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Reshaping the Future

Gender-responsive Climate Smart Agriculture Options for Northern Uganda

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Foreword

Climate change is a fundamental concern for Uganda and Northern Uganda in particular because of its effects on the agriculture sector which is a mainstay for rural households. The most frequent climate risk that has affected farmers across northern Uganda has been prolonged dry spells with consequences of heat and water stress leading to reduced yields. Shifting onset of rains is also posing challenges to farmers with unpredictable rainy seasons making it difficult to plant in time. This puts farmers in a vulnerable position, jeopardizing food security for many.

Climate Smart Agriculture (CSA) is an approach to overcome existing barriers in achieving food security, adaptation of agriculture to climate change and mitigation of greenhouse gas (GHG) emissions. Climate Smart Agriculture is a key aspect for Uganda in achieving its national commitments summarized in the National Determined Contribution (NDC) towards achieving the goals of the Paris Climate Change Agreement.

This report seeks to provide an analysis of the political, social, cultural, institutional, environmental, agricultural and economic context of seven districts of Northern Uganda (Kitgum, Agago, Oyam, Lira, Amolatar, Dokolo and Napak), with a view of compiling a basket of climate smart agriculture options that are gender-responsive and suitable for the conditions of the respective districts. We are certain that more options exist, which are not captured in this report. The report lays the foundation to receive feedback and engage in further discussions with all stakeholders in the region.

We will continue the process of capturing additional options with you.

This compilation was done together with the International Institute for Tropical Agriculture (IITA) in a great collaboration. The work is part of the German support to Uganda in promoting Climate Smart Agriculture (ProCSA) under the wider GIZ Uganda's Promoting Rural Development Programme (PRUDEV). The ProCSA project is co-funded by the European Union.

We extend our gratitude to the Ministry of Local Government, the District Local Governments, smallholder farmers and all other stakeholders for their support and contribution towards accomplishing the report. We thank all persons interviewed, including district-level experts within government and outside government, and all the farmers who participated in focus group discussions at community level from the seven districts of Kitgum, Agago, Oyam, Lira, Dokolo, Amolatar and Napak.

We also thank the National Semi-Arid Resources Research Institute (Serere), the Ngetta Zonal Agricultural Research and Development Institute (Lira), the National Forestry Resources Research Institute (Mukono) and the National Fisheries Resources Research Institute (Jinja) for their valuable input.

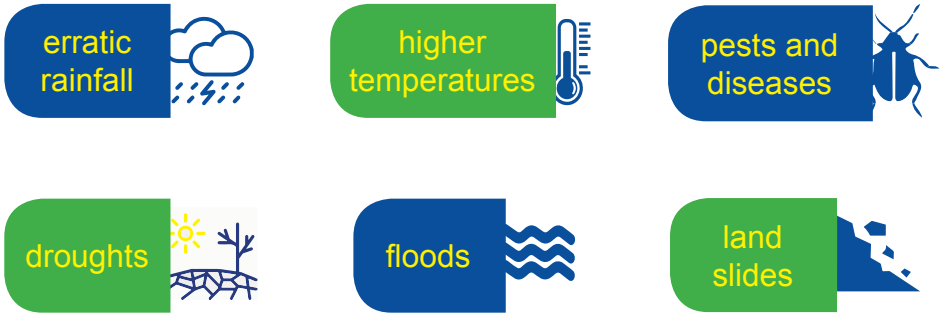
PRUDEV- ProCSA looks forward to continuing the collaborative engagement with all our partners as we work towards empowering smallholder farmers in northern Uganda to embrace CSA farming methods that boost their agricultural productivity and strengthens their resilience against the effects of climate change.

Thank you,

Armin Kloeckner
Head of Rural Development Programme
Kampala, Uganda, 22.04.2020

Executive Summary

In recent decades, the adverse impacts of climate change on agriculture are increasingly apparent, including changes in weather patterns, erratic rainfall, higher temperatures, increased outbreaks of pests and diseases and an increasing frequency and intensity of extreme events such as droughts, floods and landslides.



For households whose livelihoods are largely dependent on rain-fed agriculture, such as in the Northern Uganda region, weather shocks and natural disasters pose challenges on productivity, food security and income generation, among others. GIZ, through its Promotion of Climate Smart Agriculture (ProCSA) project, aims to support the rural population of seven districts of Northern Uganda (Kitgum, Agago, Oyam, Lira, Dokolo, Amolatar and Napak) to embrace and sustain climate smart agriculture in a gender-responsive manner. This report contributes to the GIZ ProCSA objectives by providing an analysis of the political, social, cultural, institutional, environmental, agricultural and economic contexts of the respective districts; followed by a compilation of existing and recommended climate smart agriculture options that suit conditions in specific target districts.

