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CCAFS

Situational analysis study for the agriculture sector in Uganda

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Abstract

Uganda submitted its first Nationally Determined Contribution (NDC) in 2015 to the UNFCCC through which it committed to reduce approximately 22% of national GHG emissions in 2030 compared to business-as-usual of 49 million MtCO2eq. The country is currently in the process of updating its NDC in accordance with decision 1/CP.21 of the UNFCCC. As part of the process, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is leading the process of defining the sector's medium- and long-term low emissions, climate development pathway (Agricultural LTS) in order to identify concrete short-, medium- and long term adaptation and mitigation options that would inform updating of the agricultural component of the Nationally Determined Contributions (NDCs) and successive NDCs. As a precursor to the LTS, understanding the status of the sector (baseline) is critical.

This situational analysis study assessed the current status and trends of the agriculture sector in Uganda and identified opportunities to transform the sector towards a low carbon and climate resilient development pathway.

The methodological approach adopted a mix of both qualitative and quantitative methods to collect both primary and secondary data. Secondary data was obtained through extensive desk research on agriculture and its sub-sectors (crop, livestock, fisheries, forestry and agroforestry) and climate change from policy, strategy and framework documents as well as other publications and research documents relevant to the sector. Primary data on the other hand was collected basically through key informant interviews. The study had a national scope in geographical coverage and the analysis took into consideration the 10 Agricultural Production Zones (APZs) and the four water management zones (WMZ). Using well-structured tools/checklists, key informant interviews were conducted with both state and non-state actors. The key informants provided information on current efforts (policies, programs, projects) in place to address climate change, implementing institutions, coordination mechanisms, and achievements to date, challenges encountered, and possible remedies to these challenges. The main thrust, in primary and secondary data analysis, was trend analysis (for the past twenty years 2000-2010 and 2010-2020) and where possible projections for the future. The primary quantitative data was analysed and the results were

presented as tables or graphs, interpreted and conclusions drawn. Other considerations were gender differentiated impacts of climate change including gender gaps in agriculture in the context of climate change, gender analytics for CSA interventions and gender responsiveness to climate change, commodity value chains, including opportunities and challenges along the value chains (i.e. pre-production, production and post-harvest). The role of different gender categories and other social groupings in the commodity value chains were also explored. Overall, the study adopted the PESTLE analytical framework to enable macro and micro analysis of the Political, Economic, Social, Technological, Legal and Environmental (PESTLE) dimensions of agriculture to analyse the sector's responsiveness to climate change.

The findings show that trends in agricultural productivity in the country, in the last twenty years (2000-2020) show a mixed picture in that although there has been progress in increasing the yields of crops such as maize, rice, millet, simsim, cassava and sweet potatoes, the yields of crops such, cotton, coffee and bananas have been declining in recent years. The low crop productivity and low returns are tied to climate related impacts (droughts, floods, rainfall variability), poor quality agro-inputs, diminishing soil fertility, poor land management and agronomic practices, disease and pests, coupled with high harvest and post-harvest losses. In the landscapes land degradation is a major impediment to agriculture, natural resources productivity and sustainable national economic development. Around 36% of Uganda is affected by severe land degradation and 10% by very severe land degradation. These land degradation zones experience a myriad of climate related pressures and risks, coupled with other human pressures, like deforestation, wetland encroachment, etc. Climate change related impacts (droughts, excessive rain, landslides etc.) have exacerbated the situation.

Trends in livestock (2000-2020) show an increase in livestock numbers and products across all types (cattle, sheep, goats, and poultry, among others), however, productivity per unit is overall, declining and domestic and regional demand surpasses the supply. Fish statistics, during the review period, generally indicate a gradual decline in fish stocks within Uganda's lakes attributed mainly to overfishing and interference with fish breeding grounds particularly the wetlands. An improvement in enforcement, during spans of the review period, lead to cyclic fisheries recovery (e.g. during 2017-2019 period [NDP3, 2020]) and this

should be strengthened. Capture fisheries, however, can no longer meet East Africa's fish needs, whether for local consumption or export. The gap between the supply and demand of fish is likely to widen if aquaculture programmes are not strengthened i.e. if the industry is not transformed.

It is also important to note that the effects of climate change have led to changes in gender roles, consequently making some men and women take on non-traditionally prescribed roles. These include women's engagement in income generating activities to provide for their families and men's involvement in fetching water from distant places during the dry season for domestic use.

Finally, and perhaps most important to note, several policies have been enacted in the country, and particularly on climate change adaptation in Uganda. However, despite the progress so far made towards building governance systems for climate change adaptation the enforcement of policies and regulation still limits positive responses at different levels. Various reasons constrain enforcement; policies are formulated through top–down approaches, NGOs and local governments are minimally involved while local communities are largely excluded (Ampairwe et al., 2015). In addition, unclear roles among actors, weak links between different administration levels, limited human and financial resources and political interference also contribute to weak enforcement of policies and regulations. The linkages between government ministries, departments and other actors still need to be strengthened and structured.

Keywords

Uganda; sciences; policies; partnerships; agriculture; climate change; food security.

About the author

Matthias Magunda is an Independent Consultant.

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Acronyms

ACCF	African Climate Change Fund
ACF	Agriculture Credit Facility
ACTC	African Climate Technology Centre
ACTED	Agency for Technical Cooperation and Development
AEZs	Agricultural Ecological Zones
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AGI	Agro-Industrialisation
AGNES	African Group Negotiators Expert Support
ANPP	Aboveground Net Primary Productivity
APZs	Agricultural Production Zones
ASSP	Agriculture Sector Strategic Plan
AU	African Union
AWF	African Water Facility
BAU	Business As Usual
BBW	Banana Bacterial Wilt
BOU	Bank Of Uganda
CAADP	Comprehensive Africa Agriculture Development Programme
CBO	Community-Based Organization

CBSD	Cassava Brown Streak Disease
CDM	Clean Development Mechanism
CDO	Cotton Development Organization
CIAT	International Centre for Tropical Agriculture
CIF	Climate Investment Fund
CISs	Climate Information Systems
CITARD	Communication and Information Technology for Agriculture and Rural Development
CMD	Cassava Mosaic Disease
CMPs	Catchment Management Plans
COCTU	Coordinating Office for The Control Of Trypanosomiasis In Uganda
COMESA	Common Market for Eastern and Southern Africa
COP	Conference Of Parties
CSA	Climate Smart Agriculture
CTA	Technical Centre for Agricultural and Rural Cooperation
CTF	Clean Technology Fund
CWD	Coffee Wild Disease
DAES	Directorate of Agricultural Extension Services
DFID	UK Department for International Development
DLDD	Land Degradation and Drought
DLG	District Local Governments

DRR	Disaster Risk Reduction
DSIP	Development Strategy and Investment
EAC	East African Community
EADD	East Africa Dairy Development
EPRC	Economic Policy Research Centre
ENR	Environment and Natural Resources
EUS	Epizootic Ulcerative Syndrome
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FDI	Foreign Direct Investment
FEWS NET	Famine Early Warning Systems Network
FIP	Forest Investment Program
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFAR	Global Forum for Agricultural Research
GGA	Global Goal on Adaptation
GGGI	Global Green Growth Institute
GIZ	German Corporation for International Cooperation
GLEAM	Global Livestock Environmental Assessment Model
GOU	Government Of Uganda

ICPAC	IGAD Climate Prediction and Application Centre
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
IIRR	International Institute for Rural Reconstruction
IPCC	Intergovernmental Panel on Climate Change
IRA	Insurance Regulatory Authority
IRWR	Internal Renewable Water Resources
ISFL	Initiative for Sustainable Forest Landscapes
ISFM	Integrated Soil Fertility Management
KARDC	Kajjansi Aquaculture Research and Development Centre
LDC	Least Developed Countries
LDN TSP	Land Degradation Neutrality Target Setting Program
LPG	Liquid Petroleum Gas
LRA	Lord's Resistance Army
LUCF	Land Use Change And Forestry
M&E	Monitoring and Evaluation
MAAIF	Ministry of Agriculture, Animal Industry, and Fisheries
MDAs	Ministries, Department & Agencies
MDBs	Multilateral Development Banks
MDGs	Millennium Development Goals
MEAs	Multilateral Environmental Agreements

MFPED	Ministry of Finance, Planning and Economic Development
MoLG	Ministry of Local Government
MRV	Measurement, Reporting and Verification
MWE	Ministry of Water and Environment
NAADS	National Agricultural Advisory Services
NAP-Ag	National Adaptation Plan for the Agriculture Sector
NAES	National Agricultural Extension Strategy
NAFIRRI	National Fisheries Resources Research Institute
NAGRIC-DB	National Animal Genetic Resources Centre and Data Bank
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme of Action
NAPs	National Action Programmes
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NBSAPs	National Biodiversity Strategies and Action Plans
NCCP	National Climate Change Policy
NDC	Nationally Determined Contributions
NDP	National Development Plan
NEMA	National Environment Management Authority
NEPAD	New Partnership for Africa's Development
NFA	National Forestry Authority

NIPAPs	National Investment Policy for Aquaculture Parks
ODA	Overseas Development Assistance
OECD DAC	Organisation of Economic Cooperation and Development's Development Assistance Committee
OPM	Office of The Prime Minister
PESLTE	Political, Economic, Sociological, Legal, Technological and Environmental
PIDA	Programme for Infrastructural Development in Africa
PIP	Public Investment Plan
PMA	Plan for Modernisation of Agriculture
PPP	Public Private Partnership
PWDs	Persons With Disabilities
R&D	Research And Development
REDD	Reducing Emissions from Deforestation and forest Degradation
SACCOs	Savings and Credit Cooperative Organizations
SDGs	Sustainable Development Goals
SEFA	Sustainable Energy Fund for Africa
SFDRR	Sendai Framework for Disaster Risk Reduction
SLM	Sustainable Land Management
SPCR	Strategic Program for Climate Resilience
STI	Science Technology And Innovation
STISA	Science Technology Innovation Strategy for Africa

UBOS	Uganda Bureau Of Statistics
UCA	Uganda Census of Agriculture
UCDA	Uganda Coffee Development Authority
UDB	Uganda Development Bank
UIAS	Uganda Insurance Agriculture Scheme
UMDF	Urban Municipal Development Fund
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNMA	Uganda National Meteorological Authority
USAID	United States Agency for International Development
USIF-SLM	Uganda Strategic Investment Framework for Sustainable Land Management
WB	World Bank
WfAP	Water for Agricultural Production
WfP	Water for Production
WMZ	Water Management Zones
WSSP	Wetlands Sector Strategic Plan

Executive summary

Uganda submitted its first Nationally Determined Contribution (NDC) in 2015 to the UNFCCC through which it committed to reduce approximately 22% of national GHG emissions in 2030 compared to business-as-usual of 49 million MtCO2eq. The country is currently in the process of updating its NDC in accordance with decision 1/CP.21 of the UNFCCC. As part of the process, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is leading the process of defining the sector's medium- and long-term low emissions, climate development pathway (Agricultural LTS) in order to identify concrete short-, medium- and long term adaptation and mitigation options that would inform updating of the agricultural component of the Nationally Determined Contributions (NDCs) and successive NDCs. As a precursor to the LTS, understanding the status of the sector (baseline) is critical.

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Constraints to agricultural development and growth

According to MAAIF, the constraints and risks associated with the agricultural sector development and growth include:

- *Production constraints:* there are many sources of production risks and constraints to Uganda's agriculture sector. Risks may arise from climate-related factors such as erratic weather patterns and extreme weather events such as droughts and floods. Constraints may also be related to lack of or limited access to agricultural inputs for example, Uganda has a poorly developed seed sector where the informal seed system accounts for an estimated 87% of planted seed. The total demand for grain crop seed is estimated at approximately 110,580 MT, while total sales from the formal seed market account for

only 12,000MT. The supply shortages create incentives for substandard and/or counterfeit seed. Yields for maize, millet, rice, and sorghum are only 20% to 33% of the potential yield for rain fed agriculture and even less for irrigated agriculture. A major factor is the lack of good quality, higher yielding, more vigorous, drought resistant, and disease-free seeds and planting materials. Uganda also has one of the lowest fertiliser application rates in Sub-Saharan Africa, resulting in nutrient depletion and thus low crop yields. Limited availability of quality feeds also affects livestock and aquaculture production.

- *Biological and environmental risks:* A range of pests and diseases cause crop failure and livestock deaths and their effects are exacerbated by climate change. On crops they include among others - Cassava Brown Streak Virus, African Cassava Mosaic Virus, Banana Bacterial Wilt (BBW), Maize Streak Virus, MSV) etc. These affect the major food crops and hence threaten food security in Uganda. In livestock, the endemic New Castle Disease and the sporadic and cyclic outbreaks of African Swine Fever cause serious losses in poultry and pigs, respectively. Other diseases such as foot and mouth disease (FMD), Bovine Pleuropnemonia, East Cost Fever (ECF) although largely managed by routine vaccinations they still occur and cause widespread losses in livestock.
- *Marketing constraints:* Uganda experiences high price fluctuations on account of relying largely on weather conditions for production (rain fed production), low levels of stocks, low level of organization of producers in the value chain, and segmentation of regional and domestic markets. Additionally, the country lacks price stabilization mechanisms. Increasing food prices erode people's purchasing power, especially among low income groups causing serious implications for food security. Grain trade and agro-processing play a crucial role in the national economy, but the sector currently faces challenges such as inadequate supply due to lower production, the volatility of agriculture commodity prices and inadequate storage facilities. In order to increase agricultural production and address post-harvest challenges, Uganda ministry of trade, industry, and cooperative introduced "The National Grain Trade Policy" in 2016 which is in line with Uganda's Vision 2040 and the National Development Plan II in improving the food security, income generation and advancement of industrialization.
- *Logistical and infrastructural risks:* The lack of sufficient storage capacity both at farm level and agricultural produce trading system levels, coupled with inability to construct

durable and weather tight stores, leads to high losses due mainly to damage by pests and poor handling prior to storage. There is an estimated 550,000 MT storage capacity but the estimated demand for storage facilities is estimated at 2.3 million MT and yet up to 20% of what is harvested is lost during storage. There are also inadequate cooling facilities for fish and milk, leading to substantial losses.

- *Weak enabling environment:* The legal environment for the agricultural sector is conducive but implementation of many initiatives has been poor in the past due to inadequate institutional arrangements and financial resources to invest in enforcing the policies.
- Gender constraints*:* The differentiated impacts of climate change and differentiated access to production resources and inputs by men and women, including extension, information, and climate finance, results in gender-related productivity gaps in agriculture. In most cases external resources and technical assistance is directed towards men, even though women are responsible for the bulk of agricultural work. Women are also accorded minimal rights compared to men especially when it comes to land access, tenure rights and security. This has been noted a barrier to adoption of sustainable agricultural practices, hence the need to review customary and statutory provisions governing the rights and security of tenure using a gender lens.

To address those challenges in NDP 3 (2020-2025) emphasis in the agriculture sector has been put on Agro-Industrialization (AGI) given the dominance of agriculture as a source of livelihood, AGI offers a great opportunity for Uganda to embark on its long-term aspiration of increasing household incomes and improving the quality of life. First, AGI presents an avenue for promoting inclusive and equitable growth. Second, Uganda has a positive trade balance in agro-industrial products. Third, it provides an opportunity to add value to agricultural raw materials in order to promote export expansion of high value products. Fourth, it provides an opportunity for import substitution. Fifth, it provides an opportunity to address the high post-harvest losses, minimize losses to disasters, stabilize prices and increase household incomes. Additionally, the backward and forward linkages between agriculture and agro-industries will necessitate that Uganda sustainably transform agro-

value chains to ensure sufficient supply for domestic industries to undertake transformative sustainable manufacturing while creating employment for its citizens (NDP 3)

Additionally, four areas for immediate attention, to spur agricultural growth, have been identified (WB, 2018):

- **Fostering sustainable agricultural total factor productivity growth.** To increase agricultural productivity, providing effective advisory (extension) services to smallholder farmers is important to enable them adapt quickly to new production technologies, regulate the markets for agricultural inputs to ensure their quality, and to help smallholder farmers to access inputs through targeted mechanisms, such as e-vouchers.
- **Promoting commercialization of agriculture, and private sector led value addition and trade.** Smallholder farmers need to be assisted to invest in agriculture as a business, meaning producing surplus for the markets, to improve their incomes and livelihoods. To achieve this, access to markets and agro-processing facilities is key through their farmer or producer organizations.
- **Building resilience to agriculture production systems and managing related risks – climate change, disease and pests.** Investing in irrigation and water harvesting technologies to combat climate variability and climate change is critical; as well as putting in place early warning systems (EWS) and emergency response mechanisms (ERM) for managing disasters, such as droughts, floods, and outbreak of pests and diseases.
- **Improving policy and regulatory environment and strengthening institutions.** To attract private investments in the agriculture sector, the government needs to create an enabling business environment. This include addressing institutional capacity gaps at the national and district level, so that they are able to provide advisory and regulatory services; and adopting policies that will enhance competitions in the input (particularly seeds and fertilizers) and output markets, as well as value addition or agro-processing.

Recommendations

Crops

- Promote and encourage highly adaptive and productive crop varieties and cultivars in drought prone, flood-prone and rain-fed crop farming systems
- Promote and scale up CSA and ecologically compatible cropping systems to increase resilience to the impacts of climate change.
- Strengthen **r**esearch into climate smart and sustainable agricultural practices, including dissemination of good practices;
- Promote irrigated agriculture by encouraging irrigation systems that use water sustainably
- Promote and encourage agricultural diversification, and improved post-harvest handling, storage and value addition in order to mitigate rising climate related losses and to improve food security and household incomes.
- Support community-based adaptation strategies through expanded extension services and improved systems for conveying timely climate information to rural populations for enhanced climate resilience of agricultural systems

Livestock

- Promote more productive livestock production systems through adoption of higher yielding breeds, intensive management systems, improved availability of quality animal feeds (establish fodder grasses and legumes), better animal health (regular vaccination), pest and disease management, and intensive husbandry practices (zero grazing) systems to minimize GHG emission and better resilience against climate induced stress.
- Promote and encourage highly adaptive and productive livestock breeds.
- Promote sustainable management of rangelands and pastures through integrated rangeland management.
- Climate change impacts could partly be mitigated by keeping larger stocks of fodder and feeds, and developing water-harvesting and storage facilities.
- There is great potential for use of concentrate feeds in Uganda. To enhance this, there is a need to put in place the necessary technical, policy and institutional structures to ensure access to and high quality of affordable feed concentrates.

- Improve marketing of livestock products at all levels, from the farmer through transporters, processors so as to meet the quantity, quality and timeliness demanded by the different market niches.

Fisheries

- Promote recovery of depleted stocks of the large commercial fishes;
- Promote commercial aquaculture;
- Develop infrastructure along the value chain;
- Strengthen monitoring and enforcement on all water bodies;
- Control invasive weeds
- In order to promote adaptation at the beginning of the fish value chain, support is needed to ensure physical capital is insured against extreme weather events.
- Strengthen livelihood diversification support for fishing communities to promote adaptability of the entire sector to climate change and variability
- Promote public and private research into seed and alternative feeds for aquaculture;
- Promote and encourage climate change resilient fishing practices;
- Promote and encourage collaborative and participatory management of aquatic ecosystems;
- Promote awareness of the climate change–related impacts on fisheries amongst the various stakeholders, such as local communities, resource managers and policy makers;
- Provide economic incentives to diversify livelihood options in order to reduce dependence on climate-sensitive fisheries resources.

Landscapes/agroforestry and land resources

- Identify and map the GHG emission hotspot landscapes.
- Promote both below and above ground carbon sequestration. However, the current soil maps are still coarse. There is therefore need develop high resolution soil maps and determine their sequestration potential in order to support adaptation and mitigation efforts.
- Promote the use of earth observation (EO) tools for landscape monitoring and evaluation of climate adaptation and mitigation and land degradation neutrality actions.

- Monitor and control soil, runoff and nutrient losses from different ecosystem through promotion of efficient SLM.
- Promote on-farm tree planting in the landscape, particularly indigenous multi-purpose species that at least maintain crop yield and have other environmental benefits.
- The distinctive diversity of the different agro-ecological zones and WMZ are valuable environmental assets, contributing to the quality of life in different parts of Uganda. Therefore, the protection and improving the quality of these landscape features and patterns should be encouraged.
- Most sensitive landscapes should be protected and more positive management actions promoted, targeting environmental enhancement and restoration.
- Uganda has developed various policies and strategies, however, there is need to monitor regularly the impacts of the different policies in terms of protecting, conserving and enhancing landscape character, quality and diversity. A framework for monitoring landscape change should then be developed.
- Forests are an essential solution to climate change adaptation and mitigation, however, areas for forest plantation need to be judiciously identified for maximum benefits in all sectors. This will also require strengthening strategic partnerships among sub-sectors, and engagement with all key stakeholders including the local communities.
- WMZs present huge opportunities for making policy-relevant contributions to integrated land management approaches and strengthening the collaboration with policymakers. However, dialogue and experience sharing between WMZ is important.

Cross-cutting initiatives/recommendations

- Agricultural Insurance - Develop innovative insurance schemes (low-premium micro-insurance policies) and low-interest credit facilities to insure farmers against crop failure and livestock loss due to droughts, pests, floods and other weather-related events.
- Training youth in agro-enterprise development.
- Identifying youth champions and targeting them to serve as role models.
- Training youth in farming as a business and identifying linkages to agribusiness incubators and financing.
- Promoting youth participation in small-scale value addition and processing.

- Promoting utilisation of the youth livelihood fund and other funds targeting youth by profiling and supporting the youth to develop agricultural enterprises.
- Capacity building, technology transfer and finance, including for women and youth.
- Considering the leading role women play in farming activities, gender must be explicitly incorporated into climate change adaptation and access to services including information, extension, climate finance, and inputs.
- Strengthen the capacity of the planning, monitoring, and supervision team of MAAIF in order to enable it to undertake proper supervision of the services delivered by the various agencies within the sector and at the local government level.
- Devise innovative climate finance approaches that can raise capital and drive down mitigation costs by harnessing the capacity of the private sector to deliver climate investments.
- Strengthen public-private partnerships.
- Promote and encourage the mainstreaming of gender considerations in climate change issues.

Introduction

Background and context

Uganda is located in East Africa between 1º N and 4º N latitude, and 30º E and 35º E longitude, extending on a surface area of about 241,139 square kilometres. Uganda is a landlocked country and borders Tanzania and Rwanda to the south, DRC Congo to the west, Sudan to the north, and Kenya to the east. It has a population of approximately 42.72 million with an annual population growth rate of 3.24%. At this growth rate, the country's population is expected to double by 2050.

The country lies within an equatorial climate that is relatively humid but its topography, large water bodies and prevailing winds cause large differences in rainfall patterns across the country. The country receives average rainfall ranging from 800mm to 1500mm, with the southern part of country experiencing two rainfall seasons (March to May and September and November) and the northern part one season (April to October). Average daily temperature is about 28^{o}C but varies with altitude (Uganda Climate Change Profile, 2018).

Agriculture is the backbone of Uganda's economy and the largest provider of employment to the Ugandan workforce. The sector contributes about 24.7% to the national gross domestic product (GDP), 80% to the total export earnings and employs 72% of the work force (MAAIF, 2016). The sector is also the source of raw materials of the country's industrial activity as most industries are agro-based, generating approximately 60% of the entire manufacturing sector. Agricultural production is dominated by smallholder subsistence farmers engaged in production of food and cash crops, horticulture, fishing and livestock farming, and contributing 75 - 80% of the total agricultural output and marketed agricultural produce (FAO, 2018). The agricultural production system in the country is largely rainfed and therefore sensitive to climate change. Crops are the most dominant sub-sector of agriculture. Most farmers grow bananas, maize, beans, simsim, cassava, sweet potatoes and groundnuts. A smaller proportion of smallholder farmers grow cash crops, mainly coffee, cotton, sugarcane, tea and cotton. About 60% of households engage in livestock production with cattle, sheep, goats and chicken being most common (World Bank, 2018)., Fishing is also a key economic activity in most of the country's water bodies, with fisheries export being one of the non-traditional export commodities for Uganda.

Trends in agricultural productivity in the country show a mixed picture in that although there has been progress in increasing the yields of crops such as millet, simsim, cassava and sweet potatoes, the yields of crops such maize, cotton, coffee and bananas have been declining in recent years. Trends in livestock shows an increase across all types (cattle, sheep, goats, poultry among others), however, domestic and regional demand surpasses the supply. Fish statistics generally indicate a gradual decline in fish stocks within Uganda's lakes attributed mainly to overfishing and interference with fish breeding grounds particularly the wetlands.

Climate change presents a serious threat to agricultural production systems in Uganda. Projections downscaled for the 2015-2045 period show a warming trend of more than 2°C increase by 2030 and a 1.4°C -4.2°C increase by the end of the century. Extreme weather events characterized by floods, droughts and landslides are also expected to continue increasing. The impacts of climate change interacting with poverty, low rural incomes, lack of income diversity and heavy dependence on rainfed agriculture will have serious implications for the economy, livelihoods and food security (Uganda Climate Change Profile, 2018). The adverse impacts of climate change have been indicated to affect agricultural production in a number of ways including: declining the area suitable for crop cultivation, drop in yield potential, the frequency and severity of extreme events (droughts and floods) increased incidence of pests and diseases and increased heat stress (MAE, 2015). Additionally, the differentiated impacts of climate change and differentiated access to production resources and inputs by men and women results in gender-related productivity gaps in agriculture.

Ugandan women account for more than 60% of all food production and are especially vulnerable to the impacts of climate change because of their dependence on natural resources and agriculture for the livelihoods of their families. The challenges they face are compounded by unequal access to production resources, limited decision making power and mobility particularly in rural areas.

Source: MWE SPCR, 2017

Uganda's contribution to the total global GHG emissions is insignificant (0.099%) ranking 176 of 188 countries in per capita emissions. In spite of its low emissions, the country remains highly committed to the global efforts of addressing climate change. The country has put in place macroeconomic and sectoral policies to address the negative impacts of climate change. These include: Uganda Vision 2040, National Agriculture Policy; the Agriculture Sector Strategic Plan (ASSP) (2015 – 2020); National Agricultural Extension Strategy (NAES) 2016/17 – 2020/2021; Plan for Modernisation of Agriculture (PMA), Uganda Climate Smart Agriculture Country Programme (2019-2030), National Climate Change Policy (NCCP), National Adaptation Programme of Action (NAPA), the National Adaptation Plan for Agriculture Sector (NAP-Ag) and the Nationally Determined Contribution (NDC).

This situational analysis report assesses the current status and trends of the agriculture sector in Uganda and identifies opportunities to transform the sector towards a low carbon and climate resilient development pathway: This report is organized in 10 chapters:

- Chapter 1 gives the background, context of the study and summarizes the approach and methodology used in the study.
- Chapter 2 elaborates the status and trends of the main sub-sectors in the agriculture sector.
- Chapter 3 gives an analysis of the impacts of climate change on agriculture and adaptation response measures.
- Chapter 4 elaborates the mitigation potential of the agriculture sector
- Chapter 5 deals with the enabling policy environment.
- Chapter 6 gives an account of research efforts, data, knowledge, and information management.
- Chapter 7 summarizes issues related to governance and performance measurements.
- Chapter 8 analyses the transformation agenda that will lead the country towards low carbon, climate resilient development.
- Chapter 9 provides an analysis of finance and investments in the agriculture sector.
- Chapter 10 presents conclusion and recommendations and charts the way forward.

Methodology of the study

Desk review

The methodological approach adopted a mix of both qualitative and quantitative methods to collect both primary and secondary data. Secondary data was obtained through extensive desk research on agriculture and its sub-sectors (crop, livestock, fisheries, forestry and agroforestry) and climate change from policy, strategy and framework documents as well as other publications and research documents relevant to the sector. The desk research gathered information on agricultural sector value chains, trends in different sub-sectors and their contribution to national GDP, household incomes and overall livelihoods. Information also collated the impacts of climate change on the different sub-sectors as well as the adaptation and mitigation responses that have been implemented. Additional data on knowledge and information management, governance and performance measurement in the sector was collected. Data on finance and investments (from both public and private sectors) into Uganda's agriculture sector was also collected as well as climate finance from multilateral, bilateral and other sources.

The major sources of data included relevant national and district local government agriculture departments and actors. It also included regional and global agricultural institutions relevant to Uganda that are custodians of the different policies, strategies and framework documents. The internet was also an additional data source particularly with regards to publications and research documents by various institutions such as the World Bank, USAID, AfDB, NEPAD and others that have undertaken studies on agriculture and climate change.

Interviews

Primary data on the other hand was collected basically through key informant interviews. The study had a national scope in geographical coverage and the analysis took into consideration the 10 Agricultural Production Zones (APZs) and the four water management zones (WMZ). Using well-structured tools/checklists, key informant interviews were conducted with both state and non-state actors. The key informants provided information on current efforts (policies, programs, projects) in place to address climate change, implementing institutions, coordination mechanisms, and achievements to date, challenges encountered, and possible remedies to these challenges. The effectiveness of different

policies on the resource use, opportunities and challenges of inclusive governance was assessed to draw recommendations to strengthen climate change governance.

Data analysis

The main thrust, in primary and secondary data analysis, was trend analysis (for the past twenty years 2000-2010 and 2010-2020) and where possible projections for the future. The primary quantitative data was analysed and the results were presented as tables or graphs, interpreted and conclusions drawn. Other considerations were gender differentiated impacts of climate change including gender gaps in agriculture in the context of climate change, gender analytics for CSA interventions and gender responsiveness to climate change, commodity value chains, including opportunities and challenges along the value chains (i.e. pre-production, production and post-harvest). The role of different gender categories and other social groupings in the commodity value chains were also explored. This review facilitated a synthesis of the impact of climate change on women, based on their roles in the production, post-harvest, processing and marketing of different enterprises. From this synthesis, strategies to reduce climate change impacts on vulnerable categories such as women were identified.

Additionally, the study adopted the PESTLE analytical framework to enable macro and micro analysis of the Political, Economic, Social, Technological, Legal and Environmental (PESTLE) dimensions of agriculture to analyse the sector's responsiveness to climate change. This analysis assessed how these specific components are interacting and influencing each other in the wider agriculture sector in Uganda.

A national stakeholders' workshop was held to validate the draft Situation Analysis Report of the Agriculture Sector in Uganda.

Limitations of this study

The time allocated for the completion of the assignment was one month , from 1st to 31st May, 2020. The short period compounded with the COVID-19 lockdown had serious implications on the delivery of the assignment especially on stakeholders' consultations.

Status and trends of the agriculture sector

Overview

Uganda's economy is primarily agrarian with the agriculture sector contributing about 24.7% of total national GDP and 54% of the country's export earnings (UBOS, 2018). There has been a remarkable decline of agriculture's contribution to GDP from approximately 50% in 1995 to the current levels of 24.7% in 2020. The crops sub-sector is the most dominant, contributing 13.8% to the GDP followed by livestock sub-sector (4.3%), forestry (3.9%) and fisheries (1.6%). The agriculture sector provides employment for three quarters of the population aged between 15 and 24 years. About 78% of Uganda's population lives in the rural areas, with farming being the main economic activity. In addition, the country's manufacturing sector is dominated by agro-processing, which accounts for over 60% of the total output. Furthermore, the strong gains made in poverty reduction from the 1990s up to 2013 were as a result of agricultural income growth (Cooper, 2018).

Agricultural production in Uganda is primarily rain-fed and practiced by small-holder farmers who own less than 2.5 hectares of land. According to the Uganda Bureau of Statistics (UBOS, 2019), the five years prior to 2017 exhibited rapid growth in manufacturing augmented by the food processing sub-sector, particularly for meat, fish, dairy and edible oils, with an average annual growth of about 6%. Further, demand for food has been rising due to high population growth (3.2% per annum), rapid urbanisation (5.4% urban population growth per annum) and income growth causing dietary shifts and increased demand for high value and processed foods such as meat, fish, milk and eggs. However, demand for staple food grains, root crops and legumes on the other hand are growing at a slower pace relative to income growth. Fowler and Jakob (2019) predict that these trends are expected to intensify in the future. The challenges experienced by smallholder farmers in Uganda that are a hindrance to realization of the sector's full potential include: low access to quality agricultural inputs, markets and agricultural support resources such as credit and suffer from unreliable and erratic weather patterns. All these factors interact to affect food and nutrition security, livelihoods, and socio-economic development in Uganda (MAAIF, 2015).

Status and trends in agriculture sub-sectors

Uganda has a diverse agricultural production system (GoU, 2004) within 10 agricultural production zones (APZs) (Fig. 1). The zones are characterized by different farming systems determined by soil types, climate, topography and socio-economic and cultural factors.

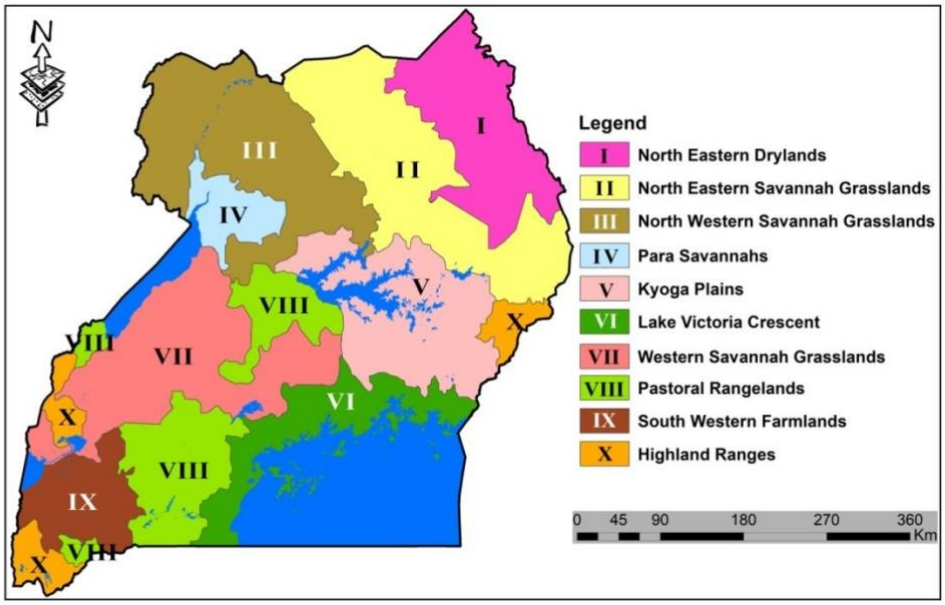


Figure 1. The Agricultural Production Zones in Uganda (GOU, 2004).

There are four major agricultural sub-sectors namely: crops, livestock, fisheries and forestry. The crops sub-sector is the most dominant. Key categories in the crops sub-sector include cereals, pulses, roots and tubers, oil crops and plantains. The livestock sub-sector is characterized by cattle (beef & dairy), poultry, pig, sheep and goats. The fisheries sub-sector comprises both capture fisheries from Uganda's large water bodies and aquaculture production. The majority of Uganda's farming systems practice agroforestry.

Crop sub-sector

Uganda grows several food crops of which 15 are major[1] according to the Uganda Census of Agriculture (UCA) 2008/09. These include: **Cereals** (Maize, Millet, Rice, Sorghum); **Root crops** (Cassava, Irish potatoes, Sweet potatoes); **Pulses** (Beans, Cow peas, Field peas, Pigeon peas); **Oil crops** (Groundnuts, simsim, Soya beans) and **Plantains** (Table 1). Food crops contribute substantially to the national GDP. For instance, during the fiscal year 2018/19, food crops accounted for 10.5% of the GDP (UBOS, 2019), leading all the other sub sectors in

[1] Widely grown and some being staples

agriculture, forestry and fisheries and only third to services (43.3%) and manufacturing (27.1%) overall.

Trends of land area planted with food crops

In a 20 year period (from 1998 to 2017), the land area under maize, sorghum and groundnuts steadily increased, the area planted with field peas was almost the same, and the area planted with cassava was almost the same in the 20-year period apart from a period of four years (2012-2015) when it increased remarkably. The area of land under 10 of the major crops (paddy rice, millet, beans, cow peas, pigeon peas, sweet potatoes, Irish potatoes, banana, sim sim and soybean) had almost the same pattern, with a steady increase from 1998 to 2007 followed by a sharp drop of the annual average between 2008 and 2018.

Table 1. Area planted and production of food crop (group) in 2018.

Food crop (group)	Area (ha)	Production (MT)
Cereals	1,817,590	3,733,034
Pulses	727,119	1,078,221
Roots and tubers	902,421	4,363,722
Plantains	885,567	3,959.20
Oil crops	721,968	411,243

(Data source: FAOSTAT, 2020)

Cereals: In 2018 the total land area under cereals was 1,817,590 ha with 62% planted with maize and 25% with sorghum. Since 1998, there has been a steady increase in the land area planted with maize and sorghum (Fig. 2). The land area planted with paddy rice doubled from 64,000 ha in 1998 to the peak of 128,000 ha in 2008 before it drastically dropped to 86,000 ha in just one year and has averaged 92,582 ha between 2009 and 2018. The land area planted with millet was on average 404,400 ha between 1998 and 2007, but this plummeted to an average of 172,771 ha between 2008 and 2018, a decrease of 57%.

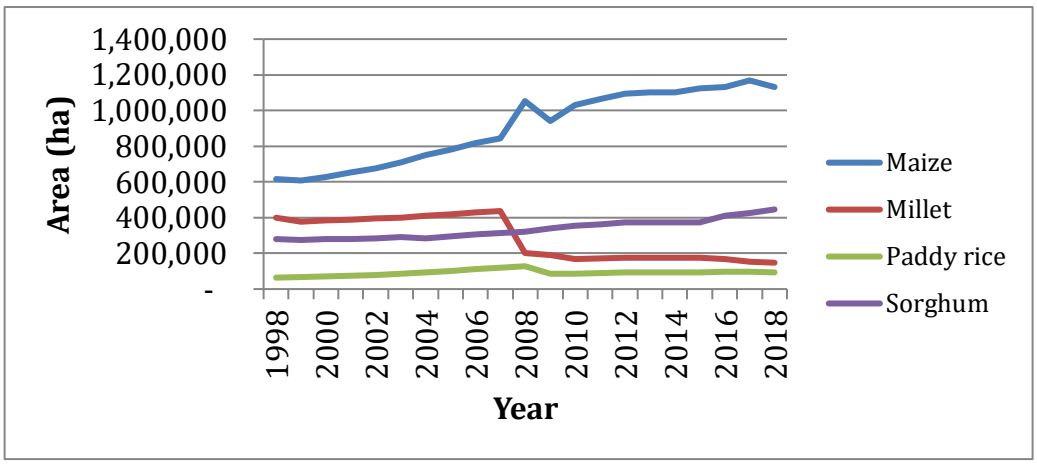


Figure 2. Area planted with cereals (maize, millet, paddy rice & sorghum) from 1998 to 2018.

Pulses: In 2018 the total land area under pulses was 727,119 ha with 86% planted with beans and the rest (14%) planted with cowpeas, field peas and pigeon peas. Generally, the trend of land area under pulses had a similar trend in the two decades under review (Fig. 3). There was a steady increase between 1998 and 2007 from 824,000 to 1,070,000 ha, but the area plummeted sharply in 2008 and has not recovered since then.

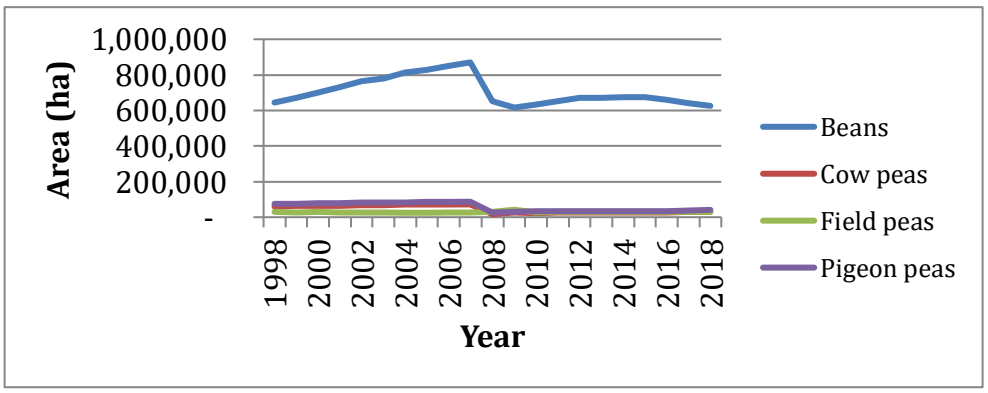


Figure 3. Area planted with pulses (beans, field peas, cowpeas & pigeon peas) from 1998 to 2018.

Roots and tubers: In 2018 the total land area under roots and tubers was 902,421ha with 56% planted with cassava, 40% with sweet potatoes and only 4% planted with Irish potatoes. Apart from a period of four years between 2012 and 2015 when the land area under cassava increased to an average of 851,585 ha the rest of the time from 1998 to 2018 it was at an average of 423,434 ha, which is about 50% of the maximum land area cassava has ever occupied (Fig. 4). In the two decades under review, the land area under sweet potatoes was on average 574,800 ha in the first decade (1998 to 2007), but it decreased to an average of

436,891 ha between 2008 and 2018, a decrease representing 24%. The land area planted with Irish potatoes steadily increased between 1998 and 2007 reaching a record high of 93,000 ha in 2007, but plummeted to an average of 37,112 ha between 2008 and 2018, with a record low of 37,754 ha in 2018.

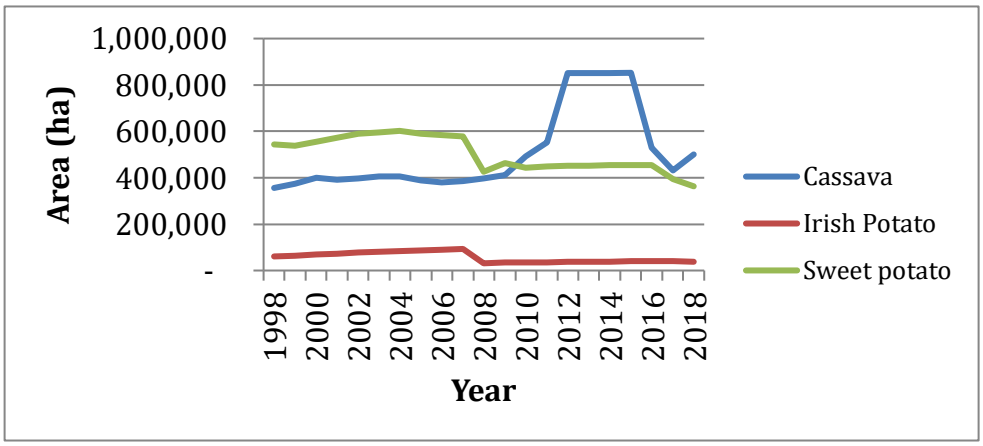


Figure 4. Area planted with roots and tubers (cassava, Irish potato& sweet potato) from 1998 to 2018.

Plantains (dessert and cooking types): Between 1998 and 2007 the land area under plantains gradually increased from 1,553,000 reaching a record high of 1,678,000 ha in 2007 (Fig. 5). During this period the annual average area planted with plantains was 1,635,200ha. After 2007 the land area plummeted to 919,000 ha in 2008, a decrease of 45%. Between 2008 and 2018, the annual average area planted with plantains was 923,904 ha.

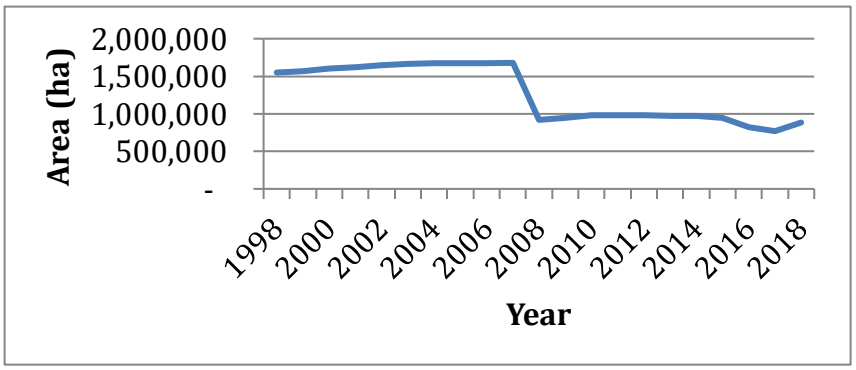


Figure 5. Area planted with plantains from 1998 to 2018.

Oil crops: In 2018 the total land area under oil crops was 721,968ha with 64% planted with groundnuts, 29% with sim sim and only 4% planted with soybean. Since 1998, the land planted with groundnuts has been increasing (Fig. 6). However, there was a leap in the average from 214,100ha between 1998 and 2007 to 403,933ha between 2008 and 2018,

with a record high of 463,968ha in 2018.The land area planted with simsim and soybean steadily increased between 1998 and 2007 (Fig. 6). However, between 2008 and 2018 the land area plummeted to an average of 200,989ha for simsim and 44,900ha for soybean, with very little variation.

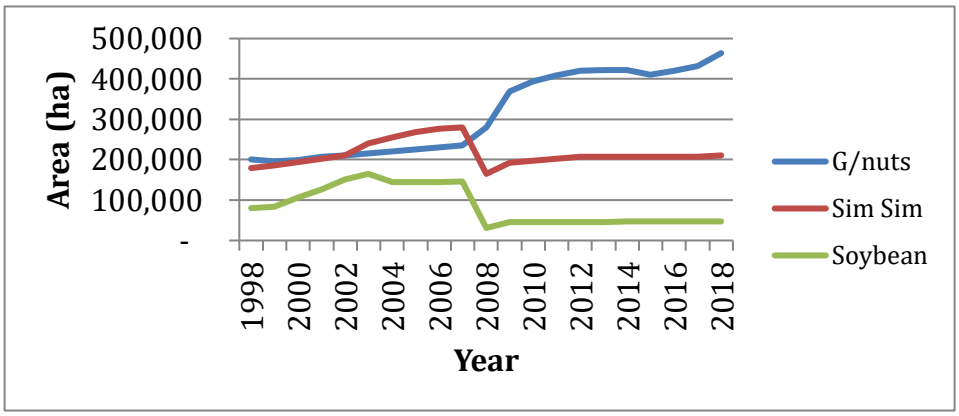


Figure 6. Area planted with oil crops (groundnuts, simsim & soybean) from 1998 to 2018.

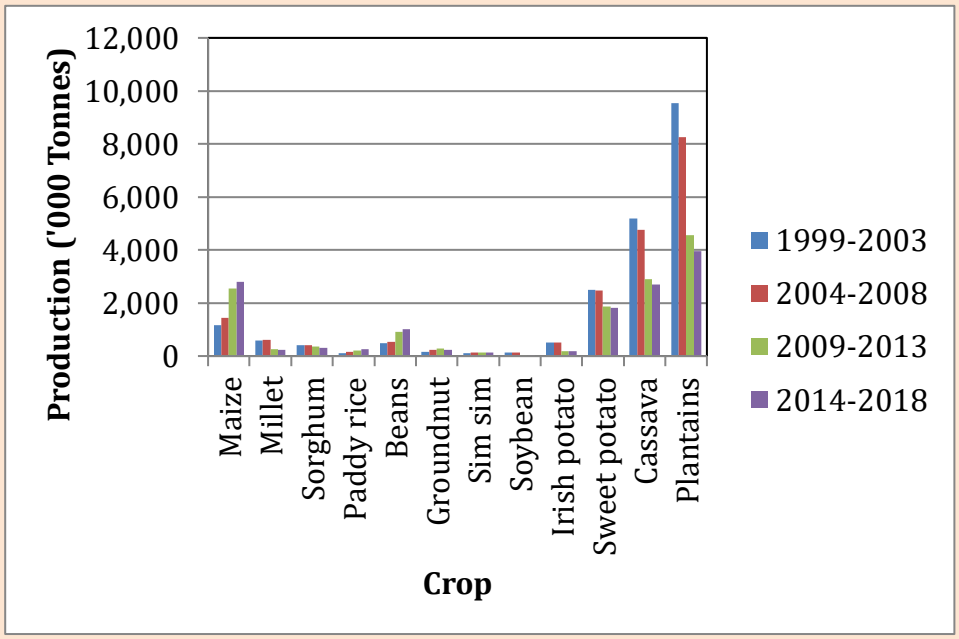
Production and productivity trends (Tables 2 and 3)

Every crop, except groundnuts and Sorghum, has demonstrated increase in production without area expansion. However, in the case of groundnuts reported increase in production could be attributed to increase in the area planted. For sorghum, production did not significantly change in the 20-year period, but yields were decreasing, implying that production was being sustained by area expansion. Other food crops where production has been supported by yield increases rather than area expansion e.g. paddy rice, beans and simsim. For these crops, production increased even when area planted was decreasing, indicating that production was being sustained by yield increases. However, in the case of maize, production has been supported by both area expansion and increased yields.

