policy frameworks is critical for translating the NDCs into action, as well as leveraging synergies for sustainable development objectives.

FIGURE 53.

NATIONAL PLANNING FOR NDC IMPLEMENTATION



Source: NDC, UNFCCC, NAMA AND NAP/A Registry

*Under development

3.4.2.4 Improving the knowledge base for action in the agriculture sectors

The priority of mitigation and adaptation actions in the agriculture sector depends on the availability of and access to quality data and technology. Hence, improving the knowledge base and enhancing access to updated methodologies and tools will increase opportunities for successful and cost-effective NDC implementation. The majority of countries in Eastern Africa cite the need for improved data collection, vulnerability assessment, land inventories, and climate modelling. Lastly, knowledge sharing through coordination platforms and partnerships can scale up the benefits of an improved information base, such as through the NDC Partnership.

3.4.2.5 Leveraging climate finance for NDC implementation

Given the prominence of the agriculture sectors in Eastern Africa's NDCs, mobilizing financial support through climate finance mechanisms, such as the Green Climate Fund (GCF), and other climate-related bilateral, multilateral and domestic financing is necessary for timely climate action. However, the agricultural sectors receive only a modest share of international climate finance, estimated at around 4 billion

USD in 2014 (UNDP, 2016). As the agriculture sectors hold the unique opportunity to capture mitigation and adaptation synergies through concerted priority actions, raising awareness of the potential “win-win” of climate smart investment is critical for enhancing the role of the agricultural sectors in national and international finance portfolios.

3.4.3 Conclusion

The agriculture sectors in Eastern Africa represent a pivotal opportunity for simultaneously leveraging the mitigation potential of the region, while enhancing adaptive capacity and food security outcomes through a transition to more sustainable agriculture and land use. However, change will only come about if supported by appropriate policies, institutional arrangements, capacity development and finance mechanisms. By highlighting the gaps in the coverage of mitigation and adaptation actions in the agriculture sector, as well as illustrating opportunities for enhancing climate ambitions in the next round of NDCs, this analysis can serve as an important roadmap for directing future investment and international support toward low-emission, climate-resilient and inclusive agriculture systems in the region.

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ANNEXES

ANNEX 1.

2006 IPCC LAND USE CATEGORIES, RELEVANCE TO AFOLU REPORTING GUIDELINES, REFERENCE TO 1996 IPCC GUIDELINES AND LINK TO AGGREGATED 1996-2006 GHG CATEGORY IN NDC ANALYSIS