The study followed a purely qualitative approach, involving desk reviews of national- and district-level policies, programs and plans; academic research and grey literature relating to climate change, gender and climate smart agriculture. Expert interviews were also held with district-level stakeholders from government and outside government with climate change-related operations in the districts, as well as research institutes at regional and national level. Additionally, focus group discussions were held with male and female farmers from 14 sub counties in the seven districts.

The main findings from the study reveal the following:

- Climate change is a fundamental concern in Northern Uganda because of its effects (especially drought) on agriculture, which is the main source of livelihood for the majority of rural households;

- High population growth rates across the districts that are already quite densely populated, notably Amolatar, Dokolo and Lira, have led to an increasing rate of land degradation for conversion to agricultural land, as well as higher demand for wood fuel for energy needs. There is also a high demand for wood products (timber, fuel) from the region to other districts and neighbouring countries;

- The climate change policy environment across the districts is relatively weak, with several district-level ordinances either under draft or awaiting approval, and therefore not operational. Enforcement of existing policies is also weak, owing to factors including inadequate funding and technical staff, leaving loopholes for increased environmental degradation with impunity;

- There is limited collaboration amongst the diverse actors engaged in environment and climate-change-related actions across the districts, leading to duplication of efforts in some sub counties, with gaps in terms of reach and variety of options promoted in other locations;

- Adoption rates of climate smart agriculture options are perceived to be lower among females compared to males across the districts, owing to limited accumulation and control over resources such as land and income, limited ability to take strategic decisions within the household and limited diversified sources of livelihood besides agriculture.

Drawing from the study findings, the following recommendations are made:

- Potential climate smart agriculture practices for Northern Uganda should aim at supporting farmers to adjust soil and water nutrient management, sowing and planting dates, plant densities and cultivars so as to increase their productivity and resilience to the impacts of climate change;

- Government departments and development partners should prioritise the promotion of appropriate sustainable intensification climate smart approaches among smallholder farmers to address the increasing conversion of land cover (including wetlands and woodlands) to agricultural land. The promotion of cost-effective energy efficiency options and potential diversification enterprises (focusing on value addition) is also recommended;

- Political and technical actors at national and sub-national level should commit to fast-tracking the enactment of the climate change bill and district-level ordinances to legitimise the enforcement of actions against environment and natural resource degradation;

- Climate change actors within the districts should increase collaboration through the establishment of or revival of multi-stakeholder climate change innovation platforms, which should routinely meet to enhance knowledge and information exchange, strengthen the development of effective and coordinated solutions for smallholder farmers and minimise duplication of efforts; and

- Mainstream gender into climate change actions through a careful consideration of the effectiveness of promoted options in: enhancing equitable opportunity and participation of women and men in their application; improving women's productivity by reducing time, energy and labour spent in agricultural production; and increasing women's equitable access to and control over resources such as agricultural inputs, information, technologies and income. The latter may be achieved by providing tailored information on climate smart agriculture that considers the literacy levels of women and providing financial support to women groups to boost their adoption ability of climate smart agriculture.

Strategic collaboration with cultural leaders as drivers of change is also envisaged to foster transformation that boosts women's decision-making ability and accumulation and control over productive assets and resources.

Acronymns

AFOLU	Agriculture, Forests and Other Land Use
CGIAR	Consultative Group on International Agricultural Research
CH4	Methane
CNDPF	Comprehensive National Development Planning Framework
CO2	Carbon dioxide
CSA	Climate Smart Agriculture
FAO	Food and Agriculture Organization of the United Nations
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
CCAFS	Climate Change, Agriculture and Food Security
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
LSBs	Local Seed Businesses
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MEMD	Ministry of Energy and Mineral Development
MRV	Measurement, Reporting and Verification
MWE	Ministry of Water and Environment
N2O	Nitrous oxide
NAMAs	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programmes of Action
NARO	National Agricultural Research Organisation
NCCP	National Climate Change Policy
NDC	Nationally Determined Contribution
NDP	National Development Plan
ProCSA	Promotion of Climate Smart Agriculture
PRUDEV	Promoting Rural Development Programme
RCP	Representative Concentration Pathway
REDD+	Reducing Emissions from Deforestation and forest Degradation
UBOS	Uganda Bureau of Statistics
UGGDS	Uganda Green Growth Development Strategy
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNMA	Uganda National Meteorological Authority
USAID	United States Agency for International Development
WBG	World Bank Group