Other food crops especially cowpeas, pigeon peas, cassava, sweet potatoes, Irish potatoes, banana and soybean, production has been affected by both shrinkage in area planted and decreasing yields. On the other hand, millet production has been mainly affected by shrinkage in area planted although the yield has remained almost the same in the 20-year period. In the case of field peas, the area planted, production and productivity have almost remained the same in the 20-year period.

Table 2. Production of major food crops: averages of 5-year periods from 1999 to 2018 (MT).

Crop	Five-year period			
	1999-2003	2004-2008	2009-2013	2014-2018
Maize	1,168,000	1,430,348	2,552,233	2,807,302
Millet	590,800	605,000	249,340	227,656
Sorghum	409,000	417,573	367,418	305,232
Paddy rice	114,000	153,571	216,575	248,848
Beans	478,400	540,800	920,047	1,019,019
Groundnut	158,000	228,127	290,208	234,934
Sim sim	103,600	143,800	124,827	142,196
Soybean	145,200	137,800	26,410	27,786
Irish potato	507,600	516,600	173,817	172,145
Sweet potato	2,493,800	2,465,942	1,878,186	1,818,755
Cassava	5,185,800	4,770,124	2,893,258	2,699,970
Plantains	9,539,400	8,249,000	4,558,671	3,959,195



(Data source: FAOSTAT, 2020)

Table 3. Productivity of major crops: avg. of 5-year periods from 1999 to 2018 (kg/ha).

Crop	1999-2003	2004-2008	2009-2013	2014-2018	Change
Maize	1,781	1,652	2,439	2,480	+
Millet	1,519	1,570	1,419	1,391	-
Sorghum	1,448	1,376	1,021	755	-
Paddy rice	1,489	1,383	2,419	2,605	+
Beans	654	708	1,420	1,555	+
Groundnut	764	964	720	547	-
Sim sim	501	578	620	684	+
Soybean	1,155	1,062	580	590	-
Irish potato	6,993	6,483	4,767	4,417	-
Sweet potato	4,374	4,422	4,159	4,284	-
Cassava	13,168	12,206	5,008	4,536	-
Plantains	5,888	5,340	4,700	4,495	-

(Data source: FAOSTAT, 2020)

There have been efforts by research institutions to improve the yield potential of all food crops through breeding. Despite these efforts, the yields of some food crops have continued to decline, indicating that the problem is extrinsic rather than intrinsic. The extrinsic factors could be land degradation including declining soil fertility and soil erosion; impacts of climate change and extreme weather events such as droughts and floods; pests and disease outbreaks; and socioeconomic factors e.g. low adoption levels and low input use. Table 4 shows the yield gap of selected crops (national yield average versus yield potential).

Table 4. Yield gap of selected crops (kg/ha).

Crop	National average	Yield potential	Yield gap (%)
Maize	2,500	4,000-11,000	60-340
Millet	1,500	2,000-3,000	33-100
Sorghum	750	2,500-5,000	233-567
Paddy rice	2,600	2,000-3,600	38
Beans	1,500	2,000-4,000	33-167
Groundnut	550	2,700-3,500	391-536
Sim sim	700		
Soybean	600	2,500-3,500	317-483
Irish potato	4,500	15,000-38,000	233-744
Sweet potato	4,500	21,000-45,000	367-900
Cassava	4,500	28,000-50,000	522-1011
Plantains	4,500	20,000-44,000	344-878

Disposition of food crops in Uganda

Disposition in this context refers to the different ways in which food crops are utilized for example for sale, consumption or storage. Food supply in Uganda is estimated to average 2,279 kilocalories per day per person, slightly above the requirement for a healthy life, and is thus considered a food secure country (FAO, 2016).

Cereals: The three most common types of disposition for cereal crops include: sold, consumed and stored (Table 5). The biggest percentage of maize produced (40.5 percent) and Rice (54.5 percent) was sold while most of the Finger millet (37.7 percent) and Sorghum (46.9 percent) were consumed by the households. Maize is the third most important cereal crop in Uganda after finger millet and sorghum. (USAID, 2010). It is a major staple, providing over 45% of the country's daily calorie consumption. The average annual per capita consumption is estimated at 28kg. Much of the produced maize is exported in the region, mostly Kenya and South Sudan. According to Bank of Uganda (2019), total exports to Kenya rose to USD 719 million in 2018 as compared to USD 551.06 million in 2017. Export market has boosted production of the crop in the country. The maize sub-sector is estimated to provide a livelihood for about 3 million Ugandan farm households, close to 1,000 traders and over 20 exporters (UBOS, 2011).

Table 5: Cereal production (Mt) and percentage disposition

Crop	Production (MT)	Sold	Consumed	Stored	Used for other purposes
		----------%----------			
Maize	2,361,956	40.5	34.3	19.3	3.5
Finger millet	276,928	19.0	37.7	33.5	9.8
Sorghum	375,795	14.3	46.9	30.1	8.6
Rice	190,736	54.5	24.1	12.4	8.3

(UCA 2008/09)

Rices: Rice is a major food and cash crop in Uganda, with most of it being consumed in the country's urban areas. Since its introduction into the country in 1942, rice production remained minimal until 1974 when the government constructed the Doho Rice Irrigation Scheme with the help of Chinese experts. Today, rice is grown mainly by small-scale farmers throughout the country. Since 2000, the demand for rice in Uganda has grown at an average rate of about 9.5% per year. By 2007 total production was estimated at 177,000 MT of unmilled rice which was about 115,000 MT of milled rice yet total rice consumption by then

was estimated to be 175,000 MT of milled rice annually. By 2018, paddy rice production alone had risen to 260,786MT though it was still short of the set target of 499,200 MT by Uganda National Rice Development Strategy 2008-2018.

Pulses: Pulses are vital for food and nutrition security. Over 80% of Ugandan households consume beans over a 7-day period in both rural and urban areas (Larochelle and Katungi, 2016). Uganda is among the top bean producers in SSA and a major net seller of common beans in the East African regional markets (FAO statistics, 2013). Common bean is the most important legume crop grown and consumed in Uganda. Approximately, 1,060,000 hectares of land are planted yearly producing about 425,400 tons of beans (FAOSTAT, 2016). Per capita bean consumption is about 9.8kg annually, contributing, on average, 12% of total protein and about 4% of total calorie intake consumed per person (FAOSTAT, 2016). The Uganda census on Agriculture of 2008/2009 established that out of the total beans produced during the 2008/2009 seasons, 32% of the production was sold (UBOS-UCA, 2010), an increase from 16% in 2005/06 and 9% in 1999/00 (PMA, 2008 in Kilimo Trust 2012). Kenya, DRC and South Sudan are the major markets for beans produced in Uganda to the range of between 25,000 and 30,000 tons during the 2006-11 period; equivalent to 6.3% of the production.

Cassava: Cassava (*Manihot esculenta* Crantz) is the second most important staple crop after bananas. Uganda is the sixth largest producer of cassava in Africa, producing 4.2 million metric tonnes in 2010 (MAAIF, 2011). About 88% of cassava produced in Uganda is consumed locally. Cassava plays an important role in the national diet and contributes a substantial proportion of the caloric requirements of the population. Consumption of cassava in Uganda was estimated at 96 kg/capita/annum in 2009.

Plantains: For many years, Uganda has been among the top five leading plantain-producing countries but has since slipped to be among the top ten. More than 75% of all farmers grow bananas, the country's staple food. According to FAOSTAT (2020) production went from a high of 10.5 million tonnes in 2002 to a low of 4.3 m tonnes in 2016. Over the same period, the surface area cultivated in bananas (the dessert and cooking types) supposedly declined from 1.8m hectares to less than 1m hectares. Depending on the region, Ugandans eat as much as 1 kg of bananas a day, mainly cooking bananas. The decrease in production in 2016

was due to the prolonged dry spell which affected the major banana producing areas in South Western Uganda.

Irrigation status and its potential in Uganda

Cultivated percentage area under irrigation to the potential irrigable land is 0.5%. This is very low compared to the 3.6% for Tanzania, 1.6% for Burundi and 2.05% for Kenya (MAAIF and MWE, 2017). About 1.5 million hectares are targeted for irrigation by 2040 (MAAIF and MWE, 2017), which represent about half the potential irrigation area of the country (Nile Equatorial Lakes Subsidiary Action Program, 2012). The major water resources exploited by the small-scale farmers are the protected and unprotected springs, deep boreholes and shallow wells. These are sources of water for production as well as licensed independent water providers.

According to Wanyama et al. (2017), the available irrigation systems in Uganda are classified by size, or scale of irrigated area (large-scale > 500 ha, medium-scale 100-500 ha, small-scale <100 ha); ownership of irrigation structure; source of water and power; water conveyance and distribution and the in-field water application technique. Large scale irrigation systems dominate functional irrigation schemes in Uganda, contributing 76% of the total command area under irrigation (Table 6). Most of the irrigation schemes are concentrated around Lakes Victoria and Kyoga. The northern, western and eastern regions require special attention for irrigation establishment since they have low or even negative rainfall. There is one public irrigation scheme in the west (Mubuku), four in eastern (Kiige, Labori, Odina, and Doho), and four in northern Uganda (Ongom, Atera, Agoro, and Olweny), most of which are non-functional although, rehabilitation efforts by the Government of Uganda for some of the schemes (Doho, Mubuku, Agoro) have been completed.

Furthermore, private small-scale irrigation schemes include small irrigated farms of less than 10 ha and are under the control of a farmer. Here, farmers access surface and ground water directly and decide on how much and when to use it. This is informally practiced at the wetland fringes and sometimes in the valley bottoms near the stream using traditional/informal irrigation techniques, mostly in eastern Uganda as a coping mechanism to erratic rainfall. The practice has increased over years although no statistical evidence exists.

A total of four (4) medium scale irrigation schemes of Olweny in Lira District, Agoro in Lamwo District, Mubuku I in Kasese District and Doho I in Butaleja District and Seventeen (17) Small Scale Solar Powered Irrigation Systems in the Districts of Bugiri, Soroti, Abim, Amuria, Kaabong, Napak, Oyam, Alebtong, Lira, Nwoya, Lwengo, Mbarara, Isingiro, Mukono, Rukiga and Masaka have been constructed (MWE, 2018). Construction of twenty one (21) additional Small Scale Solar Powered Irrigation Systems in the Districts of Katakwi, Kaabong, Ngora, Kamuli, Bukedea, Iganga, Tororo, Kaberamaido, Bushenyi, Mubende, Kyankwanzi, Bushenyi, Isingiro, Kiboga, Mbarara, Mubende, Lyantonde, Mityana, Gulu, Zombo and Adjumani is reported by MWE (2018) to be ongoing. A summary of the installation status of small-scale irrigation systems and other large- and medium-scale irrigation schemes countrywide is shown in Tables 6 – 9.

In addition, 34 dams and 1282 valley tanks have been constructed during the 2000 to 2018 period (MWE, 2018). Out of the 1282 valley tanks, 363 are under community-based management system and fully functional while out of the 34 dams which are all under the community-based management system, 24 are under the Water User Committees (71%) and fully functional. The rest of the valley tanks and dams are non-communal and managed by individual farmers, constructed by MWE equipment under Public Private Partnership (PPP) arrangement. A summary of the functionality status of each Water for Production (WfP) facility as for the year 2018 is shown in Table 7. These developments have increased the storage capacity of water for production facilities from 28.4 million m^3 in 2017 to 31.7 million m^3 (MWE, 2018).

Table 6. Irrigation schemes undergoing construction.

Irrigation Schemes	Location	Area (Ha)	No. Farmers	Time frame
Doho II	Butaleja	1,178	1,448	Aug, 2017- Aug.2020
Wadelai	Nebbi	1,000	1,230	Nov.2017 – Nov.2020
Tochi	Oyam	500	615	Aug, 2017- Aug.2020
Ngenge	Kween	880	1,082	Aug, 2017- Aug.2020
Mubuku II	Kasese	480	590	Aug, 2017- Aug.2020
Rwengaaju	Kabarole	116	250	Aug, 2017- Aug.2020

(Source: MWE, 2018)

Table 7. Functionality status for each WfP facility type.

Functionality Status	Valley tanks		Dams		Small scale irrigation system		Medium scale irrigation systems		Total	
	No	*%*	*No*	*%*	*No*	*%*	*No*	*%*	*No*	*%*
Fully functional	1,115	87	23	67.6	16	100	4	100	1,158	86.7
Partially functional	159	12.4	9	26.5	0	0	0	0	168	12.6
Non-functional	8	0.6	2	5.9	0	0	0	0	10	0.7
Total	1,282	100	34	100	16	100	4	100	1,336	100

(Source: MWE, 2018)

Table 8. Existing formal Irrigation schemes in Uganda.

No	Irrigation scheme	District	Region	Area (ha) 2015	Scale	Ownership	Source of water	Abstraction method	Irrigation practice	Main crops	Status
1	Mubuku I	Kasese	Western	750	Large	Public	Rivers Sebwe and Mubuku	Gravity-fed	Furrow	Maize, vegetables, rice, citrus	Functional
2	Agoro	Lamwo	Northern	745	Large	Public	Agoro river	Gravity-fed	Furrow	Maize, vegetable, rice	Functional
3	Doho I	Butaleja	Eastern	1000	large	Public	River Manafwa	Gravity-fed	Basin	Rice	Functional
4	Kiige	Kamuli	Eastern	369	Medium	Public	Lake Nabigaga	Pumping-fed	Sprinkler	Citrus	Dilapidated
5	Odina	Soroti	Eastern	365	Medium	Public	Lake Kyoga	Pumping-fed	Sprinkler	Citrus, cashew nuts	Dilapidated
6	Labori	Serere	Eastern	285	Medium	Public	Lake Kyoga	Pumping-fed	Sprinkler	Citrus, mangoes, vegetables	Dilapidated
7	Atera	Apac	Eastern	809	Large	Public	River Nile	Pumping-fed	Sprinkler	Citrus	Dilapidated
8	Ongom	Alebtong	Northern	300	Medium	Public	Ongom & Owameri dams	Pumping-fed	Sprinkler	Citrus, cashew nuts	Dilapidated
9	Olwenyi	Dokolo	Northern	650	Large	Public	Olwenyi swamp	Gravity-fed	Basin	Rice	Functional
10	Kibimba	Bugiri	Eastern	3900	Large	Private	Kibimba dam	Gravity-fed	Basin	Rice	Functional
11	Kakira	Jinja	Eastern	1500	Large	Private	Lake Victoria	Pumping-	Sprinkler	Sugar cane	Functional

								fed			
12	Lugazi	Buikwe	Central	322	Medium	Private	River Sezibwa	Pumping-fed	Sprinkler	Sugar cane	Functional
13	Greenhouse farms in L.Victoria	Kampala /Wakiso	Central	230	Medium	Private	Lake Victoria	Pumping-fed	Drip	Flowers, horticulture	Functional
14	Muhokya	Kasese	Western	50	Small	Community based	River Nyamwamba	Gravity-fed	Furrow/sprinkler	Rice	Functional

(Source: Wanyama et al., 2017)

Table 9. Installation of Small Scale Irrigation Systems Countrywide.

No	District	Sub County	Parish	Village	Project	Acreage (Acres)	Status of work
1	Bugiri	Lwemba	Nabirere	Sonai	Construction of small scale Irrigation	6	Construction Works Complete; Technical Commissioning is done
2	Soroti	Kamuda	Agora	Ojikai	Construction of small scale Irrigation	11	Construction Works Complete; Technical Commissioning is done
3	Abim	Lotuke	Orwamuge	Achangli	Construction of small scale Irrigation	11	
4	Katakwi	Usuk	Akum and Chelewuko	Ongongoja	Construction of small scale Irrigation	20	Construction Works Complete
5	Kaabong	Kawalokol	Kokoro	Moruse-Naro	Construction of small scale Irrigation	6	Abstraction system is installed, Sprinkler system is installed Transplanting of the seedlings to the main farm is ongoing
6	Amuria	Wera	Angole	Akisim	Construction of small scale Irrigation	10	Construction Works Complete
7	Ngora	Kobwin	Tiling	Tiling	Construction of small scale	12	Construction Works are complete; sprinkler

					Irrigation		system installed, Abstraction system the solar system is being installed, Lined Pit latrine is complete
8	Kamuli	Namwendwa	Namwendwa Technical Institute	Bukafungo	Construction of small scale Irrigation	10	Stakeholder engagement is ongoing, Construction of the Valley Tank is complete
9	Kaabong	Kaabong West	Lobongia	Lokumomomoe	Construction of small scale Irrigation	2.4	Construction Works Complete; the drip irrigation system is running
10	Bukedea	Kachumbala	Kawo	Kawo	Construction of small scale Irrigation	10	Construction of the Valley Tank is complete
11	Napak	Matany	Nakichumet	Arechet	Construction of small scale Irrigation	2.4	Construction Works Complete; the drip irrigation system is running
12	Iganga	Busesa		Ibako	Construction of small scale Irrigation	13	Pump house is complete, Installation of the solar system, main pipeline and water access points on the farm is complete.
13	Tororo	Mulanda	Kisote	Kisote East	Construction of small scale Irrigation	10	Construction of the Valley Tank is complete
14	Kaberemaido	Kalaki	Kamuda	Oimai	Construction of small scale Irrigation	6	Construction of the Valley Tank is complete
15	Lwengo	Kiseka	Busubi	Kyassonko	Construction of small scale Irrigation	20	Construction Works complete.
16	Mbarara	Nyamitanga	Nyamitanga	Nyamitanga	Construction of small scale Irrigation	5	Construction works complete.
17	Isingiro	Ruhimbo	Ruhimbo	Ruhimbo	Construction of small scale Irrigation	20	Construction works complete.
18	Mukono	Seeta-Namagunga	Kituula	Mbulamuti	Construction of small scale Irrigation	50	Construction works complete.
19	Rukiga	Bukinda	Bukinda	Nyamihang	Construction of small scale	20	Construction works complete.

					Irrigation		
20	Masaka	Mukungwe	Luvule	Kasaala	Construction of small scale Irrigation	30	Construction works complete.
21	Bushenyi	Nyabubare	Kanyantama	Kanyantama	Construction of small scale Irrigation	15	Construction Work completed; The solar system is installed.
22	Mubende	Kalwana	Mayirikiti	Mayirikiti	Construction of small scale Irrigation	20	Construction works complete.
23	Kyankwazi	Ntwetwe	Wattuba	Kigoma	Construction of small scale Irrigation	10	Construction works complete.
24	Bushenyi	Bushenyi municipality	Bushenyi Demonstration	Bushenyi	Construction of small scale Irrigation	20	Construction works complete; The solar system is installed.
25	Isingiro	Ruborogota	Bugarika	Bugarika	Construction of small scale Irrigation	24	Construction works complete.
26	Kiboga	Kibiga	Katoma	Katoma	Construction of small scale Irrigation	25	Construction works complete.
27	Mbarara	Rubaya	Mishenyi	Mishenyi	Construction of small scale Irrigation	15	Construction works complete.
28	Lyantonde	Kaliro	Bulunga	Bulunga	Construction of small scale Irrigation	12	Construction works complete.
29	Masaka	Buwunga	Bulenge	Bulenge	Construction of small scale Irrigation	20	Construction works complete.
30	Mityana	Central Division	West Ward	Kanamba	Construction of small scale Irrigation	24	Construction works complete.
31	Oyam	Acaba	Barr	Barr	Construction of small scale Irrigation (drip system)	5	Construction works complete.
32	Alebtong	Aloi	Aloi	Oloo	Construction of small scale Irrigation (drip system)	4	Construction works complete.

33	Lira	Adekokwok	Adwiila	Awang dyang	Construction of small scale Irrigation (drip system)	20	Construction works complete.
34	Nwoya	Koch Goma	Lutuk	Lutuk	Construction of small scale Irrigation (drip system)	5	Construction works complete; Installation of the drip irrigation system is complete; Water abstraction system and elevated tank stand are complete
35	Gulu	Achwa	Paibona	Uyweri	Construction of small scale Irrigation (sprinkler system)	13	Construction of the abstraction system is ongoing; Installation of the Sprinkler system is complete
36	Zombo	Atyak	Angol	Ugudu	Construction of small scale Irrigation (sprinkler system)	16	Construction of the abstraction system is ongoing; Installation of the Sprinkler system is complete
37	Adjumani	Arinyapi	Liri	Ogolo South	Construction of small scale Irrigation (sprinkler system)	16	Construction works complete.
38	Abim	Abim TC	Kalala	Akado	Construction of small scale Irrigation (drip system)	10	Construction works complete.
39	Mayuge	Malongo	Agora	Bukatabira A	Construction of small scale Irrigation (drip system)	11	Construction works complete.
40	Kamuli	Namwenda			Construction of small scale Irrigation (drip system)	10	Construction works complete.
41	Bukedea	Kamuge	Kawao	Kawo	Construction of small scale Irrigation (drip system)	10	Construction of valley tank complete
42	Tororo	Mulanda		Kisote Eat	Construction of small scale Irrigation (drip system)	13	Construction works complete.
43	Manafwa	Bukusu	Nambale	Bumusse	Construction of small scale Irrigation (drip system)	15	Construction works complete.
44	Kibuku	Buseta	Kakutu	Natoto B	Construction of small scale	7	Construction works complete.

					Irrigation (drip system)		
45	Dokolo	Agwata			Construction of small scale Irrigation (drip system)	20	Construction works are ongoing
46	Agago	Adilang	Agora		Construction of small scale Irrigation (drip system)	20	Construction works complete.
47	Pakwach	Pacego	Andibo	Andibo	Construction of small scale Irrigation (drip system)	9	Construction works complete.
48	Kitgum	Amido	Akworo	Akworo	Construction of small scale Irrigation (drip system)	10	Construction works complete.
49	Nakaseke	Kiwoko	Kiryanfufu	Kiryanfufu	Construction of small scale Irrigation (drip system)	18	Construction works complete.

(Source: MWE, 2018)

Livestock sub-sector

Overview of livestock sub-sector

Livestock production is an important subsector of Uganda's agriculture, accounting for about 17% of agricultural value added and 4.3% of GDP. About 58% (3.9 million) of households depend on livestock for their livelihoods, most of them being subsistence smallholders (UBOS, 2018). The livestock sector contributes between 1 and 1.5% to Uganda's export trade value. According to CTA and IIRR (2016), pastoralists and small-scale livestock producers are the fourth-largest contributors to Uganda's foreign currency earnings. The current livestock population in Uganda is estimated at 14.2 million cattle, 16 million goats, 4.5 million sheep, 4.1 million pigs and 47.6 million poultry, with over 90% being indigenous (UBOS, 2017). Also included are smaller numbers of donkeys, camels, turkeys and rabbits. Bee keeping is also gaining importance.

Cattle and poultry are the most important with their production valued at USD 8.7 and USD 0.9 million per year, respectively (UBOS, 2017). Livestock provides benefits, both economic (e.g. meat, milk, eggs, hides, skins and direct sale) and social (e.g., marriage, death, dispute settlement, and gift giving). They also provide manure and draft power. Out of the national herd (14.2 million), 11.9 million cattle are raised for meat. Cattle contribute over 40% to the value of livestock production and about 7% to the value of agricultural production (UBOS, 2017). The dairy industry provides daily income to the farming households while contributing to food security, foreign exchange earnings and employment along the entire value chain (GOU, 2016a).

Cattle are mostly reared on rangelands which occupy 84,000 km². Over 90% of cattle are kept under natural pastoral and mixed smallholder farming systems. The greatest concentration of livestock is found in the "cattle corridor", extending from South-Western to North Eastern Uganda (GOU, 2016a). Karamoja region hosts 20% of Uganda's cattle, 16% of the goats and 50% of the sheep (UBOS, 2008). Over 90% of the cattle population in Uganda is of indigenous breed, and mainly for dairy. Dairy farming is concentrated in 42 districts found in the cattle corridor. On average, 60% of the households in the cattle corridor keep livestock (GOU, 2016a).

Dairy production falls in four categories, namely:

- Zero grazing accounting for 2% of total dairy production and entails confinement of livestock in a small enclosure where feeds, fodder and water are brought in. It is suitable for people without much land for grazing. According to Mbabazi (2005), at least 20% of low-income households in Ankole have a zero-grazing cow. This system is widely practiced in Uganda especially in the Eastern, Western and Southern Western regions.
- Fenced/paddock grazing accounts for 8% of total dairy production and is largely practiced by farmers of hybrid and cross-breed cattle and has expanded rapidly with the liberalization of the economy which has resulted in the need to make farms economically viable. In order to increase production, dairy farmers have planted legumes, elephant grass and alfalfa to improve pasture for their cattle;
- Free range grazing accounts for 41% of dairy production entails the traditional open grazing system but is gradually being phased out due to land fragmentation; and
- Community grazing comprises the largest proportion (49%) and entails grazing cattle on clan-owned communal land. It is still practiced in North- Eastern part of Uganda (Karamoja, Kotido, Moroto, Amuria, and Soroti).

Overall, many farmers are slowly adopting modern farming techniques through the Send A Cow (UK), Heifer International Project, government initiatives and cross breeding with improved breeds such as Friesian through Artificial Insemination.

Trends in livestock population and monetary value between 2000 and 2016

Uganda has experienced an overall increase in the number of livestock for all the main animals over the period 2000 to 2010 and 2011 to 2018. Cattle numbers increased from 5.9 million 2000 to 12.1 million in 2010 representing a growth of 102%. Between 2010 and 2018 cattle numbers further grew from 12.1 to 15.7million, representing a growth of 30%. Between 2000 and 2018, goats increased from 6.3 to 16.2 million (showing a growth of 153%) while poultry numbers increased from 26 to 27 million (a growth of 39%) (Fig. 7). Over the same period, the total livestock monetary value has increased from US $ 775 to $1,523 million, representing a 96% growth. The contribution of livestock to Agriculture has grown from 15.5 to 29.1, representing a 13.6% increment over the 18-year period (Table 10). It is

worth noting that while the agriculture sector contribution to GDP decreased from 83% in 2000 to 21% in 2016, the contribution of the livestock sector to GDP decreased, from 13% in 2000 to 6% in 2016 (Fig. 8).

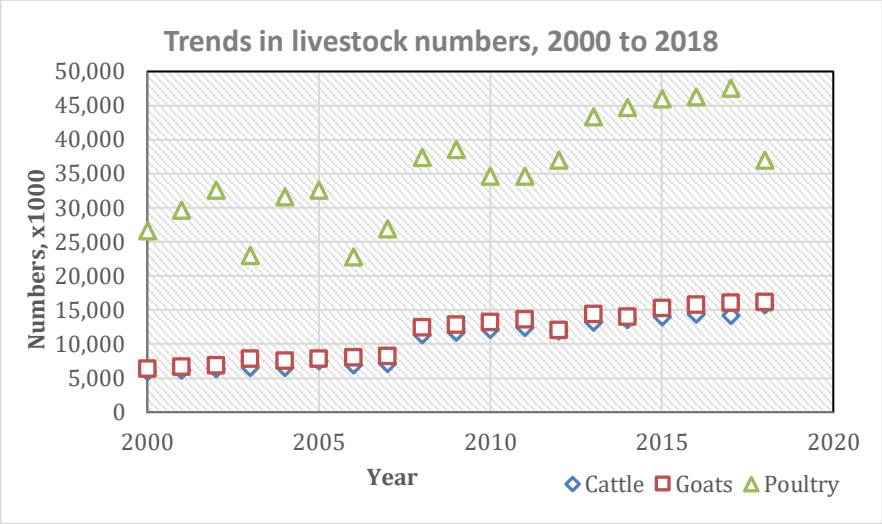


Figure 7. Trends in livestock numbers, 2000 to 2020.

Source: UBOS, 2018

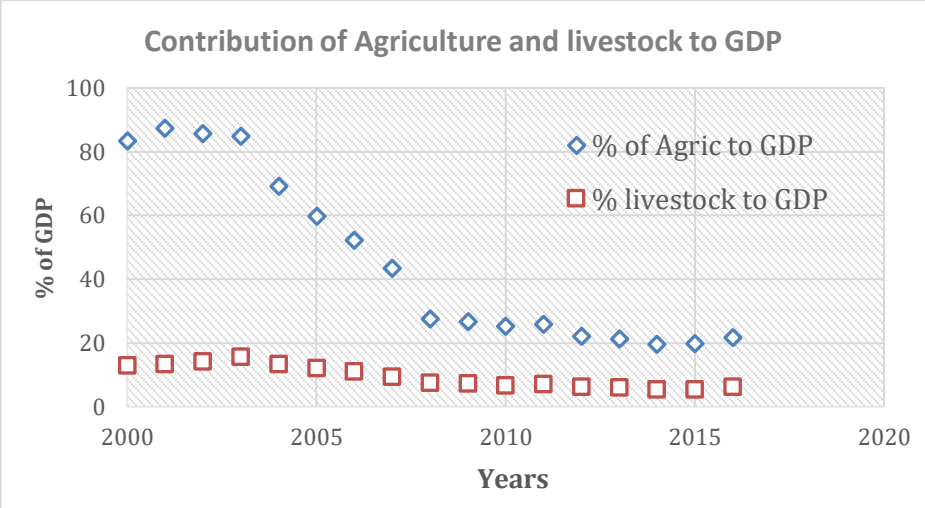


Figure 8. Trends in the contribution of agriculture and livestock sectors to GDP.

Source: UBOS, 2018.

Table 10. Trends in livestock numbers, monetary value and contribution to GDP.

	Livestock numbers, x103						Economic value					
Year	Cattle	Sheep	Pigs	Poultry	Goats	Total	Total livestock value, USD x106	Total Agric. Production value, USD x 106	Annual GDP, USD x 106	% of Agric to GDP	% of livestock to Agri.	% livestock to GDP
2000	5,966	1,081	1,573	26,622	6,396	41,638	775	4,985	5,978	83.4	15.5	13.0
2001	6,148	1,108	1,644	29,671	6,620	45,191	805	5,279	6,039	87.4	15.2	13.3
2002	6,328	1,141	1,710	32,639	6,852	48,670	918	5,559	6,494	85.6	16.5	14.1
2003	6,558	1,603	1,226	23,031	7,821	40,239	1,051	5,703	6,724	84.8	18.4	15.6
2004	6,567	1,552	1,940	31,622	7,566	49,247	1,106	5,728	8,285	69.1	19.3	13.4
2005	7,531	1,600	2,000	32,600	7,800	51,531	1,165	5,734	9,603	59.7	20.3	12.1
2006	6,973	1,648	2,060	22,849	8,034	41,564	1,197	5,666	10,851	52.2	21.1	11.0
2007	7,182	1,697	2,122	26,950	8,275	46,226	1,267	5,876	13,497	43.5	21.6	9.4
2008	11,409	3,410	3,184	37,434	12,450	67,887	1,284	4,767	17,279	27.6	26.9	7.4
2009	11,751	3,513	3,280	38,557	12,823	69,924	1,339	4,953	18,579	26.7	27.0	7.2
2010	12,103	1,847	2,297	34,680	13,208	64,135	1,362	5,101	20,190	25.3	26.7	6.7
2011	12,467	1,902	2,377	34,660	13,604	65,010	1,410	5,208	20,180	25.8	27.1	7.0
2012	11,979	3,842	3,584	36,956	12,012	68,373	1,433	5,116	23,110	22.1	28.0	6.2
2013	13,226	3,937	3,691	43,396	14,433	78,683	1,477	5,248	24,600	21.3	28.1	6.0
2014	13,623	3,842	3,584	44,698	14,011	79,758	1,465	5,388	27,290	19.7	27.2	5.4
2015	14,031	3,842	3,916	46,039	15,312	83,140	1,504	5,358	27,100	19.8	28.1	5.5
2016	14,368	4,198	4,037	46,291	15,725	84,619	1,523	5,240	24,130	21.7	29.1	6.3
2017	14,189	4,445	4,109	47,578	16,034	86,355	---	---				
2018	15,768	2,094	2,731	37,039	16,196	73,828	---	---				
2050*	11,800	5,000	7,100	175,000	34,000							

*Projections based on FAO. http.www.fao.org

Trends in livestock products

Milk production increased over the years 2000 to 2018, with the values hitting 1.6 billion litres between 2016 and 2017 (Fig. 9). Beef production also increased between 2007 and 2017; however, between 2014 and 2017, the values stagnated at around 200,000 Metric Tons (Fig. 9). The slow growth in beef production is partly attributed to constraints such as animal diseases, poor feeding, use of poor breeds and breeding methods. The number of eggs produced grew progressively from 2012 to 2017 (Fig. 10).

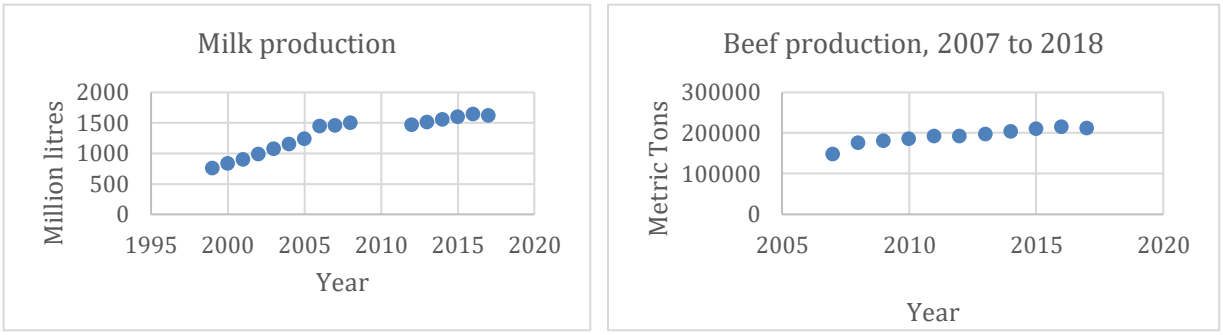


Figure 9. Trends in the production of milk and beef, 2000 to 2017.

Source: UBOS, 2013.

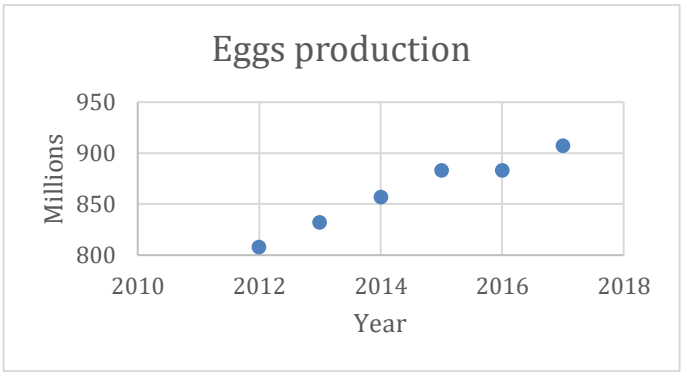


Figure 10. Trends in the quantity of eggs sold, 2012 to 2017.

Source: UBOS, 2013.

Figure 11 presents trends in the monetary value of live animals sold between 2007 and 2011. The trend is erratic, with values rising between 2008 and 2009, stagnated to 2010, and then fell back to the 2008 value.

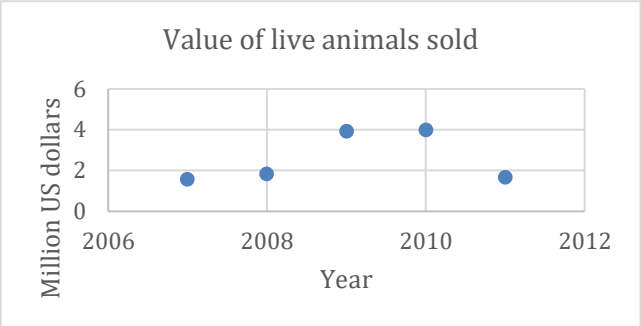


Figure 11. Trends in the monetary value of live animals sold, 2007 to 2011.

Source: UBOS, 2013.

Trends in livestock productivity between 2000 and 2016

Figure 12 presents trend in livestock monetary value, which is a measure of the monetary value of the products (e.g. milk, meat, eggs) obtained from livestock. Livestock productivity was obtained by dividing the total livestock value by the total livestock numbers as presented in Table 10. Between 2000 and 2006, the livestock monetary value per unit increased from 18.6 to 28.8 USD per unit; between 2006 and 2008, the livestock value per head of livestock dropped sharply from 28.8 to 18.9 USD. The value increased gradually to 21.7 in 2011, then declined progressively to 18.0 by 2016.

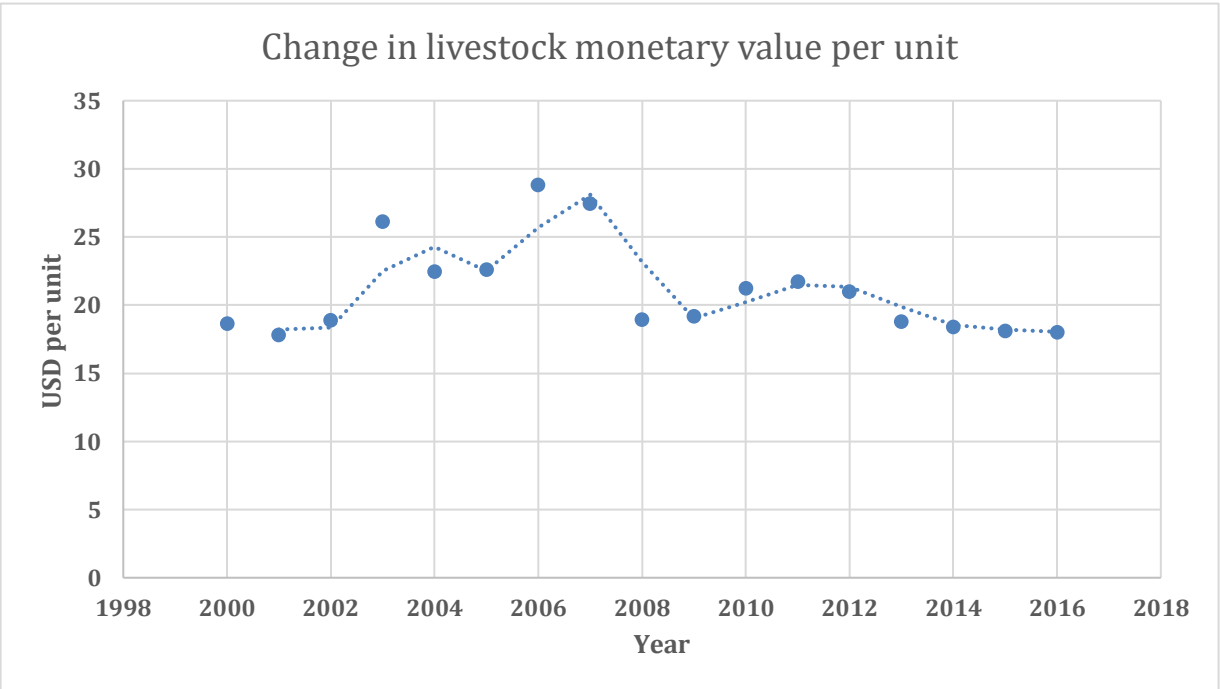


Figure 12. Changes in livestock monetary value per unit, between 2000 and 2016.

Taking the example of milk, in line with the increases in the number of livestock, production increased from 1.38 billion litres in 2010 to 1.55 billion litres in 2014, representing a 12.6% increase over the period. According to EPRC (2019), this growth resulted from increased number of milk producing cattle rather than growth in milk yield per cow. Between 2002 and 2016 for example, the number of milk producing cows increased from 1.6 million to 3.7 million. However, average annual milk yield dropped from 450 litres per cow in 2002 to 415 litres in 2012. After 2012, the yield witnessed a marginal increase to 425 litres but later stagnated for three years before declining to 415 litres in 2016 (EPRC, 2019). Thus, in spite of the overall increase in livestock numbers, and advances in scientific research towards better breeds and feeds, the monetary value of products there from, over the 17-year period is overall, not increasing. This points to other extrinsic factors such as drought (FAO et al., 2018) limiting livestock productivity. This decrease is partly attributed to frequent droughts in the country (FAO et al., 2018).

According to the ASSP (2019/2016 to 2019/2020), key constraints to production in the livestock sub-sector include inadequate supply of quality pastures; unavailability of water for livestock, inadequate sources of high yielding breeding stock; weak capacity to provide effective veterinary services and to control livestock diseases; inadequate capacity for sanitary and phytosanitary control measures; and lack of appropriate meat marketing infrastructure. Studies conducted by Kilimo Trust show that the demand for animal feeds in Uganda will be 986,000 MT by 2020. Despite the country being one of the top producers of raw materials used in processing animal feeds in the region, the country was facing an animal feeds supply deficit of 4,201 MT as of 2019. The undeveloped animal feeds sector in Uganda is attributed to poor regulatory frameworks and limited supply of raw materials to manufacture good quality and quantity animal feeds.

Opportunities in the livestock sector

- *Production and marketing:* Uganda's population growth averages 3% for the last 10 years. This rapidly increasing population size coupled with increased income and urban population growth has led to a rise in demand for dairy products. For processed milk, demand is growing at 11% in urban centres, presenting an opportunity for more investment in this area, since the supply is not adequate. The growing national and regional demand for dairy products presents a big opportunity for farmers, transporters

and processors and other actors in the dairy value chain (FAO, 2018a). The growing regional market for other livestock products (eggs, meat, hides & skins, Day Old Chicks and live animals) also presents a big opportunity for investment. The formal market also appears to be expanding with the private sector liberalization. There is great potential in improving the quality of fodder and feeds.

- *Conducive policies governing the livestock sector:* The Dairy Master Plan (1993) provides key guidelines for transformation of the dairy subsector. The Dairy Industry Act (1998) is the principal legislation regulating the sector supported by the general livestock sector policies such as the Policy on marketing of livestock and livestock products, Plan for Modernization of Agriculture (PMA) and the National Agricultural Advisory Services (NAADS). The Agriculture Sector Strategic Plan (ASSP) 2015/16 – 2019/20, prioritized investments in *inter alia*: beef, dairy cattle, poultry and goats. The Meat Industry Development Act was enacted to provide for improvement of production, processing and marketing of meat and meat products (GOU, 2016).
- *Gender in livestock:* Women are heavily involved in the rearing of chicken, sale of chilled raw milk through the informal sector (which constitutes 90% of all the milk marketed in Uganda), as well as value addition to milk in making ghee, cheese, yoghurt. Men and youths are involved in piggery, rearing cattle, goats and sheep. In Karamoja, women, girls, and some boys participate in the trade of poultry and small ruminants especially goats, sheep and pigs. Meanwhile, men and young boys participate in marketing cattle and donkeys.

Fisheries sub-sector

Overview of the fisheries sub-sector

Uganda is endowed with rich natural fresh water resources that cover about 20% of the land area, making fishing an important economic activity (DFR, 2011). In 2009, fisheries generated 3% of the total GDP. Statistics show that fish exports grew from about $1 million in 1990 and increased to $45 million within a span of 6 years, rising to a peak of $148 million in 2005. Thereafter the annual value of exports started declining amounting to $126 million in 2013. Most of the fish in Uganda come from five major lakes (Victoria, Kyoga, Albert, Edward and George) and over 160 minor lakes; rivers; wetlands; water reservoirs; valley dams and ponds. Total capture production peaked in 2014 (461,200 tons) but decreased by

14% in 2015 to reach 396,200 tons. In the last decade, catches of the most valued species (Nile Perch) continued to decline from the peak achieved in 2005 (175,000 tons) to 71,900 tons in 2015. Uganda is the second largest aquaculture producer in sub-Saharan Africa after Nigeria. Aquaculture production in Uganda increased from just 800 tons in 2000 to 117,000 tons in 2015, the major species in aquaculture being catfish (51%) and Nile tilapia (49%).

It is estimated that about 72% of fish produced in Uganda is consumed locally leaving about 28% for export. The fisheries sector employs 1 m to 1.5 m artisanal fishermen and over 5,000 people are involved in activities along the production and marketing value chain. It is estimated that 140,377 Ugandans were involved in fisheries and aquaculture sectors employment in 2015, of which 116,213 were engaged in inland waters fishing and 24,434 in fish farming. It is estimated that out of the total quantity of fish landed (~ 450,000 t), about 60% goes to fish processing plants for export, while 20% is processed using traditional methods of smoking, salting, frying and sun drying. Large quantities of smoked and sun-dried fish originating from Lake Victoria are traded - legally and illegally into western Uganda and in the Democratic Republic of Congo. In 2015, fish and fishery product exports were valued at USD 118.3 million, with the bulk destined to European countries and with Nile perch, mainly fillets, as the main species exported; 2015 imports were valued at USD 2.5 million (FAO, Country Brief, 2015). Fish provide the most affordable source of animal protein with an average annual per-capita consumption of about 8 kg, accounting for more than 50% of the animal protein intake of an average Ugandan's diet. The annual per capita consumption of fish was estimated at about 12.5kg in 2013, higher than the African average of 10.1 kg. Consumers generally prefer fresh fish, but smoking, sun-drying and salting by artisanal processors (many of whom are women) is done to prolong shelf-life. The most popular fish commodity is dried lake sardine (mukene). However, declining trends in annual fish production are a real threat in terms of the loss of potential foreign exchange earnings, household income, food and nutrition security (EPRC, 2017).

Uganda's fisheries are under stress from many factors, including market pressure and fishing practices (NEMA, 2008). The current production is only 460,000 MT from capture fisheries and about 100,000 MT from aquaculture. This under-performance in the capture fisheries is attributed to limited regulation and enforcement of laws and guidelines which has led to use of illegal destructive gears that catch immature fish. In addition, aquaculture is constrained

by limited investment in fish farming; high cost; limited access to high quality fish seed and feed; and inadequate extension services. Both capture and aquaculture production systems face challenges of high post-harvest losses; inadequate human, technological and infrastructural capacity at all stages of the value-chain leading to low production and productivity overall (National Fisheries and Aquaculture Policy, 2017).

Aquaculture development in Uganda can help fishing communities to supplement their capture fisheries but this development is constrained by low adoption of appropriate technologies, inadequate investment in research and inadequate aquaculture extension services (SPCR, 2017). The target in the National Development Plan 2015-2020 is 300,000 MT for aquaculture alone (NDP II, ASSP 2015-2020). The regulatory framework guiding fisheries has been largely influenced by export standards for Nile perch from the European Union (EU). Regulatory framework for aquaculture is weak.

Fish production and productivity

Capture Fisheries Trends (2000-2010): Table 11 shows the estimated fish catch in tons over the period 2000-2009, with Lake Victoria accounting for more than half of the total annual fish catch. However, the fish catch in Lake Victoria has declined sharply in recent years. As shown in Figure 13, there has been a rising trend in capture fish production from 245,223 tons in 1990 declining to 219,356 in 2000 and rising again to 413,805 in 2010. Table 11 also shows that between 2003 and 2004 fish production nearly doubled from 247,000 tonnes to 435,000 tonnes. These changes can partly be attributed to the full recovery from the ban on fish exports imposed in 1999. They may also reflect improvements in security as a result of reduced rebel activities by the LRA after 2003, especially along Lake Kyoga—the second most important source of fish products in Uganda and Lake Albert.

Table 11. Fish catch by water body (thousands tonnes), 2000-2009.

Water Body	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Lake Victoria	133	132	136	175.3	253.3	253.3	215.9	223.1	219.5	221.3
Lake Albert	19	19	19	19.5	56.4	56.4	56.4	56.4	56.5	56.5
Lake Kyoga	-	-	-	32.9	68.5	68.4	60.0	60.0	60.0	60.0
Lake	5	5	5	5.9	9.6	9.6	8.8	8.8	8.8	8.8

Edward, George &Kazinga Channel										
Other Waters	6	6	6	8.3	40.6	24.1	27.0	21.0	20.0	20.0
Total	**220**	**221**	**222**	**247.5**	**434.8**	**416.8**	**367.2**	**374.3**	**364.8**	366.6
	-4.3	**0.5**	**0.5**	**1.7**	**75.4**	**-4.1**	**-1.2**	**1.9**		

(Source: Directorate of Fisheries MAAIF and UBOS Statistical Abstracts, 2010)

The main challenges in the fisheries sub-sector during 2000-2010 include licensing too many factories for fish processing, licensing of too many fishing boats by local governments, weak institutional framework, lack of community involvement in fisheries management, lack of well-developed landing sites and underdevelopment of aquaculture.