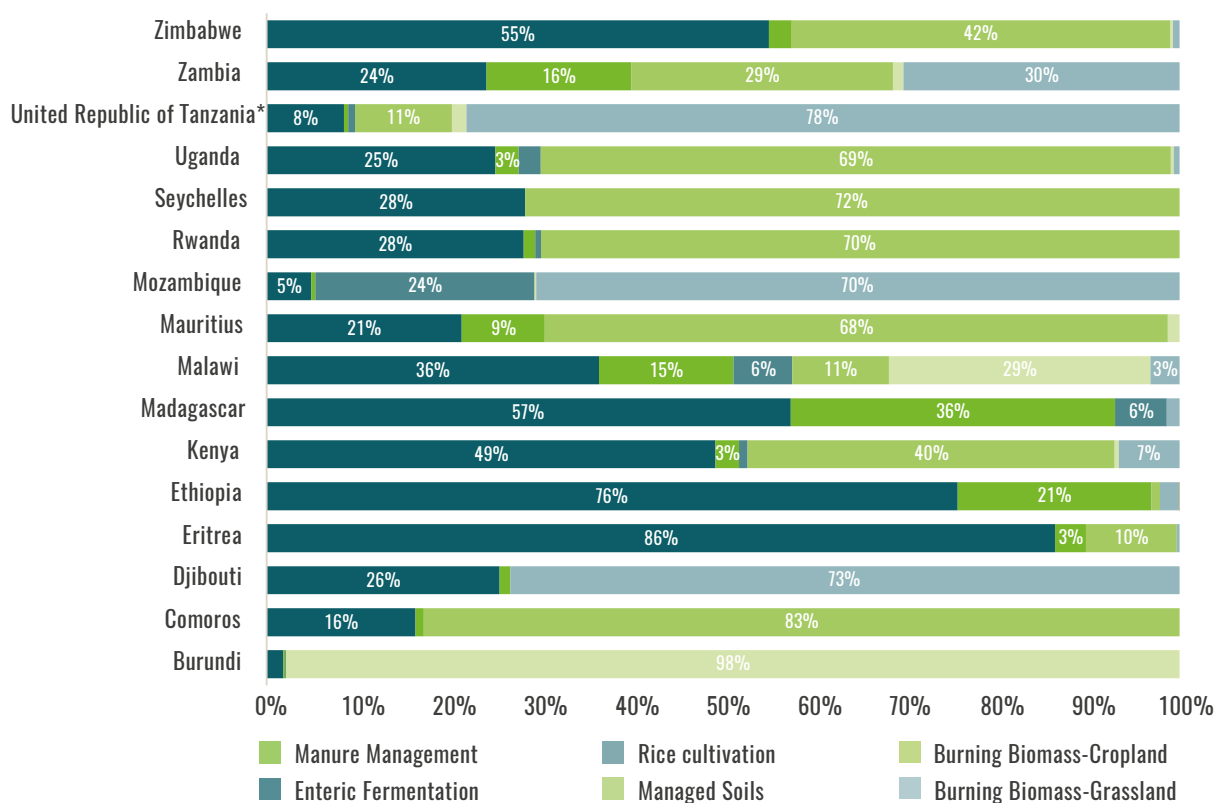
2006 GHG SOURCE AND SINK CATEGORY		1996 GHG SOURCE AND SINK CATEGORY	1996-2006 AGGREGATED GHG SOURCE/SINK CATEGORY (IN NDC ANALYSIS)	
LIVESTOCK	Enteric Fermentation	Enteric Fermentation	Enteric Fermentation	
	Manure Management	Animal Wastes	Manure Management	
AGGREGATE SOURCES AND NON-CO ₂ EMISSION SOURCES ON LAND	Direct and indirect N ₂ O emissions from managed soils	Agricultural Soils	Managed Soils	
	Indirect N ₂ O emissions from manure management	NE		
	Liming	NE		
	Urea Fertilization	NE		
	Rice cultivation	Rice Cultivation	Rice cultivation	
	Biomass burning	Field Burning of Agricultural Residues + Prescribed Burning of Savannas	Biomass burning	
LAND	FOREST LAND	Forest land remaining forest land (FF)	Changes in Forest and Other Woody Biomass	Forest land remaining forest land
			CO ₂ Emissions and Removals from Soil	
	Land converted to forest land (LF)	Changes in Forest and Other Woody Biomass + Abandonment of Managed Lands	Land converted to forest land	
		CO ₂ Emissions and Removals from Soil		
	CROPLAND	Cropland remaining cropland (CC)	Changes in Forest and Other Woody Biomass Stocks	Cropland
			CO ₂ Emissions and Removals from Soil	
		Land converted to cropland (LC)	CO ₂ Emissions and Removals from Soil	
	GRASSLAND	Grassland remaining grassland (GG)	Changes in Forest and Other Woody Biomass Stocks	Grassland
			CO ₂ Emissions and Removals from Soil	
		Land converted to grassland (LG)	CO ₂ Emissions and Removals from Soil	Forest land converted to other land
			Forest and Grassland Conversion	
	WETLANDS	Peatland remaining peatlands	Other	Wetlands
		Land being converted for peat extraction		
		Flooded land remaining flooded land		
		Land converted to flooded land		
	SETTLEMENTS	Settlements remaining settlements (SS)	Other	Settlements
		Land converted to Settlements (LS)		
	OTHER LAND	Land converted to other land (LO)	Other	Other Land

NE = not estimated under default method in the 1996 IPCC Guidelines

Source: IPCC, 1996; 2006

ANNEX 2.