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1 INTRODUCTION

1.1 Overview and Purpose

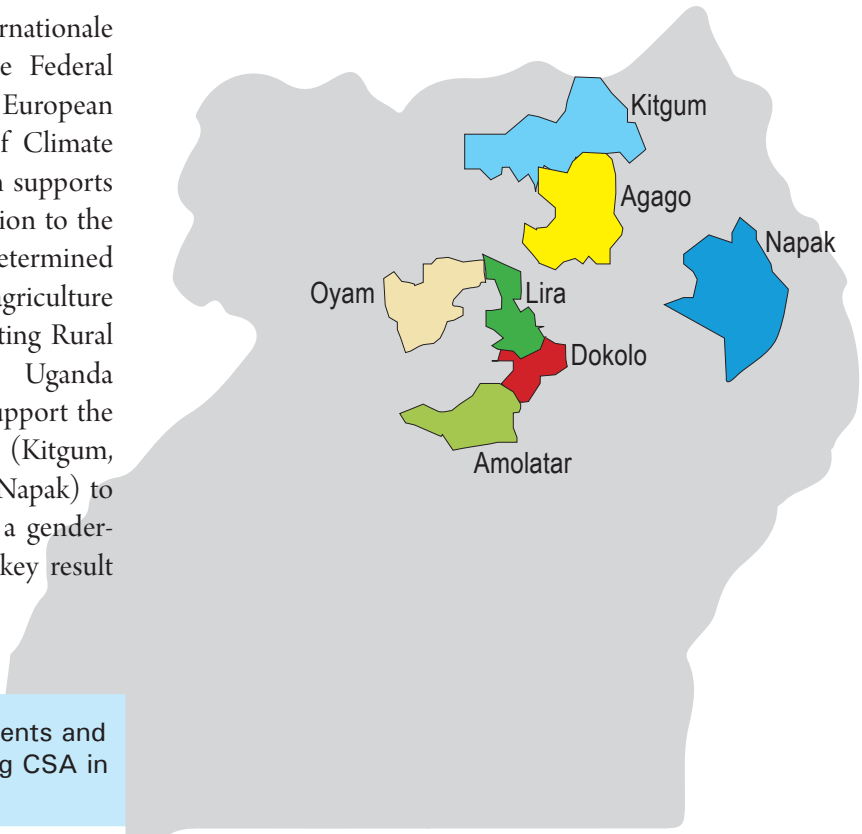
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), on behalf of the Federal Republic of Germany and co-funded by the European Union, is implementing the Promotion of Climate Smart Agriculture (ProCSA) project, which supports the Government of Uganda in its contribution to the implementation of Uganda's Nationally Determined Contribution (NDC) through climate smart agriculture (CSA). Implemented as part of the Promoting Rural Development Programme in Northern Uganda (PRUDEV), the ProCSA project aims to support the rural population of seven selected districts (Kitgum, Agago, Oyam, Lira, Dokolo, Amolatar and Napak) to embrace and sustain CSA development in a gender-responsive manner. The project has three key result areas, namely:

1. Enhanced capacity of local governments and other stakeholders for mainstreaming CSA in local planning processes;
2. Application and sustainability of gender responsive CSA practices among smallholder farmers; and
3. Enhanced awareness and capacities on Measurement, Reporting and Verification (MRV) of Greenhouse Gas Emissions in the agricultural sector.

This report contributes to the implementation of Result Area 2 of the project by

- providing a gender analysis of the political, social, cultural, institutional, environmental, agricultural and economic context of the project area; and
- compiling a basket of options of CSA techniques that are gender-responsive and suitable for the specific conditions of the seven selected districts in Northern Uganda.

1.2 Scope and Methodology



The basket of CSA options presented in this report was informed by a study conducted by the International Institute of Tropical Agriculture (IITA) between November 2019 and February 2020 in the seven districts of Kitgum, Agago, Oyam, Lira, Dokolo, Amolatar and Napak. Additional information was obtained from the GIZ PRUDEV programme and national research institutes, including the National Semi-Arid Resources Research Institute (Serere), Ngetta Zonal Agricultural Research and Development Institute (Lira), National Forestry Resources Research Institute (Mukono) and National Fisheries Resources Research Institute (Jinja) respectively.

The study adopted a qualitative research design, which involved desk research of secondary information and primary data obtained through focus group discussions and expert interviews held with various stakeholders. Data collection was undertaken to ascertain the following:

- Existing CSA profiles and practices identified for Uganda;
- Contextual agricultural, environmental, economic, institutional, financial and policy factors related to CSA in the seven districts;
- Gender-responsive CSA options (existing and potential) that are suitable for conditions in the seven districts and their contribution to the CSA pillars of productivity, adaptation and mitigation;
- Opportunities and barriers for the adoption of existing and promising CSA options through a gender lens.