Capture Fisheries Trends (2010-2020): Over the period 2010-2014, Government directed efforts towards promoting recovery of depleted stocks of the large commercial fish. As shown in Figure 13, capture fish production have been rising since 1980 from 165,840 tons, reaching a peak in 2014 (461,196 tons) but started declining to 389,244 tons in 2016 and as of 2018 production was 439,354 tons. Catch assessment surveys carried out revealed that in Lake Victoria, the catches of Nile perch increased from 85,000 MT in 2010 to 91,000 MT in 2014 and tilapia increased from 17,000 MT to 42,000 MT in the same period. In Lake Albert, Nile perch decreased from 8,600 MT in 2012 to 3,800 MT in 2014. Overall, fish catch increased by 16.6% over the five years, 2010-2014 indicating recovery of fish stocks. The biggest increase in fish catch was recorded on Lake Victoria (50.4%) but three lakes reported declines in fish catch. Table 12 presents the distribution of fish catch by lake (ASSP, 2015).

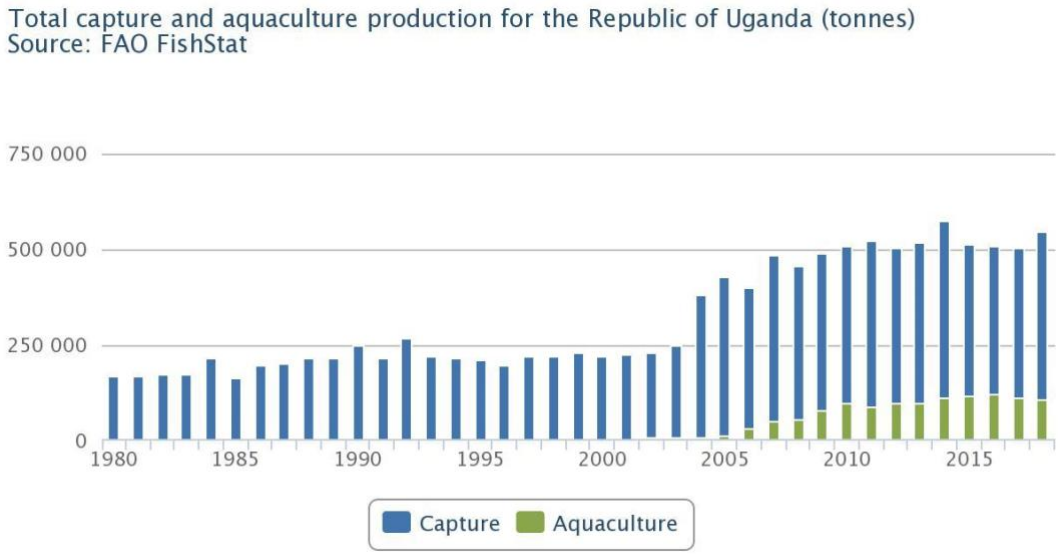


Figure 13. Capture and Aquaculture Production Trends (1980-2018).

Table 12. Fish catch by water body (thousands tonnes), 2010-2018.

Water Body	2010	2011	2012	2013	2014	2015	2016	2017	2018
Lake Victoria	162.93	175.82	185.52	193.00	245,000	238,630	252,804	133,231	138,037
Lake Albert	154.15	163.60	152.56	160.00	152,000	149,040	148,159	171,767	148,540
Lake Kyoga	49.06	61.58	44.05	40.00	36,000	41,768	40,710	41,540	40,133
Lake Edward, George &Kazinga Channel	4.50	5.3	5.21	6.25	6,246	6,354	6,638	3,070	3,074
Albert Nile	-	-	-	-	5,390	5,122	5,375	2,540	2,794
Lake Wamala	-	-	-	-	4,590	4,186	3,959	5,062	4,303
Other Waters	15.30	14.80	20.30	20.00	10,500	9,760	9,883	9,320	8,820
Total	385.94	421.10	407.60	419.00	461,726	454,860	467,528	366,531	345,803

(Source: UBOS Statistical Abstract 2019)

However, from 2017, Lake Albert continued to be the biggest contributor to fresh water fish production accounting for 43% in 2018. This surpassed Lake Victoria (39.9%) which was the biggest contributor in the earlier years for the period under review and this has greatly

impacted on the total fish production for the country while Lake Kyoga was the third largest contributor to fish catch (11.6%) as shown in Figure 14 and Table 12.

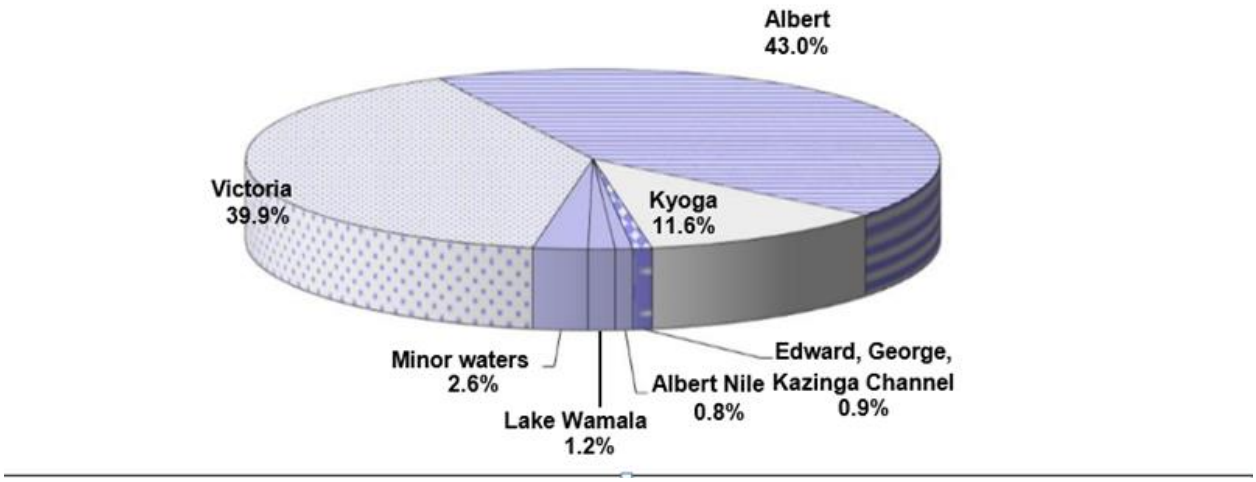


Figure 14. Proportion of fish catch by water bodies 2018.

(Source: UBOS Statistical Abstracts, 2019)

Efforts were also made to control illegal fishing during the period under review (2010-2020). In that effort 14% of the boats that were licensed in 2011 reduced to 6.3% in 2014. In addition, over 60,000 nets were impounded and destroyed and over 100 trucks with immature fish impounded, 150 boats were destroyed; over 2,000 suspects were arrested and prosecuted. By 2014, compliance level by factories had increased with a reduction of undersized fish processed by 90% mainly through self-policing schemes. Regular monitoring and enforcing fish quality and safety standards has been implemented and to-date all fish export consignments from the three main lakes are issued with fish health certificates.

In an effort to develop the fishery of Small Pelagic Fishes, suitable fishing crafts, gears and methods including catamaran boats, fishing equipment, large scale mechanized fishing rigs were adopted and promoted resulting in the number of bigger motorized boats targeting small pelagic fishes to increase on all water bodies. In addition to this, 106 mukene fishing grounds were mapped in three districts on Lake Victoria and 40 community demonstration mukene handling infrastructure (drying racks) at landing sites in nine local government districts riparian to Lakes Kyoga, Albert and Victoria were established. Other achievements included promotion of suitable packaging methods; promotion of five new mukene products (sweet mukene, powder mukene, sesame seeds mukene, chilled mukene and chips mukene)

to artisan women processors; standards were developed for the two products namely ground or powdered and sundried mukene products, resulting in an increase in the number of fish products available in supermarkets from 3 in 2009 to now over 10.

Over the past four years, there has been an increase in fish stocks across all major water bodies, mainly as a result of increased enforcement on the water bodies. This resulted in a 43% increase in catch from 391,260 MT in 2016 to 561,065 MT in 2017. In effect, this resulted in the re-opening of four fish factories.

Minister of Agriculture Animal Industry and Fisheries – New Vision, May 26, 2020.

The key challenges include: weak policy and regulatory framework; production constraints e.g. limited availability of quality feeds; land tenure and water rights issues affected water for agricultural production; weak M&E System and statistics e.g. data management. Others included poor postharvest handling and processing constraints; poor stakeholder coordination – including Public Private Partnership (PPP); human resource challenges including inadequate staff, lack of training and poor equipment; poor markets and marketing infrastructure; and funding constraints.

Capture Fisheries Production Constraints in Uganda

- Open access to the fisheries;
- Environmental degradation of water bodies and thus of fish habitat;
- Decline in fish stocks and fish species diversity due to excessive fishing effort (over-fishing or overcapitalization of the fisheries);
- Use of destructive fishing gears and methods; e) Capture of immature fish and introduction of exotics;
- The spread and impacts of exotic fish species (Nile perch);
- Proliferation of invasive weeds, in particular, water hyacinth;
- Post-harvest losses (10-30% of the catch) due to poor handling, processing and storage;
- Ineffective management of the fisheries due to limited community participation;
- Inadequate investment skills among fisher folks; and
- Inadequate access to information technologies and inefficient dissemination of technologies.

Aquaculture: As shown in Figure 13, aquaculture production in Uganda is still underdeveloped, although the trend in production has been rising over the years. Aquaculture production systems used in Uganda include earthen ponds, cages in reservoirs

and tanks. The use of earthen ponds dominates production. Although fish farming in Uganda has been dominated by pond culture, there is a growing interest in commercial cage culture in lakes, water reservoirs and dams (Rutaisire, 2007). The main species farmed are African catfish (Clarias gariepinus) and Nile tilapia (Oreochromis niloticus), in ponds ranging from 100–6,000 m^2 (though most are approximately 500 m^2) (Isyagi et al., 2009). Tilapia is increasingly being grown in cages, which are cheaper to build and operate than ponds and most farmed fish is sold fresh. Ninety percent (90%) of aquaculture is contributed by Nile Tilapia and Catfish. Processing is significantly under-developed for aquaculture, particularly relative to fisheries. Some local processing is done, such as drying, salting and smoking.

In an effort to promote commercial aquaculture, an aquaculture parks investment policy was developed for creating an enabling environment to spur commercial aquaculture investments. In order to improve operation of aquaculture production systems, processes and input supplies, guidelines for cage fish establishments were developed and cage enterprises have increased from 50 in 2009 to 1,300 cages on L. Victoria by 2014. One land-based and one water-based aqua parks in Apac and Kalangala districts were mapped. On the other hand, to support small scale production to commercial aquaculture, enhance production and supply of quality seed and to promote production of improved feeds, (a) three dams in Rubirizi, Sembabule and Kole districts were stocked with a total of 78,000 fingerings of Chinese carp (b) four regional fry centres were constructed at Kajjansi, Mbale, Gulu and Bushenyi and (c) one feed mill was established in Kibuku district by government and a private major feed mill established in Jinja District.

Stakeholders acknowledge that all inputs (feed, seed and extension) present challenges to the aquaculture value chain. The instability in the price of feed is related to the variable input prices for feed production. Ugachick's floating feeds are composed of maize, soya, and mukene. While the price for maize is known to be volatile, the price for mukene is increasing as more people consume it as a source of protein.

Figure 15: Production constraints such as the rampant use of illegal fishing methods, increased nutrient loading, pollution and water hyacinth shown above affect fishes

(Source: NAFIRRI, 2013)

Tilapia production: Tilapia is the main fish species in aquaculture. The share of farmed tilapia in total (farmed and wild caught) fish production increased from less than 0.5% in 2000 to nearly 10% in the early 2010s (Figure 16). According to FAO statistics (2015) farmed tilapia production grew rapidly from 600 tonnes in 2000 to about 50,000 tonnes in the early 2010s (Figure 16). Most of the farmed tilapia or farmed fish in general are sold directly to consumers at farm gate, whereas some farmed fish are sold in marketing centres (MAAIF, 2012; Hyuha et al., 2011; MAAIF, 2000;). Some fish farmers or traders process farmed fish by salting, sun drying or smoking to serve distant and bigger markets. There is only one firm in Entebbe known for exporting cold-smoked catfish internationally (MAAIF, 2012).

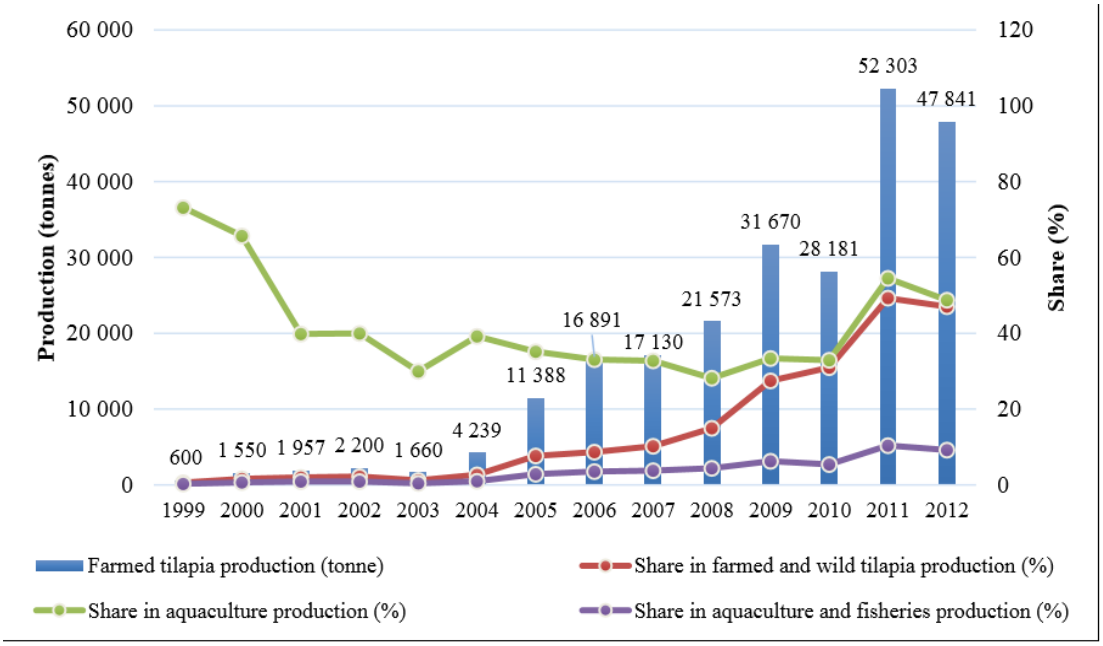


Figure 16: Farmed tilapia production in Uganda Source: FAO. 2015. Fishery and Aquaculture Statistics. Global production by production source 1950-2013

(FishStatJ)

Aqua parks development: Current aquaculture production does not meet both local and external demand despite the existing potential. Aqua parks through PPP could fill this gap in augment production, handling, value addition and marketing. This will attract investment and transform current farmers from subsistence to profit oriented commercial producers through cost effective methods, technologies, and business management skills. This could be supported by approval of the draft National Investment Policy for Aquaculture Parks (NIPAPs) whose main objective was to create a framework for a conducive investment environment for increased fish production through APs. Under this arrangement, government aimed at boosting aquaculture production to an ambitious target of 300,000 tonnes (Republic of Uganda, 2012).

Cage fish farming: During the 2010-2020 period there has been a prominence in other production methods mainly cage farming (Fig. 17) and a growing interest in commercial aquaculture which requires a lot of initial high investment cost. Cage culture is fish farming carried out in caged enclosures. It involves raising fish in containers enclosed on all sides and at the bottom with mesh material that secures the fish inside while allowing relatively free water exchange with the surrounding environment (Schmittou et al. 1998). In 2006 when

cage farming began, there were less than 50 cages but this increased to over 3,000 cages currently on Lake Victoria and other water bodies (Fisheries and Aquaculture Policy, 2017). A 6x6x6 cage (216 m3) with proper feeds yields between 7-8 tonnes per cycle. Investing in similar 42,000 cages would generate the targeted 300,000 MT in a year. A farmer using floating cage technology produces 12 times more tonnage per annum than his or her counterparts practicing capture fishery.

Challenges of cage farming

- Water quality may be reduced due to high stocking density; easy or more rapid spread of fish diseases; easier to poach fish; production rates are less than those in production ponds.
- The risk of losing crop is higher in cages than in ponds. There are major concerns regarding high production costs, quality feed, seed and market availability, potentially negatively impacting cage culture.
- There are diseases associated with cage culture - seven viral diseases with high mortality rates are cited. Other diseases include eight that are caused by bacteria, parasites and nematodes.
- Lack of economies of scale in the use of labour, cage cost and marketing; high loss due to poor management and water quality; vandalism and theft; increasing incidences of disease outbreaks; expensive for the poor.
- Low extension efforts; inadequate fry (seed) and feed production; and environmental threats/pollution.
- Trans-boundary water resources, conflict where water bodies have multiple uses.
- Lack of prerequisite legislation and regulation, and inclusiveness in its development.
- Farmers also lack technical knowledge/skills on aquaculture husbandry.

Adapted from EPRC, 2017 & Blow and Leonard (2007)

At the national level, fish cage culture and aquaculture parks have been identified as strategic cutting-edge technologies with the potential to increase fish production (MAAIF 2012; Rutaisire et. al., 2009).

Figure 17: Cage farming, the technology being promoted by NaFIRRI in collaboration with the Uganda-China Aquaculture Technology Demonstration Centre

(Source: NAFIRRI, 2013)

Fish exports

All fish export from the lake was banned in 1999 due to poor conditions at landing sites and in processing facilities, issues with health certificates, and lack of monitoring capabilities in the sector (Bambona, 2002; Hempel 2010; Ducker and Webber 2010). Exports rose in the early half of the 2000s, but then declined sharply, as indicated in Table 13, which clearly shows the success and subsequent decline of the fish exports. The decline in exports was due to a ban by European countries in 1999 due to quality concerns. After the European ban was lifted in July 2000, fish exports increased immensely (Table 13). The export value of fish products went up from a low of about 20 million US dollars in 2000 to a high of 146 million dollars in 2006. Fish exports in this period earned almost as much as coffee, a traditional export commodity. For example, in 2004 the value of coffee earnings was about 124 million dollars and that of fish earnings about 103 million.

Table 13. Fish exports (chilled and frozen fillets, gutted and beheaded) from 1991 - 2012

Year	Volume (tonnes)	Value (US$'000)	% Total Exports
1991	4,751	5,309	2.9
1992	4,831	6,451	2.7
1993	6,037	8,807	2.7
1994	6,563	14,769	3.7
1995	12,971	25,903	3.9
1996	16,396	39,781	4.5
1997	9,839	28,000	4.7
1998	13,805	34,921	7.4
1999	13,380	36,608	5.2
2000	15,876	34,363	7.7
2001	28,672	80,398	17.3
2002	25,169	87,574	18.8
2003	25,111	86,343	17.0
2004	30,057	102,917	16.0
2005	36,600	143,618	17.6
2006	32,855	136,851	15.2
2007	28,400	117,364	9.3
2008	23,503	115,306	7.2
2009	17,253	87,655	7.9
2010	16,697	86,017	7.9
2011	17,332	91,447	6.3
2012	20,562	115,508	8.0

(Source: FishStatJ)

Fish Biosafety and Disease Control

The growth of aquaculture production has resulted in significant movement of live fish within the country and the neighbouring countries. These activities pose a danger of spreading diseases in the country, region, and beyond. Disease outbreaks although common in aquaculture have in the recent been reported in the wild fish population. The recent epizootic ulcerative syndrome (EUS) outbreak caused major losses to wild fish harvests in southern Africa in the Chobe-Zambezi River system an occurrence that poses a threat to Uganda given the extensive hydrological patterns and trade in the region. In Uganda, there are occurrences of fish diseases that include white spot in ponds. As production is intensified there is likelihood for disease outbreaks. The developments are happening at a time when there is scarcity of knowledge and limited capacity on the epidemiology of fish diseases. Biosecurity in Uganda is even more critical because of its borders on Lake Victoria and the Nile River system; thus, any introduced disease could quickly spread throughout a large portion of North and East Africa. Because of the critical location in the Nile River water shed and the actively developing aquaculture industry, it is imperative that Uganda develops a

strong biosecurity system for aquatic animal diseases. In addition, there are increasing threats of water contamination as a result of illegal activities around water bodies and poor agronomic practices (MAAIF, 2017).

Gender considerations in the fisheries value chain

In fisheries, women often dominate in trading and processing activities (e.g. smoking, salting and sun drying). They buy fish from farmers or landing sites for processing and sell to consumers (Keizire, 2006). When fish farming was introduced in Uganda, it was assumed that men would have control of the sector as they were perceived to be the "owners" because they owned the land through the inheritance system. This perception has implications on extension services offered. Even though women manage their husband's farms, extension agents would talk only to men. The women are often bypassed in training even though they have management skills required to properly manage the ponds (Aganyira, 2005). In spite of the role of women in managing fish farms, they are often not involved in farm decisions relating to construction, pond management, harvesting, marketing, and the sharing of farm proceeds. Men control proceeds from fish farming, just like other agricultural activities, even though both genders participate in farm activities. A study on the involvement of women along the value chains indicates that women, especially those at the lower end of the social ladder, are more vulnerable to, as well as exposed to, health hazards because they generally work with limited protective gear (Bjørndal, Child and Lem, 2014).

Under gender development the National Fisheries and Aquaculture Policy (2017), government will ensure that women, men, youth, children, the elderly and Persons with Disabilities (PWDs) are full beneficiaries of this policy and that they are not marginalized in its implementation. Government will address this through equity in employment, access, tenure, and participation in all interventions as well as equal benefits sharing that accrue to fisheries and aquaculture. Government shall ensure that reformed institutional structures promote the active participation of women, men and the vulnerable groups to ensure sustainable social and economic development.

Youth in agriculture/fisheries

Uganda has the world's youngest population with over 78% of its people below the age of 30 and about half are below 24 years of age (FAO, 2017). The participation of the youth in

agriculture sector is minimal and is partially attributed to the migration of youth from rural to urban areas, to engage in small urban based income generating activities like riding "bodaboda" (motorcycle for hire), petty trade and service sector work. The youth prefer to participate in activities that offer quick and regular income with less risk and yet opportunities for them to cause change in rural communities with their increased involvement exist especially if they can perceive agriculture as a business while adopting commercially viable practices.

Landscapes and agroforestry

Status of the landscapes

Land degradation has been reported to increase in several parts of the country. The form and processes of degradation vary from one location to another contributing significant deterioration of water quality and reduction of water quantities. Under the Land Degradation Neutrality Target Setting Program (LDN TSP, 2018), approximately 20 % of the country was mapped as degradation hot spots and areas showing early signs of declining land productivity were also identified. The following areas were identified as areas of declining productivity in the different Water Management Zones (WMZ):

- L. Albert WMZ – Nwoya, Kiryandongo, Buliisa, Kyankwanzi, Mpigi and Hoima
- L. Kyoga WMZ – Katakwi, Napak, Amuria, Nakapiripiriti, Kamuli, Serere, Kayunga, Luuka. These districts lie in the typical "Cattle Corridor";
- Upper Nile WMZ – Lamwo, Kitgum, Gulu, Nwoya
- L. Victoria WMZ – Mayuge, Rakai, Isingiro and Kyegegwa.

The water management zones (WMZ, Figure 18) were demarcated by MWE to enable decentralized management of water resources along hydrological units and are, therefore, independent of administrative boundaries. This is important for effectiveness and efficiency in achieving long-term sustainable development by balancing growing water demands with limited water resources amidst the unique challenges, risks, and threats within the WMZ. The WMZ concept is based on a partnership approach where MWE engages with other relevant organisations and builds on ongoing and planned WRM activities by the partners. Various Catchment governance structures (Stakeholder Forum, Catchment Management

Committee, Secretariat) have been put in place, and baseline assessments have been conducted, and management plans developed.. These include Lake Victoria, Lake Kyoga, the Upper Nile; and Albert (Figure 18). They cover the catchment associated with Lake with the same names and River Aswa for the Upper Nile WMZ.

MAAIF identified Land Degradation Neutrality (LDN) targets at the national level and supplemented them with sub-national or WMZs and specific targets (LDN TSP, 2018). Geographically sound targets for achieving a neutral (no net loss) or improved (net gain) state will allow Uganda to focus on areas that have been identified as degradation "hot spots" and/or are considered to be a high-value priority in achieving LDN.

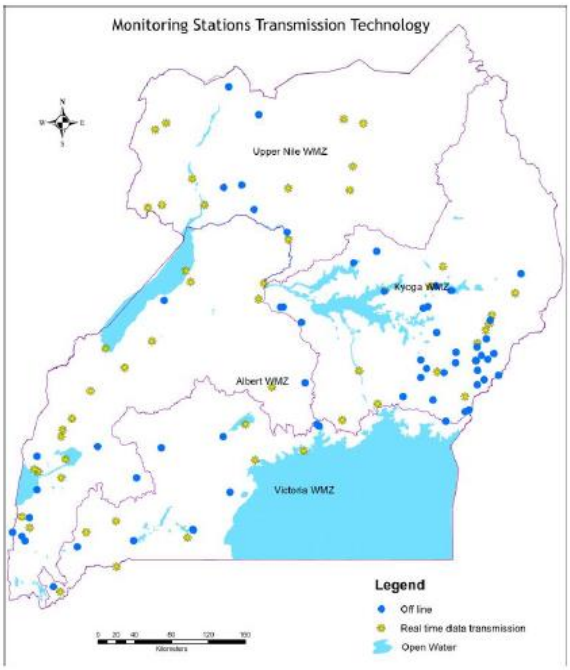


Figure 18. Water Management Zones and Location of monitoring station.

(Source: MWE, 2018)

Status of forests and agroforestry

Forests: The total forested area of the country is about 3.6 million ha, which is 15% of the total land area (Kabogoza, 2011, UFRE, 2018). Only 36% of the forests are owned by the government and the rest is under private ownership. Uganda's forests have suffered a lot from deforestation and degradation. For the period 1990-2005, the forest cover decreased from 4.9 million ha (24%) in 1990 to 3.6 million ha (15%) in 2005. This represents an average annual rate of deforestation of 1.8%; with the highest loss registered on private forests

(NFA, 2006). The causes of deforestation include over-harvesting of forest products (timber and charcoal), forest clearance for agriculture, overgrazing, urbanisation, and industrial development (Kabogoza, 2011). Over 95% of Uganda's households depend on firewood and charcoal for their energy needs and 91% of all round wood consumed are used as fuelwood (Drigo, 2006).

Table 14 presents the carbon stocks (above-ground, below-ground, litter biomass and soil organic carbon) for Uganda from forestry and other wooded lands including agroforestry for a period of 1990-2009. There is a general increasing trend in the above-ground and below-ground carbon stocks from 1990-2009 for all the land use/cover classes although forested land had the highest carbon sequestration potential followed by other wooded land including agroforestry. This is an indication of the potential of agroforestry in carbon sequestration and thus, reduction of CO_2 emissions.

Table 14. Carbon stocks for Uganda for a period of 1990-2009.

Source	Carbon pool	Forest land	Other wooded land	Other land
1992 report	Above Ground Carbon Stock (tC/ha)	41.93	8.7	8.39
	Below Ground Carbon Stock (tC/ha)	21.41	4.44	NA
	Litter biomass carbon stock (tC/ha)	5.2	5.2	NA
	Soil organic carbon (tC/ha)	37	37	37
2002/3 Report	Above Ground Carbon Stock (tC/ha)	54.75	4.63	4.59
	Below Ground Carbon Stock (tC/ha)	27.96	2.36	NA
	Litter biomass carbon stock (tC/ha)	5.2	5.2	NA
	Soil organic carbon (tC/ha)	37	37	37
2009 Report (a)	Above Ground Carbon Stock (tC/ha)	49.16	5.9	2.07
	Below Ground Carbon Stock (tC/ha)	25.1	3.01	NA
	Litter biomass carbon stock (tC/ha)	5.2	5.2	NA
	Soil organic carbon (tC/ha)	37	37	37
2009 Report (b)	Above Ground Carbon Stock (tC/ha)	68.23	4.25	1.25
	Below Ground Carbon Stock (tC/ha)	34.84	2.17	NA
	Litter biomass carbon stock (tC/ha)	5.2	5.2	NA
	Soil organic carbon (tC/ha)	37	37	37
Average (aggregated) Carbon Standing Stock (tC/ha)		124.65	48.63	38.25

(Source: MWE, 2016)

Agroforestry: Agroforestry is a widespread practice recommended for the achievement of many of the Sustainable Development Goals (SDGs) (Agroforestry Network, 2018). The SDG targets linked to agroforestry include SDG 2.4 and SDG 15.3. Agroforestry has been practiced deliberately by farmers for a very long time, and its forms vary considerably across landscapes and regions, depending on the needs and capabilities and the prevailing environmental, cultural and socioeconomic conditions. Agroforestry systems promotion started in the 1990s in selected districts of the Lake Victoria Crescent (Masaka and Rakai) and of the western region (Bukomansimbi). It was later extended in other districts of central region of Mubende and Mityana and western region such as Kabale and then to other parts of the country including Mbale, Manafwa and Bududa.

Studies have established that while forest cover is declining at the expense of agricultural land, the proportion of agricultural land with trees integrated has been increasing (Majaliwa *et al*., 2018). The composition and diversity of trees in agroforestry systems vary with WMZ and depends on farmers' local knowledge (Bukomeko *et al*., 2017). Common agroforestry **trees:** *Coffea canephora Froehner, Persea americana Mill., Artocarpus heterophyllus* Lam*., Maesopsis eminii* Engl*., Mangifera indica* L*., Milicia excelsa (Welw.) C. Berg, Carica papaya* L*., Ficus natalensis Hochst., Sennaspp., Acacia spp., Carica papaya* L*., Albizia coriaria Oliv., Citrus sinensis (L.) Osb., Eucalyptus spp.* and *Canarium schweinfurthii* Engl*., Cordia Africana, Ficus ovata, Ficus synchromonous, Spathodea campenulata, Neolamarckia cadamba* and *Grevillea robusta.*

Different agroforestry tree species have different benefits for farmers. For example, *Eucalyptus spp., Senna siamea, Senna spectabilis* are multipurpose yielding products that include edible fruits, timber, construction, and firewood. *Mangifera indicaL., Artocarpus heterophyllus Lam., Persea Americana Mill.* are highly valued for their edible fruits. *Milicia excelsa (Welw.) C. Berg* and *Pinus spp*. are preferred for their timber. Others such as *Coffea canephora Froehner* are sold to earn incomes. All species except *Carica papaya L*. can be used as firewood. Agroforestry trees also serve other multiple functions including provision ecosystem services; shade for crops (e.g. *Ficus sycomorus L*.); creating wind breaks; contributing to rain fall formation; enriching soils (fixing nitrogen in the soil), keeping soils moist, controlling soil erosion; and adding scenic beauty. Therefore, the growing of trees on farms has continually been identified as a very important production and livelihood strategy

by rural communities in Uganda (Van der Wolf *et al.,* 2016; Gram *et al.,* 2018; Bukomeko *et al.,* 2019).

Agroforestry practices vary from one region to another but are often characterized by improved fallows, growing annual crops during the establishment of plantation forest, home gardens, alley cropping, growing multipurpose trees and shrubs on farmland, boundary planting, farm woodlots, orchards or tree gardens, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, trees on pasture and apiculture with trees (Nair, 1993; Sinclair, 1999). Some of the factors affecting agroforestry include: limited awareness, shortage of land, inadequate extension services, lack of planting materials and starting stocks, lack of income, and poor policy implementation (e.g. Sebukyu and Mosango, 2012; Kabiru *et al*., 2018).

Productive resources

Land resources

Uganda has several land resources (Stark, 2011) but six of them have been reviewed because of their leading importance in the country. These are: agricultural land resources, rangeland resources, wetland resources, forest resources, wildlife resources and mining resource. Approximately 80% of the total area is arable though, it is estimated that only 30% is under cultivation with bananas as the major food crop accounting for 28 percent of the total cropped area, followed by cereals, root crops, pulses and oilseeds with 25 percent, 17 percent, 14 percent and 8 percent of the area, respectively (FAO 2003).

Rangelands are a very important natural resource and according to Government of Uganda (2014), they cover approximately 44% of the total land area supporting 80 and 90% of the national livestock herd and cattle respectively. They constitute cattle corridor stretching from the south east through the central region and to the north eastern area (McGahey and Visser, 2015; Mutambukah, 2016). NEMA (1996) indicates that grasses are the most important forage plants. However, according to Mutambukah, rangelands are rich in a variety of economic resources which include unique biodiversity including tree species in addition to petroleum and minerals.

Wetland resources occupy an area of about 30,100 km^2 and comprise of papyrus swamps, swamp forests, riverine wetlands, lake edges, flood plains, dambos and artificial wetlands. They possess distinct trees, shrubs and grasses and quite unique soils. NEMA (1996) suggests that Wetlands in Uganda serve four major physical functions namely: i) regulation and conservation of water ii) sediment and nutrient trapping iii) climate modification and iv) provision of habitat for a wide range of unique flora and fauna. Further, they provide products and services including plant products, grazing, water supply and nutrient and toxic chemicals retention. Wetlands resources have significantly declined and between 1994 and 2008, they had reduced by 30%.

Uganda's forest reserves currently constitute approximately 7% of the total land area of the country comprising about 700,000 hectares in tropical high forests, 632,000 hectares in savanna forests and 24,300 ha in plantation forest. Tropical high forests are mainly found in western Uganda around Lake Victoria and on Mt. Elgon in the east. Unfortunately, these forests have been severely declined due to indiscriminate clearing. For example, at the start of the century, tropical high forests which were covering 12.7% of the country's land area (FOSA, 2001), though reported at 14% in 2011 (Obua *et al*., 2010).

The country is endowed with wildlife resources occurring as either protected or ungazetted public land national parks, wildlife reserves, wildlife sanctuaries and community wildlife areas (NEMA 1996). National parks cover 4.6% (11,150 sq. km) of the total area of the country, wildlife reserves cover 3.6% (8,760 sq. km), wildlife sanctuaries, 0.35% (850 sq. km) and community wildlife areas 11.4% (27,600 sq. km). The country is also endowed with rich mineral deposits and except for petroleum, the sector is generally underdeveloped and dominated by artisan mining.

Uganda's land resources have experienced serious degradation especially in the highlands and the drylands. Approximately 41% of Uganda's total area is undergoing some form of degradation, and 12% is in a severe state of degradation. Soil erosion is the most common form of degradation, affecting 85% of degraded land (Cooper, 2018). Assessment of soil erosion across the country estimates 80% of Uganda's total surface area to be to prone to erosion, resulting in soil losses of about 62million tons as of 2014. One of the key signs of soil degradation in Uganda is the obvious decline in crop yields despite the increase in the area

under cultivation. Expansion of the area under cultivation is mainly attributed to short and medium distance migration and conversion of wetlands, forests and grasslands into cropland. Deforestation is another cause of land degradation in Uganda with the annual rate of deforestation estimated to be 2.4%. Population growth has been indicated to be a key driver of deforestation and wetland encroachment as land is cleared for agriculture and settlement.

Soils

Uganda is endowed with various types of soils (Fig. 19). These include Lixic Ferralsols in the western part of the country and stretching around the Lake Albert, Luvisols around the Lake Victoria, Planasols around the Lake Kyoga and below the foot of Mt Elgon, Vertisols around the Karamoja region and Regosols in north-western part of the country. Most of these soils are acidic and characterized by low level nutrient reserves (Eswaran et al., 1997; Henao and Banaante, 1999; Stocking, 2003; NEMA, 2009). The predominance of quartz and kaolinite predisposes these soils to very low cation exchange capacity (CEC). The latter coupled with nutrient mining through harvest, soil erosion and very low fertilizer application has contributed significantly to decline of the fertility of most of the soils in Uganda. The majority of the soils are below average productivity, except the Andosols on the lower slopes around Mt Elgon, the northern part of Lake Edward, around Kabarole and Kisoro districts, and small patches around the country, including in Busia, Kabale, Nebbi, Mbarara, Lira and Bundibudyo districts; and the stretch from Jinja to Masaka District around the northern shores of Lake Victoria. As earlier indicated, land degradation processes have significantly compromised Uganda's soils primarily due to soil erosion processes. Estimates show that approximately 39% of the country's lands that are prone to erosion experience unsustainable rates of soil loss.

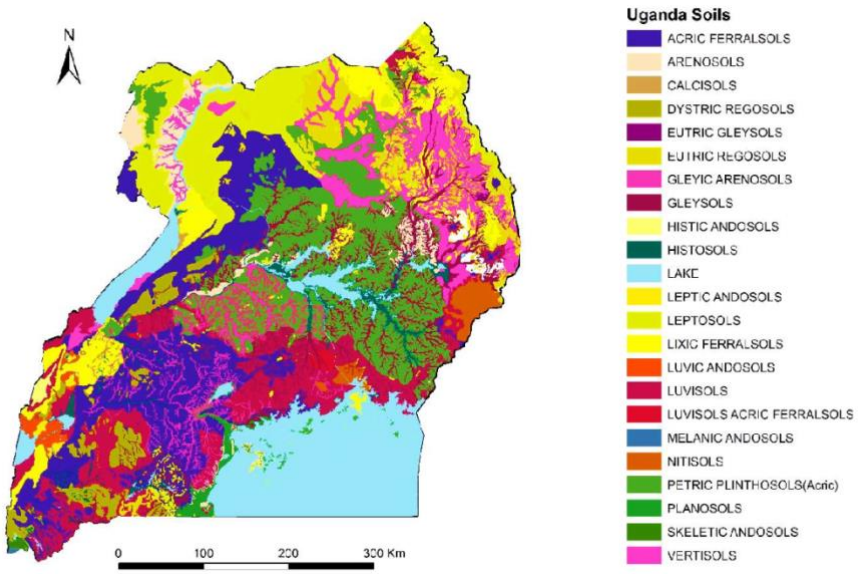


Figure 19. The soils of Uganda (scale: 1:250,000).

Though soil erosion is wide spread in Uganda, its magnitude varies significantly from one region to another. It is estimated that about 80% of Uganda's total surface area is prone to soil erosion, with an average potential soil loss rate of 3.2 t/ha/yr (Karamage *et al.*, 2017). All the Water management Zones are potentially affected by soil erosion due the nature of the terrain, land-use, soils and climate variability. Though mountainous regions such as Mount Elgon and Kabale highland do not experience very high rates of soil erosion, the actual rates are beyond the threshold for mountainous ecosystems (Luswata *et al*., 2013; Bamutaze *et al*., 2017). The pattern of soil erosion in the different agro-ecological zones is likely to be influenced by the frequency and magnitude of high return period rain events (heavy storms) and the time of their occurrence. Studies in the Lake Victoria basin have shown that the little rainfall amount beyond 25 mm generate more than 40% of the soil loss (Majaliwa *et al*., 2004; Bamutaze *et al*., 2017). The effect of these storms may be more detrimental if they occur when the land has inadequate cover, due to the antecedent dry conditions. Table 15 shows the soil loss reported under selected land-use/cover of the different WMZ of Uganda.

Table 15. Soil loss from the different landscapes of Uganda.

WMZ	Land-use/cover	Soil loss range	Authors
WMZ Lake Victoria	Land-use/cover	Soil loss range	Authors
	Annuals	93-126	Lufafa et al. 2003; Majaliwa et al.

			2015
	Rangeland	3.2-52	Lufafa et al. 2003; Majaliwa 2005, Mulebeke , 2004
	Perennials	19.6-48	Majaliwa 2005, Luliro et al. 2013
	Landing site	107-207	De Meyer et al. 2011
Lake Kyoga	Forest	0.01-48	Lufafa et al. 2003; Majaliwa et al.2004; Luswata et al. 2013, Mulebeke et al. 2004
	Annuals	0.061–45	Tenywa 1993, Nakileza 1994; Bamutaze 2005,
Northern	Annuals		
	Rangeland		
	Perennials		
	Forest		
Albertine Rift	Woodland	1.6-	Luswata et al. 2016,
	Rangeland	0.9-	Luswata et al. 2016,
	Perennials	0.2 -	Luswata et al. 2016
	Annuals	0.07-129	Bagoora 1998, Tukairwa 1996, Luswata et al. 2016

Soil loss in undisturbed forest is generally extremely low (< 1 $Mg \cdot ha^{-1} \cdot yr^{-1}$) and can reach to more than 100 $Mg \cdot ha^{-1} \cdot yr^{-1}$if the forest is converted to another land-use/cover. The magnitude of the variation increases with rainfall intensity, slope gradient, land-use/cover and their management.

The intensification of agriculture without soil conservation practices is likely to have detrimental impacts on soil including high erosion rates and low soil fertility as well as ground water pollution and eutrophication of lakes and rivers. Soil fertility is declining as a result of nutrient loss, affecting agricultural land productivity (NEMA, 2016). A number of constraints have been mentioned for the low productivity of Uganda's soils including declining soil fertility, reduced fallow periods, poor farming practices characterised by limited use of improved seeds and low manure and fertiliser use, limited access to appropriates technologies, inadequate knowledge on proper soil/land use practices as well as poor farm to market structure and exogenous factors for example low prices and climate change (Government of Uganda, 2017). For example, the current fertilizer consumption is 1.91kg/ha of arable land compared to 38.2 in Kenya and 89.6 in Zambia. Nutrient mining with or no replenishment of soil fertility is a key driver of low soil fertility in Uganda.

Water resources

Water resources are categorized into surface and groundwater which form part of the earth's hydrologic cycle. Water covers 15.4% of the surface of Uganda (Nayebale et al., 2014). Rainfall plays the most important role as contributor to ground and surface water recharge within Uganda (MWE, 2013). Surface- and ground-water resources play significant roles in agricultural production, industrial operations, fisheries, domestic water supply and environmental conservation (Kumar et al., 2005). Uganda's water resources comprise of large lakes (Table 16) such as Lakes Victoria, Kyoga, Albert, George and Edward; wetlands and rivers, such as the Nile River, Katonga, Rwizi, Kafu, Manafwa, Sio, Mpologoma, Aswa, Semliki, and Malaba; rainfall, surface water runoff and ground water (Fig. 20).

Uganda is divided into eight main water drainage/catchment sub-basins including Albert Nile, Aswa, Victoria Nile, Kidepo and the lakes of Victoria, Kyoga, Edward and George. The yields from these sub-basins dominate the water resources potential within the country. About 98% of the total area of the country is covered by the Nile basin (FAO, 2015).

Table 16. Major lakes and their characteristics.

	Surface Area (Sq. Km)	Area in Uganda (Sq. Km)	Mean Elevation above Sea Level (m)	Maximum depth (m)	Volume in Uganda (cubic km)
Lake Victoria	68,800	28,655	1,134	84	1237
Lake Albert	5,659	2,850	618	56	80
Lake Kyoga	2,636	2,636	1,034	10.7	7.9
Lake Edward	2,324	638	912	117	16.8
Lake Kwania	540	540	1,033	5.4	2
Lake Wamala	250	250	1,290	9	1.2
Lake Bisina	150	150	1,030	N/A	0.5
Lake George	228	228	914	7	0.8
Lake Bunyonyi	61	61	1,974	39.3	0.2
Lake Kachira	39.6	39.6	1,235	4.8	0.2
Other 149 minor Lakes		2453			7.2
Total		38,500.6			1,353.8

(Source: UN-Water, 2006 in Nsubuga et al., 2014)

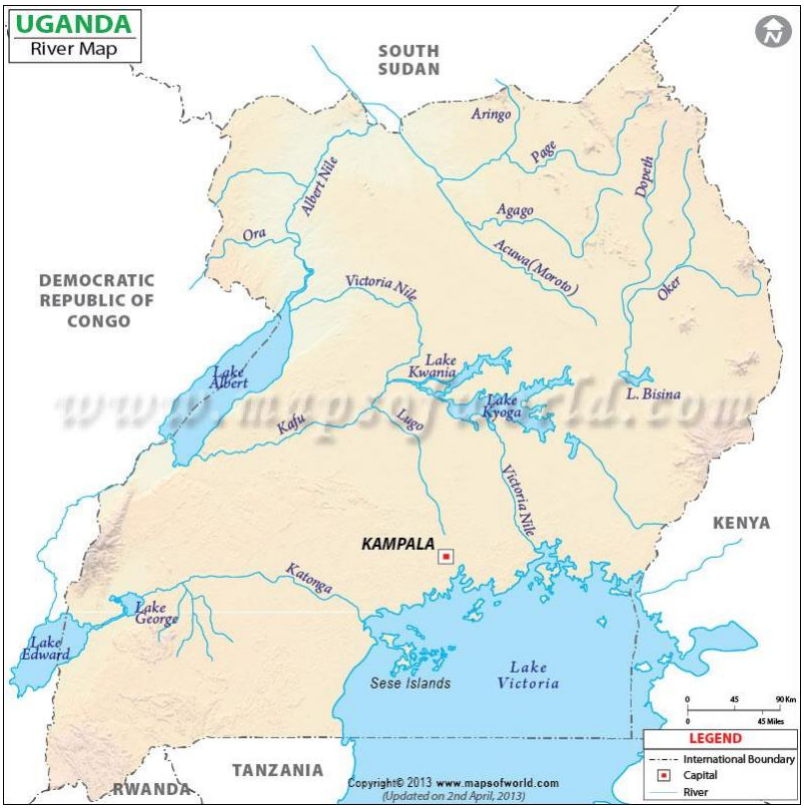


Figure 20. Distribution of the major lakes and Rivers in Uganda.

Despite its abundant water resources, many parts of the country have remained water stressed for relatively long periods of the year because of the spatial and temporal distribution of these resources (Nsubuga et al., 2014). These include districts in the north-eastern and south-western parts of the country which present the least per capita water availability (Figure 21).

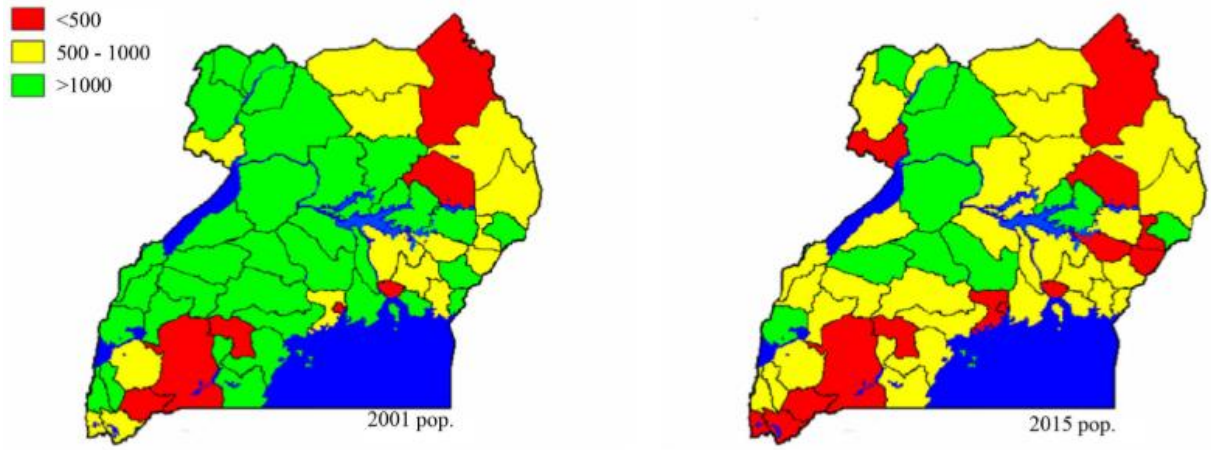


Figure 21. Spatial per capita surface water distributions (m^3/yr).

(Source: Nsubuga et al., 2014).

Wetland resources in Uganda are broadly categorized as natural lacustrine swamps located around the major lakes and the riverine and floodplain wetlands associated with major rivers. Wetlands also include seasonally flooded grasslands, swamp forest, grass swamps, permanently flooded papyrus and bogs. According to MWE (2013), wetland resources cover about 13% of the country's total land area of which one-third is permanently flooded. However, in 2008, wetland area coverage had declined by 30% between 1994 and 2008 (Table 17), mostly around Lake Kyoga, Albert and Lake Victoria basins, although an increase of 0.03% in wetland area was reported between 2008 (26,307km^2) and 2014 (26,315 km^2) (MWE, 2014). The extent of decline varies from 53.8% in the Lake Victoria basin to 14.7% in the Lake Albert basin. Wetlands offer enormous ecosystems services and functions among which food provisioning through supporting cropping and grazing and providing fish resources and water production to communities at different levels. Currently, wetland coverage is at 8.9% intact, 4.1% degraded and 2.6% completely lost (MWE, 2018). The decline in area coverage according to MWE (2011) is attributed to the encroachment in expansion for agricultural land, settlement, and industrial development (MWE, 2011).