SHARE OF NATIONAL AGRICULTURE EMISSIONS, PER GHG SOURCE CATEGORY

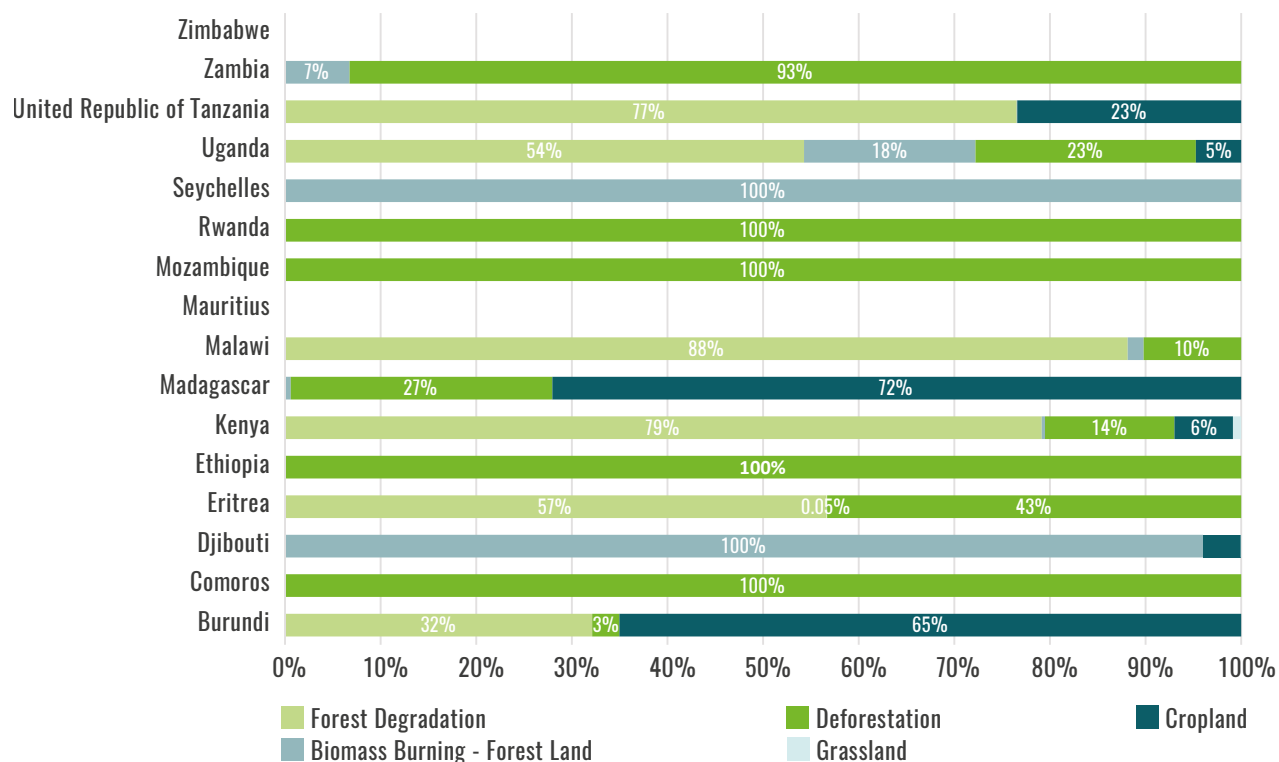


Source: National Communication (NC). Somalia and South Sudan did not submit a NC.

*Activity data value under burning savannah in the NC of United Republic of Tanzania contains high uncertainty.

ANNEX 3.

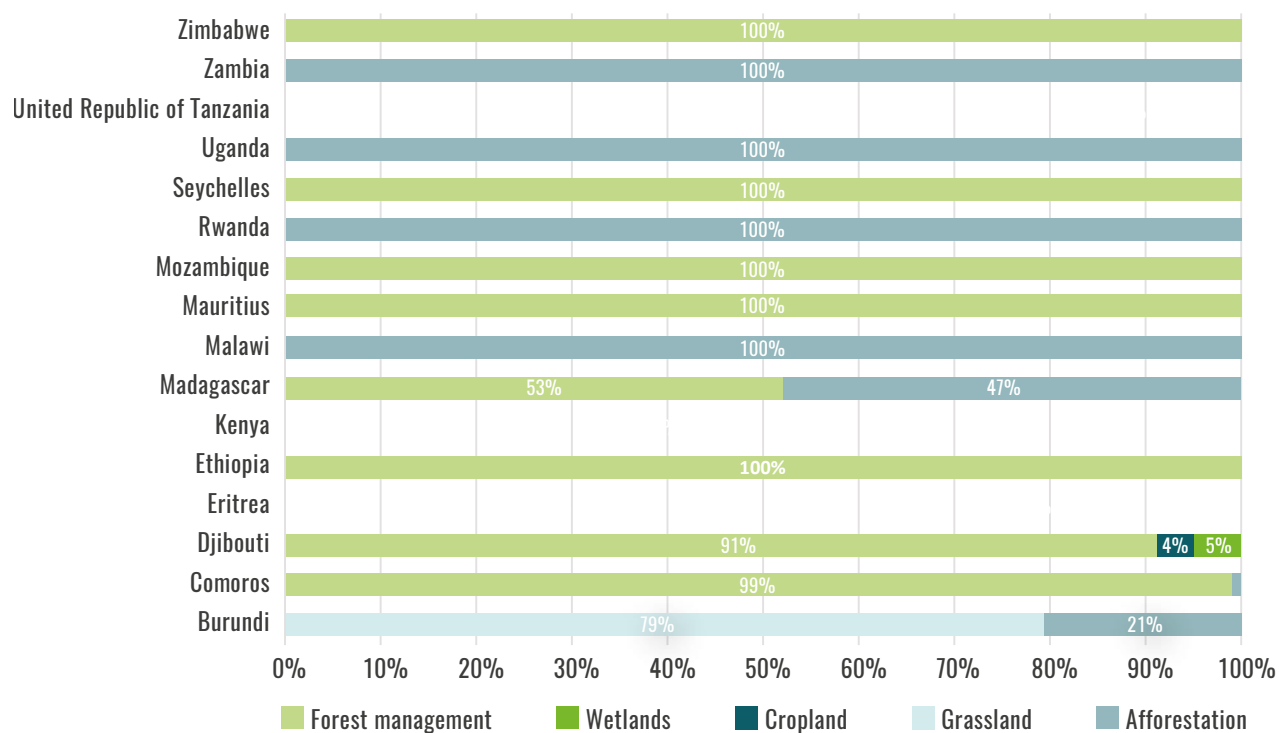
SHARE OF NATIONAL LULUCF EMISSIONS, PER LAND USE CATEGORY



Source: NC. Somalia and South Sudan did not submit a NC.

ANNEX 4.

SHARE OF NATIONAL LULUCF REMOVALS, PER LAND USE CATEGORY



Source: NC. Somalia and South Sudan did not submit a NC.

ANNEX 5.