1.2.1 Desk research

The documents reviewed included national-level policies, programs, plans and reports relating to climate change; five-year district development plans and budgets of the seven districts; academic literature; and grey literature published on climate change and CSA by organisations including Food and Agriculture Organisation of the United Nations (FAO), CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS), IITA, United Nations Development Program (UNDP), United States Agency for International Development (USAID), the World Bank, Government sectors and agencies (Ministry of Water and Environment (MWE), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Uganda Bureau of Statistics - UBOS), among others. A review was also made of project documents and reports from GIZ ProCSA. A list of the documents reviewed may be found in the references section of this report.

1.2.2 Primary data

Expert interviews were held with 61 stakeholders including: district local government officials from the departments of production; marketing; environment/natural resources; community development; and district and sub-county political leaders. Other respondents included cultural leaders; staffs of non-governmental organisations engaged in climate change/environment-related work; trainers of farmers at community level; leaders of district farmers associations and/or cooperatives; staffs of ProCSA and staffs of national resources research institutes. Figure 1 summarises the experts interviewed by category:

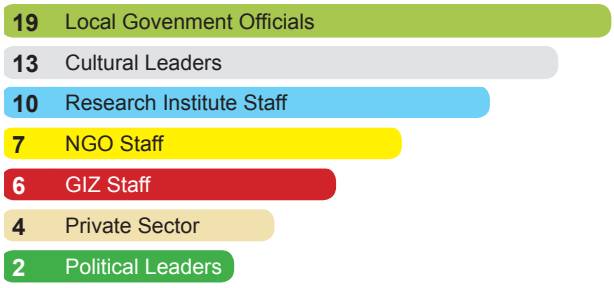
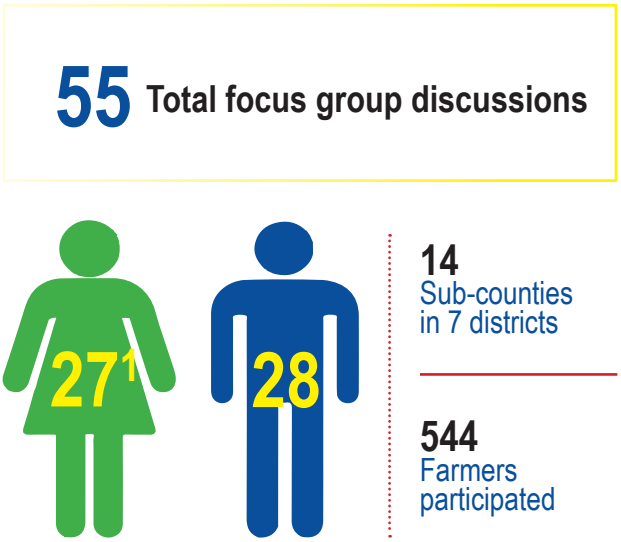


Figure 1: Experts interviewed at district level by category

Within the districts, separate focus group discussions were held with male and female farmers at community level.



[1]Owing to low attendance in Oyam District, only 3 out of the intended 4 female focus group discussions were held.

The participants from each district were selected from lists of farmers targeted under the PRUDEV programme using a three-step process as follows:

i. Clustering sub counties in the selected districts into distinct categories

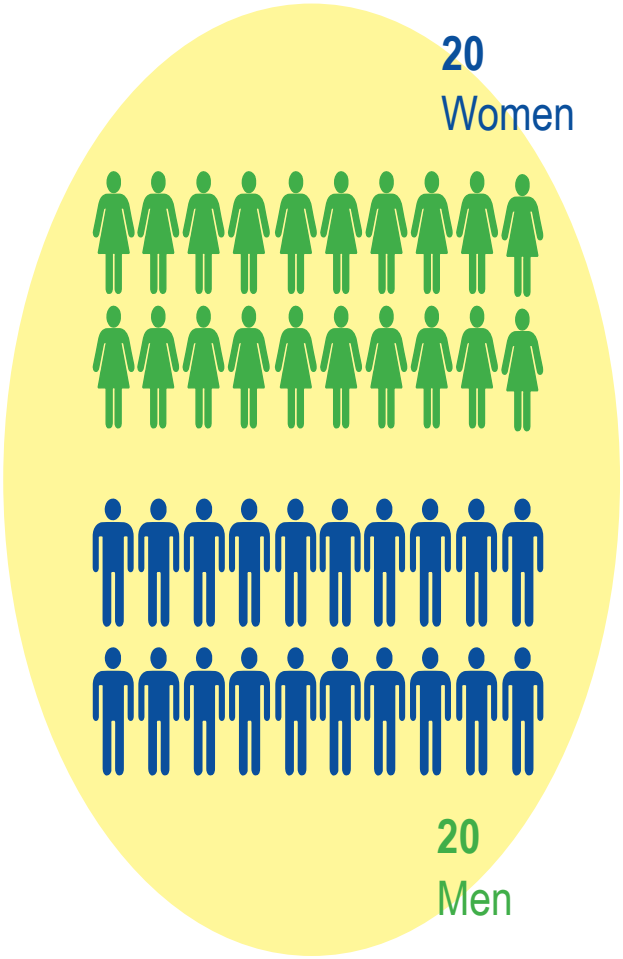
In the first step, contextual information from District Development Plans and UBOS District Profile reports of 2014 was used to develop a composite set of criteria for categorising sub counties into distinct groups. The criteria included environmental, social, economic and demographic characteristics; agroecology; access to services (health, safe water, markets); and distance from the district headquarters. Using the selected criteria, sub counties with relatively similar attributes in each district were clustered into two categories, notably 'better-off' and 'worse-off'. The research team then utilised farmer group lists from GIZ PRUDEV to identify and map the represented sub counties into the respective categories. This was followed by the purposive selection of two sub counties per district, one 'better-off' and one 'worse-off' respectively.