Table 17. Change in wetlands coverage for the different drainage sub-basins between 1994 and 2008.

Drainage basin	Area		Change in area
	1994	2008	
Albert Nile	1736.3	1255.2	-27.7
Achwa	3028.0	2168.9	-28.4
Kidepo	168.1	197.2	17.3
Lake Albert	2838.6	2421.7	-14.7
Lake Edward	1671.1	1096.3	-34.4
Lake Kyoga	15008.3	11028.5	-26.5
Lake Victoria	7167.6	3310.2	-53.8
Victoria Nile	5786.3	4829.4	-16.5
National	37575.4	26307.7	-30.0

(Source: MWE, 2011 in Wetland Atlas, 2016)

The total internal renewable water resources (IRWR) are estimated at 39 km^3/yr, groundwater about 29 km^3/yr, albeit all of this is considered to be an overlap between surface water and groundwater. Peripheral resources of 21.1 km^3/yr constitute inflows from Lake Victoria, from which 10.7 km^3/yr flows from Tanzania and 8.4 km^3/yr from Kenya, and 2 km^3/yr inflow from Lake Edward and Lake Albert from the Democratic Republic of Congo

(FAO, 2015). The total renewable water resources of the country are estimated at 60.1km^3/yr as of 2013 (FAO, 2015). The total water withdrawal of the country was estimated at 637 million m^3 in 2008 (GOU, 2010) compared to 300 million m^3 in 2002 (FAO, 2002). This accounts for 1 and 0.5% of the total renewable water resources, respectively (Wanyama et al, 2017).

The major water user is domestic sector withdrawing approximately 328 million m^3 (51%), followed by irrigation for agricultural production and livestock with 259 million m^3 (41%), and industry (50 million m^3, 8%) (FAO, 2015). The major water sources exploited include: deep boreholes, protected and un-protected springs and shallow wells. There are approximately 40,233 deep boreholes, 21,567 shallow wells and 28,908 protected springs mainly constructed for rural water supply (MWE, 2018). According to UNESCO (2006), the estimated groundwater recharge in Uganda ranges between 7-20% of the precipitation. Table 18 shows the monthly groundwater recharge for the eight drainage sub-basins. The mean sustainable groundwater for major river and lake basins is presented in Table 19.

Table 18. Monthly groundwater recharge for each sub-basin (MCM).

River basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Lake Victoria	305	294	690	1097	931	562	607	851	839	1023	805	389
Lake Kyoga	229	221	519	824	700	422	456	640	630	769	605	292
Victoria Nile	130	125	294	467	396	239	258	362	357	435	342	165
Lake Edward	84	81	190	301	256	154	167	234	231	281	221	107
Lake Albert	84	81	191	303	258	155	168	235	232	283	223	108
Aswa	112	107	252	401	341	205	222	311	307	374	294	142
Albert Nile	90	87	204	323	275	166	179	251	247	302	237	115
Kidepo	11	10	24	38	32	19	21	29	29	35	28	13

(Source: MWE, 2013 in Sundin and Lndblad, 2015)

Table 19. Mean sustainable groundwater for major river and lake basins

Drainage Basin	Area	Land area	Sustainable Groundwater

	km²	km²	(mm/yr)
Lake Edward	18,946	17,855	20.3
Lake Victoria	61,886	32,924	24.7
Lake Albert	18,079	14,882	23.7
Victoria Nile	27,961	27,807	39.9
Lake Kyoga	57,236	53,899	36.1
Albert Nile	20,727	20,484	24.4
Aswa	27,637	27,635	17.3
Kidepo	3229	3228	6.3

(Source: Monitoring and Assessment Department)

The surface and groundwater resources (quantity and quality) are monitored daily by the MWE through a network of surface water and groundwater stations which are installed at the major drainage basins. The collected data is partly used to provide forecasts for floods and drought to warn and protect communities in the hotspot areas. By 2018, the MWE reported a total of 48 surface and 30 groundwater monitoring stations distributed in the different water management zones (Table 20). Out of the installed stations, 24 surface water and 10 groundwater stations have been upgraded from manual to real time data transmission (telemetric stations; Figure 18 above). From the data archives, for instance in Lake Victoria, water levels have been generally increasing from 2008 to 2018 although there are inter-seasonal variations (Figure 22). According to MWE (2018), water levels in Lake Victoria have been rising above the 2012 mark. Groundwater levels have also been reported to steadily increase for instance in Kimengo-Masindi district (Figure 23). The increase in water and groundwater levels in the different drainage basins have influenced irrigated agricultural production in one way or the other.

Table 20. Surface and ground water monitoring stations

Zone	Surface water	Groundwater
Albert WMZ	12	8
Kyoga WMY	16	8
Upper Nile WMZ	6	5
Victoria WMZ	14	9

(Source: MWE, 2018)

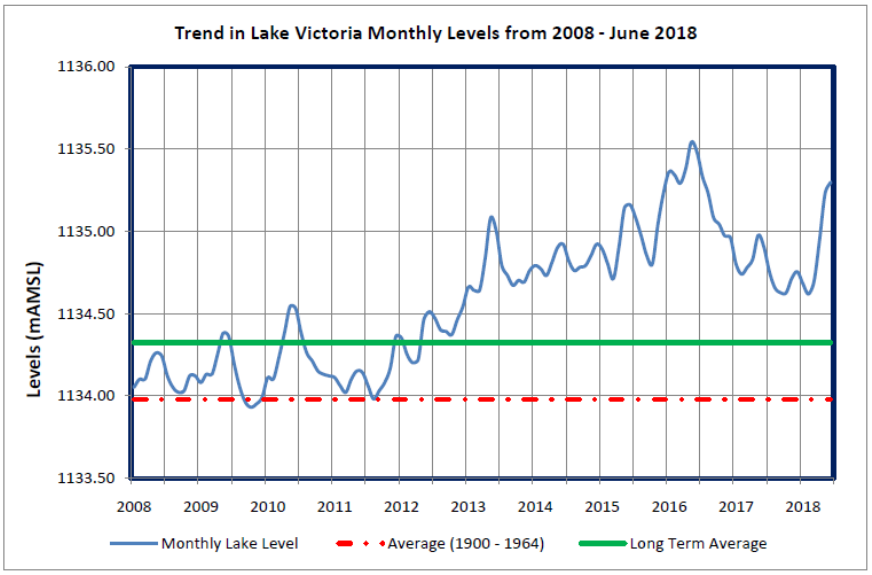


Figure 22. Lake Victoria water level variations between 2008 and 2018.

(Source: MWE, 2018)

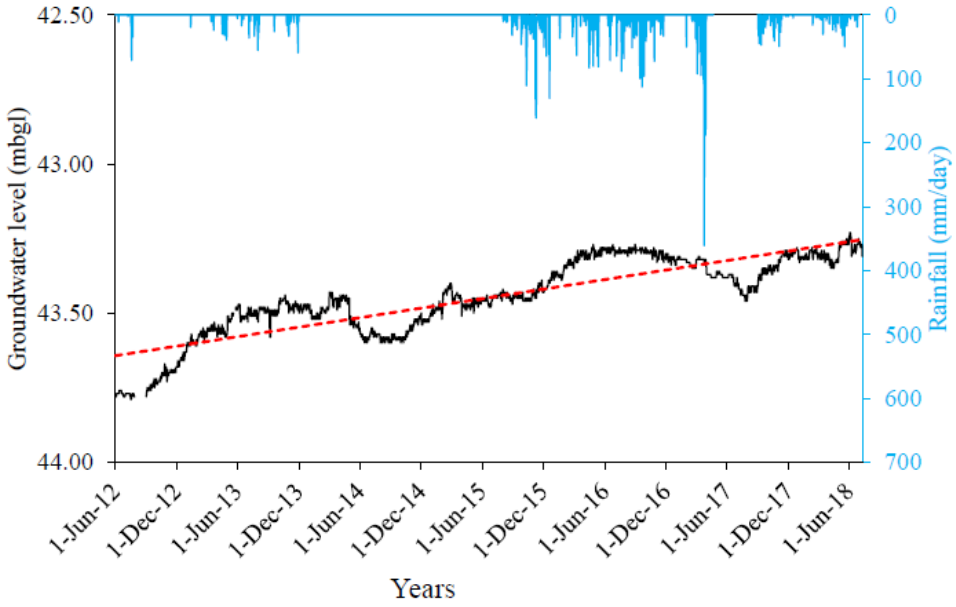


Figure 23. Groundwater levels in Kimengo-Masindi.

(Source: MWE, 2018)

The MWE operates 119 water quality monitoring stations in the different water management zones (Table 21), of which 82 stations (69%) are in operation and were regularly sampled in the year 2018.

Table 21. Water quality monitoring network in the different WMZs.

Zone	Stations planned for monitoring	Stations monitored	Performance (%)
Upper Nile	16	16	100
Albertine	37	34	92
Kyoga	33	13	39
Victoria	33	19	58
Total	119	82	69

Uganda has adopted the Catchment based Water Resources Management (CbWRM) as part of its water resources management reforms through the Directorate of Water Resources Management (DWRM) under the Ministry of Water and Environment in 2010. Water resources are managed at catchment scale thus, linking the management of land, water ecosystems, and socio-economic systems to achieve a sustainable effective and efficient water resources management (MWE, 2014). As part of the CbWRM framework, Uganda has been subdivided into four Water Management Zones (WMZs): Upper Nile, Albert, Victoria, and Kyoga. The CbWRM recognizes that several water use and management issues are interrelated and stakeholder involvement in ensuring sustainable water management practices is a key to its success.

Approaches to Implementation of Sustainable Water Management Practices

Public Private Partnership (PPP): Water for production facilities under PPP arrangement with farmers, who take full responsibility in management thus, ensuring ownership of the facilities.

Water Use Committees/Farmer Field Schools (FFS): Water user committees and farmer field schools have been established in the different WMZs to enhance and promote self-driven approaches for community ownership and sustainability of water resources facilities.

Promotion of Riverbank stabilization and gully plugs: Promotion of riverbank stabilization in the major streams and gully plugs to control soil erosion and nutrient loadings into the water bodies

The Catchment Management Organizations (CMO) within the WMZs have been established to promote coordination and integrated planning among stakeholders in the catchment such as development and implementation of the Catchment Management Plans. Catchment Management Plans have been developed by MWE for all the WMZs to guide sustainable development and management of water resources practices. The operationalization of the catchment-based water resources management framework has improved adoption and implementation of sustainable water management practices at all levels. It has also strengthened the linkage and coordination for water resources management between MWE and MAAIF including other ministries and the private sector, thus improving agricultural production and productivity. In addition, important steps have been made in the implementation of catchment based integrated water resource management in the WMZs through the establishment of WfP Department in MWE and MAAIF.

There are a number of water management issues in the agriculture sector which have continued to affect its development and productivity and these include among others:

- Poor disposal and management of industrial wastes, agricultural fertilizers, pesticides, herbicides and cultivation up to the Lake shores increasing siltation. The quality of catchment surface and ground water resources, mostly downstream is deteriorating because of the increasing pollutant loads and non-point sources into the water sources.
- Lack of streamlined extension structures leading to inadequate extension services for farmers to enhance provision of advisory services and technical backstopping in agricultural water management such as irrigation management from the local to national levels. Farmers lack knowledge of on-farm water application techniques, agronomic practices and management of agrochemicals. This leads to poor water-use efficiency and reduced water productivity (Wanyama et al., 2017)
- Poor coordination among various stakeholders e.g. MAAIF, MWE, NAADS, the districts and NGOs in Water for Agricultural Production interventions
- Operation and maintenance of water for agricultural production: The lack of highly skilled irrigation personnel focused on irrigation water management, operation and maintenance has limited the developments in agricultural water management.
- Low levels of Returns on Investment: The poor markets/access and supporting infrastructure for crop enterprises results into low levels of returns on investment. Thus,

the limited access to reliable produce market channels discourages investment in proper water management technologies such as irrigation systems.

Constraints to agricultural development and growth

According to MAAIF, the constraints and risks associated with the agricultural sector development and growth include:

- *Production constraints:* there are many sources of production risks and constraints to Uganda's agriculture sector. Risks may arise from climate-related factors such as erratic weather patterns and extreme weather events such as droughts and floods. Constraints may also be related to lack of limited access to agricultural inputs for example, Uganda has a poorly developed seed sector where the informal seed system accounts for an estimated 87% of planted seed. The total demand for grain crop seed is estimated at approximately 110,580 MT. While total sales from the formal seed market account for only 12,000 MT. The supply shortages create incentives for substandard and/or counterfeit seed. Yields for maize, millet, rice, and sorghum are only 20% to 33% of the potential yield for rain fed agriculture and even less for irrigated agriculture. A major factor is the lack of good quality, higher yielding, more vigorous, drought resistant, and disease-free seeds and planting materials. Uganda also has one of the lowest fertiliser application rates in Sub-Saharan Africa, resulting in nutrient depletion and thus low crop yields. Limited availability of quality feeds also affects livestock and aquaculture production.
- *Biological and environmental risks:* A range of pests and diseases cause crop failure and livestock deaths and their effects are exacerbated by climate change. On crops they include among others - Cassava Brown Streak Virus, African Cassava Mosaic Virus, Banana Bacterial Wilt (BBW), Maize Streak Virus, MSV) etc. These affect the major food crops and hence threaten food security in Uganda. In livestock, the endemic New Castle Disease and the sporadic and cyclic outbreaks of African Swine Fever cause serious losses in poultry and pigs, respectively. Other diseases such as foot and mouth disease (FMD), Bovine Pleuropnemonia, East Cost Fever (ECF) although largely managed by routine vaccinations they still occur and cause widespread losses in livestock.
- *Marketing constraints:* Uganda experiences high price fluctuations on account of relying largely on weather conditions for production (rain fed production), low levels of stocks,

low level of organization of producers in the value chain, and segmentation of regional and domestic markets. Additionally, the country lacks price stabilization mechanisms. Increasing food prices erode people's purchasing power, especially among low income groups causing serious implications for food security. Grain trade and agro-processing play a crucial role in the national economy, but the sector currently faces challenges such as inadequate supply due to lower production, the volatility of agriculture commodity prices and inadequate storage facilities. In order to increase agricultural production and address post-harvest challenges, Uganda ministry of trade, industry, and cooperative introduced "The National Grain Trade Policy" in 2016 which is in line with Uganda's Vision 2040 and the National Development Plan II in improving the food security, income generation and advancement of industrialization.

- *Logistical and infrastructural risks:* The lack of sufficient storage capacity both at farm level and agricultural produce trading system levels, coupled with inability to construct durable and weather tight stores, leads to high losses due mainly to damage by pests and poor handling prior to storage. There is an estimated 550,000 MT storage capacity but the estimated demand for storage facilities is estimated at 2.3 million MT and yet up to 20% of what is harvested is lost during storage.
- *Weak enabling environment:* The legal environment for the agricultural sector is conducive but implementation of many initiatives has been poor in the past due to inadequate institutional arrangements and financial resources to invest in enforcing the policies.
- Gender constraints*:* The differentiated impacts of climate change and access to production resources and inputs by men and women results in gender-related productivity gaps in agriculture. In most cases external resources and technical assistance is directed towards men, even though women are responsible for the bulk of agricultural work. Women are also accorded minimal rights compared to men especially when it comes to land tenure rights and security. This has been noted as a barrier to adoption of sustainable agricultural practices, hence the need to review customary and statutory provisions governing the rights and security of tenure using a gender lens.

Impacts of climate change on agriculture and adaptation response measures

Overview

Uganda is highly vulnerable to climate change and variability – its economy and the well-being of its people are tightly bound to climate. Human induced climate change in the coming century has the potential to halt or reverse the country's development trajectory. In particular, climate change is likely to result in increased food insecurity; shifts in the spread of diseases like malaria; soil erosion and land degradation; flood damage to infrastructure and settlements and shifts in the productivity of agricultural and natural resources. It will be the poor and vulnerable who feel these impacts the hardest. Climate change damage estimates in the agriculture, water, infrastructure and energy sectors collectively amount to 2-4% of the GDP between 2010 and 2050[2]. The national-level studies (SPCR, 2017) show that if no adaptive action is taken, annual costs could be in the range of US$3.2 - 5.9 billion within a decade, with the biggest impacts being on water, followed by energy, agriculture, and infrastructure. Over the 40 years from 2010-2050, the costs of inaction are estimated at between US$273 - 437 billion. Even if there were no further increases in climate impacts, the cost of inaction would rise over time because of an increase in population. The cost of adaptation is high, but the cost of inaction is 24-46 times greater.

Projections of future climate in Uganda shows that temperatures are likely to increase by up to 1.5 ºC in the next 20 years and by up to 4.3ºC by the 2080s. Changes in rainfall patterns and total annual rainfall amounts are also expected but these are less certain than changes in temperature. Regardless of changes in rainfall, changes in temperature are likely to have significant implications for water resources, food security, natural resource management, human health, settlements and infrastructure. Climate projections developed for the country using the models used in 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, and in the order of +2.5°C in the next 80 years under Representative Concentration

[2]CDKN, 2008. Climate Change in Uganda: Understanding the implications and appraising the response

Pathway (RCP) 4.5; and in the order of +2.5°C in the next 50 years, and in the order of +4.5°C in the next 80 years under RCP 8.5. They also predict a slight decrease in total annual rainfall in most of the country, with slightly wetter conditions over the west and north-west under both RCP 4.5 and RCP 8.5. Rainfall totals might drop significantly over Lake Victoria (-20% from present).[3] The decrease in rainfall in most parts of the country, combined with significantly wetter seasons, will result in significantly drier conditions for the rest of the year [longer wet season that extends from September, October, November (SON) towards December January February (DJF)]. This is combined with significant temperature increases, especially during the March April May and June July August seasons.

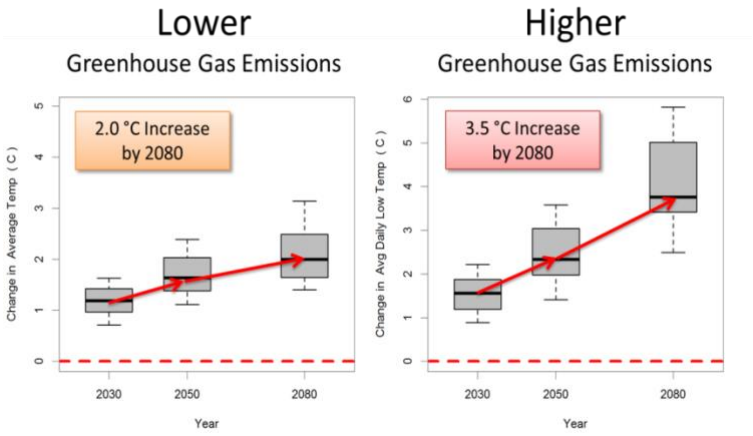


Figure 24. Projected change in average temperature (°C).

The thick black lines represent the average of 29 different climate models, whereas the grey box and dashed lines represent the range of climate models.

Global projections downscaled to Uganda generally reveal a small increase or possible small decrease in annual rainfall in the future. There are indications, however that there may be an increase in precipitation during December, January, and February, which historically has been the dry season across the country (Figure 25).

[3] http://sedac.ipcc-data.org/ddc/ar5_scenario_process/RCPs.html for an overview of the four RCPs.

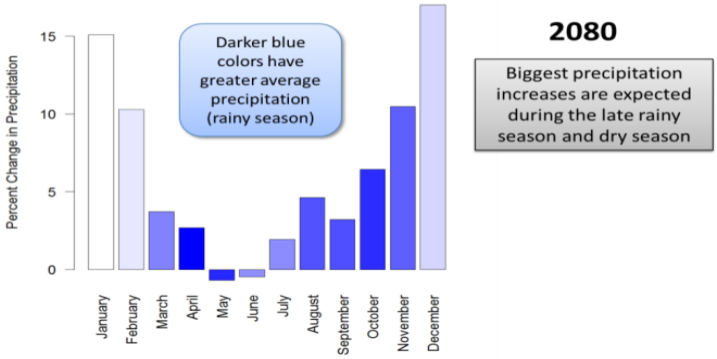


Figure 25. Percent change in precipitation in 2080 under the higher RCP 8.5 greenhouse gas emissions scenario based on an ensemble of 19 climate models from the IPCC Fifth Assessment Report.

The darker bars represent months with greater average precipitation (from Climate Wizard, CIAT, 2015).

In addition, it is estimated that 90% of Uganda's extreme weather events are as a result of climate change, especially droughts and floods. Studies (e.g. Kitutu, 2013; Hepworth and Goulden, 2008; GOU, 2007) show that 8 out of the 10 most severe floods and droughts in terms of numbers affected that have been reported since 1900 have taken place in the last 10 years. This is an indication that the number of extreme weather events in Uganda have been increasing within the recent years as shown in Table 22.

Table 22. Climate change induced hazards in Uganda between 1911 and 2020

Period	Climate change hazard		
	Drought	Landslides	Floods
1911-1920	1	1	RNA
1921-1930	RNA†	2	RNA
1931-1940	1	RNA	RNA
1941-1950	RNA	1	RNA
1951-1960	1	7	RNA
1961-1970	RNA	13	RNA
1971-1980	3	6	RNA
1981-1990	2	13	RNA
1991-2000	7	53	RNA
2001-2010	RNA	3	RNA
2011-2020	RNA	21	26

(Source: GOU, 2007 and Kitutu, 2013)

†RNA = Record not available

The effects of such events are devastating to the country's food security since it takes for instance an estimated two years to recover from each drought. The northern region is particularly vulnerable to floods and droughts and statistics show that approximately 30% of the food needs are covered by aid each year (Hepworth and Goulden, 2008). Sixty districts in the Cattle Corridor/ dry lands (comprised of North Eastern Dry lands, North Eastern Savannah Grasslands, Kyoga Plains, Western Savannah Grasslands, Pastoral Rangelands and South Western Farmlands) are prone to drought. However, among these, North Eastern Dry lands, and North Eastern Savannah Grasslands, majorly Karamoja sub region, are the most affected (Kitutu, 2013). Whilst many of these impacts are negative, there may also be potentially beneficial outcomes such as increased grazing area for livestock in the cattle corridor with increased rainfall or opportunities to grow more profitable crops and watering points arising from extensive runoff from degraded hilltops e.g. artificial lakes formed in Mbarara after the 2008 second rain season (Hepworth, and Goulden, 2008). Specific impacts of climate change on the different sub-sectors are elaborated below.

Impacts of climate change on agriculture sub-sectors

Crop sub-sector

Climate change is expected to cause yield reductions of important food and cash crops in the long term (Table 23). The direct impacts such as erratic rainfall, high temperatures and extreme events, several indirect impacts such as increased runoff and erosion rates as well as increased losses from crop pests, diseases and weeds will significantly magnify production losses. The observed shift in rainy seasons (September-November) and (March-May) and short or prolonged dry seasons in some regions distorts growing seasons, affecting the timing of planting activities by farmers. This affects timing of field preparation and planting with negative implications on crop growth, intensification of crop diseases and pests, resulting in lower yields. The shift in rainfall patterns also leads to reduction in amounts of rain water harvested; affecting both hillside and valley irrigation projects, through either decreased water levels in ponds/dams or high amounts of water destroying dam/pond embankments and causing erosion and silting.

Crop production is also directly affected by heavy rains. For example, the unusually heavy rains in March 2010 caused landslides in the Bududa district of the Mount Elgon region burying three whole villages, including crops and livestock. In 2011, the District of Bulambuli

was also strongly affected by landslides, which destroyed homes and crops. Landslides also frequently destroy crops and livestock in the highlands of south-western Uganda. A value chain analysis of crops most widely grown in Uganda showed that many crops are vulnerable to rising temperatures, increasing dry season and unpredictable rainfall patterns (USAID, 2013); with Arabica coffee being particularly vulnerable, while cassava is the least vulnerable. From the study, most to least sensitive crops are: Arabica coffee, Robusta coffee, rice, maize, East African Highland Banana (matooke), beans, sorghum, sweet potatoes, and cassava. In addition, crop production in Uganda is affected by pests and diseases, whose outbreak and prevalence has been linked to climate change and variability. The most important economic pests and diseases include, Banana Bacterial Wilt (BBW); Coffee Wild Disease (CWD); Black Coffee Twig Borer (BCTB); Maize Streak Virus; Fall Army Worm; Aphids; Cassava Brown Streak Disease (CBSD) and Cassava Mosaic Disease (CMD). For example, available data shows that in the FY2016/17, the fall armyworm reduced national production by 15-30% by causing poor yields of mainly maize, sorghum and cassava.

Table 23. Widely grown crops in Uganda and their vulnerability to climate change

Crop	Effect of climate change
Maize	Vulnerable to water stress during poor rains and aflatoxin contamination when harvesting period coincides with off-season rains. This contamination is a serious threat to the marketing of maize and will likely worsen if dry season rainfall increases.
Rice	Two major rice diseases (blast and bacterial leaf blight) affect rice yields and are significantly aggravated by weather conditions such as higher temperatures, air humidity, or soil moisture
Sorghum	Coupled with irregular precipitation, increased temperatures could result in the proliferation of striga, a parasitic weed that affects sorghum and is prevalent in areas with degraded soils.
Multiple Grains	Erratic rain could increase post-harvest storage losses of crops typically dried in the sun (e.g., maize, beans, coffee, rice, etc.), due to increased pests and rotting.
Beans	Beans are vulnerable to fungal and viral diseases when excessive rain falls during critical growing periods. Aphids are also rampant on bean crops during periods of water stress.
East African Highland Banana (matooke)	While matooke is less vulnerable to increasing temperatures than coffee is, the potential impact of pests and diseases on the crop is significant for example banana bacterial wilt, banana weevils and nematodes.
Sweet potatoes and cassava	Both crops grow well at temperatures much higher than current ones, but are also vulnerable to pests and diseases such as aphids and cassava mosaic. Also vulnerable to water logging.
Coffee	Rising temperatures and erratic rainfall increase the risk of disease and pest infestations in coffee such as the red-berry disease in Robusta coffee and the coffee berry and leaf rust diseases in Arabica coffee.

Climate change affects crop production by reducing the area of land suitable for production. For example, beans are projected to experience the greatest decreases with an up to 70% potential decrease in areas suitable for production by 2040-2069 (Figure 26). In contrast, millet, banana and groundnut are projected to increase in suitable areas, albeit only slightly (5-10%). Further, projections show that by 2050, the value of the coffee crop could fall by half, due to contraction of the area that can support its production (as a result of a changing climate), costing the country up to USD 1,235 million. This could be a huge impact on an economy that derives up to 18% of its export earnings from coffee. Estimates of impacts on tea growing areas also indicate significant losses of up to 50% (fall in production) by 2050. An IFPRI modelling shows potential losses of cotton production due to yield impacts in the range of 60-77% by 2050. If no action is taken on climate adaptation, Uganda could lose up to USD 1.5 billion on food crops (cassava, groundnuts, maize, millet, pigeon peas, potatoes, rice, sorghum, soybean, sugar cane and sweet potato), due to climate change impacts by 2050.

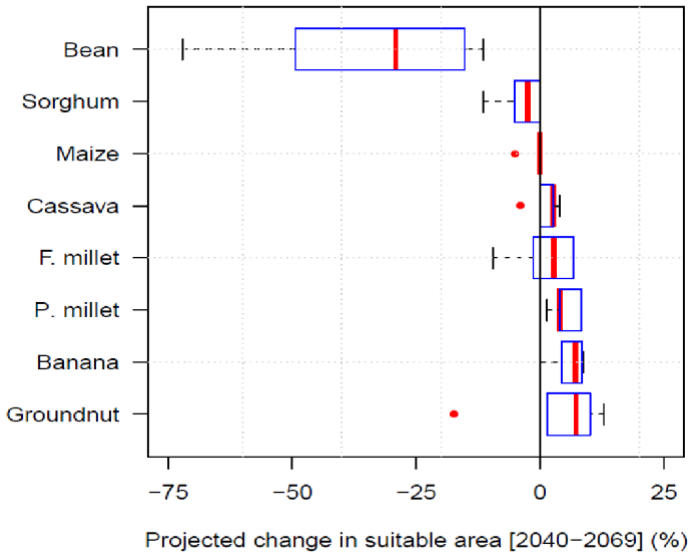


Figure 26. Percent change in suitable area for major crops in Uganda due to climate change.

The red line represents the average projected change and the blue box and dashed lines represent uncertainty associated with the crop modelling (J. Vargas, CIAT)

Women and Youth in Uganda play a vital role in crop production, providing most of the labour force. Generally, women contribute about 65% to agricultural production and

processing, consequently they are more vulnerable to the adverse impacts of climate change. This is exacerbated by cultural limitations to women and youth in decision making and of limited access to and control over different assets and resources. Women are more vulnerable since they are mainly involved in the production of food crops as compared to the men who are largely involved in income generating crops. With a growing population of unemployed youth, this calls for a paradigm shift in agricultural development models. Government prioritization of SLM and the new orientation towards CSA provide an opportunity to address inequalities related to women and youth besides increasing productivity and incomes and reducing emissions from the agriculture sector.

Livestock sub-sector

The effects of climate change on livestock production in Uganda are manifested by reductions in water and pasture availability, increased incidences of livestock pests and diseases and livestock mobility. Increasing temperatures and warming due to climate is expected to alter the feed/water access and intake, mortality, growth, reproduction, maintenance and production of animals - all of which have negative impact on livestock productivity (GoU, 2018).

Pastoralism is the dominant form of livestock keeping in Uganda (particularly along the cattle corridor). It is highly dependent on mobility as a way of managing climate variability. However, with the increase in occurrence of extreme events due to climate change, the impact of factors constraining the livelihoods of pastoralists is multiplied. Prolonged dry spells and drought for instance, cause severe water shortage, leading to loss of animals, low production of milk, food insecurity, increased food prices, and a general negative effect on the economy. For example, based on the 2010–2011 Integrated Rainfall Variability Impacts, Needs Assessment by OPM, about US$ 45.35 million of the total damage (US$ 907.0 million) was due to animal deaths. Furthermore, within the livestock sub-sector, 83% of the damage and losses for livestock was attributed to production losses, 9% was due to damage due to animal deaths, and the remaining 8% was due to higher production costs.

Prolonged dry spells and drought in livestock grazing systems reduces the availability of water and pasture/fodder both directly and indirectly. Most of the milk in Uganda is produced by smallholder farmers, who rely on rain-fed natural pastures. Natural pastures

are fairly productive and contain many desirable grasses and browse plants but little or no legume component. This leads to low dry matter yields and poor nutritive value for the greater part of the year (Mwebaze, 2006). The common grasses in the traditional cattle corridor include *Panicum maximum*, *Brachiaria decumbens*, *Chloris gayana*, *Hyparrhenia rufa*, *Pennisetum clandestinum*, *Setaria anceps*. During the dry season, there is commonly, shortage of pasture leading to decline in animal productivity. Few households keeping improved cattle have planted improved pastures (mainly Napier and various legume species), but it is not enough to meet the fodder requirements of their herds throughout the year. Thus, most farms frequently experience a severe shortage of forage during the dry season. In addition, there is progressive shrinking of grazing land, becoming a serious constraint to dairy farming (Balikowa, 2011). Thus, planting additional pastures supplements livestock diet. Napier is the common forage species on smallholder farms keeping improved dairy cattle. Others include: grasses such as *Bracharia brizantha*, herbaceous legumes such as lab lab (*Dolichos lablab*), centro (*Centrosema pubescens*), *Desmodium spp*, stylo (*Stylosanthes guianensis*), siratro (*Macriptilium atropurpureum*), alfalfa or lucern (*Medicago sativa*), *Chamaecrista rotundifolia*; tree legumes mainly calliandra (*Calliandra calothyrsus*), leucena (*Leucaena leucocephala*), and gliricidia (*Gliricidia sepium*) as well as bulk forages, mainly Guatemala grass, Giant setaria, forage sorghum and maize.

Figure 27 shows the implications of climate change on the above-ground net productivity of rangelands in Uganda by 2050 and thus the effects on livestock productivity. Water deficits reduce access to water for production, and grazing landscapes, reducing productivity and prolonging seasonal scarcity of feed resources, which accounts for about 70% of value chain production costs. These factors drive a feed price increase, which forces livestock owners to sell their cattle. Massive sales, while there is a reduced demand, push cattle prices down, forcing farmers to sell even more cattle, to buy feed. These effects on prices reduce farm and household income and assets. Moreover, the changes in prices reduce the value of assets (livestock) and the productive capital for the future. Prolonged or repeated drought also has long lasting degrading effects on land. For instance, a combination of drought and overgrazing, especially near watering points destroys the vegetation cover thus increasing soil erosion. Furthermore, studies have shown a tendency of pastoral communities migrating with livestock (assets) away from settlements in search of pasture.

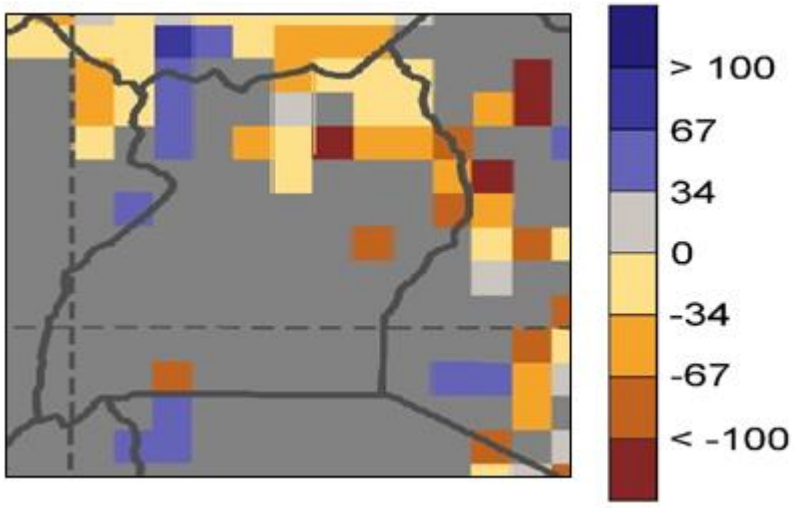


Figure 27. Projected changes in Aboveground Net Primary Productivity (ANPP) in Uganda's rangelands ANPP by 2050s and RCP8.5 (high-end emissions) in relation to the mean value of 1971-1980.

Some areas also suffer livestock disease outbreaks of foot and mouth disease, black quarter, tick borne diseases and lumpy which are associated with weather changes in districts like Kitgum, Agago, Pader and Lamwo among others that experienced economic losses (IPCC, 2017). The economic impacts of climate change to farming households through livestock diseases are diverse: farmers incur costs of disease control, treatment, and vaccination. Direct losses are associated with animal mortality, reduced milk production, and use of animal for traction. The total annual economic cost for diseases in cattle alone is estimated at USD 76.5 million (Taghouti Ibtissem et al., 2015). In pastoral communities, drought may lead to cattle migration, which increases the risk for cattle diseases and intercommunal conflict. Studies have also shown that at temperatures higher that 30^{o}C, heat stress leads to low production in poultry by reducing the rates at which poultry gain body weight, feed intake, carcass weight as well as the content of protein and muscle calorie. On hens, heat stress reduces production efficiency and thus egg production due to reduced food intake and interrupted ovulation. Heat stress has also been associated with low sperm count in livestock.

Projected increases in the demand for animal source foods

Drivers of the demand for livestock products

The demand for animal products is influenced by: increase in the human population, increase in per capita income, and level of urbanisation (Satterthwaite et al., 2010). Between

1980 to 2012, the Ugandan population grew from 12.5 to 35 million people, and is projected to increase to 102 million people by 2050 (UN, 2017). In 1980, 7.5% of Ugandan population lived in urban areas, and by 2012, this had increased to 20.4%. Projections indicate that, by 2050, 44.1% of the population (about 45 million people) will live in urban areas (UN, 2018). Kampala city alone which had a population of 1.5 million people in 2015, is projected to host about 9.4 million people in 2050 (Hoornweg and Pope, 2014). The GDP per capita is estimated to increase from USD 700 in 2012 to over USD 1,900 by 2050 (SSP, 2016). These three factors (population growth, urbanization and gains in real per capita income) will result in an increased demand for livestock products.

Projected increases in the demand for animal source foods

Table 24 presents data on projected trends in consumption of major livestock products. Population growth, urbanization and gains in real per capita income will result in an increased demand for livestock products. According to FAO (2018a) between 2012 and 2050, the aggregate consumption of all livestock products will more than triple, and about quadruple for beef, poultry and pork. On an annual basis, demand will grow between 3.6% for milk to 4.8% for poultry and pork, which translate in major increases in volume terms. These increases in demand of livestock products represent a major opportunity for livestock producers to expand their business. As a response to the growing demand for animal source foods, Ugandan livestock producers are anticipated to make investments that increase production and productivity, which will in turn contribute to increases in production of milk, eggs and meat. This amidst the challenges of climate change or variability, which might impact on livestock productivity owing to their effects on diseases, pastures, etc.

Table 24. Previous and Projected Consumption of livestock products, 2012 to 2020.

				Growth, 2012 to 2050	
	2012	2030	2050	Percent	Annual rate, %
Milk	1330	2767	4615	247	3.6
Beef	185	446	932	403	4.7
Mutton & Goat	44	97	196	347	4.4
Poultry	61	146	316	419	4.8
Eggs	34	74	136	298	4
Pork	118	277	607	412	4.8

Source: FAO. 2018a.

Fisheries sub-sector

Capture fisheries and aquaculture are vulnerable to climate change and variability. Fisheries have a critical thermal maxima and minima and cannot survive temperatures that exceed their threshold. Climate change affects fisheries in a number of ways including: increasing water temperatures; extreme weather events which lead fluctuations in water levels (floods, droughts, storms); changes in water quality parameters such as pH, conductivity and turbidity; decreasing pH, and; changes in current open water productivity patterns (Table 25). Value chain analyses show that the impacts of climate change on fisheries in Uganda result from an increase in mean air temperature, changes in rainfall patterns, and an increase in extreme weather events (GoU, 2018). Small pelagic species (Mukene, Enziri, and Agogi) and large species (Nile perch, Tilapia) value chains differ significantly, but may be impacted by climate change and variability in similar ways related to production, processing and transportation

Table 25. Impact pathways of climate change and variability for Uganda's fisheries sector

Point on value chain	Impact	Potential outcome for fisheries
Inputs and services	Increased exposure of inputs (gear, boats, labor) to extreme weather i.e. winds and storms	Destruction of inputs and gear Increased danger to boat crew and fishermen
Production	Changes in stream & groundwater temperature Changes in hydrology regimes (a function of land use, precipitation, soil moisture, evapotranspiration) Eutrophication Water temperature effects on limnology Increase in ultraviolet (B) rays Higher incidence of disease Water loss from lentic systems (evaporation is expected to be higher than precipitation) Changes in water quality	Shifts in primary production Changes in food web structure Shifts in secondary production (volume and distribution) Disease and species invasion Decreased areas to breed in shallow waters Less predictable seasonality of lakes
Trade and Transport	Roads and trade routes become impassable	Lack of access to markets Changes in migratory/market routes and transport times
Processing	Processing areas hit by unpredictable rain patterns	Postharvest losses Changes in processing technologies and costs due to abundance of new species
Marketing	Supply scarcity	Price increases for available supply of

		fish Increased number of fishers Decreased revenues from declines in catch and/or stock abundance

[Adapted from Ficke et al. (2007); WorldFish Center (2007); Daw et al. (2010)]

Aquaculture production, climatic variables are likely to affect the main inputs for feed production (fish (mukene), and crops (maize and soya)), both directly and indirectly through increased competition for human consumption. Rising temperatures and unpredictable rainy seasons will impact crop planting and harvesting times, and may lead to higher prices. Given that the main inputs for floating fish feed also serve as food crops, decreased production resulting from climate change and variability will drive prices higher, and warrant less use of human foodstuffs for animal feed. Extreme events threaten infrastructure and can be particularly disastrous for farmers lacking insurance (Beveridge et al. 2011).

Landscapes and agroforestry

Landscapes

Inter-seasonal climate variations have been heavily experienced around Lake Kyoga, Lake Victoria and Lake Edward and Albert basins (Mulinde et al., 2019; Majaliwa et al., 2015, Nimusiima et al., 2014). These climate variations have significantly impacted on Uganda's landscapes and agroforestry-based systems around these basins such as coffee agroforestry system which is sensitive to rainfall and temperature variations (Bunn et al., 2015). These regions have experienced frequent prolonged drought, erratic rainfalls during rainy season and shorter rainfall periods which have affected the productivity of the coffee agroforestry system for example.

Agroforestry

Agroforestry is increasingly being recognized as a viable option for counteracting the current global challenges of climate change adaptation, food security and household income. Agroforestry systems offer environmental benefits such as helping to attain food security, increasing farm income, restoring and maintaining above ground and belowground biodiversity as well as providing corridors between protected forests (Namaalwa et al., 2019). Agroforestry improves soil properties and water availability to plants thus, suitable for landscape restoration. Other agroforestry ecosystem services include climate buffering,

flood control, food and wood which are all vital for resilience to climate change and reduced vulnerability of communities (Mbowa et al., 2014).

The promotion of agroforestry activities in Uganda has been intensified by the different non-government organizations (NGOs) and Government Institutions operating in different regions of the country. The use of agroforestry has been reported to reduce temperatures in the coffee canopy by up to 2°C (Jassogne et al., 2013). Some of the agroforestry approaches include use of shrubs such as *Calliandra* and *Leuceana* as contour hedges to reduce soil and water loss thus, increasing soil and crop productivity. Local governments are promoting agroforestry in different landscapes such as promotion of improved tropical fruits (e.g. Mangoes, oranges in lowlands; avocado and temperate fruits like apples and pears in highlands) as an option for improving livelihoods and nutritional status of households has increased its adoption in the country. As a result, the widespread use of agroforestry systems comes with a benefit of climate mitigation functions through increased tree cover, increasing carbon stocks on land and thus, reduced carbon emissions. The shade tree cover in agricultural farms play an important role in facilitating carbon sequestration and soil conservation due to the high amounts of organic materials attributed to the continuous inputs of leaves, foliage and dead roots.

However, agroforestry systems are not fully closed systems, thus changes in climate variables such as temperature, precipitation and humidity affect important biological processes such as carbon cycling, pollination and nitrogen fixation, thereby affecting the capacity of agroforestry systems to provide ecosystem services and increase productivity in different landscapes such as the highlands, wetlands and dry lands of Uganda.

Various agroforestry practices exist in Uganda. These include boundary marking, live fences, woodlots, hedges and home gardens (Kabiru et al., 2018) and in most cases they are reinforced with other SLM practices (contour bunds, manure application, mulching etc). Generally, indigenous species (e.g. *Albizzia coriaria, Cordia* Africana) are given priority in rehabilitation of degraded land; however, sometimes planting of faster growing species (*Pinus caribaea*, *Eucalyptus grandis, Maesopsis eminii)* has been promoted to reap the benefits of new products and services such as carbon sequestration and new forms of bioenergy. Reduction of vulnerability and increasing resilience to climate change may entail

diversification at the expense of productivity, and change in tree management (e.g. modification of thinning schedules) may help stabilize stands against drought, storms and diseases. According to Kiptot and Franzel (2012), men and women have different objectives for planting trees in that whereas men are interested in commercial purposes, women are driven by tree products for subsistence such as firewood, soil fertility improvement, fodder and fruits.

Adaptation measures being undertaken

Crop sub-sector

Building resilience in the agriculture sector is of paramount importance as risks and vulnerabilities to agricultural and livelihood systems due to climate change are on the increase. To address the current and future impacts of climate change on crop production in Uganda, a number of adaptation options have been proposed with the goal of developing climate resilient agricultural cropping systems and value chains. These include:

A) Development of appropriate early warning systems and contingency plans. The National Early Warning system in Uganda coordinated in MAAIF in cooperation with the Uganda National Meteorological Authority (UNMA) and the Disaster Preparedness Department in the Office of the Prime Minister (OPM) offers timely climate information, including seasonal forecasts to the users at various levels, including small scale farmers. In addition, the Famine Early Warning Systems Network (FEWS NET) the leading provider of early warning and analysis on food insecurity has helped to develop the national livelihood zones and baselines, which have been consecutively used (2010, 2011 and 2012) for seasonal outcome analysis assessments. Other initiatives are also being piloted, including a community Early Warning System in Karamoja region by MAAIF, ACTED and OPM.

B) The sustainable land management (SLM) approach is advocated as one of the ways essential for promoting healthy and resilient landscapes by combating land degradation and mitigating climate change effects while supporting sustainable human livelihoods. Sustainable Land Management strategies and practices enable farmers and communities to adapt, as well as become more resilient, to climate change by increasing food production, conserving soil and water, enhancing food security and restoring productive natural resources. Additionally, SLM strategies and practices (Table 26) can prevent land

degradation, restore degraded lands, and reduce the need for further conversion of natural forests and grasslands. SLM practices are intended to conserve soil and water (e.g. by controlling runoff and soil erosion), enhance soil fertility/ health and manage pests and diseases.

Table 26. Common SLM practices/ technologies in Uganda and their functions.

Practice/ technology	Function of SLM practice/ technology
Terraces **Contour bunds** **Trenches** **Grass strips** **Trash-lines** **Stone-lines** **Mulching** **Tied ridges** **Cutoff drains** **Check dams** **Micro basins** **Conservation agriculture/ farming** **Water harvesting technologies** **Irrigation**	Conserve soil and water
Integrated nutrient management (INM) **Agroforestry** **Crop rotations** **Mixed cropping** **Bush fallows** **Improved fallows** **Cover crop and green manures** **Manure (compost, FYM, etc.)** **Mulching** **Inorganic fertilizers** **Bio-fertilizers [BNF, Mycorrhizea]**	Enhance soil fertility
Crop rotations **Mixed cropping** **Integrated pest management (biological agents, inorganic and organic chemicals, physical control, etc.)**	Manage pests and diseases

C) Improved crop varieties: Promotion of crop varieties which are highly adaptive and productive into systems that are prone to droughts and floods and are primarily rain-fed making cropping systems more resilient to the impacts of climate change. There are on-going initiatives to breed, promote and disseminate climate resilient varieties that are

resistant to drought, pests and diseases in different agro-ecological zones through initiatives such as the Support for Tea and Cocoa, Vegetable Oil Development, Agriculture Cluster Development, Commercialization of Agriculture in Northern Uganda and Agriculture Technology Transfer and Water Efficient Maize projects. Table 27 shows some of the improved crop varieties bred by research institutions in Uganda.

Table 27. Some Improved crop varieties and their attributes.

Crop	Variety	Attribute
Maize	Longe 5 (Quality Protein Maize)	Resistant to maize streak virus (MSV), grey leaf spot (GLS); early maturity; drought tolerant; high content of Lysine and Tryptophane
	Longe 7H	Hybridity; resistant to MSV, GLS, the northern corn leaf blight (NLB) and Turcicum; drought tolerant; and maturity of 120 days
	Longe 10H	Hybridity; resistant to MSV, GLS, NLB and Turcicum; drought tolerant; and maturity of 120 days
Beans	NABE 15	Resistant to anthracnose, red seed colour
	NABE 16	Marketable, suitable for all regions, tasty and swell when cooked
	NABE 19	Highly marketable, tasty and cooks well
	NABE 20	Highly marketable, tasty and cooks well
Soy bean	Maksoy 2N	Tall variety reaching 1m, resistant to shattering and bacterial pustule
	Maksoy 3N	Resistant to soybean rust, protein content 48%
	Maksoy 4N	Tolerant to soybean rust, early maturing
	Maksoy 5N	Tolerant to soybean rust, early maturing
Rice	NERICA 6	Tolerant to RYMV, blast, BLB, long soft but no sticky grains when cooked
	Komboka	Tolerant to RYMV, blast, BLB, long soft but no sticky grains when cooked
	Okile	Tolerant to RYMV, blast, BLB, long soft but no sticky grains when cooked
	Agoro	Tolerant to RYMV, blast, BLB, long soft but no sticky grains when cooked
Sorghum	Epuripur	Resistant to shoot fly and stem borers, white seeded and good for brewing
	SESO 1	White seeded, high yielding, resistant to stem borers and shoot fly, for brewing and ready market for breweries
	SESO 3	Brown seeded, large seeded, excellent for food, resistant to stem borers, diseases and bird damage
Groundnuts	Serenut 2	Resistant to Rosette and drought, tan seeded with average 42% oil content
	Serenut 3R	Resistant to Rosette and leaf spots, red seeded with average 47% oil content

Cassava	NASE 17	
	NASE 18	
	NASE 19	Resistant to Cassava Brown Streak Disease (CBSD)
	NASE 20	Resistant to CBSD and high yielding
Sweet potato	NASPOT 12	High vitamin A content, resistant to sweet potato weevil, low dry matter
	NASPOT 13	High vitamin A content, resistant to sweet potato weevils, low dry matter
Irish potato	Kachpot 5	High yielding, resistant to late blight
	Kachpot 6	High yielding, resistant to late blight, good processing quality
Plantains	KABANA 6H (Kiwangazi)	Resistant to banana weevils, Sigatoka and nematodes, long lasting i.e. mat disappearance is over 5 years

D) Other adaptation measures, include:

- Promotion of conservation agriculture and ecologically compatible cropping systems to increase resilience to climate change impacts.
- Building resilience to droughts and floods by strengthening water harvesting and irrigation farming. On-going initiatives to achieve this goal include among others the construction of strategic dams for multi-purpose use including irrigation, promotion of water harvesting at household and community levels, construction and rehabilitation of valley dams and water tanks with complete abstraction systems for animal watering and micro-irrigation schemes.
- Encourage agricultural diversification and improve post-harvest handling, storage, value-addition and marketing in order to spread climate risks, enhance post-harvest management including reduction of aflatoxin contamination and promote off-farm livelihood diversification.
- Support community-based adaptation strategies by expanding climate smart extension services. This is through programs such as the regional pastoral livelihoods resilience and agriculture advisory services.
- Development and promotion of appropriate and efficient small-scale and large scale technological packages [ponds, valley tanks/ dams].
- Development and promotion of technologies and practices that reduce the labour load/ drudgery.