METHODOLOGICAL MATRIX OF POLICY AND MEASURES IN THE NDCs IN RELATION TO IPCC GHG SOURCE AND SINK CATEGORIES

POLICY AND MEASURE CATEGORY	1996-2006 IPCC AGGREGATED GHG SOURCE/SINK CATEGORY												
	ENTERIC FERMENTATION	MANURE MANAGEMENT	RICE CULTIVATION	MANAGED SOILS	BURNING BIOMASS - CROPLAND	BURNING BIOMASS - GRASSLAND	FOREST LAND REMAINING FOREST LAND	OTHER LAND CONVERTED TO FOREST LAND	BURNING BIOMASS - FOREST LAND	FOREST LAND CONVERTED TO OTHER LAND	CROPLAND	GRASSLAND	WETLANDS
FERTILIZER MANAGEMENT				+									
RICE MANAGEMENT			+										
SOIL/BIOMASS MANAGEMENT				+							+		
GRASSLAND MANAGEMENT				+								+	
INTEGRATED SYSTEMS MANAGEMENT				+	+	+	+				+	+	
CROPLAND					+								
GRASSLAND					+								
FOREST LAND						+		+					
FEEDING	+												
BREEDING	+												
MANURE		+		+									
REDUCING DEFORESTATION/FOREST CONSERVATION						+			+				
SUSTAINABLE FOREST MANAGEMENT/REDUCING DEGRADATION						+			+				
AFFORESTATION/REFORESTATION										+			
REWETTING OF DRAINED ORGANIC SOILS AND PALUDICULTURE (HISTOSOLS)				+									+
LIQUID BIOFUEL PRODUCTION				+							-		
BIOGAS PRODUCTION		+									+	-	
SOLID BIOFUEL PRODUCTION											+	-	
SUSTAINABLE WOODFUEL AND CHARCOAL PRODUCTION											+	-	
IMPROVED COOKSTOVE USE									+				

+ = POSITIVE MITIGATION EFFECT - = NEGATIVE MITIGATION EFFECT + / - = EFFECT IS CONDITIONAL TO NUMEROUS VARIABLES

Source: Author's elaboration of IPCC 1996/2006 GHG source/sink categories and policies and measures (P&Ms) in NDCs.

ANNEX 6.

DEFINITIONS OF ADAPTATION COMPONENT CATEGORIES. SOURCE: AUTHOR'S ELABORATION

	CLIMATE-RELATED HAZARDS AND RISKS	TOTAL NUMBER OF COUNTRIES	PROPORTION OF COUNTRIES
OBSERVED/PROJECTED CHANGES IN METEORO-LOGICAL VARIABLES	CHANGES IN T	14	78 %
	CHANGES IN P	15	83 %
OBSERVED/PROJECTED CLIMATOLOGICAL, HYDRO-LOGICAL AND CLIMATE-RELATED BIOLOGICAL HAZ-ARDS	STORMS	7	39 %
	CYCLONE	6	33 %
	DROUGHTS	17	94 %
	FLOODS	17	94 %
	WILD FIRE	1	6 %
	PESTS AND DISEASES	5	28 %
OBSERVED/PROJECTED CLIMATE-RELATED SLOW ONSET EVENT AND RISKS	DESERTIFICATION	3	17 %
	SOIL EROSION	7	39 %
	SEA-LEVEL RISE	7	64 %
	INCREASE SEA SURFACE T	5	45 %
	OCEAN ACIDIFICATION	2	18 %
	COASTAL EROSION	5	28 %
	ICE-MELTING	0	0 %
	DRIVERS AND IMPACTS	TOTAL NUMBER OF COUNTRIES	PROPORTION OF COUNTRIES
DRIVERS OF CC VULNERABILITY (SOCIAL, ECO-NOMIC AND ENVIRONMENTAL)	ECONOMIC DEPENDENCE ON AGRICULTURE SECTORS	11	61 %
	POPULATION DENSITY OR GROWTH	5	28 %
	POVERTY AND LOW HUMAN DEVELOPMENT	9	50 %
	TOPOGRAPHY, LAND USE	8	44 %
	ENVIRONMENTAL MANAGEMENT, NRM	6	33 %
OBSERVED/PROJECTED VULNERABILITIES	POVERTY AND INEQUALITY	8	44 %
	FOOD INSECURITY /MALNUTRITION	9	50 %
	HUMAN HEALTH & LIFE INCIDENCE	15	83 %
	SOCIAL AND POLITICAL CONFLICTS	3	17 %
	MIGRATION, DISPLACEMENT	4	22 %
	HUMAN SETTLEMENT AND INFRASTRUCTURE	13	72 %
	CROP AND LIVESTOCK PRODUCTIVE ASSETS AND LIVELIHOODS	15	83 %
	LULUCF/ FOREST RESOURCES	9	50 %
	FISHERIES AND AQUACULTURE	7	39 %
	WATER RESOURCES	13	72 %
	BIODIVERSITY, MARINE AND TERRESTRIAL ECOSYSTEMS AND THEIR SERVICES	10	56 %
	GENDER IN RELATION TO VULNERABILITIES	2	11 %
	VULNERABILITY ASSESSMENTS IN GEN-ERAL/RELATED TO AGRICULTURE SECTORS TO INFORM THE INDC	11	61 %