ii. Selection of representative farmer groups

The second step involved a compilation of all the main agricultural enterprises undertaken by the farmer groups in the selected two sub counties of each district. Separate lists of farmers were prepared by gender and agricultural enterprise for each selected sub county and totals were generated. The totals by gender and agricultural enterprise were then used to proportionately select numbers of farmer representatives that constituted the samples of 20 males and 20 females per sub county location. Table 2 presents the selected sub counties by district

iii. Selection of respondent farmers

In the third step, MS Excel was used to assign random numbers to each farmer on the lists prepared in step ii (by gender category and agricultural enterprise). The random numbers were then used to select the individual 20 male and 20 female farmers per sub county location, who were mobilised to participate in the focus group discussions.



District	Agago	Amolatar	Dokolo	Kitgum	Lira	Napak	Oyam
Sub County 1	Paimol	Etam	Kangai	Kitgum Matidi	Agali	Iriri	Acaba
Sub County 2	Lapono	Muntu	Amwoma	Lagoro	Agweng	Nabwal	Otwal

Table 1: Sub county locations for focus group discussions by district

1.3 Limitations

The study encountered some limitations, which were addressed accordingly as follows:

i. Relatively new districts (post 2006) had insufficient contextual information in the District Development Plans for use in the categorisation of sub counties. Consequently, the research team relied on socio-economic data in UBOS district profiles and consultation with GIZ ProCSA field staff to select the two sub counties in the respective districts.

ii. The agricultural enterprises undertaken by target farmers under the PRUDEV programme were listed according to farmer groups and not individual farmers. This meant that the selection of individual farmers within farmer groups using random assignment would not ensure the inclusion of all agricultural enterprises. The research team addressed this by providing the proportionate numbers of farmers required per agricultural activity to the selected group leadership and requesting them to nominate, from among their members, farmer representatives who actively engage in the selected agricultural enterprises for each group.

iii. The timing of the data collection (November to December 2019) coincided with the festive season, as well as annual planning retreats of key organisations that implement environment and/or climate-change-related interventions in most of the districts. Consequently, several expert interviews could not be completed while in the field. This was partially addressed using telephone interviews and/or the completion of interview responses by mail, although the response rate was still poor.

iv. The selection of sub county sites for the sample was restricted to locations where PRUDEV target farmers existed in the respective districts. In some instances, this meant that the sub county sites did not follow the clustering criteria (step 1) of the methodology (e.g. Kitgum District where Kitgum Matidi and Lagoro – the only PRUDEV sites are in the same climatic zone). Nonetheless, efforts were taken to ensure contrasts between sites selected across the seven districts to guarantee a diversity of opinions.

The limitations notwithstanding, this report presents a comprehensive analysis and makes recommendations to inform project implementation in the respective districts for the achievement of Result Area 2. It is also important to note that the community-level findings presented in this report were generated from participants who are already organised in groups, with some level of exposure, and therefore may not be representative of all farmers in the respective districts.

1.4 Climate Change, Agriculture and Gender

The impacts of climate change and variability on ecosystems and agro-ecosystems are increasingly apparent, with the Intergovernmental Panel on Climate Change (IPCC) projecting increase in global mean temperatures in the range of 1.4 to 5.8 degrees centigrade during the period 1990 and 2100. Predictions are also made on increases in the frequency and intensity of extreme events and the unpredictability of weather patterns (MWE, 2015). According to FAO (2017b), the impacts of climate change on agricultural productivity occur overtime through modifications in the physical environment (carbon dioxide (CO2) levels, air and water temperatures, rainfall patterns and the sea level) and indirectly by shifting bio-geographies of pollinators, among others. Other more immediate and often catastrophic events include floods, droughts, storms and pest invasions like the fall army worm and locusts.