Livestock sub-sector

To address the current and future impacts of climate change in the livestock sub sector, a number of adaptation options have been put in place to make livestock systems more resilient. These include:

Provision of an enabling environment: The Government of Uganda has developed a range of policies and strategies to ensure a sustainable growth and transformation of the livestock sector. These are guided by the Agriculture Sector Strategic Plan (ASSP) 2015/16 – 2019/20, which prioritizes investments in beef, dairy cattle, poultry and goats as well as in other agricultural commodities. Others include: The Dairy Master Plan (1993), Dairy Industry Act (1998), Policy on Marketing of Livestock and Livestock Products, Animal Health Policy, the Animal Breeding Policy, Public Health Act, Liberalisation, Privatisation, Decentralisation policy (Local Government Act); the Poverty Eradication Action Plan (PEAP), Plan for Modernisation of Agriculture (PMA), the National Agricultural Advisory Services (NAADS) and the Meat Industry Development Act (GOU, 2016).

Animal feeds, forage and water security enhancement: The natural pastures in Uganda are fairly productive and contain many desirable grasses and browse plants but little or no legume component, leading to low dry matter yields and poor nutritive value for the greater part of the year. With good management, these forage species can be produced during the rainy seasons well above the farmers' herd requirements and conserved to meet the deficit experienced during the dry season, or sold to earn extra income. Use of concentrate feeds is low in Uganda (less than 4% of cattle keepers use concentrates), which may contribute to low milk production on farms. Of the farmers using concentrates, 33% feed commercial dairy meal while nearly 56% use feed ingredients, such as maize bran and rice bran as straights (EADD, 2010). Uganda has serious problems related to availability of well formulated and balanced rations for adequate dairy cattle feeding (Nakiganda et al., 2006).

Animal feeds production and quality assurance enhancement: Due to the growing dairy sector, a number of commercial farmers are making use of supplementary feeds and concentrates to improve productivity. Livestock concentrate feeds value chain in Uganda comprises a formal large-scale value chain and an informal value chain. The formal value chain includes a range of actors with wholesalers, distributors and large-scale farmers being

more dominant. In this chain, concentrate feeds are traded within and across countries and even regions. Most (80–90%) of the feed produced goes through rural distributors, wholesalers and retail traders who then sell directly to farmers. A small proportion also goes directly to dairy cooperative societies, institutions and large-scale farmers. The informal small-scale value chain is rather simple in that feed is sold where it is produced in quantities as demanded by the consumer with little regard for quality control. The large-scale feed producers source raw materials from large-scale grain millers, while small-scale feed producers buy most of the raw materials directly from producers and other cheaper sources. Feed mixing in large scale production is by large mechanical and/or automatic feed mixers while small scale feed producers only use shovels or horizontal drum mixers where all feed mixing is often done by hand (Lukuyu et al., 2012a).

National beef genetics resource development: Proposed actions to increase meat production are: a) Implementing a national beef cattle breeding programme; b) Promoting countrywide crossbreeding programmes through the use of artificial insemination (beef and dual purpose cattle semen) and improved beef bulls; and c) Establishing a national beef cattle improvement scheme to enhance production and multiplication of quality beef breeds using the open nucleus-breeding scheme; d) Re-establishing Lusenke Stock Farm as a national cattle-testing centre for pedigree beef bulls. Institutionally, the National Animal Genetic Resources Centre and Data Bank (NAGRIC-DB) is mandated to promote, regulate and control the import, export and marketing of animal genetic material, including quality assurance.

Goat breed improvement schemes: Among the interventions proposed to improve the goat enterprise are:

- Selectively screening local breeds (Mubende, Savannah and Small East African) for large body size and multiple births and develop an elite performing indigenous breed for increased meat production;
- Importing improved Boer and Savannah goats for cross breeding with indigenous Small East African goats and supply the products to goat farmers. These measures would improve productivity of local indigenous goat species, which are well-acclimatised to local conditions, thus adapting to climate change.

- Developing nucleus breeding schemes cooperatives to generate superior bucks for distribution to farmers on a sustainable basis.

Investments in the poultry sector: Considering the important contribution of poultry to the economy and livelihoods of majority smallholder farmers agriculture, a number of adaptive measures have been put in place to increase the production and productivity of commercial poultry establishments including:

- establishing of exotic layer and broiler grandparent stock farms and provide seed stock to increase local availability of good quality layer and broiler parent stock for commercial hatchery operators;
- conducting commercial layer and broiler breeding;
- improving capacity utilisation of the local commercial hatcheries to produce and increase availability of day-old-chicks (DOC) through provision of seed stock;
- providing technical support, training, monitoring and supervision to hatchery operators of exotic layer and broiler grandparent and parent stock and commercial producers of layers and broilers.
- development of Kuroilers and indigenous chicken resources, aimed at ensuring indigenous chicken genetics are conserved, developed, multiplied and utilised through:
    - supporting the sustainable rearing of quality and healthy Kuroiler and indigenous chicken parent stock on the government poultry breeding farms for production of hatching eggs, to achieve increased availability of Kuroiler and indigenous chicken through improved production capacity of government and private sector farmers; and
    - supporting the establishment and strengthening of functional poultry breeding societies and associations.

Other measures include integrating crops with livestock – this is common within the agro-pastoral communities to increase the adaptive capacity of farmers; Building the capacity of farmers, extension service providers and veterinary drug dealers in modern practices and appropriate technologies for livestock husbandry, pest and disease control, acaricide handling and use, including e-verification; Establishment of livestock disease control zones

and quarantine stations to restrict livestock movement, implement a mandatory and free vaccination programme against major diseases like Foot and Mouth Disease, CBPP and Rabies, etc. and re-enforcement of the national animal / vector diagnostic and surveillance system; and Promotion of dairy infrastructure through promotion of PPP arrangements (Table 28).

Table 28. A selection of climate change adaptation practices for livestock

Climate change-related Constraint	Impact	Adaptation measures
Drought	Livestock production, reduced pastures,	- Promote sustainable management of rangelands and pastures through integrated rangeland management. - Promote water harvesting and storage - Enhance local and modern pasture and feeds production and management, - Strengthen supply systems for pasture/ fodder seeds, animal feeds (including conserved feeds) and inputs - Genetic improvement through planned cross-breeding, provision of better breeds - Reduce age at slaughter of finished cattle
	Increased risk of diseases and vectors	- Build capacity of farmers, extension service providers and veterinary drug dealers in modern practices and appropriate technologies for livestock husbandry, pest and disease control, acaricide handling and use, including e-verification - restrict livestock movement, - implement a mandatory, free vaccination programme against major diseases (e.g. Foot and Mouth Disease, CBPP and Rabies, etc.) - Re-enforce the national animal / vector diagnostic and surveillance system
High temperature (global warming)	Feed and water scarcity decrease in forage quality, leading to inadequate pasture, increase in GHG emissions	- Reduce forage intake and replace it with high energy feeds containing cereal grains and oil meals to prevent elevated methane emissions by livestock - Include legume silages for improved quality. - Include silage as improved forage quality on the farm and reduce GHG emission intensity - Include concentrate feeds in ruminant diet
	Increased water consumption	- Raise animals in livestock sheds (zero grazing)
	Increased livestock diseases, pathogens or parasites risk; Increased spreading	- Disease surveillance and technologies

	of vector-borne diseases, food-borne diseases, host resistance	
Heat stress	Reduced feed intake, increased water intake, change in respiration rate, and altered physiological functions such as reproductive and productive efficiency. Heat stress is dependent on temperature, humidity, species, genetic potential, life stage, and nutritional status.	- Adopt confined livestock production systems (e.g. zero grazing) that have more control over climate exposure
Drought, floods, pests, and weather-related diseases	Livestock production, reduced pastures, increased disease risks	- Put in place an early warning system to advise and support farmers put in place mitigation measures (e.g., stocking feed and fodder, finding alternate pasturelands, facilitating seasonal cattle migration, and destocking cattle) - Water harvesting and storage - Improved pasture stocks - Develop innovative insurance schemes (low-premium micro-insurance policies) and low-interest credit facilities to insure farmers against crop failure and livestock loss due to droughts, pests, floods and other weather-related events - Promote agricultural diversification, and improved post-harvest handling, storage and value addition in order to mitigate rising climate related losses, improve food security and household incomes.

Fisheries adaptation measures

The adaptation strategies directly involve the value chains for fisheries and aquaculture in Uganda. However, effective adaptation must also address the non-climate related drivers of change that hinder successful fish production. Creating and supporting an enabling environment for adaptation, and regulating negative informal adaptation are also very critical.

Public and Private Spheres of Responsibility

Adaptation can be separated into public and private spheres of responsibility. The privatization of input services lessens the influence of the public sector, but many opportunities to support an enabling environment for adaptation and discourage negative, informal adaptation exists. Adaptation planning to decrease vulnerability within the fisheries value chain may involve supporting fishers' advocacy and safety, and developing and disseminating post-harvest handling technologies.

Feed

Feed is considered a major constraint to increasing aquaculture production in Uganda, and is also particularly vulnerable to climate change and variability. Although the feed industry is privatized there is a place for both public and private research into alternative feeds through UgaChick, SoN Fish, and KARDC. For seed, KARDC or the increasing number of private hatcheries may help in selective breeding for reduced susceptibility to disease associated with stress and shifting temperatures

Road Infrastructure

Generally, the transport node of the value chain for many food products in Uganda would benefit from improved road infrastructure, which falls under the responsibility of the state. "Climate proofing" roads to combat unpredictable rainy seasons and extreme events would create more efficient, dependable market channels (Timmers, 2012).

Cooperatives Fish Farming

Cooperative fish farming groups can allow farmers to network, develop stronger ties to markets and share knowledge of best practices (WorldFish Center 2011). Additionally, farmers can organize cluster insurance schemes to deal with the potential impacts of extreme weather events.

Consequently, adaptation measures in fisheries mainly target the constraints that have been highlighted in Table 29. These include, among others: a) Provision of alternative livelihoods aimed at reducing pressure on fisheries; b) improvement in provision of inputs; c) Production and processing etc. In aquaculture adaptations target provision of feeds; marketing - improvements in infrastructure; improvements in weather forecasting etc.

Other adaption practices include promotion of climate change resilient fishing practices; promotion of sustainable fish farming as a means of economic diversification and enhancing the resilience of the fishing sector to the impacts of climate change; provision of economic incentives to diversify livelihood options in order to reduce dependence on climate sensitive fisheries resources and insurance to protect fisher folk from potential impacts of extreme weather events.

Table 29. Potential Adaptation within the fisheries value chain in Uganda

Point on value chain	Impact	Potential adaptation measure
Inputs and services	Increased exposure of inputs Feed and seed constraints in aquaculture production systems	Insurance of physical capital equipment Weather warning systems Support for fishers' advocacy Public and private partnerships for research into alternative feeds through UgaChick, SoN Fish, and KARDC. For seed, KARDC or the increasing number of private hatcheries may help in selective breeding for reduced susceptibility to disease associated with stress and shifting temperatures.
Production	Changes in stream and groundwater temperature Changes in hydrology regimes Eutrophication Water temperature effects on limnology Increase in Ultra Violet (B) rays Water loss from lentic systems High disease incidence Changes in water quality	On-going public research into climate change and variability in freshwater ecosystem Support for diversified livelihoods Improved monitoring of illegal gear use Management of wetlands/lakeshore area
Trade and transport	Roads and trade routes become impassable	Infrastructure provision i.e. roads
Processing	Processing areas hit by unpredictable rain patterns	Improved post-harvest technology e.g. solar driers Training in post-harvest handling suitable for migratory populations e.g. mukene Improved market information channels on consumer preferences
Marketing	Supply capacity	Promotion and support of cooperative groups to allow farmers to network, develop stronger ties to markets and share knowledge of best practices. Farmers can organize cluster insurance schemes to deal with the potential impacts of extreme weather events

[Adapted from Ficke et al. (2007); WorldFish Center (2007); Daw et al. (2010)]

Landscapes and agroforestry

Adaptation measures in landscapes

At the scale of landscapes, climate change adaptation may include reducing the potential impact of climate change, these include soil and nutrient losses and associated pollution loading into fresh waters, landslides, flood and drought mitigation; and minimize the potential impacts of fire, insects and diseases. Landscape approaches have been increasingly advocated as a way of enhancing integration and synergy among sectors for effective and efficient control of soil and nutrient losses and natural resource management, as climate change sets in. For this reason, Uganda has embarked on preparation of Catchment Management Plans (CMPs). The latter were developed for15 hotspot catchments based on population pressure, water scarcity, loss of wetlands and soil erosion (Victoria Water Management Zone, 2018; Ministry of Water and Environment, 2015c, 2018). Forests are vital for maintenance of the hydrological cycle as well as stabilisation of soils across different landscapes. Plantation forests have been promoted in LVB, and in protected forest reserves. Riverbanks stabilisation, using bamboos has also been promoted in Awoja catchment. When riverbank vegetation is well preserved it helps reduce the risk of flooding by stabilization of the shore line. Sustainable Land Management practices such as contour bunds, tie-bunds, mulching, etc. have been promoted across the country by MAAIF. However, sufficient efforts should be put in place to ensure that the CMPs incorporate fully the inter-linkages between water and land management and climate change. In addition, the involvement of sub-regional and local management structures as well as extension service workers in management of water and related resources has been limited.

Agroforestry

Various agroforestry practices exist in Uganda. These include boundary making, live fences, woodlots, hedges and home gardens (Kabiru et al., 2018) and in most cases they are reinforced with other SLM practices (contour bunds, manure application, mulching etc). Generally, indigenous species are given priority in rehabilitation of degraded land; however, sometimes planting of faster growing species has been promoted to reap the benefits of new products and services such as carbon sequestration and new forms of bioenergy. Reduction of vulnerability and increasing resilience to climate change may entail diversification at the expense of productivity, and change in tree management (e.g.

modification of thinning schedules) may help stabilize stands against drought, storms and diseases.

According to Kiptot and Franzel (2012), men and women have different objectives for planting trees in that whereas men are interested in commercial purposes, women are driven by tree products for subsistence such as firewood, soil fertility improvement, fodder and fruits. The youth are also actively engaged in agroforestry in Uganda. For example, World Agroforestry Center (2015) documented the efforts by Weyaula Bernard leading fruit tree planting in deforested areas around schools in Bududa and Keneema Immaculate who established a rural livelihood improvements farmer-led agroforestry projects in the Queen Elizabeth National Park Agro-Forestry Project in Kamwenge, involved in replanting of native trees on private smallholder lands. FAO has engaged youth in Uganda in several agriculture and agroforestry activities.

Agricultural insurance pilots in Uganda

In an attempt to protect farmers from the adverse effects of bad weather, the Uganda government piloted an agricultural insurance scheme in a few districts between 2016-2018. This followed two earlier initiatives implemented through the private sector. Hence there was need to review and learn from these pilot initiatives before up-scaling the insurance scheme to other districts. A study was consequently conducted at national level for selected key stakeholders and in 14 districts to gather the views and experiences of different stakeholders, discern any challenges, and learn lessons from the on-going pilots, to make recommendations for a wider, more inclusive agricultural insurance scheme for the country (MWE, 2018).

Current agricultural insurance pilots

The Uganda Insurance Agriculture Scheme (UAIS) was introduced as an insurance subsidy program for both small and large scale farmers, and farmers in high risk areas to ensure every farmer in Uganda can be protected from the effects of losses of their crops/livestock on their overall income that season. The key players within the Uganda Agricultural Insurance Service (UAIS) are the MFPED, MAAIF, Insurance Regulatory Authority (IRA) and Bank of Uganda (BOU).

The general objective of the Uganda Agricultural Insurance scheme is to ensure that a Ugandan farmer is largely protected against the effects of agriculture risks (especially the production risks) by introducing measures which shall ensure an indemnity sufficient to keep the farmer in business. The specific objectives of the Scheme are to

- To make agriculture insurance affordable to farmers in Uganda.
- To increase access of farmers to credit by protecting agriculture loans disbursed by financial institutions from the effects of specific agriculture risks.

Selected Products/Pilots

Tables 30 and 31 summarize some of the insurance products available to farmers.

Table 30:. Description of UAP Agricultural Insurance Products.

Insurance products	Cover	Items covered	Basis of cover
Multi-peril crop insurance (MPCI)	Losses due to excessive rainfall, drought, hail and frost, windstorms, fire, pests, diseases	Crops	65% of pre-agreed value of growing crop or harvest
Crop weather index insurance	Drought	Crops	Expected or pre-agreed value of growing crop/harvest or loan cover
Livestock insurance	Accidental death and theft	Livestock	Pre-agreed value of animal
Green house Insurance	Damage	Greenhouse structure, equipment and crops	Cost of structure and equipment and expected harvest or input value of crops

(Adapted from MWE, 2018).

Table 31. Description of Kungula Agricultural Insurance Products.

Insurance Products	Cover	Items covered	Basis of cover
Weather Indexed based Insurance	Drought	Crops and grazing animals	Expected or pre-agreed value of harvest or animal or loan cover.
All Risk Mortality (ARM) Insurance	Death	Livestock	Pre-agreed value of animal
Greenhouse Insurance	Damage	Greenhouse structure, equipment and crops	Cost of structure and equipment and expected harvest or input value of crops.

Adapted from MWE, 2018.

Study results showed evidence of a substantial gender gap in agricultural insurance demand, such as fewer women and youth are involved in the insurance; and this has important implications for the promotion of insurance programs in agricultural development and climate change adaptation efforts. Most actors at national and district level and with NGOs and the private sector, did not have a clear articulation of the ways in which gender influences the uptake of inclusive insurance schemes to reduce the risk of weather shock and encourage commercial livestock and cropping intensification in the face of climatic shocks. Much of the available weather, agricultural credit and insurance statistics, contain some descriptive sex-differentiated numbers but with little analysis to help shed light on gender-specific preferences for (and constraints to) smallholder investment in agricultural weather-index and other forms of insurance. Yet such data is a precondition for: i) having better-monitored policies; ii) providing knowledge on what works at multiple scales; iii) reporting on sector commitments and targets by government and development partners; and iii) facilitating decisions about which agricultural insurance to finance and disseminate. Research elsewhere indicates that gender barriers to insurance include financial illiteracy, lower levels of discretionary income to buy insurance and lower levels of ownership of mobile phones to access insurance.

From the study it was evident that agriculture insurance is feasible in Uganda and it is a viable venture for government and private sector investors. Insurance business written per region is shown in Table 32.

Table 32. Insurance business written per region

Product	Region	Number of farmers	Sum Insured (UGX)
Crop Weather Index Insurance	Central	1074	1,069,986,451
Crop Weather Index Insurance	East	434	493,990,000
Crop Weather Index Insurance	North	144	328,000,000
Crop Weather Index Insurance	West	191	109,300,000
Multi-Peril Crop Insurance	Central	8,359	68,741,550,817
Multi-Peril Crop Insurance	East	6,885	23,736,684,930
Multi-Peril Crop Insurance	North	3,612	19,464,695,056
Multi-Peril Crop Insurance	West	12,923	88,983,954,253
Livestock Insurance	Central	28	218,750,000

Aquaculture Insurance	Central	1	53,312,000
Poultry Insurance	Central	32	30,927,120,012
Poultry Insurance	North	1	60,000,000
Area Yield Index	Central	6,932	1,538,904,000
Total			235,726,247,519

(Source: MWE, 2018)

Opportunities

- **GOU and development partners willingness to support agricultural insurance:** Through a pronouncement in the national budget 2017/18, government waived VAT on agriculture insurance to further reduce the cost of uptake of the product. However, full implementation of this incentive for uptake is yet to be realized because of stringent bureaucracies.
- Development partners (UNDP, aBI Trust) and the private sector(APA insurance, CIC General insurance, FICO, GoldStar insurance, Jubilee insurance, Lion Assurance Company (lead insurer), NIC Gen, Pax insurance, Phoenix insurance and UAP insurance)are already investing in Agriculture Insurance and willing to continue doing so.
- High frequency of weather-related risks, e.g. droughts, floods, hailstorms, pests and diseases (maintain the relevance of agricultural insurance).
- There is high demand for the agricultural insurance and steady increase in public awareness.
- Existence of Government programs e.g. Operation Wealth Creation, Agriculture Cluster Development Project (these provide free inputs freeing some of the farmers' incomes to paying insurance premiums).
- District leaders and technical officers, civil society organisations, and farmers are willing to participate in agricultural insurance initiatives (can be seen from the increased uptake of the products from as low as 3,000 to over 40,000 farmers in 12 months (Table 32).
- LG structure system can be relied onto facilitate implementation of the schemes. Extension staff can support awareness, technical services, monitoring and overall supervision.
- Communal land availability in some parts of the country – e.g. Northern Uganda, makes it possible to enrol many farmers into the scheme easily, especially by piggy backing on the current value chain development initiatives (dairy, maize, coffee, etc. value chains).

- Agriculture extension system being re-established and staffed up to sub-county level (Single Spine Agriculture Extension Service)– avails an important force to raise awareness and provide technical services to farmers.
- It is possible to bundle agricultural insurance with other financial products such as loans or input credits.
- Organized groups – Uganda Cooperative Alliance and its lower structure (Primary Cooperative Societies, Area Cooperative Societies, SACCOs, National Agricultural Cooperative Union and women's organizations) could work as product distribution channels for the insurance companies. The organized groups can also be easy entry points for awareness raising in communities.
- Digitalized financial services and deep mobile phone penetration - Mobile network operators (MNO) as a distribution channels are attractive because of high levels of mobile phone ownership. Strong trend across the globe for MNOs to become involved in insurance distribution. They have a large client base, have mobile money services, and can easily aggregate premium payments. About 24.8m or 70.9 per cent of Ugandans own mobile phones (National Information Technology Authority Uganda (NITA-U), 2018).

Challenges around achieving scale and sustainability

Awareness

- **Inadequate awareness** and knowledge about agricultural insurance. (This is limiting because funds and human resources to reach potential service users are limited).
- The negative perception of people towards Insurance Companies – 'insurance companies don't want to pay'
- When there is no disaster, farmers consider money paid as premiums to be a loss. This points to the greater need for education on how insurance works

Capacity

- Inadequate Capacity of farmer organizations' leaders and potential service providers:
    - There is increasing demand for capacity building by farmer organizations that want their farmers to take up agriculture insurance, and capacity of

banks and financial institutions staff to engage and market the product is low.

- Inadequate Technical capacity on agricultural inspection and loss adjustment capacity to the level which the Swiss-Re (reinsurer) will be comfortable with.
- Record Keeping - Inadequate data/information arising from poor record keeping by farmers deprives insurer of back up for insurance operations.

Weather and Production related

- Frequent, widespread weather-related risks can overwhelm insurance companies as they have to compensate a large number of farmers; huge sums of money can be spent in compensation. This could put the insurance companies out of business
- Many farmers countrywide still prefer inter-crops to mono-cropping to avert risks and as a means of increasing revenue/profits. Intercropping is also used as a food security measure, especially for families with small pieces of land arising out of land fragmentation and population pressure. Unfortunately insurance companies are not willing to insure mixed cropping/ inter-crops because of the differential behaviour of crops.
- Scale of operation of the farmers-Majority of small scale farmers may not afford premium if it is high unless they are in groups.
- iv. Poor quality of agricultural inputs on the markets makes it difficult for farmers to find reliable source of good quality seed and other inputs(consequently limiting farmers' ability /willingness to pay premium)

Gender related

- Digital gender gap – rates of mobile ownership are lower for women in Uganda, restricting their access to insurance
- Lack of attention to crops grown by women

Service provider related

- **Lack of distribution channels** and local contact points- establishing key contact points for farmers to access the products. Lack of an insurance representative in the districts makes farmers consultations difficult
- **Limitation on Number of crop types** that can be insured: the number of crops grown by farmers is high but only a few selected crops are being handled / insured
- **Delay or failure to pay compensation** by insurance companies, thus discouraging farmers from taking up the policy.
- **Inadequate monitoring by insurance** companies gives space for doubt on decisions.
- **The narrow choice of insurance products** limits the farmers who need a wide range of products to match their needs
- **The need to constantly monitor the crops** (crop performance) from the time of germination to harvest gives rise to high operational costs for insurance companies. (Inadequacy of available technology for crop monitoring).
- **Remoteness and poor accessibility of rural areas** makes reaching the grassroots very challenging. There is a need for management structures that have good networks up to the grassroots.

Other

- **Taxes levied on the farmers** that take up Agriculture insurance policies are prohibitive.

Proposals on possible options for promoting agricultural insurance in Uganda

- Weather Based Index Insurance (WBII) is recommended as the most suitable option for the mostly small scale farmers in the country.
- Agricultural insurance should work more with peasant farmers since they are the most affected by weather-related risks, and should cover multiple risks.
- Need to make premiums affordable to the small scale farmers, if possible payable in instalments.
- Both crop and livestock insurance are necessary but each is most suitable in a particular farming zone.
- Address gender constraints to access and use of insurance

Source: Daily Monitor 9 July, 2018 (*editorial@ug.nationmedia.com*)

Mitigation potential of the agriculture sector

Overview

Mitigation and adaptation are both essential aspects of dealing with climate change, but adaptation becomes costlier and less effective as the magnitude of climate change grows. Consequently, when mitigation objectives are affordably achieved, adaptation requirements are reduced and the ultimate result is less stress. The strategies for reducing emissions (mitigation) also have significant synergies with adaptation. Therefore, pursuing synergies between mitigation and adaptation in the context of increasing agricultural production and reducing poverty will be particularly important in building resilience to the effects of climate change.

Global technical mitigation potential in the agricultural sector is high at between an estimated 5.5 and 6.0 gigatons (Gt) of carbon dioxide equivalent per year by 2030. The majority of these emission reductions can be achieved through effective changes in agricultural management practices that increase soil carbon, reduce methane emissions from flooded rice fields and improve nitrogen fertilizer usage.

As of 2012, statistics show that agriculture was the most important source of GHG emissions, land use change and forestry (LUCF) being the second most important source (Fig. 28). Despite the contribution of Uganda to overall global emissions being insignificant (0.99%), the country's emissions have grown by 50% from 1990-2012, with an average annual change of 2%. Sector-specific change during that period was greatest in the industrial processes (23%) followed by agriculture and waste sectors (each at 4%) and LUCF (0%) (USAID, 2015). The total national GHG emissions in Uganda including land-use change and forestry is about 48.38 Mt CO_2e, which is 58.7% of the 82.4 Mt CO_2e regional GHG emissions. The agricultural sector has the highest emissions, contributing about 46.25% (22.38 Mt CO_2e) to the country's total GHG emissions. The four main sources of GHG emissions from the agricultural sector include enteric fermentation (42.8%), manure left on the pasture (31.1%), burning savanna (12.9%) and cultivation of organic soils at (4.8%). Production of paddy rice and nitrogen fertilizer use is also identified as important emission activities under the business as usual (BAU) scenario.

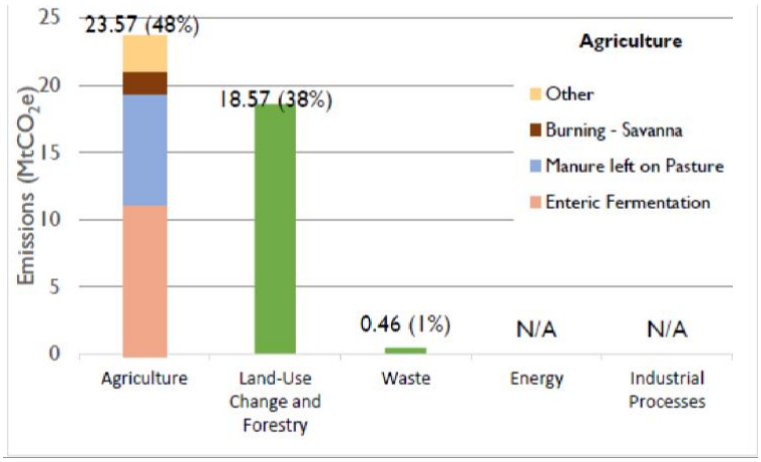


Figure 28. Emission by sector.

(Source USAID, 2015)

As part of the mitigation efforts, a number of strategies have been put in place with the goal of reducing emissions for including: intensive livestock management systems through the use of improved breeds and improved feed, fodder and pastures that is easy to digest; adoption of efficient practices for manure management such production and utilization of biogas; application of minimum tillage practices in cropland cultivation, implementation of a countrywide agroforestry plan, protection of existing forests and increased and precise fertilizer use to build soil carbon and thus enhance carbon sequestration. Proven land

management practices that allow communities to better adapt to climate change will also often contribute to climate change mitigation. The greenhouse gas (GHG) mitigation potential of Sustainable Land Management (SLM) in agricultural lands is large. Integrated land and water management can reduce land degradation, restore degraded lands, retain crop residues, increase soil carbon and reduce the need for further conversion of natural forests and grasslands. Land users can reduce GHG emissions, and maintain carbon stocks in soil and vegetation at relatively low cost, while also improving food production and securing diverse livelihoods (TerrAfrica, 2009).

The MAAIF has identified agriculture as one of the key sectors for climate change mitigation by developing a mitigation plan to guide agricultural development with respect to greenhouse gas emissions. From the plan and previous assessments, it is clear that anthropogenic emissions from agriculture sector are the principal GHG sources (MAAIF GHG Mitigation Plan,2015).

Adaptation co-benefits and mitigation potential of the agriculture sub-sectors

Crop sub-sector

Establishment of crops in Uganda is mainly done by digging with hand hoes or ploughing with tractors or oxen. Other common practices in croplands include burning of crop residues and clearing of new land for cropland expansion –practices that lead to GHG emissions. Of the total agriculture sector emissions, the crops sector accounts for 13% of the emissions arising from burning savannah (7%), cultivation of organic soils (3.2%), crop residues (1.4%), rice cultivation (0.6%), burning crop residues (0.4%) and synthetic fertilizers (0.2%). Activities that would reduce the crop subsector emissions are adoption of minimum tillage practices on cultivated land (including organic soils); and increased use of non-nitrogenous fertilizer accompanied by precision planting techniques to enhance efficiency. A number climate smart agriculture practices have been promoted to realize multiple gains in terms of enhancing adaptation and resilience of agricultural systems while realizing mitigation benefits such conservation agriculture (minimum tillage, crop rotation and mulching), Integrated soil fertility management (ISFM) and soil and water conservation techniques (terracing, strip and contour cultivation) (Njeru et al., 2016). Practices like conservation agriculture (minimum tillage) which improve the soils ability to conserve soil moisture

through soil organic carbon build up and cope with drought also help to sequester carbon in soils which induces net GHG emission reductions (sinks).

Integrated soil fertility management (ISFM) has been shown to mitigate greenhouse gas emissions from agricultural systems in addition to realizing adaptation benefits such as high productivity and yield stability and adaptation co-benefits like improved farm livelihoods and food security (Roobroeck et al., 2015). Fertilizer micro-dosing, which is an important element of ISFM reduces emissions by increasing the recovery of nitrogen (N) by crops and retention of nitrates in soils thus reducing emission of nitrogen oxide emissions. The combination of inorganic fertilizers and organic inputs also enhances fertilizer uptake and retention by balancing the processes of immobilization and release and also enhances conservation and build-up of soil carbon stocks.

Paddy rice cultivation is another source of GHG emissions in Uganda. To address this challenge, there have been efforts by the crop resources directorate coordinated by MAAIF to replace the paddy rice in Uganda with a high yielding upland variety as a nationally appropriate mitigation action (NAMA). Methane emissions from paddy rice are variable, ranging between 0.25 to 0.82 g/m^2 /day, depending on the growth stage of the rice and the level of flooding. Activities associated with rice cultivation that indirectly affect emissions in the agricultural sector include productivity of paddy and upland rice, clearing of forests and woodlands to open up new land for cultivation, and use of inorganic and/or organic fertilizers to improve yields. In addition, paddy rice cultivation is associated with clearing of all trees in the land because these are thought to attract birds that eventually feed on the rice. The NAMA therefore aims to address these methane emissions, which have been rising over the years. In 1994, methane emissions from rice cultivation were estimated at 23.54 gigagrammes. Recent estimates put methane emission from rice at about 204.24 gigagrammes in 2010. The increase in methane emissions is a result of an increased area under paddy rice cultivation, estimated to be 48,406ha in 2008.

Soils which are degraded and are under poor health (Fig. 29) do not support aboveground net primary productivity neither belowground biomass, therefore restoring degraded lands and improving soil health enhances aboveground net primary productivity and belowground

biomass which induces net GHG emission reductions (sinks), thus increasing the soil's mitigation potential.

Figure 29. A patch of bare ground devoid of net primary productivity due to severe degradation and poor soil health.

(Photo by James Lwasa)

Perennial cropping systems also have been indicated to sequester large amounts of carbon. For example, when properly established and managed, coffee-banana intercropping (CBI) systems will not only increase food security and climate resilience, but also provide climate change mitigation benefits (Jassogne et al., 2013). Some of the specific adaptation and mitigation benefits of coffee-banana intercrops include: regulation of the micro-climate by providing shade for coffee trees within a year of planting; improving soil water retention capacity; increased ability to withstand drought; and carbon sequestration. The combined system contributes to household resilience by diversifying income and levelling out irregular cash flows when compared to their respective monocropping systems. There are also direct household food security benefits through consumption of the bananas and indirectly from increased purchasing power. Carbon sequestration in the CBI system occurs through increased above and below ground carbon stocks, accumulated mulch layer on soil surface which translates to high total soil organic matter and nitrogen thus increasing soil carbon content. Besides, the increased overall productivity of CBI reduces the system's carbon footprint. Other perennial crops with a large potential for carbon sequestration and thus overall emission reduction in Uganda include banana-cocoa intercrops, tea, cashew and macadamia nuts.

Livestock sub-sector

According to the Global Livestock Environmental Assessment Model (GLEAM-i), Uganda's GHG emissions in 2016 were 2009 Gg CO_2-eq/yr of which the grazing system contributed 88.5%. The major sources of GHG emissions in the livestock sector include enteric fermentation (49%), manure left on pasture (36%), manure management (4%) and manure applied to soils (2%) (Figure 28). At an annual livestock growth rate of 3%, the projected GHG for 2020 and 2025 would increase by 12.6% and 30.7% respectively. The milk and meat emission intensities were far higher than the global averages (Kiggundu et al., 2019). At the same time, livestock accounts for up to half of the technical mitigation potential of the agriculture, forestry and land-use sectors, through management options that sustainably intensify livestock production, promote carbon sequestration in rangelands and reduce emissions from manures (Havlík et al., 2013), and through reductions in the demand for livestock products. For example, a reduction in grazing by 10% and a 10% increase in use of anaerobic digesters to handle manure led to a 4.4% reduction in annual GHG emission. Table 33 shows practices with great mitigation potential that have been proposed for Uganda.

Table 33. Practices with great mitigation potential that have been proposed for Uganda.

Practice	Benefits and Mitigation Potential
Animal breeding programmes involving genetic improvement	Improve capacity to withstand climate-related stresses, e.g. drought tolerance, heat stress, tick and disease resistance. Improving feed conversion efficiency and reduce the greenhouse gas intensity of livestock products.
Improved high-yielding drought tolerant forages	To address feed seasonality and quality constraints, digestibility and yields while reducing methane emissions from enteric fermentation Intercropping legume with grasses to reduce methane emissions
Water harvesting technologies	Increase the amount of water available for livestock consumption
Feed conservation practices	Use of silage promotes the high uptake of dry matter and accelerates the rate of food passage through the rumen, leading to a decline in emissions released.
Animal health technologies	To address high livestock morbidity rates thereby reducing emissions intensity while increasing animal productivity
Zero grazing	Improve livestock productivity and manure management Nationally Appropriate Mitigation Action on (NAMA) Climate-Smart Dairy Livestock value chains
Use of concentrates	Improve ruminant diet and milk production while minimising methane emission from enteric fermentation
Crop-livestock integrated system	Improves system productivity as both crops and animals are raised on the same piece of land
Improve manure management	Use of technologies such as biogas and composting

Fisheries sub-sector

Currently there are no major mitigation efforts in the fisheries sub-sector. Emissions from fisheries are dominantly from fishing efforts using motorized boats (MAAIF, 2015). Annual Nitrous oxide (N_2O) and Methane (CH_4) emissions from fisheries in 2014 were 0.31 and 0.90 Gg/yr of N_2O and CH_4, respectively. About 78% of these emissions were from Lake Victoria fisheries mainly due to the number of motorized boats and the productivity of the Lake (MAAIF GHG Mitigation Plan, 2015). Consequently, the mitigation potential in fisheries is low.

Landscapes and agroforestry

Mitigation strategies in agriculture can be categorized in three ways: carbon sequestration into soils, on-farm emission reductions and emission displacements from the transportation sector through biofuels. Sequestration activities enhance and preserve carbon sinks and include any practices that store carbon through cropland management "climate smart practices", such as no till agriculture or that slow the amount of stored carbon released into the atmosphere through burning, tillage and soil erosion. Sequestered carbon is stored in soils, resulting in increases in soil organic carbon (SOC). Many on-farm management practices can raise SOC. Such practices include: livestock and manure management, fertilizer management improved rice production, reducing the amount of bare fallow, restoring degraded soils, improving pastures and grazing land, adopting irrigation, crops and forage rotation and adopting no till practices. Finally, the production of liquid fuels from dedicated energy crops. However, the extent to which biofuels can offset carbon emission hinges on the type of land cover that their cultivation would replace. The conversion of land from higher carbon value, such as forest land to cropland, would release CO_2 into the atmosphere.

Landscapes

Restoration of degraded landscapes has mitigation potential in Uganda. The Government of Uganda recognizes land degradation as a major impediment to national economic development through the sustainable use of natural resources that contribute over 50% of Gross Domestic Product (GDP). Consequently Uganda is committed to maintain and manage a sustainable environment and natural resource base that is resilient to natural and manmade threats and drivers of change including: poverty, rapid population growth,

unplanned urbanization, expansion of informal settlements, industrialization and the impacts of climate change and variability among others (LDN TSP, 2018).

Soils and above ground biomass can be used to sequester more carbon in Uganda. Generally, soils tend to sequester more carbon than the above ground biomass. It was estimated that about 51 Gt of carbon are stored in the soils of Uganda (MAAIF, 2015). This can be improved since Uganda is covered by various type of soils, with different depth and capacity to sequester and store carbon due to their texture and depth. The sequestration and storage of carbon significantly differed across the various land use systems (Akodi et al., 2016). Forests store more above ground (IPCC, 2013) and deep soils have high potential to store below ground terrestrial carbon. It has been reported that stepwise re-accumulation of farming systems carbon involving tree planting and soil conservation may also contribute to the potential to increase carbon stocks (Woomer et al., 1998). On cultivated land, the stock of carbon can also be enhanced through use of agroforestry systems. The carbon storage potential for agroforestry systems is at 121-124 Mg C ha^{-1} over one or two decades, depending on the tree species and density and can potentially offset 5-10 ha of deforestation in tropical environments (Dixon, 1995). In humid tropics, the carbon sequestration potential has been estimated at 25-70 Mg C ha^{-1} in the top 20 cm of soil (Mutuo et al., 2005). Improved fallow agroforestry practices can increase up to 1.6 Mg C ha^{-1} topsoil C stocks more than that of continuous maize cropping (Mutuo et al., 2005). A combination of woody perennials and annual crops has the potential of sequestering 29-53 Mg above ground C ha^{-1} in the humid highlands of Africa (Winjum et al., 1992) (Table 34). Agroforestry has been reported to have 3-4 times more biomass than traditional treeless cropping systems (Smith and Wollenberg, 2012; Takimoto et al., 2008), consisting the third largest carbon sink after primary forests and long term fallows in Africa (Oke and Odebiyi, 2007). However, estimates of C stocks under different agroforestry systems are scarce due to variability in soils, resource constraints and complexity of agroforestry systems in Uganda (Tumwebaze et al., 2011).

Table 34. Carbon stocks from different agroforestry systems in Uganda.

System	Sub system	Carbon pool	Carbon stocks tC/ha	Region research conducted	Reference
Coffee Agroforestry system (CAS)	Robusta CAS	Below ground	57.56	Western Uganda (Kabarole, Kasese, Bushenyi, Ibanda	Tumwebaze et al., 2016[4]
	Arabica CAS		54.54		
	Arabica coffee	Above ground	42.01	Low elevation farms (1291 m a.s.l) in Mt. Elgon highlands	Justine et al., 2019[5]
			12.48	Medium elevation (1357 m a.s.l) farms in Mt. Elgon highlands	
Linear simultaneous agroforestry system	Maize crop/ *Casuarina equisetifolia* L.	Below ground	263.35	Central Uganda (Mukono district)	Tumwebaze et al., 2012[6]
	Maize crop/ *Grevillea robusta A. Cunn.*		291.84		
	Maize crop/ *Maesopsis eminii* Engl.		300.58		
	Maize crop/ *Markhamia lutea* K. Schum.		279.03		
	Maize crop/*no trees*		150.47		
Plan Vivo system	*Grevillea robust* woodlot		470	South Western Uganda (Rubirizi, Mitoma, and Kabale districts)	Kiyingi et al., 2016[7]

[4]Tumwebaze, S.B., Byakagaba, P. 2016. Soil organic carbon stocks under coffee agroforestry systems and coffee monoculture in Uganda. Agriculture, Ecosystems and Environment 216, 188–193.

[5]Justine, N., Tumwebaze, S.B., Kigonya, R., Nabanoga, G. 2019. Aboveground Species Diversity and Carbon Stocks in Smallholder Coffee Agroforestry in the Highlands of Uganda. Y. Bamutaze et al. (eds.), Agriculture and Ecosystem Resilience in Sub Saharan Africa, Climate Change Management, Springer Nature Switzerland AG 2019.

[6]Tumwebaze, S.B., Bevilacqua, E., Briggs, R., Volk, T. 2012. Soil organic carbon under a linear simultaneous agroforestry system in Uganda. Agroforest. Syst., 84, 11–23.

[7] Kiyingi, I., Ocama, D., Mujuni, D., Nyombi, K. 2016. A bioeconomic analysis of the carbon sequestration potential of agroforestry systems: A case study of *Grevillea robusta* in South Western Uganda. Uganda Journal of Agricultural Sciences, 17 (2), 219 – 229.

Table 35 shows net carbon benefits and tradable carbon for the different agroforestry systems in Mt Elgon over a period of 25 years. These systems included boundary (strip) planting (involves planting *Grevillea robusta* and *Maesopsis eminii* along the farm boundary); dispersed inter-planting (involves planting various mixed native tree species with crops) and woodlots (involves planting woodlots of various mixed native tree species). Woodlots had the highest carbon sequestration and net C benefit followed by dispersed inter- cropping system and then boundary planting.

Table 35. Net Carbon Benefits and Tradeable Carbon for the different agroforestry planting systems.

System	Sink	Baseline	Net C benefit		Risk Buffer (10%)		Tradeable Carbon	
	(tC/ha)	(tC/ha)	tCO_2/ha	tC/ha	tCO_2/ha	tC/ha	tCO_2/ha	tC/ha
Boundary planting	22.33	4.55	65.24	17.78	6.52	1.78	58.72	16.00
Woodlot	65.62	4.55	238.80	65.07	23.88	6.50	214.92	58.56
Dispersed inter-planting	50.98	4.55	170.40	46.43	17.04	4.64	153.36	41.79

Notation: The net benefit is the difference between the carbon sink and the calculated baseline and the 10% risk buffer.

(Source: ECOTRUST, Tree for Global Benefit programme report version 1.1, 2017)

Agroforestry

According to IPCC (2019), agroforestry practices reduce significant amounts of Greenhouse Gases (GHGs) through increased carbon storage in above-ground and below ground biomass and soil organic carbon. Accordingly, agroforestry has been recognized as a greenhouse gas-mitigation option under the Kyoto Protocol (Nair et al., 2009). The National Climate change Policy aims for a harmonized coordinated approach for climate-resilient and low carbon development path for sustainable development in Uganda. To achieve a climate-resilient and low carbon development path, agroforestry is seen as one of the approaches through REDD+ to reduce emissions from deforestation including conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon. Agroforestry in Uganda's forestry sector has been seen as part of potential climate mitigation action through carbon sequestration as a result of increasing area under forests, thus, increasing carbon stocks on land and contribute in reversing deforestation trend to a projected

increase in forest cover of 21% by 2030 from 14% in 2013 (MWE,2016) through sustainable biomass production.

Conservation or establishment of a tree canopy above shade-tolerant crops in agroforestry, usually brings many benefits: soil carbon enrichment, biological nitrogen fixation, tighter nutrient and water cycle, favorable microclimate, pest outbreak prevention, yield of valuable tree products, habitat for biodiversity, higher resilience to climate variability and ultimately carbon sequestration (Johns, 1999; Jose, 2009; Kumar, 2016; Lin, 2007; Mendez et al., 2010; Nair et al., 2009; Pumari~no et al., 2015; Souza et al., 2012; Tscharntke et al., 2011).

Incorporation of trees and shrubs into farms and rangelands has the potential to provide added benefits to conservation agriculture, which include maintaining vegetative soil cover, faster nutrient cycling and nitrogen fixation, weed suppression, enhancing soil structure, supporting carbon sequestration and biodiversity conservation as well as providing food, fuel, fibre and income from tree products. Many climate smart agricultural practices that reduce climate vulnerability also reduce emissions and improve agricultural production potential. Estimates show that agroforestry systems have the potential to sequester between 12 and 228 Mg C ha^{-1}, with the variation influenced by the kind of agroforestry system put in place (Björsell, 2014). Subsequently, the possibility of offsetting the current CO_2 emission if the agroforestry potential are fully utilized.

Mitigation strategies in agriculture can be categorized in three ways: carbon sequestration into soils, on-farm emission reductions and emission displacements from the transportation sector through biofuels. Sequestration activities enhance and preserve carbon sinks and include any practices that store carbon through cropland management “climate smart practices”, such as no till agriculture or that slow the amount of stored carbon released into the atmosphere through burning, tillage and soil erosion. Sequestered carbon is stored in soils, resulting in increases in soil organic carbon (SOC). Many on-farm management practices can raise SOC. Such practices include: livestock and manure management, fertilizer management improved rice production, reducing the amount of bare fallow, restoring degraded soils, improving pastures and grazing land, adopting irrigation, crops and forage rotation and adopting no till practices. Finally, the production of liquid fuels from dedicated energy crops. However, the extent to which biofuels can offset carbon emission hinges on

the type of land cover that their cultivation would replace. The conversion of land from higher carbon value, such as forest land to cropland, would release CO_2 into the atmosphere.

Enabling policy environment

Overview

Climate change is undoubtedly the most severe challenge facing our planet during the 21st century. Human interference with the climate system has increased the global and annual mean air temperature at the Earth's surface by roughly 0.8°C since the 19th century (IPCC, 2013). This trend of increasing temperatures will continue into the future: by 2100, the globe could warm by another 4°C or so if emissions are not decisively reduced within the next decades (IPCC, 2013). There is broad agreement that a warming of this magnitude would have profound impacts both on the environment and on human societies (IPCC, 2014a), and that climate change mitigation via a transformation to low emissions, climate resilient development pathways and societies has to be achieved to prevent the worst of these impacts (IPCC, 2014b).