	MAIN ONGOING AND PLANNED ADAPTATION ACTIONS	TOTAL NUMBER OF COUNTRIES	PROPORTION
CROPS AND LIVESTOCK	ADAPTED CROP VARIETIES	9	50 %
	PEST MANAGEMENT	4	22 %
	NUTRIENT MANAGEMENT	5	28 %
	ON-FARM SOIL MANAGEMENT	7	39 %
	CROP MANAGEMENT	18	100 %
	ANIMAL BREEDING	9	50 %
	ANIMAL DISEASES AND HEALTH	4	22 %
	ANIMAL AND HERD MANAGEMENT	3	17 %
	FEEDING PRACTICES	3	17 %
	PASTURE MANAGEMENT	6	33 %
	AGRICULTURAL GOVERNANCE, POLICIES AND INSTITUTIONS	3	17 %
FORESTRY, LAND MANAGEMENT AND TERRESTRIAL ECOSYSTEMS	ADJUSTING FOREST MANAGEMENT PRACTICES	9	50 %
	MAINTAINING FOREST HEALTH AND VITALITY	2	11 %
	FOREST RESTORATION	6	33 %
	AFFORESTATION / REFORESTATION	11	61 %
	FIRE PREVENTION AND MANAGEMENT	4	22 %
	PROMOTION OF URBAN AND PERI-URBAN FORESTRY	1	6 %
	RANGELAND AND GRASSLAND CONSERVATION AND MANAGEMENT	5	28 %
	OTHER TERRESTRIAL ECOSYSTEMS AND FRESH-WATER ECOSYSTEMS	13	72 %
	TERRESTRIAL AND FRESH WATER BIODIVERSITY	14	78 %
	LAND MANAGEMENT AND PROTECTION	15	83 %
	LAND REHABILITATION AND RESTORATION	7	39 %
	FOREST AND LAND GOVERNANCE, POLICIES AND INSTITUTIONS	11	61 %
FISHERIES, COASTAL ZONE AND MARINE ECOSYSTEMS	COASTAL ZONE MANAGEMENT	8	73 %
	MARINE FISHERIES	7	64 %
	INLAND FISHERIES	3	17 %
	MARINE AQUACULTURE	1	9 %
	INLAND AQUACULTURE	3	17 %
	MARINE ECOSYSTEM AND BIODIVERSITY	6	55 %
	FISHERIES GOVERNANCE, POLICIES AND INSTITUTIONS	7	39 %


WATER RESOURCES	WATER STORAGE AND HARVESTING	13	72 %
	IRRIGATION AND DRAINAGE	15	83 %
	GROUNDWATER	7	39 %
	WATER QUALITY AND POLLUTION	7	39 %
	WATER REUSE	8	44 %
	WATER GOVERNANCE, POLICY AND INSTITUTIONS	9	50 %
AGRI-FOOD CHAIN	FOOD POST-HARVEST HANDLING	6	33 %
	FOOD VALUE-ADDED PROCESSING AND MARKET-ING	5	28 %
CROSS SECTORAL	ON AND OFF-FARM LIVELIHOOD DIVERSIFICATION	9	50 %
DISASTER RISK REDUCTION/ DISASTER RISK MANAGEMENT	DRR/DRM	17	94 %
	UNDERSTANDING DRM	14	78 %
	STRENGTHENING DISASTER RISK GOVERNANCE	10	56 %
	INVESTING IN DRR FOR RESILIENCE	16	89 %
	ENHANCING DISASTER PREPAREDNESS	15	83 %
	EWS	14	78 %
GENDER	ADAPTATION MEASURES RELATED TO GENDER	11	61 %
	ADAPTATION MEASURES RELATED TO GENDER IN THE AGRICULTURE SECTORS	2	11 %
KNOWLEDGE MANAGEMENT AND EXTENSION	RESEARCH	14	78 %
	EDUCATION, AWARENESS RAISING AND CAPACITY DEVELOPMENT	16	89 %
	LOCAL, TRADITIONAL AND INDIGENOUS KNOWLEDGE	7	39 %
INSURANCE	ADAPTATION MEASURES RELATED TO INSURANCE	10	56 %
MONITORING SYSTEMS	MONITORING SYSTEM TO ASSESS THE RESULTS OF ADAPTATION POLICIES AND ACTIONS IN AGRICULTURAL SECTORS	11	61 %
	MONITORING SYSTEM TO ASSESS THE IMPACT OF CC	13	72 %
POST-HARVEST	FOOD POST-HARVEST HANDLING	6	33 %
	FOOD VALUE-ADDED PROCESSING AND MARKET-ING	5	28 %

ANNEX 7.