Excessive rains, high temperatures, frequent and long dry spells affect crop and forage development and yields, animal health and forest tree growth (FAO, 2017b). Long dry spells with high temperatures also increase the risks of bush and forest fires and may shift the habitat ranges of aquatic species, leading to reduced fish stocks or losses of species in certain areas (FAO, 2017b). The resultant impacts of climate change on agriculture include reduced or lost income and food and nutrition insecurity among populations that are highly dependent on rain-fed agriculture.

Vulnerability and adaptive capacity to the impacts of climate change differ between and among (categories of) men and women in communities and are mediated through context-specific cultural, social and economic structures and processes. The foregoing structures define gender relations that determine, among others, roles and responsibilities; access to and control over resources; access to information; decision making power, social interaction and mobility (Beuchelt & Badstue, 2013; CCAFS & FAO, 2012). It thus becomes prudent for interventions aimed at effectively reducing risks linked to climate change to integrate a gender perspective. The latter essentially entails reducing gender inequalities by carefully considering the different roles, responsibilities and resource rights of men and women in the design and implementation of interventions.

1.5 Analytical Framework for Climate Smart Agriculture Options

In line with the objective of compiling a basket of CSA options that are gender-responsive and suitable for the conditions of the respective districts, this study adapted an analytical framework in WBG, FAO & IFAD (2015: 9) that evaluates each CSA option against three broad themes, namely

i. contribution to the three CSA pillars;

ii. gender impact; and

iii. requirements for adoption of the practice.

The adapted analytical framework additionally utilises FAO and CCAFS literature on gender-responsive CSA (Nelson & Huyer, 2016) in describing the indicators of the criteria as elaborated in Table 2 below:

Table 2: Description of assessment criteria for CSA options

	Theme	Criteria	Description
1	**Contribution to CSA pillars**	Agricultural productivity, food security and incomes	The technology or practice leads to higher returns to farm production (e.g. crop and animal yields) through more efficient and effective use of resources (e.g. land, water, inputs).
		Adaptation and resilience to climate change	The technology or practice increases farmers' ability to cope with the impacts of weather shocks and natural disasters brought about by climate change.
		Mitigation	The technology or practice contributes to reduction and/or removal of greenhouse gases emissions.
2	**Gender impact**	Women's participation relative to men	The technology or practice promotes/enables women's equitable opportunity and participation in its application (e.g access to resources like land, information, labour, inputs, water, finance, etc).
		Women's productivity relative to men	The technology or practice enhances women's productivity by improving agricultural yields (for food crops) and reducing time, energy and labour spent in production.
3	**Requirements for adoption**	Access to and control of land	The technology or practice requires secure tenure (temporary or long term) of land.
		Labour availability	The technology or practice is highly labour-intensive.
		Access to water for agricultural production	The technology or practice requires an accessible source of water for successful implementation.
		Access to finance	The technology or practice requires high investment costs, which may be accessible through savings accumulation or credit facilities.
		Access to information	The technology or practice is knowledge-intensive, requiring the availability of technical information and extension services.

1.6 Report Layout

The report is organised in five chapters as follows:

Chapter 1 presents an overview of the study and describes the scope and methodology employed, as well as the study limitations. It also briefly discusses the linkages between climate change, agriculture and gender and introduces the analytical framework that is later used in the evaluation and judgement of recommended CSA options presented in Chapter 4.

Chapter 2 describes the status and trends of climate change in Uganda; the policy environment, priorities and institutional infrastructure for climate change action in Uganda; and briefly outlines ongoing climate-related initiatives at national and regional level, with a focus on the Northern Uganda region.