The global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions. Combating climate change would require substantial and sustained reductions in GHG emissions which, together with adaptation can limit climate change risk. Figure 30 summaries the different agreements from the 1970s up to 2016.

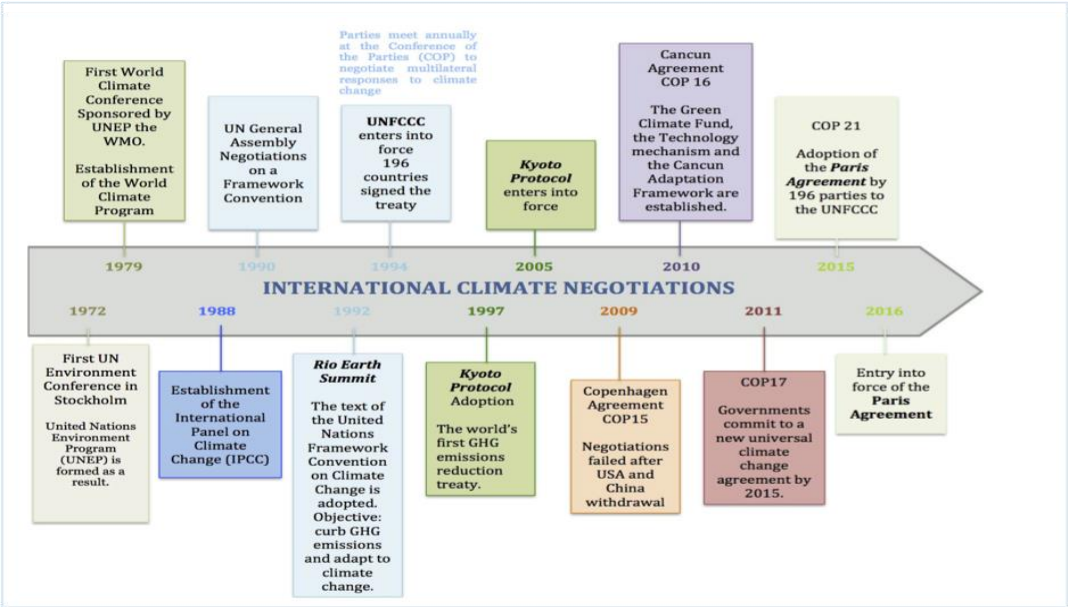


Figure 30. International climate negotiations (1972-2016).

Global frameworks

UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC) is an intergovernmental treaty developed to address the global challenge of climate change. The Convention, which sets out an agreed framework for global response to climate change was adopted in June 1992 in Rio de Janeiro, Brazil at the Rio Earth Summit. The UNFCCC entered into force on 21 March 1994. The ultimate objective of the Convention is to *"stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system"* and which *"should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner".*

Developed countries listed in Annex II (a sub-set of Annex I) are expected to provide finance, technology and capacity building support to the developing countries. Since it is a framework instrument to operationalize its provisions, other instruments have to be established. Since then two instruments have established the Convention, namely: Kyoto Protocol (1997) and Paris Agreement (2015). Uganda is a signatory to the UNFCCC).

Climate change, biological diversity and desertification are intricately related on the social, economic and environmental fronts and the nationally determined contributions/national adaptation plans (NDCs/NAPs), national biodiversity strategies and action plans (NBSAPs) and national action programmes (NAPs) are the implementation tools, respectively. In December 2009, the UN General Assembly noted the need for enhanced cooperation among the Rio Conventions and in July 2012, UNGA adopted "The Future We Want", encouraging coordination and cooperation between multilateral environmental agreements (MEAs).

Action at the national level represents an important opportunity to establish synergy, coherent policy instruments and cost-effective ways for implementation. Synergies are found when addressing problems caused by climate change, biodiversity conservation, land degradation and drought (DLDD), such as:

- Forestry, sustainable land management (SLM), rural development, other land use sectors and agricultural production, reducing emissions from deforestation and forest degradation (REDD+);
- Adaptation through ecosystem approach, resilience capacities; and
- Training and education, awareness raising, information and science.

Kyoto Protocol

The Kyoto Protocol (KP) was adopted in 1997 and came into force in 2005. The main objective of the Protocol is to reduce emissions of Annex I countries by at least 5% below 1990 levels (and in some cases 1995 levels) in the period 2008-2012. Individually, these countries had separate commitments. The European Union countries were collectively expected to reduce their emissions by 8%, the USA by 7% and Japan by 6%. Australia, Iceland and Norway were allowed to increase their emissions. The remaining countries were allowed varying levels of reduction. The Protocol identifies policies and measures that can be taken by countries (Art. 2) and quantified commitments for Annex B countries on six GHGs.

The Protocol established three flexible mechanisms: joint implementation (JI, Art. 6) with crediting among the developed country Parties; Clean Development Mechanism (CDM, Art. 12) which aims at enabling projects in developing countries to achieve sustainable development, contribute to the ultimate objective of the Convention and assist developed countries in complying with their quantified emission reduction and limitation

commitments; and the emission trading (ET, Art. 17) among themselves. The mechanisms were founded on division of a budget of permissible emissions among countries (cap and trade system). Those countries that do not use their complete share may sell the unused portion to those who need them. The assigned amounts (or quotas) were allocated to the developed countries and the quotas were equivalent to their emission reduction commitments. The underlying rationale of these co-operative mechanisms is to ensure that global emissions of greenhouse gases are reduced in a cost-effective manner. The first commitment period of KP started in 2008 and ended in 2012.

The Doha Amendment to the KP adopted in 2012 established the second commitment period for developed countries to reduce their GHG emissions by at least 18% by 2020 below 1990 levels. Unfortunately, to-date the Doha Amendments are yet to attain the requisite number of countries that have ratified it for it to come into force. The effect of this is that the KP and its Doha Amendments will come to an end at the end of this year (2020).

That notwithstanding, the KP made some useful achievements. These include: introduction of a multinational carbon market; delivery of new rules for reporting, accounting and verifying emissions; support to poorer countries through the establishment of the Adaptation Fund; incentivising green investments in the developing world; and the institution of rules-based architecture.

Paris Agreement on Climate Change

The Paris Agreement on Climate Change was adopted at COP21 in 2015 in Paris, France and came into force in November 2016. The purpose of the Agreement is set out in Article 2 to enhance implementation of Article of the Convention and to strengthen the **collective global response to climate change**. The three elements underpinning the purpose are:

- Holding the average global temperature to well below 2^{o}C above pre-industrial levels and to ensure that efforts are pursued to limit the temperature increase to 1.5oC;
- Enhancing adaptation and resilience and synergies between adaptation and mitigation; and
- Making finance flows consistent with low emissions, climate resilient development pathway.

Adaptation is recognized as a key component of the long term global response to climate change and an urgent need of developing countries. Article 7 of the PA establishes an aspirational global goal on adaptation (GGA) to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change (Art. 7.1). The importance of continuous and enhanced support for adaptation efforts of developing countries particularly vulnerable to the adverse effects of climate change are also recognized. The PA provides that adaptation should follow a country-driven, gender-responsive, participatory and transparent approach that takes into account the interests of vulnerable groups, communities and ecosystems. Adaptation action should be based on and guided by "the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions, where appropriate". Each of the developing countries is required, as appropriate, to engage in adaptation planning processes and the implementation of actions, plans and policies such as, for example, formulating national adaptation plans (NAPs), assessing climate change impacts and vulnerability and building resilience (Art. 7.9). **Means of Implementation (finance, technology and capacity building)** are crucial for supporting developing countries to transition low emissions, climate resilient development pathways.

Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. The SDGs replaced the Millennium Development Goals (MDGs). The MDGs established measurable, universally-agreed objectives for tackling extreme poverty and hunger, among other development priorities. The 17 global goals are a blueprint to achieve a better and more sustainable future for all. All these goals are closely interconnected, meaning success in one affects success for others. Adoption of the SDGs coincided with two other historic agreements, the Paris Agreement on Climate Change and the Sendai Framework for Disaster Risk Reduction (DRR).

Uganda has integrated the 2030 agenda (Agenda 2030) for sustainable development in its national planning frameworks, particularly through its Second National Development plan

(NDP II). The principles of sustainable development are also aligned with Uganda's Vision 2040. More specifically, the aspiration of Agenda 2030 (SDG2 and 9), is to end hunger, achieve food security, improve nutrition and promote sustainable agriculture as well as promoting inclusive and sustainable industrialization and foster innovation. SDG 8 also seeks to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. In addition, SDG 13 – that aims to combat climate change and its impacts and SDG 1 – which aims to end poverty, are also priority areas for the republic of Uganda. Estimates by the government show that 76% of the SDG targets are reflected in the plan and adapted to the national context (GoU, 2018).

Sendai Framework for Disaster Risk Reduction

Uganda is signatory to the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, adopted in March 2015 in Japan during the 3rd UN World Conference aimed at achieving the substantial reduction of disaster risks and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. Specifically the framework underscores seven clear targets and four priorities for action to prevent new and reduce existing disaster risks. These are understanding disaster risk through pre-disaster risk assessment (Priority 1); strengthening disaster risk governance to manage disaster risk through planning and coordination within and across sectors (Priority 2); investing in DRR for resilience from various sources (Priority 3); and enhancing disaster preparedness for effective response and to 'build back better' in recovery, rehabilitation and reconstruction (Priority 4). The SFDRR provides a robust framework that empowers governments to address disaster risk and disaster risk reduction issues in a holistic and multi-sectoral nature. Compared to its successor, the Sendai Framework represents a shift to a wider multi-hazard risk management approach, which includes transboundary, technological and biological hazards and disasters. It gives more emphasis for sectoral engagement in the planning and delivery of DRR, to the importance of science and technology in policymaking and the focus onto "Build Back Better" during recovery, rehabilitation and reconstruction. The Sendai Framework recognizes disaster risk reduction as essential to sustainable development.

The implementation of this framework is critical for Uganda as more than half of the country is vulnerable to droughts and a third to floods. Without addressing the growing levels of

disaster and climate risk, close to a half of the population of Uganda could regress into poverty. According to Development Initiatives (2019), while droughts, floods, landslides and epidemics are well-known recurrent disasters in Uganda, there are no specific budget lines or activities attached to them. It is critical for government and development partners to plan and provide adequate financing to ensure effective DRR management. Some of the challenges faced by the country in implementing the Sendai framework include dependence on donor support, limited national budget allocation, inadequate law enforcement and inadequate coordination of interventions. For instance, Uganda does not have a national law to govern DRR and management and align it with the current international thinking of linking DRR with climate change adaptation (GoU, 2019).

Regional policies

Continental frameworks

The African Union's Agenda 2063

Africa's Agenda 2063 is a strategic framework for socio-economic transformation of the continent by 2063. It builds on, and seeks to accelerate the implementation of past and existing continental initiatives for growth and sustainable development. It identifies agriculture as one of the sectors of the economy that needs to be transformed in order to achieve the needed sustainable development across the continent (AU, 2017).

The Comprehensive Africa Agriculture Development Programme (CAADP)

The Comprehensive Africa Agriculture Development Programme (CAADP) was adopted in 2003 in Maputo. The African Union under the Maputo Declaration on Agriculture and Food Security in Africa made the first declaration on CAADP as an integral part of the New Partnership for Africa's Development (NEPAD). Therefore, CAADP is a pan-African framework to allow countries to review their progress towards agricultural transformation, wealth creation, food security, nutrition and inclusive economic growth. It identifies four key pillars to accelerate agricultural growth, reduce poverty and achieve food and nutrition security including: sustainably increase the areas cultivated and served by reliable water control systems; improve rural infrastructure and trade capacities to facilitate market access; increase food supplies, reduce hunger, improve responses to food emergencies; and improve agricultural research, dissemination and adoption of technologies. The Maputo

Declaration included the decision to commit at least 10% of national budgets to agriculture. It also aimed at an annual agricultural productivity growth of 6%. In 2014, the AU Summit adopted the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods that reaffirms the central commitment of the Maputo declaration on 10% national budget allocations for agriculture. It also specifies more commitments such as increased irrigation, mechanization and reducing post-harvest losses (AU, 2014).

Findings from Malabo Biennial Report (2017) show that Uganda is among the 47 member states that are on track to achieve the Malabo declaration overall commitments by 2025 with a score of 4.4 out of 10 compared to the overall score of the whole of Africa of 3.6. With regard to enhancing investment finance in agriculture, Uganda score was 3.8 against the required minimum score of 6.67. With regard to the commitment of ending hunger and enhancing resilience to climate variability, the scores were 3.53 against 3.71 minimum score and 5.31 against 6.0 respectively, an indication that the country is not on track to achieving these important commitments. However, there has been positive progress in several other commitments such as halving poverty through agriculture by 2025, boosting intra-African trade in Agriculture commodities and recommitment to the CAADP process.

The Programme for Infrastructural Development in Africa (PIDA)

The Programme for Infrastructural Development in Africa (PIDA) provides a common framework for African stakeholders to build the required infrastructure in different sectors (transport, energy, ICT and trans-boundary water networks) to boost trade, spark growth and create jobs. It is dedicated to facilitate continental integration through improved regional infrastructure. Its implementation will help address the infrastructure deficit that has hampered Africa's competitiveness in the world market for a long time. Through this programme it is expected that there will be a transformation in the way of doing business, hence help to deliver a well-connected and prosperous Africa.

Science Technology Innovation Strategy for Africa (STISA)

The Science Technology Innovation Strategy for Africa (STISA envisions creation of a Knowledge-based Economy through science and technology innovation led transformation of the continent. Science and Technology innovations are expected to trigger socio-

economic development and growth across critical sectors such as agriculture, energy, environment and water among others. The STISA is anchored on six (6) priority areas namely: i) Eradication of Hunger and Achieving Food Security, ii) Prevention and Control of Diseases, iii) Communication (Physical and Intellectual Mobility), iv) Protection of our Space, v) Living together in peace & harmony to build the society and vi) Wealth Creation. Successful implementation of this strategy assume that the following pre-conditions are fulfilled i) building and/or upgrading research infrastructures; ii) enhancing professional and technical competencies; iii) promoting entrepreneurship and innovation; and iv) providing an enabling environment for Science Technology and Innovation (STI) development in the African continent.

Sub-regional

The Intergovernmental Authority on Development (IGAD)

Uganda is a Member State of the Intergovernmental Authority on Development (IGAD), an 8-country trade bloc in Africa to which Uganda has been a founding member since 1986. Part of the mandate of IGAD is to mitigate the effects of drought, desertification and food insecurity in the region, in line with the African Union missions. IGAD has put in place a framework for improving the efficiency of agricultural and food marketing in the region. As a response to climate change impacts (e.g. drought and floods) which the IGAD region has experienced, several initiatives have been put in place including the development of a regional climate change strategy, drought and disaster resilience and sustainability initiative. These include the IGAD Livestock Policy Initiative that has resulted in the development of the National Livestock Policy Hub in Uganda, the IGAD Fertilizer and Inputs Programme, the Regional Food Security Programme and the Livestock Marketing Information System. The IGAD Climate Centre (ICPAC) is an important climate centre for the region.

The East African Community (EAC)

Uganda is a Partner State of the East African Community (EAC). Vision 2050 was adopted in 2016 to provide a catalyst for enhancing regional growth and development and operates within the framework of Africa Union Agenda 2063. Agriculture, food security and the rural economy as well as environment and natural resources are among the key pillars in the policy. Further, the EAC Vision 2050 seeks to promote value addition through agro-processing. The AfCFTA aims to create a single market for goods and services facilitated by

movement of persons in order to deepen the economic integration of the African continent. This is an opportunity for Uganda to exploit its agro-industrialization agenda in order to feed the global value chain. The Uganda Vision 2040 puts emphasis on the establishment of economic lifeline industries including agro-based industries to drive agriculture productivity. Various important regional legislation such as the 2015 Disaster Risk Reduction and Management Act, the 2016 EAC Forest Management and Conservation Bill, the 2010 EAC Trans boundary Ecosystem Management and Conservation Bill (2010), and the 2006 Protocol on Environment and Natural Resources exist in East Africa.

The Common Market for Eastern and Southern Africa (COMESA)

Uganda is a Member State of the Common Market for Eastern and Southern Africa (COMESA), the regional economic community of the African Union. COMESA's core mandate is to enhance regional integration especially agricultural trade. This is by opening up the region to allow free flow of agricultural trade by removing all barriers to such trade to ensure that as needed, commodities move from surplus to deficit areas in the region driven primarily by demand and market forces. The other strategic approach is to put in place policies, systems, regulations and procedures which are harmonized across the region so as to create a conducive, transparent and facilitative environment for conducting regional agricultural trade with forward and backward linkages across the region from the farmer to the market.

National policies

National level

The Government of Uganda has put in place macro and sectoral policy instruments particularly on agriculture and climate change. These policies identify priority areas towards the development of a climate resilient and compatible economy while achieving sustainable development through equitable low-carbon economic growth for Uganda, including agriculture and food systems.

Macro-economic policy framework

Uganda Constitution 1995: The supreme law in the country, the Constitution of the Republic of Uganda (1995), provides for the legal and regulatory framework for Uganda on all aspects pertaining to environment management in order to ensure sustainable development. The

Constitution also recognizes the need to promote sustainable development and public awareness of the need to manage land, air and water resources in a balanced and sustainable manner for the present and future generations.

Uganda Vision 2040: Uganda Vision 2040 defines the development pathway and strategies that will transform Uganda from a predominantly peasant and low income country to a competitive upper middle income country. It builds on the progress that has been made in addressing the strategic barriers that have constrained Uganda's socio-economic development since independence, including: ideological disorientation, weak private sector, underdeveloped human resources, inadequate infrastructure, small market, lack of industrialization, underdeveloped services sector, underdevelopment of agriculture, and poor democracy, among others. The Uganda Vision 2040 calls for development of appropriate adaptation and mitigation strategies on Climate Change to ensure that Uganda is sufficiently cushioned from any adverse impact brought by climate change.

National Development Plan III (2020-2025): National Development Plan-NDP III (2020–2025) is the third in a series of six five-year Plans aimed at achieving the Uganda Vision 2040. In the agriculture sector NDP 3 (2020-2025) puts emphasis on Agro-Industrialization (AGI). Given the dominance of agriculture as a source of livelihood, AGI offers a great opportunity for Uganda to embark on its long-term aspiration of increasing household incomes and improving the quality of life. First, AGI presents an avenue for promoting inclusive and equitable growth. Second, Uganda has a positive trade balance in agro-industrial products. Third, it provides an opportunity to add value to agricultural raw materials in order to promote export expansion of high value products. Fourth, it provides an opportunity for import substitution. Fifth, it provides an opportunity to address the high post-harvest losses, minimize losses to disasters, stabilize prices and increase household incomes. Additionally, the backward and forward linkages between agriculture and agro-industries will necessitate that Uganda sustainably transforms agro-value chains to ensure sufficient supply for domestic industries to undertake transformative sustainable manufacturing while creating employment for its citizens (NDP 3, June 2020)

Uganda Green Growth Strategy 2018: The strategy is to operationalize green growth tenets outlined in Agenda 2030, the Uganda Vision 2040 and the NDP II (2015/16-2019/20) to accelerate the country's transition to a middle income status.

Relevant sectoral policies

National Agricultural Policy 2013 was developed to harmonize the different thoughts and approaches to national agricultural development. The vision of the policy is "a competitive, profitable and sustainable agricultural sector", while the mission of the policy is to: "transform subsistence farming to sustainable commercial agriculture." The overall objective of the policy is to achieve food and nutrition security and improve household incomes through coordinated interventions that focus on enhancing sustainable agricultural productivity and value addition; providing employment opportunities, and promoting domestic and international trade.

Agriculture Sector Strategic Plan (ASSP) 2020 is a flagship plan for investment and development of the agricultural sector, in line with the National Development Plan to be implemented through a multi-sector wide approach involving the Government of Uganda, Ministries, Departments and Agencies of Government, District Local Governments, Development Partners, Civil Society Organisations and the private sector. The ASSP has prioritized Agro-Industrialization (AGI). The objectives of this programme are to: 1) Increase agricultural production and productivity; 2) Improve post-harvest handling and storage; 3) Improve agro-processing and value addition; 4) Increase market access and competitiveness of agricultural products in domestic and international markets; 5) Increase the mobilization and equitable access and utilization of agricultural finance; and 6) Strengthen the institutional coordination for improved service delivery (NDP 3, June 2020).

National Irrigation policy 2017 aims to ensure sustainable availability of water for irrigation and its efficient use for enhanced crop production, productivity and profitability that will contribute to food security and wealth creation.

National Coffee Policy 2013 was developed to guide and regulate activities of various stakeholders in the coffee industry so as to improve production, roasting, processing and marketing of coffee. The policy seeks to, among others, increase coffee production and productivity at farm level in a sustainable way that addresses the social, ecological and

economic dimensions and to support and strengthen coffee farmer organizations to participate effectively in all the stages of the coffee value chain.

National Fisheries Policy 2003 provides for decentralization and co-management of the fisheries resources, with the relevant local stakeholders. As a mechanism to involve local ecosystem managers – the fisher communities, 12 Beach Management Units (BMUs) have been established, and legal powers have been delegated to these units; to plan and manage the fisheries resources.

Food and Nutrition Policy 2003 is intended to ensure that the entire food chain, from production to consumption, is efficiently managed within the overall development strategy, through building capacities at all levels for adequate action to improve household food security. However, the policy contains limited discussion on the relationship between food and nutrition security and climate change and hence needs to be reviewed.

Land Use Policy 2013 targets land productivity potential, land capability and land sustainability for agriculture as important aspects. The policy attempted to allocate agricultural land to its most optimal and sustainable uses. Agricultural zones of production excellence based on production potential and existing comparative advantages, though self-evident are not demarcated and the policy offers some direction. The policy noted that poor agricultural practices have resulted into increased land degradation due to soil erosion and soil nutrition depletion, de-forestation, over-grazing and water contamination. Over-population in some areas has resulted in land fragmentation and over use, affecting land quality, agricultural production and economic development. Land tenure security as it relates to access and ownership remains a major menace for women farmers. Agricultural production is mainly by small-holder producers.

Draft Rangeland Policy recognises overgrazing and overstocking as the major causes of rangeland degradation. Bush encroachment and spread of invasive plant species is affecting rangeland and forest ecosystem in Uganda. Bush encroachment leads to suppression of green grass biomass production and, thus, the rangeland's grazing capacity for livestock.

Uganda Climate Smart Agriculture Programme 2019-2030:

Uganda Climate Smart Agriculture Programme 2019-2030: It intends to build resilience and associated adaptation and mitigation co-benefits. CSA is key for reducing vulnerability of Uganda's agriculture sector by increasing productivity, enhancing adaptation and resilience of the farming systems and reducing GHGs emissions

National Agricultural Extension Strategy 2016: The NAES is derived from the National Agricultural Extension Policy (2016) and aligns with the 5-year NDP II. The strategy has main objectives: (i) To establish a well-coordinated, harmonized pluralistic agricultural extension delivery system for increased efficiency and effectiveness. (ii) To empower farmers and other value chain actors (youth, women and other vulnerable groups) to effectively participate and benefit equitably from agricultural extension processes and demand for services (iii) To develop a sustainable mechanism for packaging and disseminating appropriate technologies to all categories of farmers and other beneficiaries in the agricultural sector (iv) To build institutional capacity for effective delivery of agricultural extension services.

National Adaptation Plan for the Agriculture Sector (NAP Ag): The National Adaptation Plan for the Agriculture Sector (NAP-Ag) contributes to the second National Development Plan (NDP II) priority of strengthening ecologically sound agricultural research and climate change resilient technologies and practices. The plan also contributes to different government policies and planning frameworks, such as the National Climate Change Policy (2013) and the Agriculture Sector Strategic Plan (ASSP). The overall goal of the NAP-Ag is to increase resilience of the Agricultural Sector to the impacts of climate change, through coordinated interventions that enhance sustainable agriculture, food and nutritional security, livelihood improvement and sustainable development by boosting production and productivity for all agriculture sub-sectors - crop, livestock, fisheries, forestry, land and natural resources. Ultimately, the plan is to ensure a resilient agriculture sector across all the sub-sectors through gender responsive actions guided by knowledge, evidence and information on climate change.

Uganda Strategic Investment Framework for Sustainable Land Management 2010-2020: The framework aims at upscaling Sustainable Land Management (SLM) Practices across sectors and its development objective is to 'to strengthen sector cooperation in order to

halt, reverse and prevent land degradation/ desertification and to mitigate the effects of climate change and variability. The SIF targets to: i) raise crop and range productivity; ii) reduce deforestation; iii) secure ecosystem services such as water filtering, biodiversity, and carbon storage; and (iv) improve rural livelihoods. It is important these targets are integrated in sectoral policies in agriculture, water, forestry, wetlands, energy and trade policies. The SLM SIF has been revised to cover the period 2015-2030 in line with global and regional frameworks.

National climate change policies

National Climate Change Policy (NCCP) 2015 has a goal to "ensure a harmonised and coordinated approach toward a climate- resilient and low-carbon development path for sustainable development in Uganda." The policy is prepared and designed within the context of the country's vision and national development priorities. The policy aims at a harmonized approach towards a climate-resilient and low-carbon development path for sustainable development in Uganda.

National Adaptation Programmes of Action (NAPAs) and National Adaptation Plans (NAPs): Uganda was among the first least developed countries (LDCs) to develop and submit its National Adaptation Programmes of Actions (NAPAs) in 2007. The NAPAs includes a list of the following nine priority projects, many of which are yet to be rolled out and implemented (MWE, 2015) including, but not limited to: Community tree growing, Land degradation management, Strengthening meteorological services, Community water and sanitation, Water for production, Drought adaptation, Vectors, pests and disease control. Indigenous knowledge and natural resource management, and Climate change and development planning. A climate resilient and sustainable agricultural sector contributing towards achievement of the Uganda Vision 2040" through reducing vulnerability and enhancing adaptive capacity of Uganda's agricultural sector to the impacts of climate change in order to achieve sustainable agricultural development.

National Adaptation Plan (NAP): The NAP for Agriculture was developed by MAAIF in conjunction with the Climate Change Department of the MWE, and FAO and UNDP. It was launched in 2018 and supported by the Integrating Agriculture in National Adaptation Plans Programme (NAP-Ag). The NAP has 21 action areas with adaptation options for crop

production, livestock, fisheries, climate information, forestry, land and resources management, knowledge sharing, and early warning and disaster preparedness.

Nationally Determined Contributions (NDCs) and NDC Partnership Plan: Uganda submitted its first NDCs in 2015. The NDC emphasizes adaptation actions and the commitment to reduce emissions by 22% relative to business as usual scenario with actions focused on energy, forestry and wetlands. Through the Partnership Plan, Uganda is raising its ambition by setting the timeline to achieve several NDC actions sooner. Uganda seeks to mainstream climate resilience across sectors and develop early warning systems and robust monitoring systems by 2020, much earlier than originally planned. The Plan also aims to create an enabling environment for the country's NDC by elaborating and clarifying actions for transformative change as the country grows and develops into the future. The five priority areas for Uganda identified in its NDC Partnership Plan are: (1) strengthened operational and gender-responsive policy and institutional frameworks for the effective governance of climate change; (2) increased climate financing for planning and budgeting on the national and local levels; (3) effective and institutionalized measurement, reporting and verification (MRV) systems to monitor greenhouse gas emissions and gender-responsive adaptation measures; (4) strengthened capacity of government officials, civil society, the private sector and academia to effectively integrate NDC and Sustainable Development Goal (SDG) commitments with a gender lens into existing and future programs; and (5) accelerated project financing for NDC implementation.

Disaster Preparedness and management Policy 2010: The policy goal is "to establish institutions and mechanisms that will reduce the vulnerability of people, livestock, plants and wildlife to disasters in Uganda". The policy focuses on risks, including those related to climate hazards (especially droughts, floods and landslides). The DPM policy identifies policy actions to make agriculture less vulnerable to extreme weather events and offers a number of specific interventions to achieve this goal.

Other policies related to agriculture

National Land Policy 2010 whose objectives include, inter alia: (i) stimulate the contribution of the land sector to overall socio- economic development, wealth creation and poverty

reduction in Uganda and (ii) harmonize and streamline the complex tenure regimes in Uganda for equitable access to land and security of tenure.

Draft National Environment Management Policy (NEMP) 2020. The NEMP 2020 is in the final stages of approval by Cabinet. The overall policy goal is "To promote, maintain and improve environmental quality and resource productivity for socio economic transformation and sustainable development". The policy seeks to (i) promote long-term, socio-economic development for improved health and quality of life through sound environmental and natural resource management; (ii) to integrate, in a participatory manner, all environmental concerns including new and emerging issues in development policies, plans, programs, activities and budgets at national, district and local levels; (iii) to conserve, preserve, restore and maintain ecological processes and ecosystem functions; (iv) to optimize resource use efficiency to achieve sustainable consumption and production; (v) to educate and raise public environmental literacy on linkages between environment and development including employment, wealth creation and sustained economic growth; and (vi) to promote individual and community responsibility and participation in environmental improvement initiatives.

National Policy for the Conservation and management of Wetland Resources: The Wetlands Policy (1995) and the Wetlands Sector Strategic Plan (WSSP) 2011-2020, recognize the importance of wetlands as sources of essential goods and services (food, incomes, water, and aesthetic beauty) to local populations. Wetlands provide a large array of ecosystem services to the population and the system of interconnected wetlands plays a crucial role at a regional level by filtering pollutants and regulating water flows (influencing groundwater recharge, flood impacts, and water availability during the dry season).

National Water Policy, 1995: The policy provides a framework to support management of Uganda's water resources in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations with participation of all stakeholders. The Ministry of Water and Environment has developed a Water for Production Strategy and Investment Plan 2010 – 2035 and the Draft National Irrigation Master Plan, which are aimed at promoting the use of water in agricultural production through supporting farming system diversification,

private investment in bulk water infrastructure; service delivery and more Public-Private Partnerships.

Forest Policy, 2001: The policy emphasizes watershed management and soil and water conservation, all of which contribute to climate change resilience. It promotes community forestry, addresses the concern of forests on private land and government land. The policy also promotes commercial forestry, collaborative forest management, farm forestry, forest biodiversity conservation, urban forestry, and supply of tree seed and planting material.

Meteorology Policy 2012: The policy seeks to promote, monitor weather and climate, maintain a climate database, provide regular advice on the state of weather and climate and provide accurate and timely climate and weather information to various stakeholders.

National Science Technology and Innovation Policy: The goal of this policy is to strengthen national capability to generate, transfer, and apply scientific knowledge, skills and technologies that ensure sustainable utilisation of natural resources for the realisation of Uganda's development objectives.

Sub-national/district level

A number of sub-national legislative arrangements also exist to ensure that the national vision of agricultural transformation and sustainable growth is achieved at the sub-national, district and local levels. For example, the five–year District Development Plans are a legal requirement for all higher and lower local governments in Uganda. They form a baseline tool for fast tracking implementation of government programs and the basis of controlling the pace and direction of development investment. It is in these plans that stock of what is identified at lower local governments is elicited and integrated into the district expectations to inform the National Development Plan as required by article 190 of Constitution of the Republic of Uganda 1995, which is further operationalized in the Local Government Act, cap 243 section 36 and 78.

Adequacy and consistency in policies

Several policies have been enacted in the country, and particularly on climate change adaptation in Uganda. However, despite the progress so far made towards building governance systems for climate change adaptation the enforcement of policies and

regulation still limits positive responses at different levels. Various reasons constrain enforcement; policies are formulated through top–down approaches, NGOs and local governments are minimally involved while local communities are largely excluded (Ampairwe et al., 2015). In addition, unclear roles among actors, weak links between different administration levels, limited human and financial resources and political interference also contribute to weak enforcement of policies and regulations. The linkages between government ministries, departments and other actors still need to be strengthened and structured.

A detailed SWOT analysis of the environment and natural resources (ENR) policy and legislative framework was carried out during the LDN TSP (2018) process and the findings are presented in Table 36.

Table 36. SWOT analysis of the ENR policy and legislative frameworks.

STRENGTHS	WEAKNESSES
Policy and Legal Frameworks *The Uganda Constitution (1995) provides for protection of the environment and promotion of sustainable development;* *The National Environment Act (NEA, 1995) and currently under review; The National Land Policy (2009), the Uganda Vision 2040; The NDP II (2015-2020); The National Environment Management Policy; The Climate Change Policy (2013); The National Agric. Policy (2010); The Uganda Forestry Policy(2001); The National Adaptation Plan (NAP) and National Adaptation Program of Action (NAPA) among others all emphasize sustainable development; preservation, protection, management, enforcement etc of environment and natural resources. Land act, Wetland policy. Energy policy (2007)* *Public Finance and Management Act (nearing completion)* *Oil and Gas Policy, the National Energy Policy, National Policy on Renewable Energy,* *National Biodiversity Strategy and Action Plan (NBSAP),* *The draft Rangeland policy* *National Wetlands Policy (1995)* *The National Biomass Energy Strategy*	*Legal* *Protected areas – most of the forest reserves, wildlife and wetlands boundaries are not well demarcated and this has led to encroachment and land degradation* *Poor environmental governance* *Poor enforcement of policies* *Limited awareness of the existing policies and acts (especially at the grassroots);* *Land tenure systems ("land belong to the people").* *Lack of implementation guidelines/mechanisms* *Lack of sustainability mechanisms (incentives and penalties)* *Policies on data and information sharing* *Selective implementation of policies* *Obsolete policy and legal frameworks (they should not exceed 10 years, need to be reviewed to accommodate the SDGs and other frameworks)* *Lack of supportive regulations, guidelines and plans* *Lack of awareness about the existing policies and legal frameworks,* *Lack of a Land use plan (lack of physical and spatial planning)*

National Implementation Plan under the Stockholm Convention *Development programmes e.g. Peace Recovery and Development Plan (PRDP), Northern Uganda Social Action Fund (NUSAF)*	
Institutional *Parliamentary Committees (Agriculture, Climate Change, Environment and Natural Resources (ENR) etc* *The SLM Inter-ministerial Cooperation Framework brings together 5 key sectors that have a bearing on land management.* *The SLM structures are in place and have been leveraged for LDN TSP* *Civil society organizations, cultural institution, Faith Based Institutions involvement*	*Institutional* *Coordination is still weak and requires improvement e.g.Multilateral Environment Agreements(MEAs) are scattered in different sectors/ministries;* *Weak synergies in the implementation of Multilateral Environment Agreements and other instruments pertinent to LDN;* *Limited institutional capacity* *Governance issues (Political interference, corruption, poor leadership etc.)* *Intermittent or un sustained financing for institutional activities* *Limited awareness and involvement of some key stakeholders* *Weak M&E structures /mechanisms* *Access, availability and quality of data available* *Weak or non existence inter-cooperation frameworks at grassroots level* *Inadequate funding to SLM related institutions* *Weak capacity in SLM issues* *Overlapping and conflicting institutional mandates at various levels* *Failure to bring the private sector on board* *Domestication or localization of international commitments/initiatives*
OPPORTUNITIES	THREATS
Legal *Vision 2040 and the NDP II (2015-2020) all have strong statements / strategies on sustainable management of the environment and natural resources;* *The NAP, NAPA and INDC have strategies that are pertinent to LDN;* *Development Strategies and Investment Plans / Frameworks in the agric., forestry, energy, environment and other sectors have improved / sustainable land management as a key component* *The planned NAP review and alignment offers an opportunity for bringing LDN on board;* *The Uganda Sustainable Land Management*	*Legal* *Infrastructure development, especially roads, railway networks, power generation and transmission pose many legal challenges on issues pertinent to LDN;* *Degradation Hot spots – degradation of wetlands and forests has been exacerbated by the high population growth (3.5%) and climate change;* *Oil exploration and infrastructure development challenges - Oil, gas and mineral downstream, mid-stream and upstream activities are in ecologically sensitive areas that have been exposed to land degradation and the legal frameworks are new to most stakeholders and might not be easily enforced;* *Liberalization of trade (export and import liberalization)* *Transboundary issues especially on shared resources*

Strategic Investment Framework (2010-2020); the Climate Smart Agric. Program (2015 – 2025) and several other frameworks have strong components pertinent to LDN. *Global aspects (UNFCCC arrangements)* *IGAD arrangement has components of Environment and natural resource strategy* *Favorable climate* *Political will on LDN* *SDGs frameworks*	
Institutional *There are several coordination mechanisms / structures in the ENR sectors that can be leveraged e.g. existing SLM structures;* *Arrangements / plans are being made for single spine coordination of MEAs;* *Existence of the environmental police* *Existence of Para legal advisory services* *Oil and gas development and infrastructure* *Support from development partners, including UNCCD,* *Existence of Conventions to which Uganda is a signatory*	*Institutional* *Weak enforcement at all levels - National and District Local Governments / Lower levels;* *Conflicts between communities and enforcement agencies / bodies especially communities in the neighbourhood of protected areas;* *Political interference* *Access to data and information* *Oil and gas development and infrastructure* *Weak institutional response mechanisms to the adverse impacts of Climate change* *Unpredictable response or ownership of stakeholders* *Underfunded institutions*

Source: Land Degradation Neutrality Target Setting Program, 2018

Research, data, knowledge and information management

Overview

Investment in the development and dissemination of new scientific evidence and technologies is the primary driver of agricultural productivity growth. The National Agricultural Research Organization (NARO) is the country's leading public agricultural research and development (R&D) agency. The universities such as the Makerere University, Busitema University, Uganda Martyrs University, Uganda Christian University, all have priority focus on research and the science faculties and departments carry on research as a core mandate of their activities. However, the key challenge has been the weak linkage between the research system and the end-users of the outputs of research i.e. the technologies and innovations. The private sector in particular is not able to adopt the

technologies and innovations from the research system for various reasons including lack of awareness of these outputs and inability to afford them. Over the years, the institutions in the research system have been challenged to find solutions to these problems and the challenge still remains.

The sector is characterized by a weak agricultural statistics system. Available agricultural data is not regularly updated and harmonised, and the collection systems are scattered among various institutions. In that regard, data gaps in the sector include the very basic current data on crops, livestock, fisheries and forestry. Cognizant of these challenges, MAAIF established the Agricultural Sector Statistics Committee, with the mandate of providing timely and appropriate agricultural statistics service to sector stakeholders. Further, there is poor infrastructure for knowledge and information management, as well as inadequate coordination and integration. Information on weather and climate as well as disaster management, has until now mostly focused on relief and rehabilitation. This has been attributed to limited hardware (e.g. weather/climate observing infrastructure) and software (e.g. weather forecasting and analysis). In light of this, the Uganda National Meteorology Authority has established information infrastructure on weather, climate and disaster management.

Agricultural advisory services, extension and outreach in Uganda have evolved from a top-down and coercive arrangement from the early colonial period, through periods when there was no extension policy at all, then a supply-driven approach, to the present bottom-up, demand driven system. This has culminated into an integrated, coordinated and harmonized public extension system known as the *Single Spine* agricultural extension service delivery system.

Agricultural research, data, knowledge and information management

Agricultural research and innovations

A critical ingredient of agricultural led development is that of scientific research. Agricultural research has a direct benefit to commercial and subsistence farmers/ small holder farmers, as it improves production and productivity of crop farming and livestock subsector. In Uganda agricultural research is supported by Government as well as donors to generate

agricultural and climate resilient technologies for priority and strategic commodities, and promote research extension interface. Focus is mainly on three key parameters (i) Production technology generation, (ii) Research extension farmers interface through releasing new varieties for submission, and (iii) Strengthening institutional capacity through research studies under competitive grants scheme.

In spite the National Agricultural Research System (NARS) generating a significant number of technologies under its 10-year Strategic Plan (2008-2018), the majority of the smallholder farmers have not accessed or adopted these technologies. This situation is manifested in significantly wide yield gaps between the on-station and on-farm outputs. In addition, farmers continue to grapple with the effects of climate change, characterized by erratic weather patterns, which impact on agricultural production and productivity. Other constraints that have affected the performance of agricultural research in Uganda include: insufficient, delayed and non-release of funds; inadequate infrastructure; weak research-extension-farmer linkages that limit assessments of the level of adoptability of research technologies; inadequate technologies and protocols for value addition and minimum involvement of the private sector.

Research spending accounts for about 1.4% of agricultural output as compared to the SSA average of 0.5%, Kenya (1.4%), South Africa (2%) and the African Union target of 1% (Beintema and Stads, 2014). Moreover, many research projects are not geared towards solving the most urgent constraints faced by farmers. In addition, human-resource constraints are serious and growing. Nearly 20% of agricultural researchers in Uganda are over 50 years old, and only about one-third hold doctoral degrees (Beintema and Stads, 2014). A lot of agricultural research work in Uganda is supported by development partners, which is unpredictable and allocated according to donor objectives that are not necessarily consistent with those of the government or with the interests of farmers.

Agricultural data

According to the ASSP (2015), the agricultural sector is characterized by a weak agricultural statistical system. Available agricultural data in the country is mostly statistical data from past surveys and censuses and from agricultural sector agencies like UCDA and CDO among others that collect specific data for their own needs. As such, data gaps in the sector include

the very basic current data on crops, livestock and fisheries. Present data are also mainly department based, not often harmonized and collection systems are scattered among various institutions. In addition, the sector statistical system suffers from weaknesses in organisational development and management, limited human resource capacity as well as inadequate statistical production and dissemination of standards in the institutions producing this statistics. The estimation of agricultural production continues to be a challenge since it is difficult to get accurate production estimates of smallholder agriculture given the absence of a culture of farm-record keeping as well as the complexity of cropping systems.

Cognizant of these challenges, MAAIF established the Agricultural Sector Statistics Committee, which became operation during the implementation of Agriculture Sector Development Strategy and Investment Plan (DSIP) 2010-2015. It has the mandate of providing timely and appropriate agricultural statistics service to sector stakeholders. Additionally, subsector working groups (livestock, fisheries, crop and environment) were established to guide the technical implementation of the sector activities. Besides, the Statistics unit was elevated to a department level and staff increased. Statisticians have also been attached to different subsectors that include crop, livestock (where dairy lies) and fisheries. A statistical methodology for estimating production was established through the inclusion of an agriculture module in the National Population and Housing Census 2014 for construction of a master frame. Secondly, the crop cutting method, a proposed methodology for estimating production was piloted in 2015 in eastern Uganda on maize and rice production. Furthermore, the statistics division has adopted the use of global positioning system in its data collection activities. Statisticians were also trained in use of geographical information system software and use of ICT systems in statistics. An ICT unit has been formed within the statistics division headed by a senior statistician.

Overall, the agricultural statistical capacity has been strengthened with the setting up of the statistics division with more staff headed by an assistant commissioner. The statistics division has also been equipped with machinery and equipment to facilitate their work. Training of the statisticians in various areas has been conducted namely; geographical information system, industrial statistics, data processing, food balance sheet development and producer price index calculation. A national agricultural statistic databank has been

established. Tools for collecting data for the system have been developed and a database established.

Knowledge and information management

Knowledge management embodies collection, analysis, and packaging and information dissemination. Studies have shown the effectiveness of ICT in supporting agricultural knowledge and information management. In Uganda, ICT-based agricultural knowledge management has been promoted among smallholder farmers in some rural areas. For example, Communication and Information Technology for Agriculture and Rural Development (CITARD) is a community-based organization (CBO) that works to supportlocal community members to achieve sustainable development through information sharing on best agro practices and marketing, environment conservation, and clean energy (CITARD, 2016). ICTs play an important role in agricultural value chains by ensuring that farmers get information on communal marketing of their produce. A range of ICTs are used by CITARD including cellphones, radios, digital cameras, geographic information systems (GIS), cloud computing, tracking mechanisms and many more gadgets. Recognizing the important role of youth in agriculture, CITARD have set out to teach them how to search for information on the internet using the web 2.0 tools for example twitter, facebook, instagram, skype, wordpress, emails and many other applications. This is giving them the opportunity to share experiences, reach out to fellow farmers, learn new farming practices and agricultural technologies, and communicate with other farmers. Furthermore, some farmers are using the ICTs to keep records of their farms.

An important characteristic of rural farming in Uganda is the use of local/indigenous knowledge, transmitted from one generation to another. Recognizing the rapid rates at which this knowledge is becoming extinct, CITARD is making use of different ICT tools such as mobile phones, tablets, computers, social media tools and others to effectively capture, document, disseminate and store local farmers' knowledge and skills in some parts of rural Uganda thus preserving and promoting improvements and innovations to support agricultural sustainability. However, efforts targeted at knowledge and information management are characterized by fragmentation and inadequate knowledge and information management system across the country.

Some of the factors that hinder promotion of ICT-based agricultural knowledge and information management in Uganda include: lack of ICT training and capacity building programmes; inadequate rural telecentres and rural ICT access points that target farming; lack of ICT tools and applications adapted to rural conditions (e.g local language, solar-energy powered devices); and a lag in supporting extension delivery using ICTs (e-extension services) to bridge the gap of extension agents to farmer ratio.

Climate information systems (CISs)

Climate information and early warning systems provide useful inputs into the agricultural sector and assists farmers in making decisions about where, what and when to plant. Weather-related factors already form the biggest risk to agricultural productivity in Uganda now, but projecting this into an uncertain future is complex. At country level, climate predictions are affected by inadequate data and which in turn affects the accuracy of seasonal forecasts by UNMA. Thus climate projections and crop models are uncertain and make long-term decisions risky. In addition, there are challenges of inadequate capacity to down scale weather information; fragmented early warning systems; insufficient weather information flow networks and inadequate systems; and limited knowledge and capacity at household, community, district and national levels, to respond to emergencies. The need for appropriate climate information and early warning to support agriculture is thus pressing. There is also a need for innovative safety nets and insurance schemes to assist farmers deal with climate change related risks and disasters.

Despite the climate risks, information on weather and climate as well as disaster management in Uganda, has until now mostly focused on relief and rehabilitation. At present there are limited hard (e.g. weather/climate observing infrastructure and communications equipment) and soft (e.g. weather forecasting and analysis) technologies as well as human capacity to utilize these tools. This has resulted in:

- Inadequate monitoring and forecasting of climate hazards;
- Insufficient communication and restricted responses to impending climate hazards;
- Constrained planning for long-term climate changes in economic development and risk reduction efforts.

In light of this, the Uganda National Meteorology Authority and its partners has established information infrastructure on weather, climate and disaster management.

Agricultural advisory services, extension and outreach

Agricultural extension has been identified as one of the services that will play a pivotal role in realizing agricultural growth and transformation in Uganda. The role of agricultural extension has also been recognized and emphasized in all periodic national and sector development plans over the last two decades including the current National Development Plan (NDP II) (2015 /2016 - 2019/2020) and the Agricultural Sector Strategic Plan (ASSP 2015-2020). The sector strategic plan has consistently given emphasis to strengthening research and extension services, identifying and building key human resource capacity; technology adaptation and adoption at farm level including modern irrigation technologies; up scaling the transfer and utilization of food-production and labor-saving technologies for women farmers; increasing access to and use of critical farm inputs; promoting sustainable land use and soil management; nutrition and increasing access to agricultural finance with specific attention to women. Realization of all these priorities requires effectively functioning extension services. Table 37 gives a chronology of extension and advisory services in Uganda from the early colonial period up until the late 1990s.

Table 37. Chronology of extension and advisory services in Uganda from the early colonial period up until 2014.