NATIONAL GHG HOTSPOTS IN THE AGRICULTURE SECTOR, PER GHG SOURCE CATEGORY

COUNTRY	AGGREGATED 1996-2006 IPCC GHG SOURCE CATEGORY					
	ENTERIC FERMENTATION	MANURE MANAGEMENT	RICE CULTIVATION	MANAGED SOILS	BURNING BIOMASS - CROPLAND	BURNING BIOMASS - GRASSLAND
BURUNDI	2%	0%	0%	0%	98%	0%
COMOROS	16%	1%	0%	83%	0%	0%
DJIBOUTI	26%	1%	0%	0%	0%	73%
ERITREA	86%	3%	0%	10%	0%	0%
ETHIOPIA	76%	21%	0%	1%	0%	2%
KENYA	49%	3%	1%	40%	0%	7%
MADAGASCAR	57%	36%	6%	0%	0%	1%
MALAWI	36%	15%	6%	11%	29%	3%
MAURITIUS	21%	9%	0%	68%	1%	0%
MOZAMBIQUE	5%	0%	24%	0%	0%	70%
RWANDA	28%	1%	1%	70%	0%	0%
SEYCHELLES	28%	0%	0%	72%	0%	0%
UGANDA	25%	3%	2%	69%	0%	1%
UNITED REPUBLIC OF TANZANIA	8%	0%	1%	11%	2%	78%
ZAMBIA	24%	16%	0%	29%	1%	30%
ZIMBABWE	55%	2%	0%	42%	0%	1%
NATIONAL HOTSPOT COUNT	5	0	0	5	1	5

% = SHARE OF NATIONAL EMISSIONS

 = REGIONAL GHG HOTSPOT IN AGRICULTURE SECTOR
 *IF 5 COUNTRIES REPORT 50% OF TOTAL AGRICULTURE EMISSIONS FOR GHG CATEGORY

Source: NC

ANNEX 8.

NATIONAL GHG HOTSPOTS IN THE LULUCF SECTOR, PER GHG SOURCE CATEGORY

COUNTRY	AGGREGATED 1996-2006 IPCC GHG SOURCE/SINK CATEGORY				
	FOREST LAND REMAINING FOREST LAND	BURNING BIOMASS - FOREST LAND	FOREST LAND CONVERTED TO OTHER LAND	CROPLAND	GRASSLAND
BURUNDI	32%		3%	65%	
COMOROS			100%		
DJIBOUTI		100%	0%		0%
ERITREA	57%	0%	43%		
ETHIOPIA			100%		
KENYA	79%	0%	14%	6%	1%
MADAGASCAR		1%	27%	72%	
MALAWI	88%	2%	10%		
MAURITIUS			0%		
MOZAMBIQUE			100%		
RWANDA			100%		
SEYCHELLES		100%	0%		
UGANDA	54%	18%	23%	5%	
UNITED REPUBLIC OF TANZANIA	77%	0%	0%	23%	
ZAMBIA		7%	93%		
ZIMBABWE			0%		
NATIONAL HOTSPOT COUNT	5	2	5	2	0
% = SHARE OF NATIONAL EMISSIONS					
■ = REGIONAL GHG HOTSPOT IN LULUCF SECTOR					
*IF 5 COUNTRIES REPORT 50% OF TOTAL AGRICULTURE EMISSIONS FOR GHG CATEGORY					

Source: NC

ANNEX 9.

ACCOUNTING OF THE POLICIES AND MEASURES IN THE AGRICULTURE SECTOR, AT THE NATIONAL LEVEL

COUNTRY	CROP MANAGEMENT								LIVESTOCK MANAGEMENT					INTEGRATED SYSTEM MANAGEMENT				FIRE MANAGEMENT				OTHER			TOTAL P&MS	
	FERTILIZER MANAGEMENT	RICE MANAGEMENT	SOIL/BIO MASS MANAGEMENT	LIQUID BIOFUEL PRODUCTION	SOLID BIOFUEL PRODUCTION	TOTAL BIOFUEL	TOTAL CM W/OUT BIOFUEL	TOTAL CM	FEEDING	BREEDING	MANURE	BIOGAS PRODUCTION	TOTAL LM W/OUT BIOGAS	TOTAL LM	AGROFORESTRY	SYLVO PASTORAL	ARBO RICULTURE	TOTAL IS	CROPLAND	GRASSLAND	AGRICULTURAL LAND	TOTAL FM	OTHER	TOTAL OTHER		CSA
BURUNDI	1	1	0	0	0	0	2	2	0	0	0	1	0	1	1	0	0	1	0	0	0	0	1	0	0	0
COMOROS	0	0	1	0	0	0	1	1	0	0	0	1	0	1	1	0	1	2	0	0	0	0	0	0	0	0
DJIBOUTI	0	0	1	0	0	0	1	1	1	0	1	2	2	2	1	0	0	1	0	0	0	0	0	0	0	0
ERITREA	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
ETHIOPIA	0	0	1	0	0	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
KENYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MADAGASCAR	0	1	1	0	0	0	2	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
MALAWI	1	0	1	1	0	1	2	3	1	1	1	0	3	3	1	0	0	1	0	0	0	0	0	0	0	1
MAURITIUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
MOZAMBIQUE	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWANDA	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SEYCHELLES	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOMALIA	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SOUTH SUDAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UGANDA	0	0	1	0	0	0	1	1	0	1	1	0	2	2	0	0	0	0	0	0	0	0	0	1	0	1
UNITED REPUBLIC OF TANZANIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
ZAMBIA	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1
ZIMBABWE	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	2	2	6	5	0	5	7	11	3	2	3	7	4	11	4	0	2	5	0	0	0	0	5	2	6	41

NUMBER = AMOUNT OF COUNTRIES THAT INCLUDED POLICY AND MEASURE

 = BIODENERGY-RELATED POLICY AND MEASURE

Source: NDC

ANNEX 10.