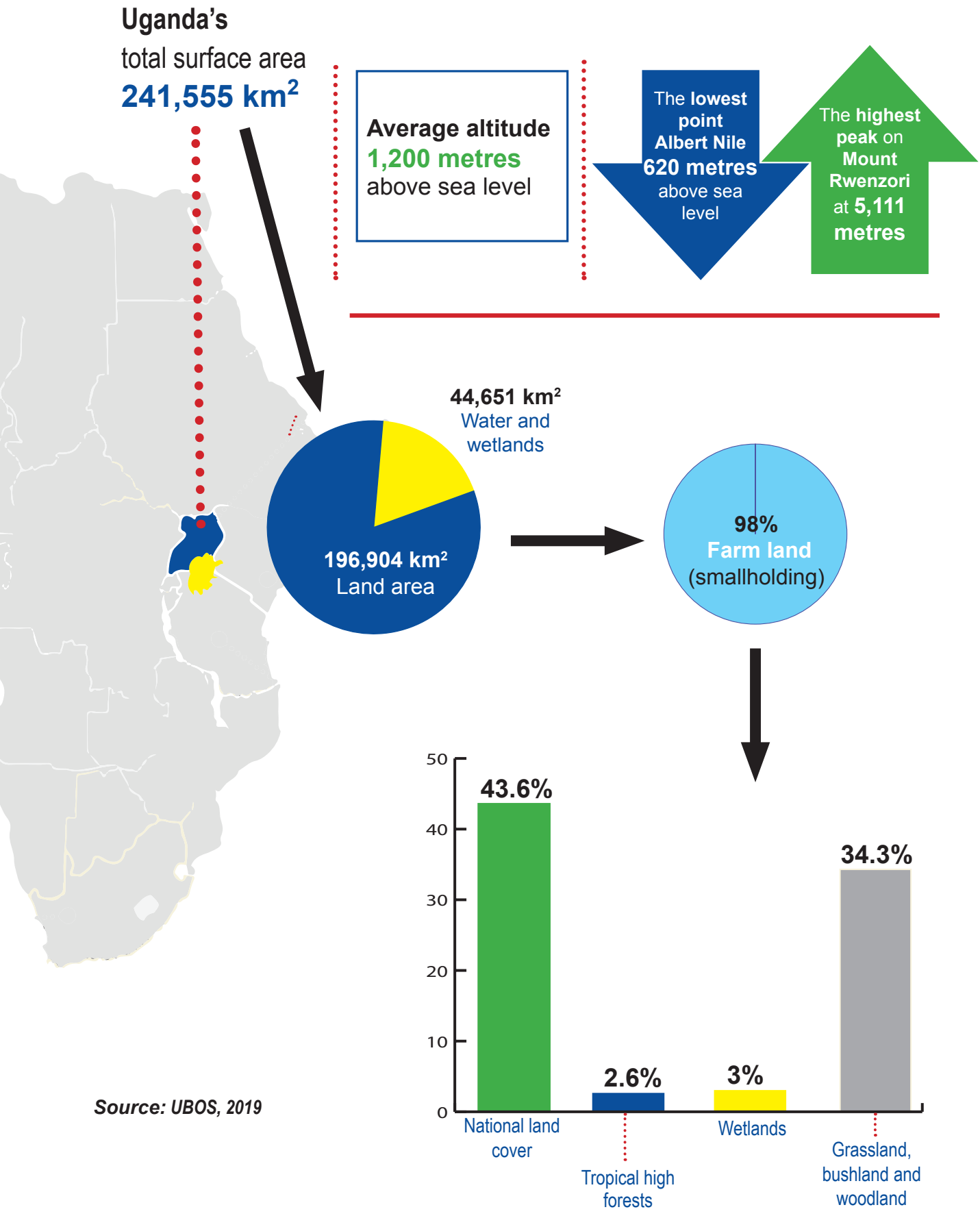
Chapter 3 discusses the Northern Uganda context, focusing on the seven ProCSA project districts. It utilises findings from the study to describe the historical, political, socio-cultural, institutional, environmental and economic contexts, as well as the farming systems practiced in the region. It also presents gendered perceptions of climate change, climate risks and vulnerabilities; the impacts of climate change on agriculture, food security and incomes; and the adaptive capacities and coping strategies employed by men and women in the region.

Chapter 4 presents the existing CSA practices among farmers in the region and recommends potential technologies and practices that suit the conditions of the respective districts, presenting them in relation to their contribution to CSA pillars, gender impact and requirements for adoption. The chapter also discusses gender implications of transitioning to CSA basing on the study findings.

concludes the report by making linkages across the chapters. It also presents practical recommendations as drawn from the analysis.