Period	Activities	Challenges
1898-1907 (early colonial period)	Beginning of agricultural extension	Importation of cash-crop planting materials such as coffee, cotton, rubber, and tobacco. During this same period, research stations were put into place to conduct agriculture and forestry research
1920-1958	Chiefs were solicited as expatriate field officers and instructors to engage in extension work such as distributing planting materials and communicating messages on good husbandry practices and proper land use to ensure food security and to produce raw materials for British industries.	Chiefs used their status to coerce (rather than to educate) farmers, sometimes leading to negative consequences.
1956-1963	Extension through progressive farmers also called the Technology Transfer Model (Compton, 1989); technical advice and support were emphasized in form of inputs and credit to selected progressive farmers. Peer-to-peer farmer demonstrations were observed to foster agricultural production	Questionable criteria were used to select farmers, many of whom abused the special support (i.e., credit and subsidized inputs) that they received. In some instances, farmers were found to be uncooperative and unwilling to educate their colleagues. The selected progressive farmers were looked at

	and productivity.	as a privileged group by others, alienating them and rendering the initiative unproductive and unsustainable. It was a one-way communication model in which technologies/ innovations relied on the extension worker and therefore lacked continuity (feedback). Overall, this system contained an element of selfishness and created divisions among farmers.
1964-1972	During this period new extension methods were introduced that promoted two-way communication. In 1964, the United States Agency for International Development (USAID) began to provide financial assistance through the Ministry of Agriculture and the extension approach changed to helping farmers to help themselves through education. This objective was achieved by giving field tours to farmers with similar farming characteristics, fostering peer-to-peer learning and providing radios, television, posters, group farms, field trials, district farm institutes and experimental stations. This approach promoted technology development and dissemination.	Despite its achievements, this extension method was curtailed by the turmoil that befell the country starting from 1971
1972-1980	During this period, Uganda experienced political turmoil, and the country's extension services lay dormant.	Lack of an extension-services policy partly led to disorganization and low productivity.
1981-1991	This was a recovery period in extension services, with an initial emphasis on infrastructure rehabilitation and the restoration of basic services, with aspects such as institutional organization and education factored in at a later date.	The system suffered from too many uncoordinated actors, each of which took action based on its own objectives. Such implementation frameworks led to the wasteful use of resources that could have been consolidated to achieve much better results.
1990 - 2001	In 1990, as a result of the parallel approaches to extension implementation seen in the 1981-1991 period, the World Bank supported the government of Uganda (GoU) in creating a new policy on the provision of agricultural extension services in what was termed as the Unified Extension System (UES). Therefore, three ministries (i.e., Ministry of Agriculture; Ministry of Animal Industry; and Ministry of Fisheries) were merged in 1992 to create the present Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The objective of this consolidation was to increase public extension programmes' efficiency and effectiveness by eliminating duplicative efforts.	With a required extension ratio of one extension worker to 33,000 farmers; the system had too few extension workers to meet with all of the farmers. In addition, challenges such as the system's supply-driven, top-down nature, a weak management and financial control system, inadequate funding (the scope of which was limited by poor facilitation), and centralized implementation and concentration of resources at MAAIF headquarters.
Late 1990s	During this period, the provision of extension services was decentralized; i.e., both financial and administrative	Extension agents at the local government level were not adequately facilitated to provide services to farmer.

	responsibilities were transferred to local governments. The purpose of decentralization was to address issues created by the centralized nature of the UES, particularly its failure to transfer resources to local governments. However, even the decentralized UES system experienced numerous challenges, primarily budget constraints.	In addition to the inadequacy of funds, the decentralized UES was criticized for having inadequate numbers of field extension workers, limited private-sector involvement, limited access to inputs and markets, and insufficient response to farmers' needs.
2001-2013	The period from mid-2001 to mid-2014 has been marked with a shift in approach from a supply- to a demand-driven system, resulting in the creation of the National Agricultural Advisory Services (NAADS) as one of the seven pillars of the Plan for the Modernization of Agriculture. Nonetheless, the UES continued to exist alongside the NAADS programme, once again creating parallel systems.	Inadequate funding, an inconsistent flow of funds, poor accountability, limited transparency, misallocation or misappropriation of funds (especially in the procurement of inputs), Local government-based service providers' inadequate numbers and technical capacities, limited out-reach of farmers, Political interference and Deviation from the original core goal of offering advisory services to farmers as input provision.

To address the failures of the previous agricultural extension systems, the government of Uganda through MAAIF introduced the *Single Spine* agricultural extension service delivery system with the goal of realizing the required reforms. This new extension approach was adopted in June 2014 with the aim of not only streamlining the agricultural extension system but also addressing the constraints experienced by smallholder farmers. Figure 31 shows the budget allocations to agricultural extension and skills management.

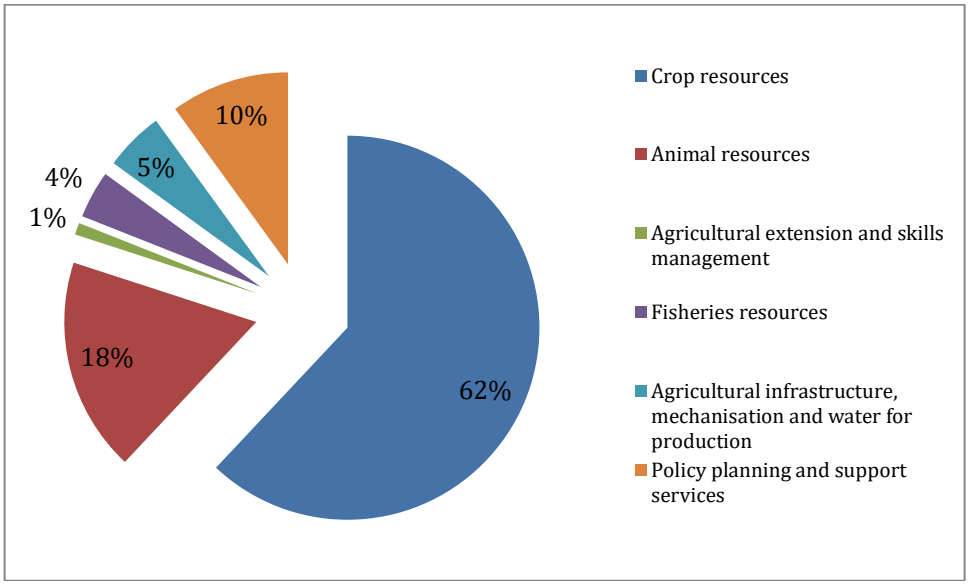


Figure 31. Budget allocations to agriculture sub-sector.

(Source: Ministerial Policy Statement FY2018/19)

Some of the emerging challenges from the Single Spine system include as analysed by BMAU (2019):

- *Lack of coordination and collaboration:* Agricultural Extension Services in Uganda are fragmented and uncoordinated due to the diverse players involved in their delivery. The key players include; the Directorate of Agricultural Extension Services, Technical Directorates, Agencies (such as: Uganda Coffee Development Authority (UCDA) and Cotton Development Organization), District Local Governments (DLGs), Private Sector Organizations and entities, among others. This fragmentation has created gaps in service delivery, duplication of efforts and conflicting messages.
- *Low coverage of extension beneficiaries and inadequate provision of extension and advisory services:* According to the Ministerial Policy Statement FY 2018/19, MAAIF has recruited 3,854 (77%) extension workers at district and sub-county levels out of the initial target of 5,000 extension workers. As a result, the current ratio of extension worker to farmer is 1:1,800 whereas the recommended is 1:500. The 5,000 extension staff were for 116 districts in FY2015/16, but districts have since increased to 128. This is an addition of 12 districts and 94 sub-counties that has led to inadequate staffing levels both at the district and sub-counties. The ability of extension staff to visit targeted communities on a regular basis is hampered severely by the limited availability of transportation, fuel and maintenance of the old transport vehicles. In FY 2018/19, MAAIF planned to procure and distribute 4,000 motorcycles to District Local Governments (DLGs), but only 1,061 motorcycles were handed over in March 2019.
- *Poor adoption of technologies and best practices*: Only 15% of technologies generated by research institutions reach the farming communities. The optimal utilization of these technologies is estimated at 28% indicating low uptake and utilization of improved technologies. Several factors significantly influence farmers' demand for extension services and the adoption of improved technologies and practices in crop, livestock and fish production. This is mainly attributed to limited access to information, low income sources and resistance to change by farmer.
- *Ineffective extension approaches:* Current extension delivery approaches are based on face-to-face contact which is unsustainable in light of the inadequate human and financial resources. This is compounded by the existence of numerous semi-skilled

extension workers that require orientation and skilling in order to effectively make use of ICTs to enhance information delivery and close the extension officer to farmer gap ratio.

- *Late release of funds:* Increase in agricultural productivity, enterprise performance and input supply efficiency are directly affected by the ability of value chain actors to access finances. Inadequate and late release of operational funds (fuel, vehicle maintenance and allowances of extension workers, demo materials for farmers, exchange visits and study tours for farmers) for agricultural extension activities has remained a big challenge.
- *Unequal access to extension services between men and women:* there are gender inequalities in accessing to the extension grant activities across the districts. Women are more involved in the dairy learning platform, while men are majorly represented in the high value commodities (groundnuts and apiary) that has a very good market.

Governance and performance measurements

Overview

Within the context of agriculture in Uganda, the presidency is the top most government structure that oversees setting of the country's strategic direction and priorities. This is followed by the Prime Ministers' Delivery Unit that leads government business in Parliament and is in charge of coordinating and implementing government policies across Ministries, Departments and other public institutions. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) has the responsibility of formulating and implementing national policies and strategies along the crop, livestock and fisheries value chains guided by the sector vision - *'A competitive, profitable and sustainable agricultural sector'.* The Ministry of Finance, Planning and Economic Development is responsible for formulating sound economic and fiscal policies and mobilization of funds for implementation of government initiatives including agriculture. To enhance engagement with the development partners and other stakeholders, the Donor Working Group and Agriculture Sector Working Group have been established, respectively. MAAIF reaches the districts and the lower local governments via the recently created National Extension Service Delivery System (Single Spine Extension Service Delivery System).

Governance of the agriculture sector

National level

Uganda has two levels of government; central and local government. The MAAIF is responsible for policy direction, sector planning, oversight, quality assurance and M&E. The local government institutions at the sub national level are responsible for implementation. The MAAIF structure consists of MAAIF headquarters and eight 'semi-autonomous' agencies. MAAIF HQ consists of four Directorates; Animal Resources; Crop Resources; Fisheries Resources; and Agricultural Extension Services (DAES) and five departments namely: Department of Human Resource Management; Department of Finance and Administration; Department of Agricultural Policy and Planning; Department of Agricultural Infrastructure, Mechanization and Water for Agricultural Production; and the National Farmers' Leadership Centre.

The agencies under MAAIF are NARO, NAADS, the Uganda Coffee Development Authority (UCDA), the Cotton Development Organization (CDO), the Dairy Development Authority (DDA), the National Genetic Resource Information Centre and Data Bank (NAGRIC&DB), and the Coordinating Office for the Control of Trypanosomiasis in Uganda (COCTU). Each of these agencies, operating at both national and sub-national levels, is responsible for the execution of approved plans and resources in their budgets. The single spine agricultural extension system is implemented using the approved structure and functions at National, District and Sub-county levels. The MAAIF structure and the linkage with the different stakeholders is shown in Figure 32. Roles and responsibilities are summarized in Table 38.

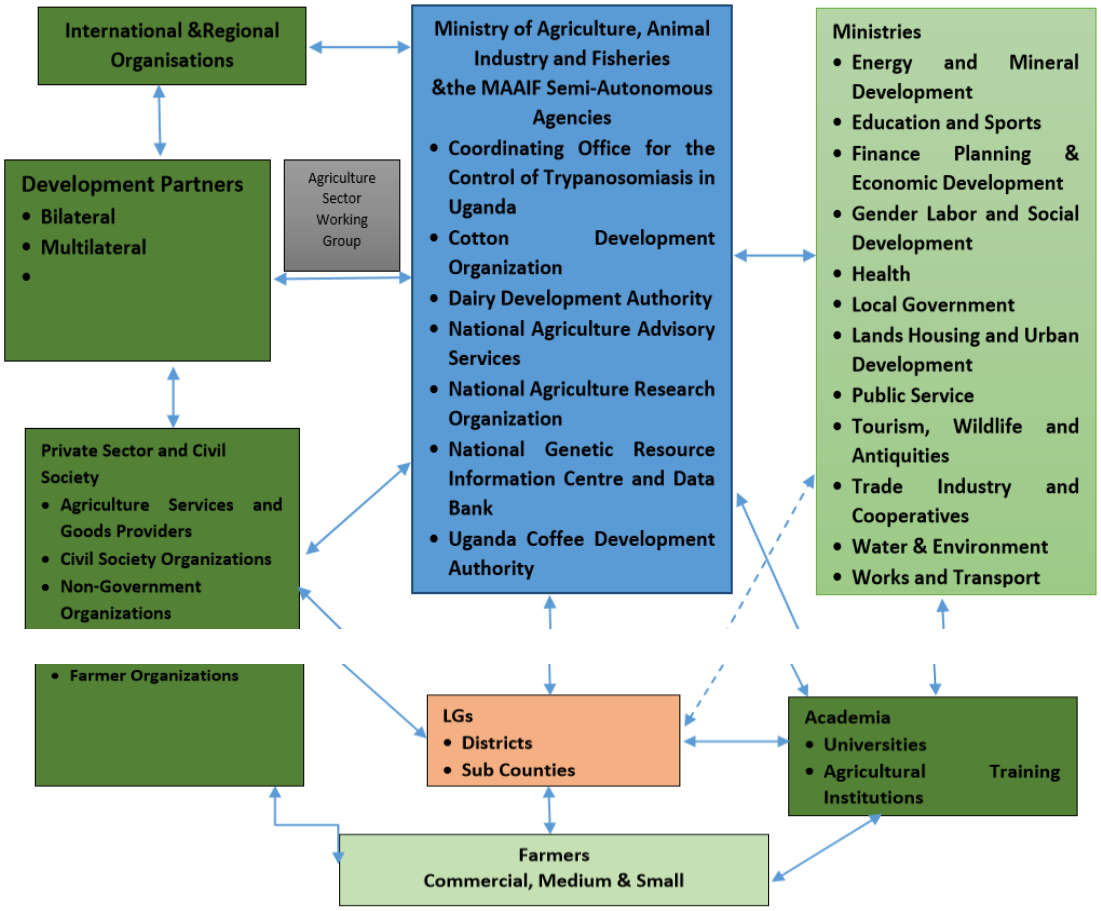


Figure 32. MAAIF Organogram.

(Source: MAAIF ASSP, 2016)

Table 38. Roles and Responsibilities of State and Non-state Actors.

Institutions	Responsibilities
MAAIF	a) Act as the lead agency in the implementation of the ASSP. b) Policy formulation, regulation and quality control; c) Establish the structure for coordinating, monitoring and evaluating ASSP; d) Develop and disseminate guidelines to operationalise the ASSP; e) Build the capacity and collaborate with other stakeholders to ensure mainstreaming of ASSP interventions in their respective programmes and plans; f) Strengthen collaboration and networking with the stakeholders to promote mutual appreciation/ understanding, guidance, involvement and community support for ASSP interventions; g) Develop the ASSP operational plans; h) Reviewing and strengthening linkages between MAAIF HQ, Agencies, ATIs and DLG production departments;

Institutions	Responsibilities
	i) Periodically review and restructure MAAIF to ensure adequate alignment with the implementation requirements of the ASSP j) Provide for the establishment of requisite approved structures and employment of personnel and ensure their effectiveness by equipping them as required
Sector Agencies	a) Strengthen the structures of the sector Agencies to enable them carry out their mandate to extend to services in line with increasing agricultural production and commercialisation.
Sector Ministries	a) Translate the ASSP into sector-specific strategies and activities; b) Collaborate with the MAAIF on matters of mainstreaming ASSP priority concerns in their respective sector interventions.
Local Governments (Production Departments)	a) Ensure that the local government development programmes are in line with objectives of increasing production and commercialisation of agriculture; b) Strengthen the structures of the LGs to enable them to effectively execute country-wide mandate to extend quality service delivery in the agricultural sector; c) Delivery of field-level agricultural services to the population. d) Monitor mainstreaming of ASSP interventions in local governments to ensure services benefit them; e) Collaborate with MAAIF on matters of increasing production and commercialisation of agriculture;
Development Partners	a) Support the implementation of the ASSP; b) Ensure consideration and alignment of ASSP priorities in development of cooperation partnerships; c) Establish appropriate institutional/ donor coordination mechanisms for ensuring responsiveness of development cooperation towards the achievement of the ASSP objectives;
Civil Society and private sector	a) Participate in Sector Working Groups and local government planning and budgeting processes to advance farm productivity b) Develop and implement programmes that address key ASSP intervention areas; c) Farm production, agro-processing and marketing of agricultural output; d) Collaborate with MAAIF and other appropriate institutions on matters of mainstreaming of increasing production and commercialisation of agriculture; e) Complement Government in delivering of agricultural services to farmers; f) Strengthen good agricultural practices (GAPs), agribusiness and market development services and governance g) Establish PPP initiatives aimed at increasing production and commercialisation of agriculture;
Academia	a) Establish collaborative partnerships with MAAIF, agencies and LGs b) Contribute to agricultural research c) Review curricula to respond to labour market needs d) Provide high quality relevant practical training
Private Sector	a) Jointly form PPPs b) Provide complimentary interventions for ASSP implementation
Farmers	a) Form farmer groups and other institutions b) Implement production and productivity enhancing interventions c) Define and articulate needs

(Source: MAAIF ASSP 2016 – Prior to implementation of Single Spine Extension Service)

Sub-national level (district/county/sub-county)

At the sub-national level, the local government system is formed by a five-tier pyramidal structure, which consists of the village (LC 1), parish (LC 2), sub-county (LC 3), county (LC 4), and district (LC 5) (Fig. 33). The district and the city are the highest local government levels, while the sub-county, municipality, municipal division, town, and city division are referred to as lower local government levels. The district technical planning committees are responsible

for collecting and integrating plans of lower local governments in order to allow for bottom-up participatory planning and budgeting. Constraints faced by non-state actors in Uganda's agriculture sector are summarized in Table 39.

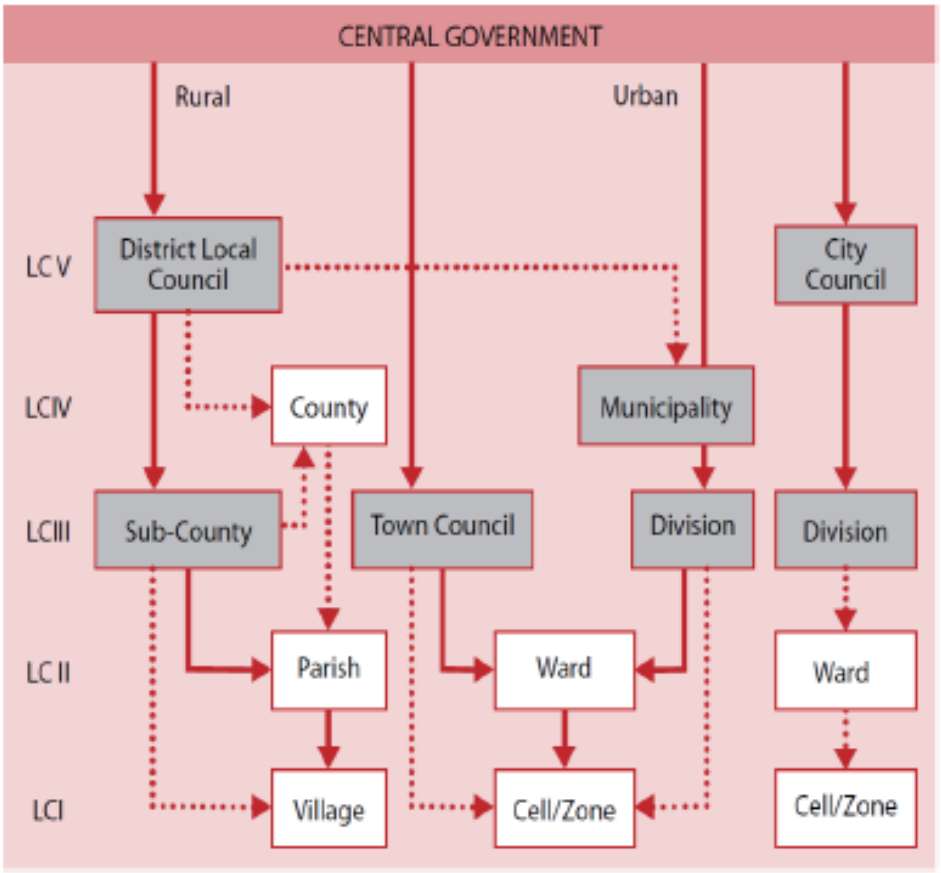


Figure 33. The local government governance structure

(Source: ACODE, 2013)

Table 39. Constraints faced by non-state actors in Uganda's agriculture sector.

Constraint	Description
Inadequate organizational and financial capacity	Nonstate actors generally have an organizational structure that includes board members or steering committees. Many small and community-based civil society organizations (CSO) do not have adequate funding for their core activities. Membership fees are small or not paid. To raise resources, they seek funding and business contracts from governmental bodies such as district local governments. These CSOs, however, also are supposed to monitor and demand accountability from local government bodies on behalf of the citizenry, so they face conflicts of interest. The private sector, especially micro-, small- and medium-size enterprises (MSMEs), face challenges of limited access to affordable business finance.
Weak governance and, hence, inadequate capacity to discharge anticipated roles	Large nonstate actors have organizational structures that include governing boards or steering committees. However, some small and local-level nonstate actors face poor governance issues that make them ineffective.
Lack of awareness about agricultural commitments and initiatives	Nonstate actors at the local level have limited capacity for research and knowledge management. They have knowledge gaps about national and international commitments, such as Comprehensive Africa Agriculture Development Program (CAADP). This information gap limits the quality of their engagement with government. Nonstate actors at the national level engage in policy formulation, have relatively stronger research and knowledge management capacities, and are thus more knowledgeable on these commitments and initiatives.
Lack of awareness about the right to contribute to planning and reviews	In some cases, especially at the local level, the knowledge of CAADP by nonstate actors remains very limited, as is their understanding of processes.
Inadequate capacity of nonstate actors to engage effectively in planning, implementation, and review processes	The capacity of nonstate actors to engage effectively in planning, implementation, and review processes in the agriculture sector is varied. Whereas national level civil society organizations and the private sector appear to have better capacity in this area, nongovernmental organizations at the local level, farmers' groups, and MSMEs still face challenges. There is a need for investments in strengthening the capacity of nonstate actors to engage more effectively in agriculture policy, planning, programming, implementation, and review processes.
Inadequate level of advocacy by nonstate actors	Not all private sector organizations are actively advocating for policy change, since this activity tends to be time consuming and is not likely to bring immediate financial gains.
Inadequate skills in conceptual and analytical thinking	The need for nonstate actors to undertake or commission studies to generate evidence to inform their contribution to agriculture policy making is growing. Many nonstate actors, however, do not have the human and financial capacities to undertake good policy analysis.
Inadequate capacity to use evidence for advocacy and policy dialogue (among the nonstate actors involved in advocacy)	Evidence-based policy advocacy is possible if nonstate actors have the capacity to support their arguments with reliable data. This capacity is always limited among small nonstate actors. It is important to increase the capacity of nonstate actors for advocacy and policy analysis in the areas of agriculture, food security, and nutrition. Some nonstate actors have the capacity to participate in government-led discussions on food security policy, because they can articulate and communicate policy positions and can provide some level of evidence-based analysis to support their viewpoints.
Poor access to information, particularly in remote areas	Nonstate actors have limited access to information on various issues, such as agriculture policies, marketing information, and regulations. This limits their ability to lobby for and participate in the design and implementation of agriculture policies.
Issues of legitimacy and representativeness of the nonstate actor organizations	Civil society and private sector members in the agriculture policy sector identified as a major gap the lack of representation on the Agriculture Sector Working Group, although they are generally involved in many other agriculture-related activities. A number of groups are working to rectify this.

(Source: Agriculture Joint Sector Review, 2015)

Performance measurements

Monitoring and Evaluation (M&E)

There is an overarching national M&E policy and M&E standards from OPM that is implemented in all ministries. The M&E framework is underpinned by the need to promote efficiency and effectiveness in service delivery to achieve results as well as transparency and accountability in the use of available resources. The MAAIF under its ASSP has developed the sector M&E system. The purpose of the system is to regularly and transparently assess the implementation of the policy, sector investments, sector performance and the welfare indicators of Ugandan households, including incomes and food and nutrition security. The M&E results are used to make necessary adjustments for better performance and improved outcomes for the sector and to feed into the national M&E. In addition, a performance Monitoring and Evaluation Framework has been developed in Uganda for the sector-specific Agriculture National Adaptation Plan (NAP-Ag) under MAAIF. The Uganda Agricultural sector NAP M&E framework is to track progress in building adaptive capacity of the agricultural sector. Indicators have been proposed against the major changes expected in resilience until 2030. It feeds into the MAAIF M&E system and the national Public Sector M&E Policy (FAO, 2019). The M&E indicators are well aligned to the SDGs and regional (AU 2063, CAADP, Malabo) indicators.

Measurement, Reporting and Verification (MRV)

Measuring, Reporting and Verification (MRV) is the term used to describe measures taken to collect data on emissions and mitigation action. MRV compiles this information in reports and inventories so that data can be reviewed and analysed. It provides a framework to quantify emissions reductions, allowing for progress on emissions-reduction commitments to be mapped. MRV systems collect information about GHG emissions, mitigation actions that allow those emissions to be reduced or avoided, and about the financial, capacity-building and technological support provided for carrying out mitigation actions and tracking incremental costs and co-benefits for sustainable development (Adapted from UNDP 2015).

Uganda's MRV is based on the requirements for domestic and international reporting (Figure 34). It is still in its infancy with many elements not yet well developed and many facets not well connected. The required data sets are available in institutions but a lot is yet to be done in terms of data collection processes, regular updates, GHG computation approaches

including quality assurance. The current system has been able to provide GHG inventories, baselines for NAMAs, REDD+ and other mitigation actions but mainly in an ad hoc manner. In many instances, axe ante emission reduction targets are stated without clear documentation of methodological approach. Apart from CDM PoA and VCS projects / programmes that follow a well-established carbon tracking system, the element of measuring and reporting mitigation and their impacts is almost none existent and is not well defined in many of the Uganda's domestic mitigation actions (MWE-FBUR, 2019). The coordination structure is elaborated in Figure 35.

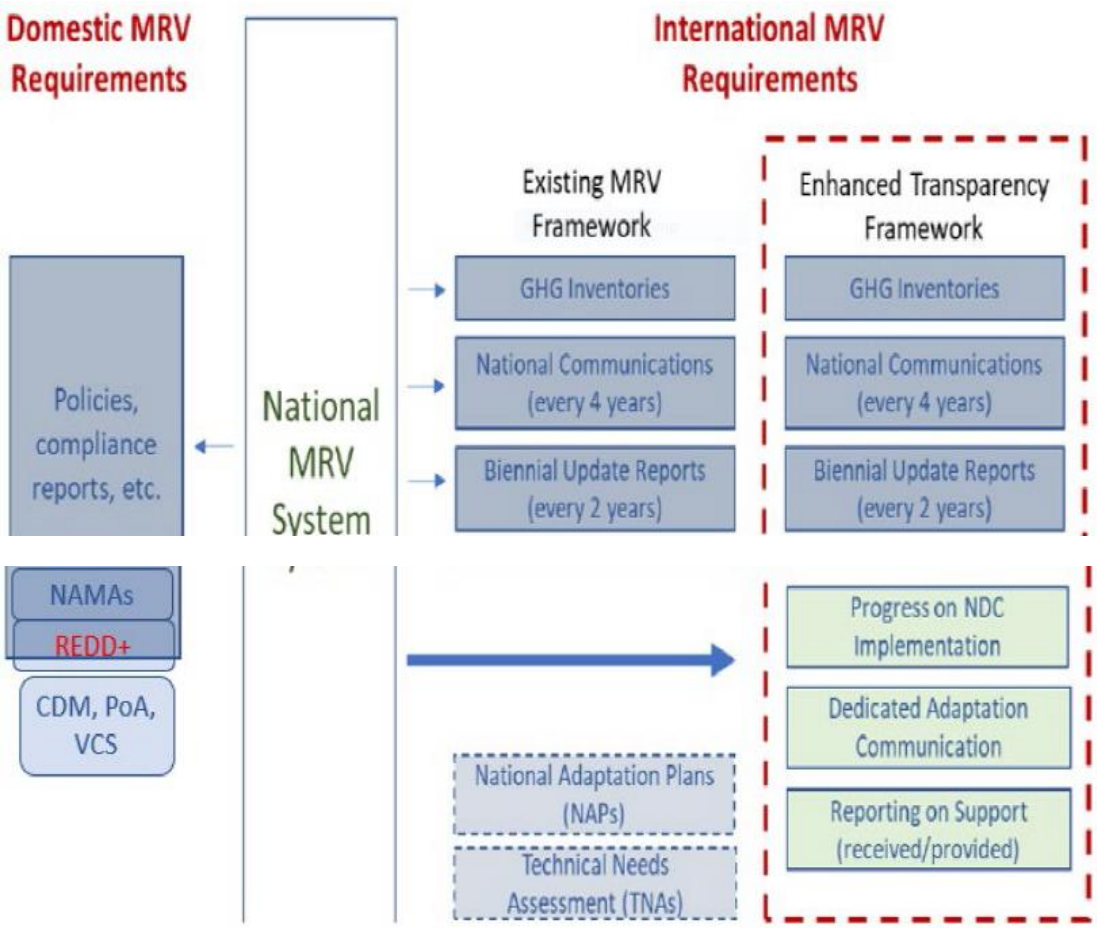


Figure 34. Domestic MRV to be anchored to the existing framework

(Source: MWE-FBRU, 2019)

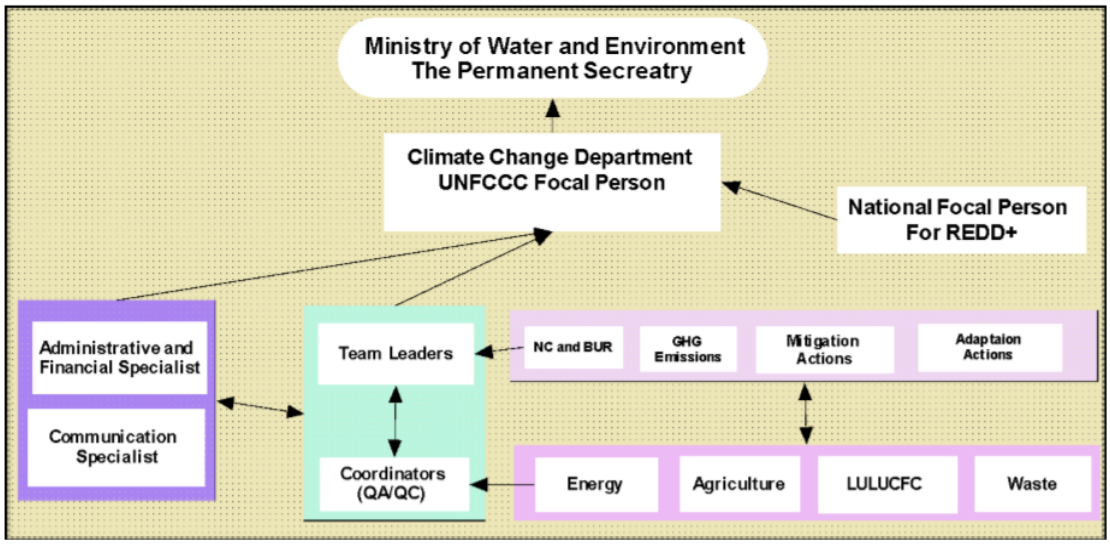


Figure 35. The proposed coordination structure of the National MRV.

(Source: MWE-FBRU, 2019)

Transformation agenda: Towards low carbon, climate resilient development

Background and context

The concept of low carbon was fronted by United Nations Framework Convention on Climate Change (UNFCCC) and subsequently adopted in Rio in 1992 requiring countries to develop national economic development plans or strategies that encompass low-emission and/or climate-resilient economic growth (OECD, IEA 2010). The concept is being referred to as the Low emissions development strategy (LEDS). Initially in 2008, the European Union (EU) tabled the proposal to introduce LEDS in order to inform the international community about the funding and priorities. The concept was then included in the UNFCCC negotiation texts and became part of the Copenhagen Accord (UNFCCC 2009) and Cancun Agreement (UNFCCC 2011). Because the concept addresses and integrates climate change with development, it received recognition and support from world leaders. In support of the concept, African countries embarked on improving adaptation actions through their Nationally Determined Commitments (NDC) (World Bank 2019a).

It is widely recognized that transition to a green economy offers new opportunities to advance the attainment of sustainable development through social inclusiveness, employment creation, rapid economic growth, planned green cities, climate resilient economic growth and environment sustainability. These outcomes are realized through targeted interventions in sectors with high green growth impacts and for Uganda as indicated in its Green Growth Development Strategy (2018) they include; energy, natural resources, sustainable transport, planned green cities and sustainable agriculture and investments in its value chains.

Uganda is ranked among the least producer of greenhouse gas emissions per capita in the world (UNDP 2015). In Uganda, GHG emissions are estimated in 36.5 million tonnes of carbon dioxide per year, accounting for about 0.01 percent of global emissions. On a per-capita basis, greenhouse gas emissions are estimated at 1.39 tonnes of carbon dioxide, far below the global per capita average of 7.99 tonnes of carbon dioxide (ASL 2050 FAO 2015). Despite this, in 2015, Uganda Government in response developed the country's climate action plan which was referred to as the Intended Nationally Determined Contribution with a commitment of reducing emissions by 22% by the year 2030. This plan intended to attain the targets through a series of policies and measures in the energy, forestry and wetland sectors and complimented by additional measures in climate smart agriculture and transport (UNDP 2015). In the same year, the Uganda National Climate Change Policy was developed with a theme: Transformation through Climate Change Mitigation and Adaptation. Other strategies leading towards low carbon commitment are contained in the several other national development plans and strategies described in Chapter 5. Under agriculture and livestock, the policy priorities the promotion of climate change adaptation strategies that enhance resilient, productive and sustainable agricultural systems.

Land degradation due to deforestation, soil erosion and continuous cropping that are common occurrence in Uganda lead to reduction in soil carbon. These environmental hazards continue to undermine efforts towards low carbon in Uganda's agricultural sector.

The Uganda Vision 2040 affirms that social economic transformation cannot be attained without paying adequate attention to climate change and the principles of green growth such as inclusive growth and low carbon emissions development. For this reason, the

Uganda Vision 2040 recommends the development of appropriate mitigation strategies on climate change at the national and sector levels to ensure that the country is cushioned against the adverse effects of climate change. Operationalization of this aspiration will therefore require formulation of development strategies that pursue economic growth and socioeconomic transformation along a low carbon development path over the vision period. In the same vein, the second National Development Plan (2015/16-2019/20) reiterates the Uganda Vision 2040 commitments national climate change response. The five year plan climate change strategy is to build a climate change resilient economy along a low emission carbon development path over the plan period.

Uganda's agricultural sector has grown slowly at an average rate of 2.5% per annum over the last five years below the population growth rate of 3.2% leading to a decline in per capita agriculture production. Its importance in the country's development process notwithstanding, the budget allocation to the sector has remained stagnant at approximately 4% over the past 5 years. The sector still accounts for the largest share of the poor; it is highly vulnerable to the impacts of climate change and bears the burden of environmental degradation. Indeed, less than 30 percent of cultivated land is under Sustainable Land Management (SLM) practices thus leading to low yields, threatening food and nutritional security as well as aggravating poverty and vulnerability. Though there have been marginal increases, agriculture productivity in Uganda is still far below optimal efficiency.

Due to the ever increasing demand for food and fibre, Uganda has to inevitably increase food production. However, according to Smith (2011), increased agricultural production normally equates to an increase in carbon emissions. In order to avoid this scenario under LCD, Uganda's agricultural sector had to adopt approaches that increase production with low carbon emissions.

The biggest contribution of carbon emissions in agriculture mainly comes from livestock and paddy rice growing. In livestock, cattle and poultry contribute over 14.2 million CO_2 tonnes eq. per year (ASL2050 FAO 2015). Most of the livestock carbon emissions come from three major sources i) emissions from feed production, processing and transportation; ii) emissions from animal production (enteric fermentation, manure management and on-farm

energy use); and iii) emissions from processing and post-farm transport of livestock commodities.

Therefore in order to reduce carbon emissions from agriculture, the following activities should be done: intensive livestock management systems using improved breed quality and improved feed, fodder and pasture quality that is more digestible; adoption of manure management practices including biogas production and utilization and use for integrated soil fertility management; adoption of minimum tillage practices on cultivated land (including organic soils); and increased use of fertilizer accompanied by precision planting techniques to enhance efficiency.

Government has made some progress towards low carbon through policy frameworks and implementing projects. The development of the National Fertilizer Policy (NFP) (EPRC 2016) was intended among others to promote intensive farming to avoid increasing production through extensification. The establishment of the fertilizer industry in Tororo is among the strategies of NFP for improving fertiliser use in Uganda. Indirectly, this approach will reduce opening up of land to expand agricultural production and indirectly enhance soil carbon. Sustainable land management (SLM) under Agricultural Technologies Advisory and Agribusiness Services (ATAAS) project, several soil and water conservation technologies and practices were implemented throughout the country. Terraces, low-till agriculture, watershed rehabilitation, agroforestry, woodlots, vegetative, small-scale irrigation, water harvesting were implemented on 11,165 ha of land across the country. About 9900 km of contour bunds and grass bunds were established (World Bank, 2019b). Uganda launched the Climate Smart Agriculture Country Program 2015-2025 (MAAIF/MWE 2015) to implement a number of technology and agricultural practices that enhance below and above ground carbon storage. In addition, several other projects have been implemented or being implemented with activities that target lowering carbon or carbon equivalent emissions. These include: Strengthening Sustainable Environment and Natural Resource Management, Climate Change Adaptation and Mitigation in Uganda project; The Low Emission Capacity Building (LECB) Project for Uganda; Improving policies and strategies for sustainable environment, natural resources and climate risk management project; Enhancing Adaptation to Climate Smart Agriculture Practices in the farming systems of Uganda; The Green Charcoal Project - Addressing Barriers to Adoption of Improved Charcoal Production Technologies and

Sustainable Land Management Practices through an Integrated Approach; SWITCH Africa Green: Promoting inclusive and sustainable economic development; Building Resilient Communities, Wetland Ecosystems and Associated Catchments in Uganda Project.

Inclusive green growth interventions in agriculture therefore presents potential opportunities for the sector to achieve NDP II targets. These interventions include; climate smart agriculture, sustainable land management practices, enhanced access to critical farm inputs, increased and more efficient mechanisation, increased access to and availability of water for production, and improving agricultural markets and value addition among others.

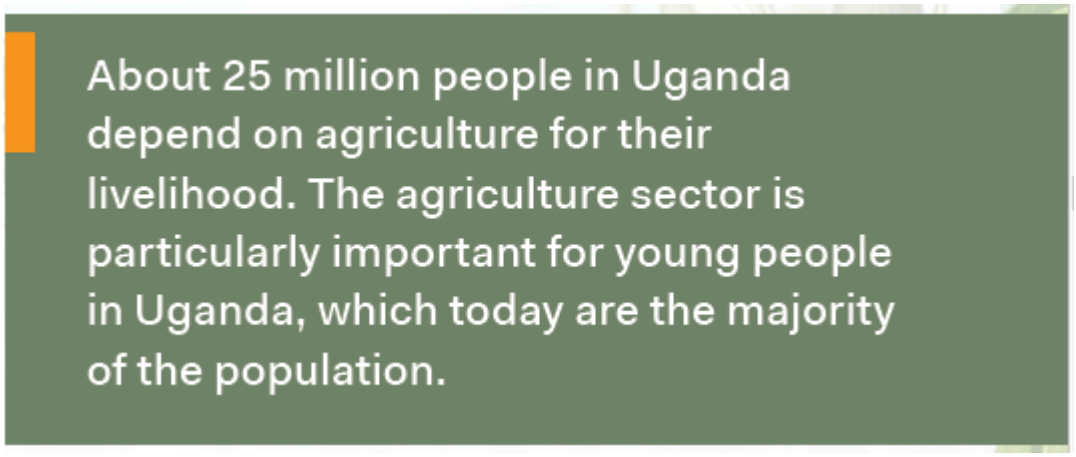
In Uganda's context, green growth is defined as a system or development paradigm that aims at catalyzing economic growth through the efficient use of the country's natural, human, and physical capital in an inclusive manner along a low carbon emission, climate resilient development pathway**.** It is important to note that the transition to green growth entails a number of trade-offs for some investments which calls for a clear understanding of where to devote policy effort and priority.

Agricultural growth potential and sources of growth

Agricultural growth potential

The agriculture sector's economic contribution extends well beyond the production sector into the wider food system, including related processing, manufacturing, and services. However, the employment potential of Uganda's agriculture and agri-food system remains largely untapped, despite providing 70% of the country's employment opportunities, contributing more than half of all exports, and about one-quarter of gross domestic product (WB, 2018).

The government has defined agriculture as a key economic sector in Uganda's transition into a middle-income country and, in this regard, has emphasized the importance of value addition, commercialization, and building resilience to climate change. Uganda's broader agri-food system also has the potential to provide significant employment opportunities for the country's predominantly young population.



(Source: World Bank, 2018)

To realize agriculture's potential, however, there is need to overcome a range of challenges in relation to agriculture productivity and vulnerability to sector-related risks. National agricultural output has grown at only about 2 percent per annum over the last five years, which is well below the population growth rate and below the 3-5 percent growth rates in other East African countries. In the medium term, the agriculture growth rate is expected to remain around 2.5%, assuming reasonable weather conditions and no army worm infestations. Both domestic and regional demand for agriculture commodities is on a rapid rise, and an increasing number of urban dwellers demand more processed food and protein-rich diets. By 2050, it is estimated that about 102 million people will live in Uganda, providing massive opportunities for the country's agriculture sector and wider agri-food system. Achieving agriculture productivity growth and resilience will require better technology, tenure security and sound land management practices, as well as the dissemination of knowledge on sustainable input use through effective extension services (World Bank, 2018).

In the NDP 3 (2020-2025) emphasis in the agriculture sector has been put on Agro-Industrialization (AGI). Given the dominance of agriculture as a source of livelihood, AGI offers a great opportunity for Uganda to embark on its long-term aspiration of increasing household incomes and improving the quality of life. This is in line with the aspiration of Agenda 2030 (SDG2, and 9), to end hunger, achieve food security, improve nutrition and promote sustainable agriculture as well as promoting inclusive and sustainable industrialization and foster innovation. SDG 8 also seeks to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Similarly, Agenda 2063 (Goal 5) aspiration is to have modern agriculture for increased production and productivity. Relatedly, the EAC Vision 2050 seeks to promote value addition through agro-processing. The AfCFTA aims to create a single market for goods and services facilitated by movement of persons in order to deepen the economic integration of the African continent. This is an opportunity for Uganda to exploit its agro-industrialization agenda in order to feed the global value chain (NDP 3).

First, AGI presents an avenue for promoting inclusive and equitable growth. Second, Uganda has a positive trade balance in agro-industrial products. Third, it provides an opportunity to add value to agricultural raw materials in order to promote export expansion of high value products. Fourth, it provides an opportunity for import substitution. Fifth, it provides an opportunity to address the high post-harvest losses, minimize losses to disasters, stabilize prices and increase household incomes. Additionally, the backward and forward linkages between agriculture and agro-industries will necessitate that Uganda sustainably transform agro-value chains to ensure sufficient supply for domestic industries to undertake transformative sustainable manufacturing while creating employment for its citizens (NDP 3, June 2020).

Sources of agricultural growth

Diverse agribusinesses, particularly along the dairy, maize, fisheries and coffee value chains, have developed in recent years, linking farmers to inputs, markets and finance, and improving rural livelihoods. To fully harness the agriculture sector's unique opportunities, the WB recommends spurring the agribusiness dynamism, and continuing to shift the agriculture sector from low-value smallholder farming towards a higher value-added agri-food sector.

To address the challenges highlighted above, the GOU has undertaken a series of policy and regulatory measures, ranging from new policies on irrigation and seeds to the setup of new agricultural finance mechanisms. These measures have, however, been insufficient, and sometimes even counterproductive. Furthermore, limited differentiation has been made between the needs of smallholder, emerging commercial and commercial farmers (WB, 2018).

Four areas for immediate attention, to spur agricultural growth, have been identified (WB, 2018):

- **Fostering sustainable agricultural total factor productivity growth.** To increase agricultural productivity, providing effective advisory (extension) services to smallholder farmers is important to enable them adapt quickly to new production technologies, regulate the markets for agricultural inputs to ensure their quality, and to help smallholder farmers to access inputs through targeted mechanisms, such as e-vouchers.
- **Promoting commercialization of agriculture, and private sector led value addition and trade.** Smallholder farmers need to be assisted to invest in agriculture as a business, meaning producing surplus for the markets, to improve their incomes and livelihoods. To achieve this, access to markets and agro-processing facilities is key through their farmer or producer organizations.
- **Building resilience to agriculture production systems and managing related risks – climate change, disease and pests.** Investing in irrigation and water harvesting technologies to combat climate variability and climate change is critical; as well as putting in place early warning systems (EWS) and emergency response mechanisms (ERM) for managing disasters, such as droughts, floods, and outbreak of pests and diseases.
- **Improving policy and regulatory environment and strengthening institutions.** To attract private investments in the agriculture sector, the government needs to create an enabling business environment. This include addressing institutional capacity gaps at the national and district level, so that they are able to provide advisory and regulatory services; and adopting policies that will enhance competitions in the input (particularly seeds and fertilizers) and output markets, as well as value addition or agro-processing.

Climate finance and investments in the agriculture sector

Overview

Uganda's Agricultural sector remains key to the National economy. The sector is majorly funded by the Government through the National annual budget. The Agricultural sector is also funded by the donor community through supplementary budgetary support as well as off-budget projects. At the same time, Uganda is among the most vulnerable countries to climate change, with limited capacity to cope. Reflected in increased frequency and intensity of extreme events such as droughts and floods, as well as unpredictable seasons, climate change adversely affects the country's Agriculture sector that is dominantly rain-fed, resulting in reduced land, crop and livestock productivity, with huge impacts on the economy. In order to cope with the impacts of climate change, GoU extends budgetary support to relevant MDAs to undertake mitigation and adaptation measures aimed at reducing climate change impacts. Similarly, the donor community extends budgetary support the Government towards her climate change adaptation and mitigation efforts. This Chapter presents a review of the status and trends in budgetary support extended by both the GoU and donor community towards the agricultural sector as well as climate change adaptation and mitigation.

Public expenditure through the national budget

Budget allocations to the sector

Despite its prominent contribution to national economic development and poverty reduction, financial resources to the Agriculture sector remain constrained. During the period of 2012/13 and 2015/16, there was a consistent increase in allocation of resources to the agriculture sector from Uganda shillings (UGX) 378.88 billion in the 2012/13 approved budget (out of the national budget of UGX 10.90 trillion) to 484.68 billion (out of the national budget of UGX 17.95 trillion. However, this represents a decline in the percentage allocation to the sector from 3.4% of the national budge in 2012/13 to 2.7% in 2015/16 (Table 40).

Table 40. Budgetary allocations to the Agriculture sector, 2012/13-2015/16.

MTEF allocations	2012/13	2013/14	2014/15	2015/16
Agriculture sector	378.88b	382.56b	473.84b	484.68b
National budget	10.90t	12.90t	14.86t	17.95t
Percentage	3.4%	3.0%	3.2%	2.7%
Projected Allocation (CAADP)	1.09t	1.2t	1.49t	1.80t
Gap between MTEF and CAADP allocations	711.12b	907.44b	1.02t	1.32t

(Source: Ministerial Policy Statements for FY 2013/14 and 2015/16)

It is clear from the above table that in all the years, the percentage allocation has been short of the Maputo / CAADP declaration of at least a 10% allocation of the national budget to the agriculture sector. It is also short of the Kyankwanzi October 2011 NRM retreat which adopted a resolution to raise MAAIF funding from the then 4.8% to 7% during FY 2012/13 and thereafter to 10% in accordance with the Maputo declaration. This amounts to a rise in the shortfall against the CAADP target from UGX 711 billion in 2012/13 to UGX 1.32 trillion in 2015/16. These shortfalls have tended to constrain the sector from achieving its objectives due to limitation of funds. According to the Joint Annual Review (JAR) of the Agricultural sector (2006) while many undertakings were implemented under PMA, most of them remained partly completed or entirely incomplete. Of the 54 undertakings agreed during the 2005 JAR, only 35 percent of them had been fully implemented, 54 percent were partially implemented, and 11 percent had not been implemented by June 2006, partly due to financial constraints (NEPAD, 2015).

Agricultural sector budget allocation

The agricultural sector is primarily funded through the national budget, with additional resources from donors in form of project support. According to (ACODE, 2015) despite emphasis on the need to increase agricultural funding in the NDP and DSIP, the sector's share of the national budget has persistently not exceeded 5 per cent for the last six financial years, including FY 2014/15, although the NDP II clearly states that one of the key drivers of the economy is agriculture. Figure 36 presents trends in allocation to the agricultural sector, while Figure 37 describes the agricultural sector resource envelope of the

total budget.