ACCOUNTING OF THE POLICIES AND MEASURES IN THE LULUCF SECTOR, AT THE NATIONAL LEVEL

COUNTRY	CROPLAND	GRASSLAND	SUSTAINABLE FOREST MANAGEMENT/REDUCING DEGRADATION										TOTAL SFM/RD	REDUCING DEForestation/ CONSERVATION	AFForestation/ REFORESTATION	WETLANDS MANAGEMENT	REDD+	TOTAL P&MS
			SOLID BIOFUEL PRODUCTION	SUSTAINABLE WOODFUEL AND CHARCOAL PRODUCTION	USE OF EFFICIENT COOKSTOVES	TOTAL BIOENERGY	SFM/REDUCING DEGRADATION	FIRE MANAGEMENT	TOTAL SFM W/OUT BIOENERGY	TOTAL SFM/RD								
BURUNDI	0	0	1	1	1	3	1	1	0	1	4	0	1	0	1	0	1	
COMOROS	0	0	0	1	1	1	0	0	0	0	1	1	1	0	0	0	0	
DJIBOUTI	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	
ERITREA	0	0	0	1	1	2	0	0	0	0	2	0	1	0	0	0	0	
ETHIOPIA	0	0	0	1	1	1	1	1	0	1	2	1	1	0	0	0	0	
KENYA	0	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	0	
MADAGASCAR	0	0	0	1	1	2	1	1	1	2	4	1	1	0	1	0	1	
MALAWI	0	0	1	0	1	2	1	1	0	1	3	1	1	0	1	0	1	
MAURITIUS	0	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	0	
MOZAMBIQUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
RWANDA	0	0	0	1	1	2	0	0	0	0	2	0	0	0	0	0	1	
SEYCHELLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SOMALIA	0	0	0	1	1	2	1	0	0	1	3	1	1	0	0	0	0	
SOUTH SUDAN	0	0	0	1	1	1	0	0	0	0	1	1	1	0	0	1	1	
UGANDA	0	0	0	1	1	1	1	1	0	1	2	1	1	1	1	1	1	
UNITED REPUBLIC OF TANZANIA	0	0	0	1	1	1	1	1	0	1	2	1	1	0	1	0	1	
ZAMBIA	0	0	0	1	1	2	1	1	1	2	4	0	1	0	1	0	1	
ZIMBABWE	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1	
SUBTOTAL	0	0	2	6	15	15	9	2	9	16	16	8	13	1	10	56		

NUMBER = AMOUNT OF COUNTRIES THAT INCLUDED POLICY AND MEASURE

■ = BIOENERGY-RELATED POLICY AND MEASURE


Source: NDC

ANNEX 11.

GAP ANALYSIS OF NATIONALLY DETERMINED CONTRIBUTIONS IN THE AGRICULTURE SECTOR

COUNTRY	REGIONAL GHG HOTSPOTS AND P&M COVERAGE IN THE AGRICULTURE SECTOR					
	ENTERIC FERMENTATION	P&M COVERAGE	MANAGED SOILS	P&M COVERAGE	BURNING BIOMASS - GRASSLAND	P&M COVERAGE
BURUNDI	0%	0		0	0%	0
COMOROS	0%	0	0.5%	1	0%	0
DJIBOUTI	0%	1		1	0%	0
ERITREA	3%	0	1%	0	0%	0
ETHIOPIA	48%	1	1%	1	1%	0
KENYA	14%	0	21%	0	1%	0
MADAGASCAR	6%	0		1	0%	0
MALAWI	1%	2	0.3%	1	0%	0
MAURITIUS	0%	0	0.2%	0	0%	0
MOZAMBIQUE	0%	0		0	2%	0
RWANDA	1%	0	5%	0	0%	0
SEYCHELLES	0%	0	0.02%	0	0%	0
UGANDA	5%	1	27%	1	0%	0
UNITED REPUBLIC OF TANZANIA	14%	0	33%	0	93%	0
ZAMBIA	2%	0	5%	0	2%	0
ZIMBABWE	5%	0	7%	0	0%	0

% = NATIONAL SHARE OF REGIONAL EMISSIONS, PER GHG CATEGORY

 = GAP IN P&M COVERAGE

*SOMALIA AND SOUTH SUDAN DID NOT SUBMIT NGHGIS THEREFORE A GAP ANALYSIS CANNOT BE PERFORMED


Source: NDC and NC

ANNEX 12.