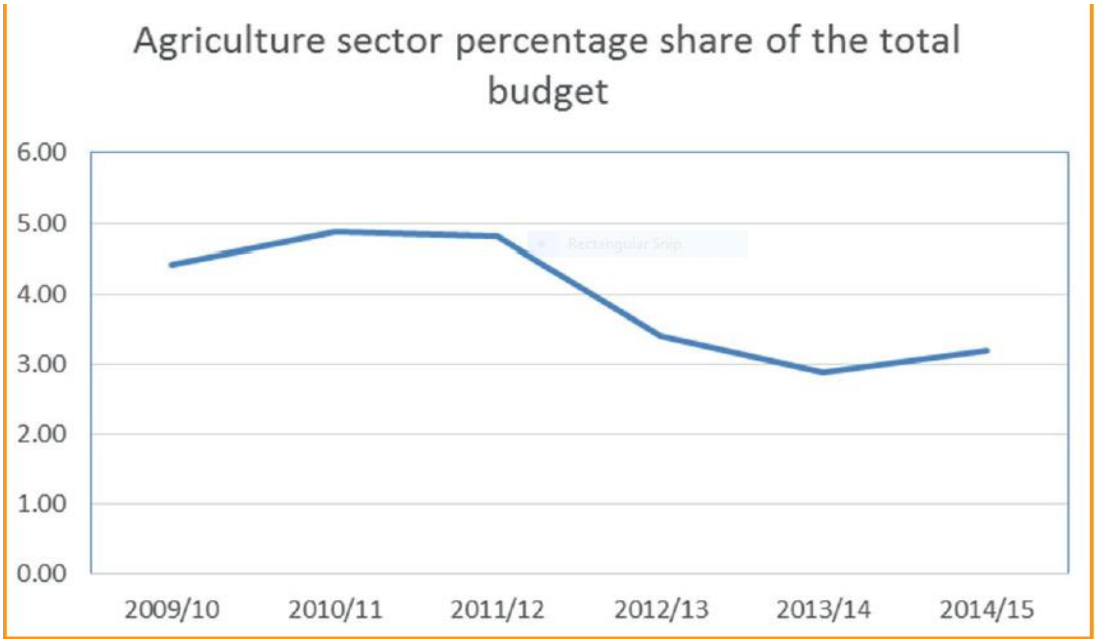


Figure 36. Trend in Allocation to Agricultural Sector and Proportional Share of Resources

(Source – ACODE, 2015. Agriculture Financing)

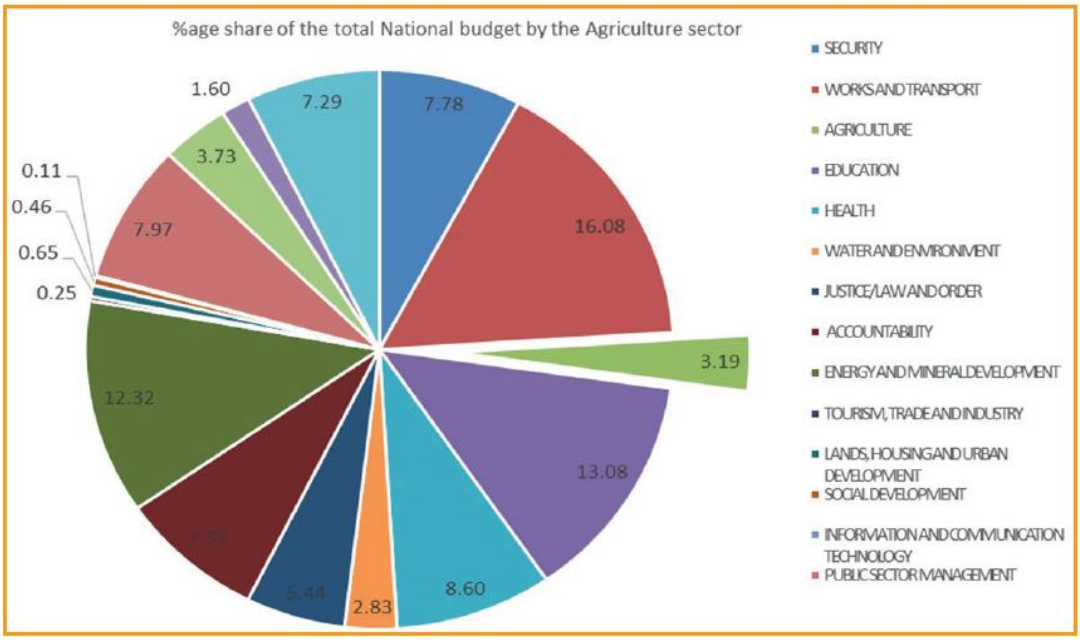


Figure 37. Share of the agricultural sector resource envelope of the total budget.

(Source- ACODE, 2015. Agriculture Financing)

Government agricultural sector funding is far less than the 10 per cent of the national budget recommended by the 2003 Maputo Declaration and the 7 per cent recommended by

NRM party Kyankwanzi Resolution (Fig. 38). Information contained in the National Budget Framework Paper (2013/14 – 2017/18) shows that the national 2014/15 Medium Term Expenditure Framework allocation to the sector (MTEF) should be UGX 14.854 trillion. This meant that the agriculture sector should have been allocated UGX. 1.4854 trillion (10% as per the CAADP/NEPAD/NRM recommendation). However, the MTEF for 2014/15 for agriculture shows a shortfall of UGX 962.54 billion for the sector (MFPED, 2013). This huge resource gap is a serious challenge because it ultimately constrains achievement of the sector's planned objectives, yet agriculture sector is important to the national growth and development.

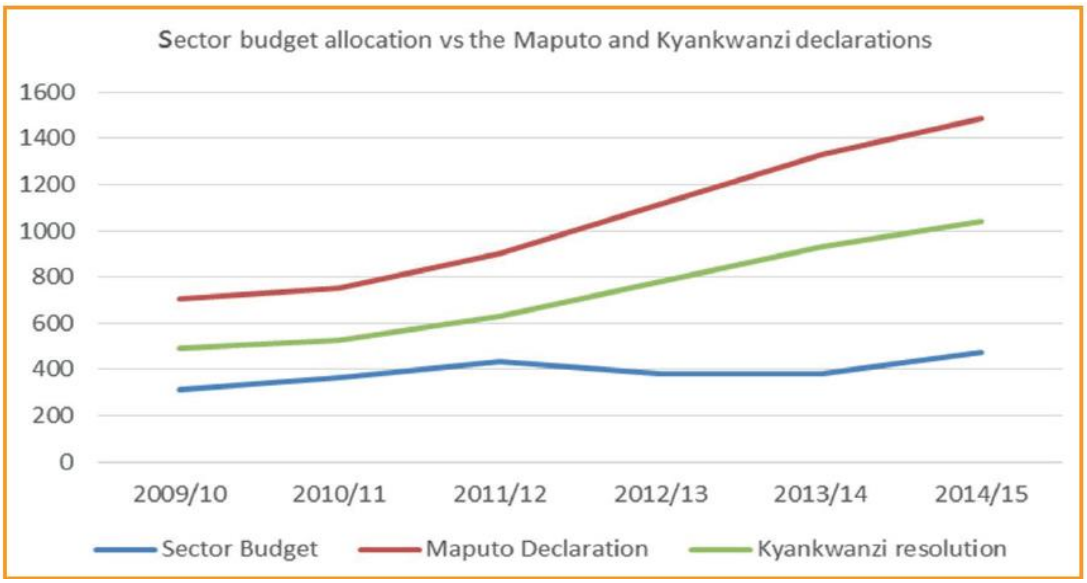


Figure 38. The Resource Gap to the Agricultural Sector versus the Declarations Made.

(Source: ACODE, 2015)

Agricultural credit facility

Government also funds the agriculture sector through the Agricultural Credit Facility (ACF) to enable farmers' access to affordable financial credit to commercialize their farms and to add value to their commodities (GoU 2010c). The government contributes USh 30 billion annually and Participating Financial Institutions (PFIs) match the GoU contribution, thereby creating a pool of annual loanable fund of USh 60 billion (GoU 2014). Through PFIs, including commercial banks, the Uganda Development Bank, micro deposit-taking institutions, and credit institutions, ACF is extended through subsidized loans to agricultural processing and mechanization projects such as: agro-processing and any other related agricultural and agro-

processing machinery and equipment; agricultural machinery; and post-harvest handling equipment and storage facilities. According to MFPED (GoU 2014a), USh 162.5 billion (or 67 percent of the released funds, including committed funds) had been expended on ACF projects by the end of June 2014. Approximately 59 percent had been invested on agro-processing machinery, 17 percent on farm infrastructure, and 14 percent on the purchase of farm equipment and machinery. Of this total, small- and medium-size enterprises (loans below UShs 200 million) comprised 58 percent.

Overseas Development Assistance (ODA) and Foreign Direct Investments

Overseas Development Assistance (ODA)

Donors supplement government funding of the agriculture sector through on-budget (i.e., aid captured in government budgets) and off-budget (i.e. not reflected in government budgets) project aid. According to the OECD (OECD Statistics (database), http://stats.oecd.org) during the period 2010 to 2013, on average donors committed US$ 107 million annually through the off-budget compared to US$ 57 million through the on-budget modality. However, over 100 percent of on-budget commitments were disbursed during 2010-13 compared to only 39 percent of off-budget commitments, showing that on-budget funding is more predictable than off-budget funding. Low disbursement of off-budget projects is attributed to (i) inadequate and untimely release of GoU counterpart funds, (ii) low absorption capacity, and (iii) procurement delays caused by complex donor procurement procedures (GoU, 2012e). The main donors in the agriculture sector over the period 2010–13 were: USA, World Bank, African Development Bank, European Union institutions, International Fund for Agricultural Development, and Japan. Figure 39 shows the total commitments to Uganda's agricultural sector by major donors during 2010 to 2013.

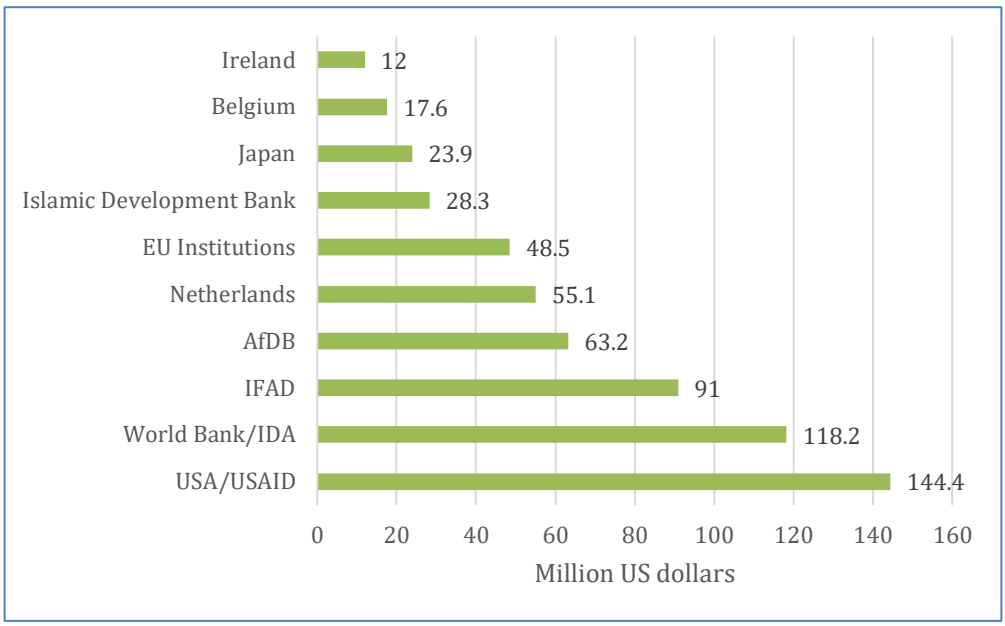


Figure 39. Total contribution by donors to Uganda's Agriculture sector, 2010 to 2013

(Source: OECD Statistics (database), http://stats.oecd.org)

According to (MoFPED (2019), Uganda Development Bank (UDB) received US$ 5m (UGX 19 billion) from EXIM bank of India in 2019 to support agri-business value chains. Secondly, Government through NSSF in collaboration with EU launched the PCP Uganda €12 million fund to invest in Small and Growing Agribusinesses (SGAs) positioned in agricultural supply chains in Uganda, the Yield Uganda Investment Fund. NSSF Uganda provided €2 million and European Union €10 million. Furthermore, between 2008 and 2018, Uganda received US $ 605 million from the UK to support Agricultural development in the Agriculture, Forestry, Fishing sectors (https://aid-atlas.org/profile/all/africa-all-sub-saharan-africa/climate-change-total/2002-2018?valueType=usd_commitment).

Foreign Direct Investments

FDI refers to inflow of foreign capital and in the form of investment that earns interest in enterprises where it is used. The foreign companies invest substantially in developing and emerging countries for profit. FDI inflow increases with success stories. Investors are drawn to a particular country that is already growing, is politically stable and has a sizeable purchasing power or a burgeoning middle class. Examples of FDIs in Uganda include: agro-processing factories like BIDCO, Fish Processors, etc. FDI flows to Uganda reached a record high of USD 1.3 billion in 2019, a 20% increase from USD 1 billion in 2018 (Fig. 40). Most FDI into Uganda has been directed towards telecommunications, real estate, banking, insurance,

petroleum sector, energy, mining and agro-export sectors. The Government has continued to promote foreign investment through the Uganda Investment Authority, the Presidential Investors Round Table and by minimising macroeconomic policy shifts, which make doing business in Uganda predictable. Kenya, Germany and Belgium are the country's main investors.

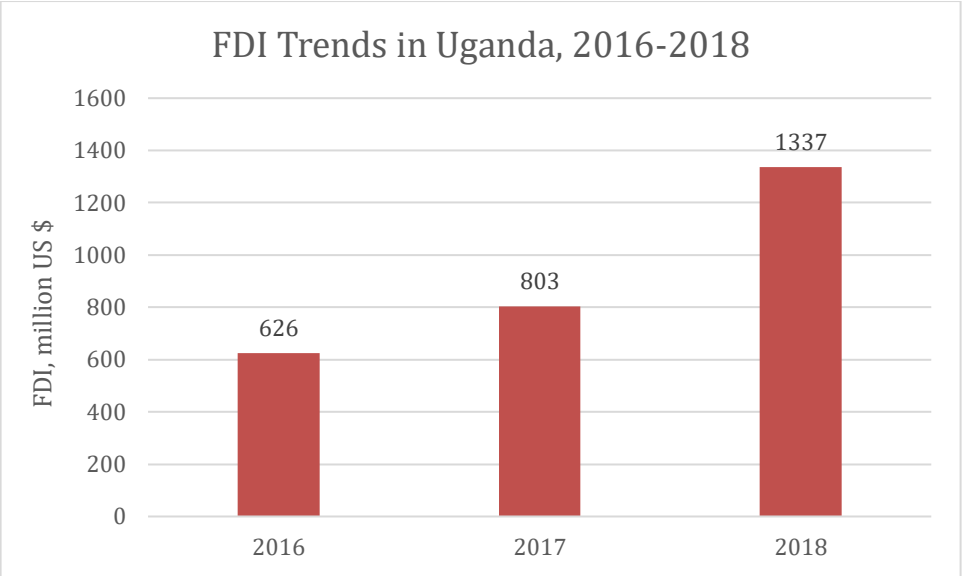


Figure 40. Trends in Uganda's Foreign Direct Investments, 2016 to 2018.

(Source: UNCTAD, 2019)

Private sector investments

The Private Sector is a major stakeholder for implementing climate change actions. According to NEPAD (2015) many small and community-based civil society organizations (CSO) do not have adequate funding for their core activities. Currently, the involvement of the private sector in climate change response in Uganda is still low and mostly self-driven. An example is the Victoria Seeds Ltd, a private company contributing to farmers' resilience to climate change by providing early-maturing seed varieties to farmers. Kayonza Tea Growers Factory has made a deliberate effort to develop a climate change strategy for the company, outlining the use of clean technologies and promoting tree planting activities.

Climate finance

Climate finance is the aggregate of local, national or international financing channelled towards responses to climate change (public and private sources of financing). Between 2008/9 to 2011/12, Government spent an estimated Ug Shs. 233 billion on climate change-

relevant activities (Table 41). This was geared to support mainly mitigation measures in the ministries of Agriculture, Animal Industry & Fisheries, Water and Environment, the Office of the Prime Minister, the Ministry of Works and Transport, the Ministry of Energy and Mineral Development. According to CSBAG (2019), climate change related expenditures from Uganda's national budget constitute about 1% of GDP (less than 1.6% what the implementation strategy of the 2015 National Climate Change Policy recommends) and is heavily biased towards adaptation activities. This amount is too low to meet the national climate change challenge. The total cost in the adaptation priority sectors is estimated at around USD 2.4 billion over the next 15 years (MWE, 2015).

Table 41. Climate change-related expenditure as a share of Government Expenditure

	Total Govt Expenditure	Total Climate change-related Expenditure	% of Govt Expenditure	Climate change expenditure as % of GDP
FY	Billion Shs	Billion Shs	Billion Shs	%
2008/09	3901	41.5	1.06	0.14
2009/10	5443	53.6	0.98	0.15
2010/11	8213	66.5	0.81	0.17
2011/12	8251	71.8	0.87	0.15

International initiatives

Global climate change finance is essential to Uganda since about 70% of additional financial resources required for full implementation of the Nationally Determined Commitments (NDCs), is highly dependent on external support (NDC, 2015). Between 2000 and 2012, Uganda received a total of US $ 264 million in adaptation finance, mainly from European countries, USA and EU Institutions (CSBAG, 2019). Over time, there has been an increase of public, private, bilateral and multilateral sources of funding for climate finance. According to CARE (2020), a total of 701 climate-related projects were committed to Uganda during 2013-2017, with the related total climate commitments summing to 1 billion USD. Climate finance was predominantly provided by five donors: Germany (15%), Denmark (11%), EU institutions (11%, excluding the European Investment Bank), UK (11%) and the African Development Bank (AfDB, 10%) (Fig. 41). Out of the USD 1 billion received, USD 476 million (48%) was committed for adaptation while 519 million (52%), was for mitigation projects. Cross-cutting

finance accounted for 30% of total climate-related finance. It is estimated that from GEF alone, Uganda has received of over USD 100 Million in grants since 2005, with the co-financing proportion estimated to be over USD 700 million (MWE, 2019).

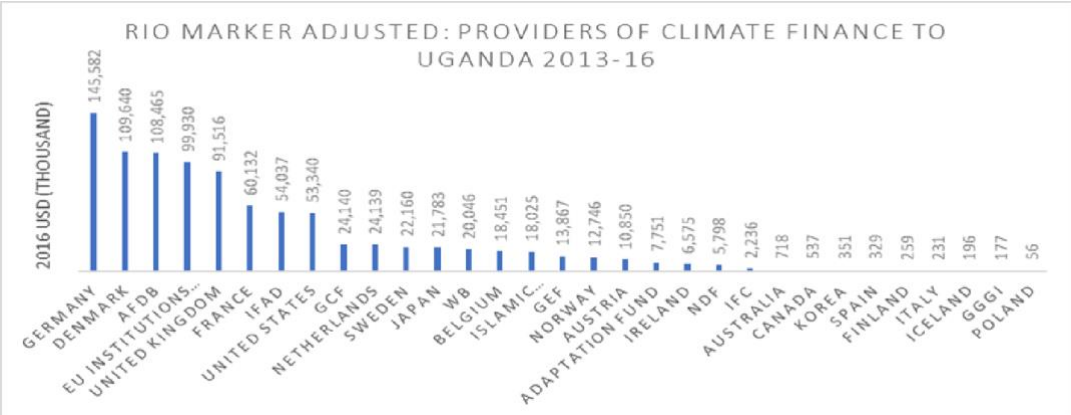


Figure 41. Providers of climate finance to Uganda.

(Source: OECD DAC development finance statistics database)

Multilateral sources

Green Climate Fund (GCF)

The GCF was established in 2010 as an operating entity of the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC). It became operational in 2015. The main objective of the GCF is to promote a paradigm shift towards low-emission and climate-resilient development pathways in developing countries. It works through Accredited Entities that include private or public, non-governmental, sub-national, national, regional or international institutions, to channel its resources to projects and programmes. The GCF has a target of providing US$ 100 billion annually from 2020 to support mitigation and adaptation in response to climate change. So far, about 7 projects are supported by the GCF in Uganda such as Acumen Resilient Agriculture Fund, Building Resilient Communities, Wetland ecosystems and Associated Catchments, bringing the total GCF financing to the tune of $369 million (Fig. 42). The GCF is also supporting one Readiness Activity with an approved readiness support of $701,000 of which $418,800 has been disbursed.

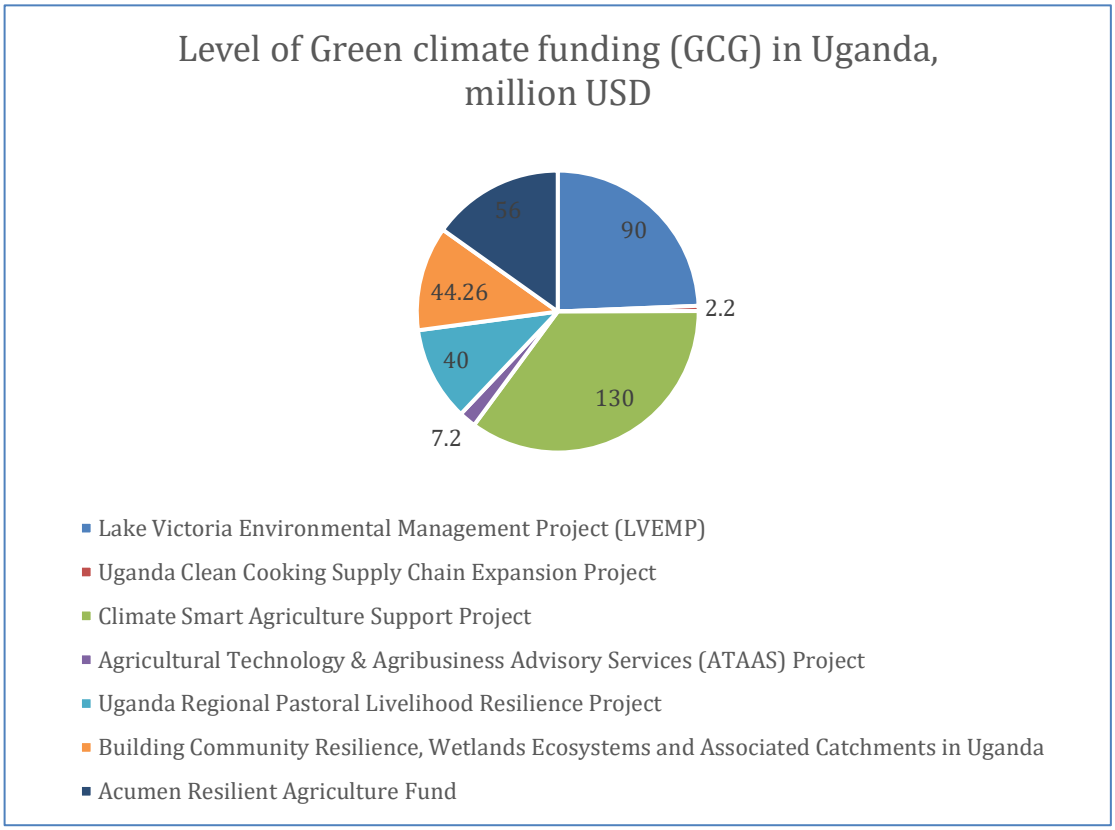


Figure 42. Level of Green climate funding received in Uganda through different projects.

(Source: OECD Statistics (database) http://Stats.oecd.org)

Global Environment Facility (GEF)

The GEF is a multi-donor trust fund which finances actions to address critical threats to the global environment. It provides grants and some concessional funding to cover the "incremental" or additional costs associated with transforming a project with national benefits into one with global environmental benefits. Developing countries and countries with economies in transition which have ratified the major Multilateral Environmental Agreements (MEAs) that the GEF serves can access the funding. NGOs, research institutions and others can be project partners or can apply for small grants. The GEF administers several funds, including the GEF Trust Fund (TF), the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). The GEF TF funds activities within five Focal Areas: biodiversity, climate change mitigation, chemicals and waste, land degradation, international waters. The LDCF and SCCF finance climate adaptation activities. Projects must: be consistent with national priorities and programs; be relevant to one or more GEF focal areas, its operational strategy and the environment; and be endorsed by the country GEF Focal

Point. Limited resources are available per country or by focal area. Since 2000, the GEF has supported 43 National climate-related projects in Uganda, implemented through UNEP (14 projects), UNDP (14 projects), The World Bank (9 projects), FAO (1 project), UNIDO (2 projects), Conservation international (1 project) and African Development Bank (2 projects), with an estimated US $ 138.8 million in Grants. This is in addition to regional and international projects. Total GEF funds implemented by the World Bank amount to over US $ 51 million (Figure 43). (http://www.thegef.org).

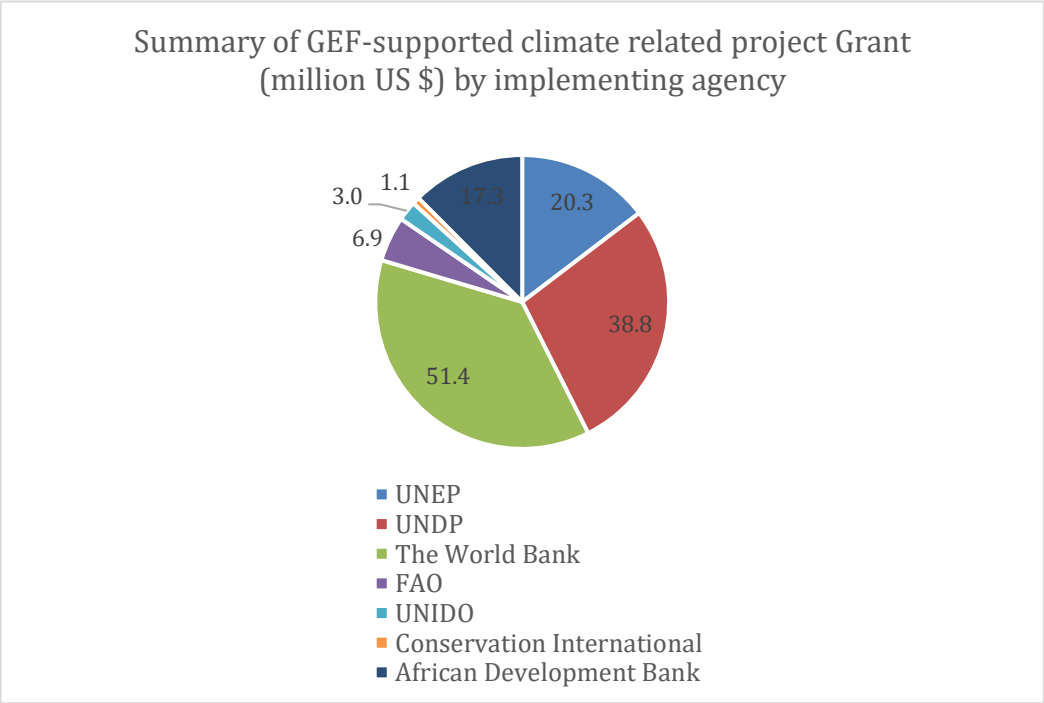


Figure 43. Summary of GEF-supported climate project grants (million US $) implemented through different Agencies, 2000 to 2020.

(Source: http://www.thegef.org)

Adaptation Fund

The Adaptation Fund aims at developing countries building capacity to adapt to the negative impacts of climate change and decrease their level of vulnerability to these effects. The fund finances projects and programmes which seek to implement concrete adaptation interventions to the effects of climate change. Uganda has received US 68.8 million in adaptation funds through multi-national projects. The projects include: Abaro fund-Sustainable forestry fund (with 7 countries participating), Climate investor one project (11 countries), Transforming financial systems for climate (17 countries), Acumen Resilient

Agriculture Fund (2 countries) and the Universal Green Energy Access (covering 7 countries). Figure 44 presents the total monetary value for each of these six projects.

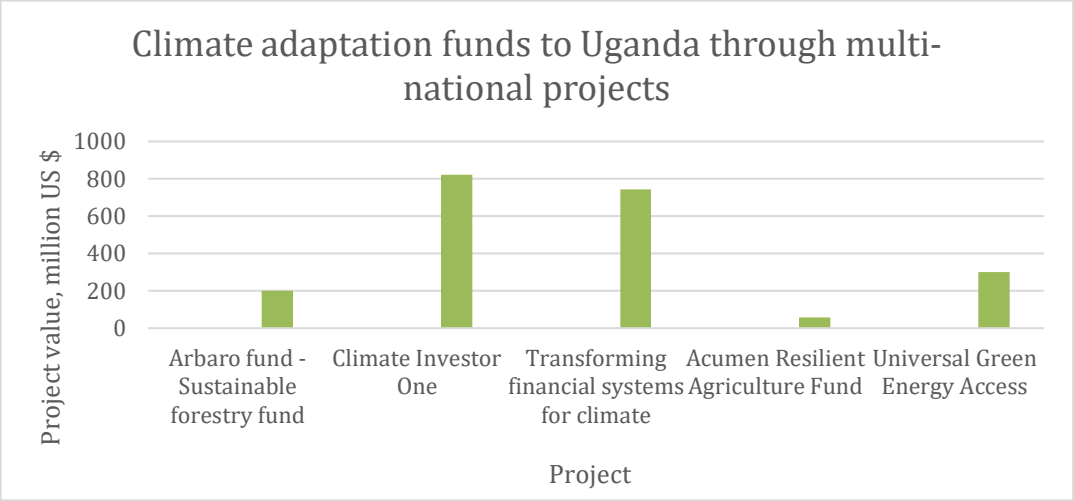


Figure 44. Climate adaptation funds to Uganda through multi-national projects.

(Source; https://www.greenclimate.fund/project/fp034)

Other global financing initiatives

Other funds include:

- Climate Investment Fund of the World Bank. Uganda has also benefitted from the **CIF**, IBRD/World Bank and African Development Bank towards preparation of the Forest Investment Program (FIP). https://www.climateinvestmentfunds.org/sites/cif_enc/files/meeting-documents/fip_-_final_doc_-version_3rd_may.pdf
- Global Energy Efficiency and Renewable Energy Fund (GEEREF), which leverages public sector funds to catalyse private sector investment into clean energy projects.
- **Clean Technology Fund (CTF).** The CTFd provides new large-scale financial resources to invest in clean technology projects in developing countries, which contribute to the demonstration, deployment, and transfer of low-carbon technologies with a significant potential for long-term greenhouse gas emissions savings.

Multilateral Development Banks (MDBs)

World Bank

During the period 2008 to May 2020, the World Bank supported over 60 National projects targeting climate-related interventions amounting to over US $ 19 billion. This is in addition to the regional and international projects supported by the Bank. For the sake of this presentation, these have been divided into ten broad categories: Energy & mineral development (16 projects), Transport (5 projects), Environment/ watershed management (8 projects), Capacity building projects (9), Poverty Alleviation (9), Urban development (2), Social development (5), Agriculture (3) and Health & Nutrition (4). Table 42 clearly shows that over 80% of the directly funded National projects have gone into supporting the energy sector, with other sectors receiving between less than 1 to 3.5%. It is also worth pointing out that the greater part of this budget (US $ 15,177 million) went into supporting the Uganda Energy Rural Transformation III project. Approved in 2016, when this mega project is excluded from the analysis then the transport sector dominates the World Bank supported National projects, followed by Environment/Watershed management, then Social development categories, valued at over 500 million US dollars. Poverty alleviation, then energy categories consumed over US $ 400 million (Figure 45).

Table 42. Nature of climate-related National projects supported by the World Bank in Uganda, 2008 to 2020.

Category	No. of projects	Monetary value, million US $	% of WB support per category
Energy & mineral development	16	15,749.81	82.63
Transport	5	658.45	3.45
Environment/Watershed Management	8	594.36	3.12
Capacity building	9	505.49	2.65
Poverty Alleviation	9	401.08	2.10
Urban development	2	362.08	1.90
Social development	5	319.46	1.68
Agriculture	3	296.67	1.56
Health & Nutrition	4	173.94	0.91
Totals	61	19061.34	100.00

(Source: https://projects.worldbank.org/en/projects-operations/projects-list)

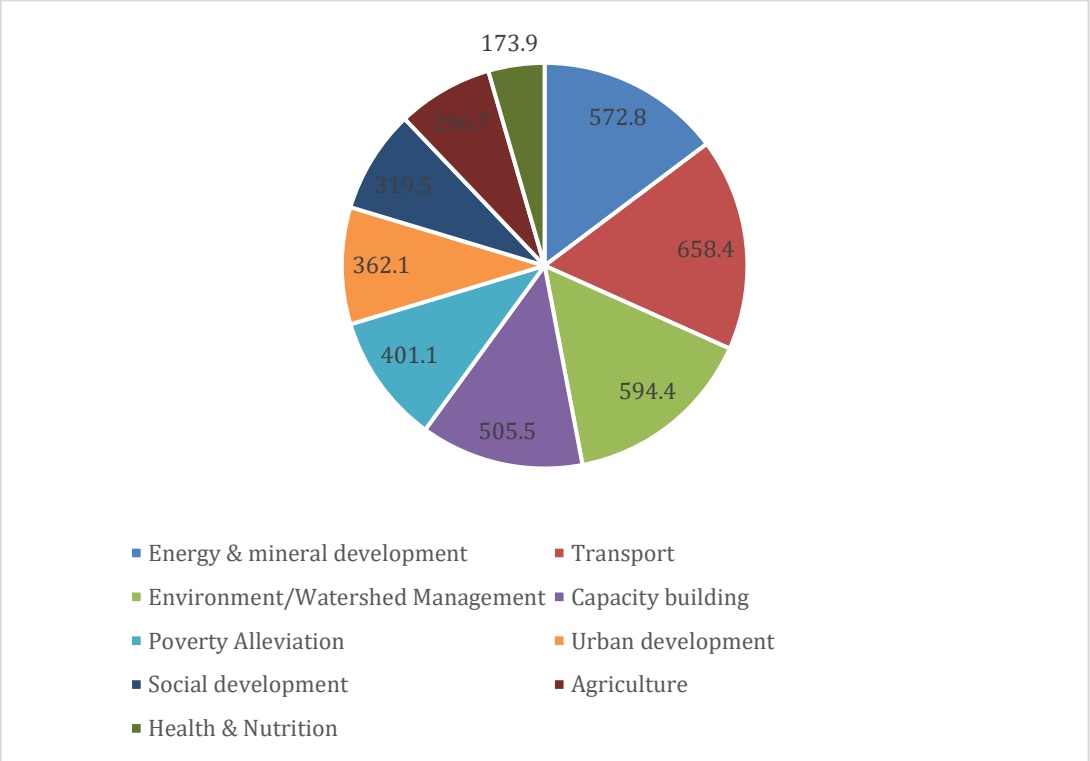


Figure 45. Monetary value (million US $) of different categories of National projects supported by the World Bank, 2008 to 2018 (excluding the Uganda Energy Rural Transformation III project).

(Source: https://projects.worldbank.org/en/projects-operations/projects-list)

African Development Bank

Since 2000, the African Development Bank has supported 19 National projects amounting to US $ 657 million to support climate-related activities. The projects fall into 7 broad categories: Water & Sanitation, Power generation, Agriculture, Road infrastructure, Education, Health, and climate resilience. This is in addition to related regional and international projects. Table 43 shows that the bigger share (36.3%) of the AfDB budget towards climate finance in Uganda has gone in the Water & Sanitation sector, 14.8% in Agriculture, and 13.8 in power generation.

Table 43. Nature of climate-related National projects supported by African Development Bank in Uganda, 2000 to 2018.

Project Category	No. of projects	Monetary value, million US $	% of AfDB support per category
Water & Sanitation	8	238.29	36.27
Power generation	4	90.41	13.76
Agriculture	2	97.00	14.76

Roads	1	72.94	11.10
Education	1	67.00	10.20
Health	1	46.00	7.00
Climate resilience	2	45.38	6.91
Totals	19	657.02	100.0

(Source: https://www.greenclimate.fund/ae/afdb/projects-and-operations)

Bilateral arrangements

Bilateral financing entails climate change financing based on a partnership between two governments. These loans assist recipient countries to meet their budgetary obligations. Figure 46 shows that in 2017, Uganda's bilateral loan with UK was highest (180.66 million US $) followed by EU (150.82), Germany (64.24), USA (46.43) and Denmark (46.41). Uganda also has other bilateral loan agreements with other countries.

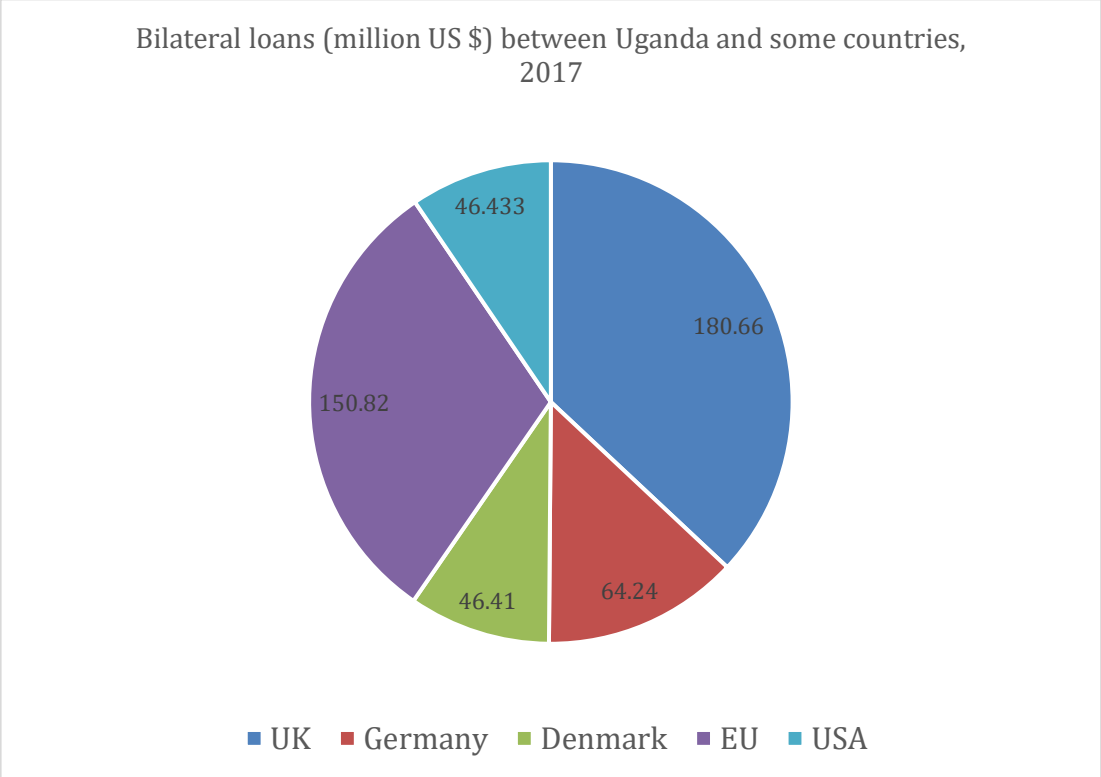


Figure 46. Uganda's bilateral loan agreements with selected countries during 2017.

(Data for USA is for 2018).

(Source: https://www.indexmundi.com/facts/uganda/net-bilateral-aid-flows-from-dac-donors)

Conclusions and recommendations

Conclusions

This situational analysis assessed the current status and trends of the agriculture sector in Uganda and identified opportunities to transform the sector towards a low carbon and climate resilient development pathway. The situation analysis of the agriculture sector intended to establish the baseline from which the LTS will be defined and this is in furtherance to the MAAIF work on its agricultural LTS/NDCs.

The findings show that trends in agricultural productivity in the country, in the last twenty years (2000-2020) have a mixed picture in that although there has been progress in increasing the yields of crops such as maize, rice, millet, simsim, cassava and sweet potatoes, the yields of crops such as, cotton, coffee and bananas have been declining in recent years. The low crop productivity and low returns are tied to climate related impacts (droughts, floods, rainfall variability), poor quality agro-inputs, diminishing soil fertility, poor land management and agronomic practices, disease and pests, coupled with high harvest and post-harvest losses. In the landscapes land degradation is a major impediment to agriculture, natural resources productivity and sustainable national economic development. Around 36% of Uganda is affected by severe land degradation and 10% by very severe land degradation. These land degradation zones experience a myriad of climate related pressures and risks, coupled with other human pressures, like deforestation, wetland encroachment, etc. Climate change related impacts (droughts, excessive rain, landslides etc.) have exacerbated the situation.

Trends in livestock, in the twenty year period, show an increase in livestock numbers and products across all types (cattle, sheep, goats, and poultry, among others), however, productivity per unit is overall, declining and domestic and regional demand surpasses the supply. Fish statistics generally indicate a gradual decline in fish stocks within Uganda's lakes attributed mainly to overfishing and interference with fish breeding grounds particularly the wetlands. Capture fisheries can no longer meet East Africa's fish needs, whether for local consumption or export. The gap between the supply and demand of fish is likely to widen if aquaculture programmes are not strengthened i.e. if the industry is not transformed.

Important to note that several policies have been enacted in the country, and particularly on climate change adaptation in Uganda. However, despite the progress so far made towards building governance systems for climate change adaptation the enforcement of policies and regulation still limits positive responses at different levels. Various reasons constrain enforcement; policies are formulated through top–down approaches, NGOs and local governments are minimally involved while local communities are largely excluded (Ampairwe et al., 2015). In addition, unclear roles among actors, weak links between different administration levels, limited human and financial resources and political interference also contribute to weak enforcement of policies and regulations. The linkages between government ministries, departments and other actors still need to be strengthened and structured.

It is also important to note that the effects of climate change have led to changes in gender roles, consequently making some men and women take on non-traditionally prescribed roles. These include women's engagement in income generating activities to provide for their families and men's involvement in fetching water from distant places during the dry season for domestic use.

Recommendations

Crops

- 1. Promote and encourage highly adaptive and productive crop varieties and cultivars in drought prone, flood-prone and rain-fed crop farming systems
- 2. Promote and scale up CSA and ecologically compatible cropping systems to increase resilience to the impacts of climate change.
- 3. Strengthen research into climate smart and sustainable agricultural practices, including dissemination of good practices;
- 4. Promote irrigated agriculture by encouraging irrigation systems that use water sustainably
- 5. Promote and encourage agricultural diversification, and improved post-harvest handling, storage and value addition in order to mitigate rising climate related losses and to improve food security and household incomes.

- 6. Support community-based adaptation strategies through expanded extension services and improved systems forconveying timely climate information to rural populations for enhanced climate resilience of agricultural systems

Livestock

- Promote more productive livestock production systems through adoption of higher yielding breeds, intensive management systems, improved availability of quality animal feeds (establish fodder grasses and legumes), better animal health (regular vaccination), pest and disease management, and intensive husbandry practices (zero grazing) systems to minimize GHG emission and better resilience against climate induced stress.
- Promote and encourage highly adaptive and productive livestock breeds
- Promote sustainable management of rangelands and pastures through integrated rangeland management
- Climate change impacts could partly be mitigated by keeping larger stocks of fodder and feeds, and developing water-harvesting and storage facilities.
- There is great potential for use of concentrate feeds in Uganda. To enhance this, there is a need to put in place the necessary technical, policy and institutional structures to ensure access to and high quality of affordable feed concentrates.
- Improve marketing of livestock products at all levels, from the farmer through transporters, processors so as to meet the quantity, quality and timeliness demanded by the different market niches.
- Closer partnerships and coordination among different players in the value chain is crucial, for example, veterinary service providers must be available at all times, offer vaccination services before disease outbreaks, provide farmers with the right drugs, and advise on appropriate technologies where needed.
- Organise dairy and beef value chain actors into cooperatives for better coordination, collective action, access to finance and a stronger voice for their cause.
- For improvement in sales for live animals, there is a need introduce livestock weighbridges.

- Farmers need a strong service sector which delivers reliable, affordable, relevant and quality services (e.g. Artificial Insemination services must be readily available). Secondly financial institutions (e.g. banks) develop a specific product for dairy.

Fisheries

- Promote recovery of depleted stocks of the large commercial fishes;
- Promote commercial aquaculture
- Develop infrastructure along the value chain;
- Strengthen monitoring and enforcement on all water bodies;
- Control invasive weeds
- In order to promote adaptation at the beginning of the fish value chain, support is needed to ensure physical capital is insured against extreme weather events.
- Strengthen livelihood diversification support for fishing communities to promote adaptability of the entire sector to climate change and variability
- Promote public and private research into seed and alternative feeds for aquaculture;
- Promote and encourage climate change resilient fishing practices;
- Promote and encourage collaborative and participatory management of aquatic ecosystems;
- Promote awareness of the climate change–related impacts on fisheries amongst the various stakeholders, such as local communities, resource managers and policy makers;
- Provide economic incentives to diversify livelihood options in order to reduce dependence on climate-sensitive fisheries resources;
- Promote selective breeding for reduced susceptibility to diseases associated with stress and shifting temperatures (aquaculture);
- Address the non-climate related drivers of change that hinder successful fish production;
- Support fishers' advocacy and safety, and develop and disseminate post-harvest handling technologies
- Improve and strengthen trans-boundary cooperation regarding fisheries and aquatic ecosystems

Landscapes/Agroforestry and land resources

- Identify and map the GHG emission hotspot landscapes
- Promote both below and above ground carbon sequestration. However, the current soil maps are still coarse. There is therefore need develop high resolution soil maps and determine thesoils sequestration potential in order to support adaptation and mitigation efforts.
- Monitor and control soil, runoff and nutrient losses from different ecosystem through promotion of efficient SLM
- Promote the use of earth observation tools for landscape monitoring and evaluation of climate adaptation and mitigation and land degradation neutrality actions.
- Promote on-farm tree planting in the landscape, particularly indigenous multi-purpose species that at least maintain crop yield and have other environmental benefits
- The distinctive diversity of the different agro-ecological zones and WMZ are a valuable environmental asset, contributing to the quality of life in different parts of Uganda. Therefore the protection and improving the quality of these landscape features and patterns should be encouraged.
- Most sensitive landscapes should be protected and more positive management actions should be promoted and targeting environmental enhancement and restoration.
- Uganda has developed various policy and strategies, however, there is need to monitor regularly the impacts of the different polices in terms of protecting, conserving and enhancing landscape character, quality and diversity. A framework for monitoring landscape change should then be developed.
- Forests are an essential solution to climate change adaptation and mitigation, however, areas for forest plantation need to be judiciously identified for maximum benefits in all sectors. This will also require strengthening strategic partnerships among sub-sectors, and engagement with all key stakeholders including the local communities.
- WMZ presents huge opportunities for making policy-relevant contribution to integrated land management approaches and strengthening the collaboration with policymakers. However, dialogue and experience sharing between WMZ is important.

Cross-cutting initiatives/Recommendations

- Agricultural Insurance - Develop innovative insurance schemes (low-premium micro-insurance policies) and low-interest credit facilities to insure farmers against crop failure and livestock loss due to droughts, pests, floods and other weather-related events;
- Training youth in agro-enterprise development;
- Identifying youth champions and targeting them to serve as role models;
- Training youth in farming as a business and identifying linkages to agribusiness incubators and financing;
- Promoting youth participation in small-scale value addition processing.
- Promoting utilisation of the youth livelihood fund and other funds targeting youth by profiling and supporting the youth to develop agricultural enterprises
- Capacity building, technology transfer and finance, including for women and youth
- Considering the leading special roles women play in farming activities, gender must be explicitly incorporated into climate change adaptation and access to services including information, extension, climate finance, and inputs.
- Strengthen the capacity of the planning, monitoring, and supervision team of MAAIF in order to enable it to undertake proper supervision of the services delivered by the various agencies within the sector and at the local government level;
- Devise innovative climate finance approaches that can raise capital and drive down mitigation costs by harnessing the capacity of the private sector to deliver climate investments
- MWE (CCD) and MoFPED to build technical capacity and mechanisms for collection of reliable data on adaptation, mitigation as well as climate finance assessments, archiving and tracking in a manner that meets the minimum IPCC requirements.
- CCD to increase awareness about the various sources of climate finance and increased stakeholder engagement, including the private sector.
- Enhancing climate change education, training and public awareness;
- Building of climate information systems;
- Strengthen public-private partnerships;
- Promote and encourage the mainstreaming of gender considerations in climate change issues.

- Promote climate change research and development and information exchange in all sectors impacted on by climate change;
- Promote and encourage the development, transfer and diffusion of climate technology;
- Promote and enhance climate change education, public awareness and capacity development through communication, training, information and knowledge management;
- Provide adequate support for policies and programmes that take into account the interactions between population dynamics, climate change and development, including the link between the national and sub-national governments.

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