GAP ANALYSIS OF THE NATIONALLY DETERMINED CONTRIBUTIONS IN THE LULUCF SECTOR

COUNTRY	REGIONAL GHG HOTSPOTS AND P&M COVERAGE IN THE LULUCF SECTOR					
	FOREST LAND REMAINING FOREST LAND	P&M COVERAGE	FOREST LAND CONVERTED TO OTHER LAND	P&M COVERAGE	CROPLAND	P&M COVERAGE
BURUNDI	1%	4	0.2%	0	3%	0
COMOROS		1	0.1%	1		0
DJIBOUTI		1		0		0
ERITREA	3%	2	3%	0		0
ETHIOPIA		2	29%	1		0
KENYA	9%	1	3%	0	1%	0
MADAGASCAR		4	15%	1	22%	0
MALAWI	10%	3	2%	1		0
MAURITIUS		1		0		0
MOZAMBIQUE		0	9%	0		0
RWANDA		2	0.4%	0		0
SEYCHELLES		0		0		0
UGANDA	3%	2	2%	1	0%	0
UNITED REPUBLIC OF TANZANIA	74%	2		1	23%	0
ZAMBIA		4	36%	0		0
ZIMBABWE		1		0		0

% = NATIONAL SHARE OF REGIONAL EMISSIONS, PER GHG CATEGORY

 = GAP IN P&M COVERAGE

*SOMALIA AND SOUTH SUDAN DID NOT SUBMIT NGHGIS THEREFORE A GAP ANALYSIS CANNOT BE PERFORMED

Source: NDC and NC

ANNEX 13.

ENHANCED MITIGATION POTENTIAL IN THE AGRICULTURE SECTORS FOR EASTERN AFRICA, 2016-2030

	UNCONDITIONAL MITIGATION	TOTAL MITIGATION (Gt CO ₂ eq)	Euro/t CO ₂	COST (BILLION EURO)
AGRICULTURE MITIGATION POTENTIAL		-1.88		€ -27.4
SUSTAINABLE SOIL AND IMPROVED CROPLAND MANAGEMENT		-0.05	-42.5	-23
CROP YIELD IMPROVEMENT		-0.1	10	1
IMPROVED LIVESTOCK MANAGEMENT		-0.3	45	13.1
GRAZING LAND MANAGEMENT		-0.2	1	0.2
AGROFORESTRY CONVERSION AND EXPANSION		-0.8	-23.3	-18.7
FORESTRY AND OTHER LAND USE MITIGATION POTENTIAL	-0.3	-2.7**/-4.28		€ 40.6
AVOIDED DEFORESTATION/FORREST CONSERVATION*	-0.1	-0.53**/-1.06	14	11.1
AFFORESTATION	-0.1	-0.9	11	9.6
SUSTAINABLE FOREST MANAGEMENT*	-0.2	-1.05**/-2.1	12	18.9
<i>EFFICIENT CHARCOAL PRODUCTION*</i>	-0.1	-0.5		
<i>EFFICIENT COOKSTOVES*</i>	0.0	-0.9		
<i>REDUCED IMPACT/PLANNED HARVEST*</i>	0.0	-0.7		
REWETTING OF ORGANIC SOILS	0.0	-0.3	4	1
AVERAGE CUMULATED MITIGATION POTENTIAL OF AGRICULTURAL SECTORS		-4.6**Gt CO₂eq		€ 13.2
PROJECTED CUMULATED ECONOMY-WIDE GHG REDUCTION IN THE NDC		-3.3 Gt CO ₂ eq		
ENHANCED MITIGATION POTENTIAL OF AGRICULTURE SECTORS (AS SHARE OF CURRENT NDC) 140%				
* Some mitigation actions may have overlapping impacts, which would lower total mitigation potential;				
** Assuming a 50 percent overlap of the mitigation potential amongst other actions.				

Source: Author's calculation based on national data reported in NC, NDC, national policy and global average marginal abatement cost (McKinsey & Company, 2009)



Building on FAO's global study of the Nationally Determined Contributions (NDCs) in the agriculture sectors, the Climate and Environment Division (CED) is developing a series of regional-level analyses of the NDCs to identify the current commitments, gaps and opportunities for enhancing regional mitigation and adaptation ambitions in the agriculture sectors. This report aims to guide FAO – and other international actors – committed to providing developing countries with the support required for implementing their NDCs and ensuring future commitments are transparent, quantifiable, comparable, verifiable and ambitious.

The agriculture sectors in Eastern Africa represent a pivotal opportunity for simultaneously

leveraging the mitigation potential of the region, while enhancing adaptive capacity and food security outcomes through a transition to more sustainable agriculture and land use. However, change will only come about if supported by appropriate policies, institutional arrangements, capacity development and finance mechanisms. By highlighting the gaps in the coverage of mitigation and adaptation actions in the agriculture sector, as well as illustrating opportunities for enhancing climate ambitions in the next round of NDCs, this analysis can serve as an important roadmap for directing future investment and international support toward low-emission, climate-resilient and inclusive agriculture systems in the region.

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