2 TACKLING CLIMATE CHANGE IN UGANDA

2.1 Overview of Uganda's climate status and trends



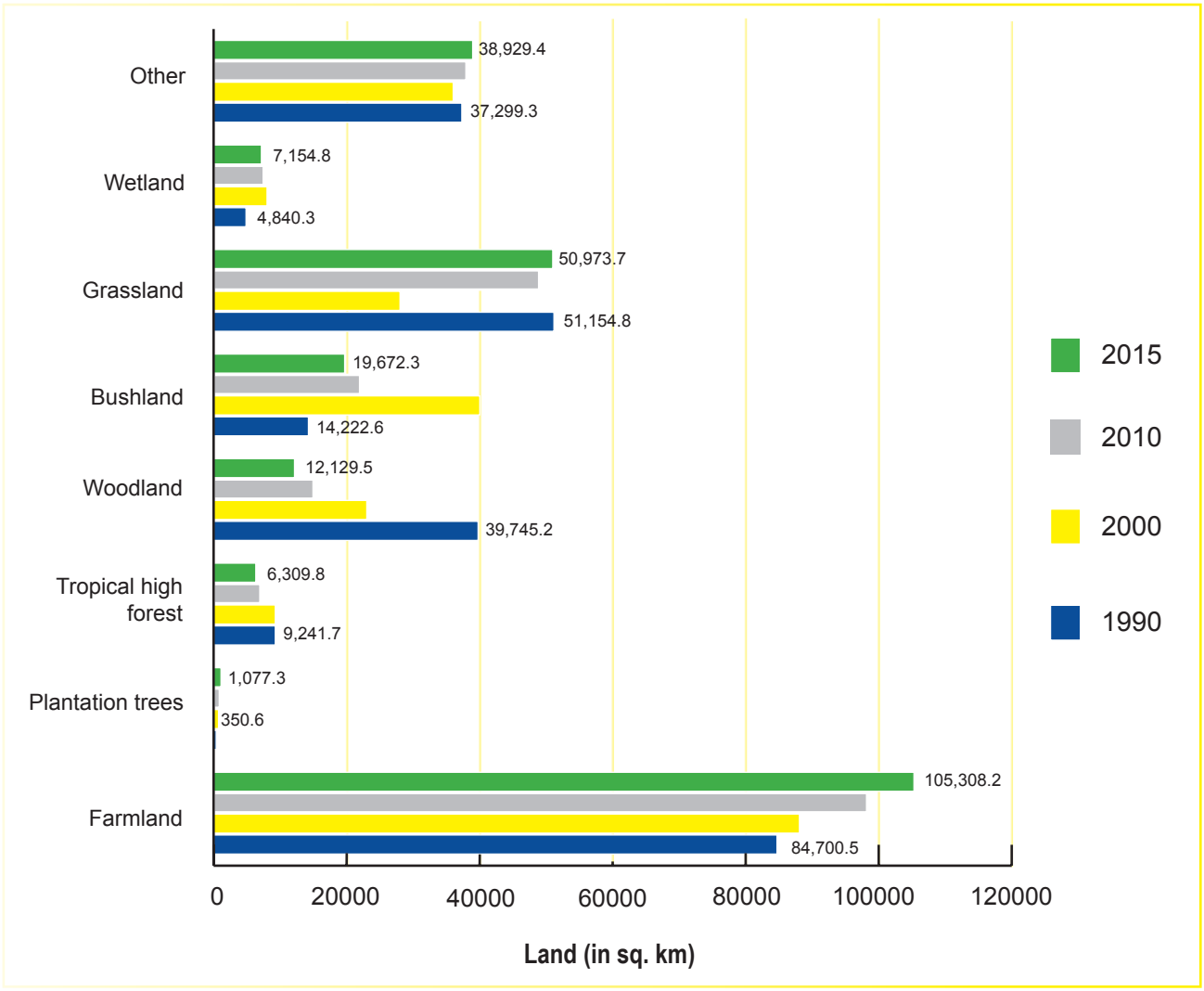
Source: UBOS, 2019

Over the years from 1990 to 2015, agricultural land has increased by 24 percent from 84,700.5km2 in 1990 to 105,308.2km2 in 2015, while tropical high forests and woodlands reduced by 3.2 percent and 69.5 percent respectively (see Figure 2). The foregoing trends are associated with pressure resulting from high population growth, with a significant proportion of the population dependent on natural resources (agriculture, forestry) for livelihoods (Republic of Uganda, 2017). Other sectors putting pressure on the environment are:

- industries (through increased demand for natural resources like water, biomass, sand, as well as effluent from factories that pollutes air and water);
- energy, with wood fuel accounting for 93 percent of Uganda's energy needs for cooking, lighting and heating; and
- urbanisation, which has expanded human settlements into gazetted places like wetlands and forested areas across the country (Republic of Uganda, 2002; 2017).

According to the 2016/17 National State of the Environment report, an estimated 846km2 of wetland is lost annually in Uganda, with projections being made of no wetlands by 2040, if the rate is left unchecked (Republic of Uganda, 2017).

Figure 2: Uganda National Land Cover Statistics (in sq. km) for the period 1990 to 2015



Source: Authors' adaptation of Table 1.1 in UBOS (2019:159).

Uganda's climate is mostly tropical with two rainfall seasons, notably March to May and October to December, with an average annual rainfall of 1,180mm (Republic of Uganda, 2014). The southern part of the country receives a mean annual rainfall ranging from 600mm to 2200mm, while the northern part of the country has one rainy season – mainly from June to August – receiving between 400mm to 1600mm of rainfall annually (Republic of Uganda, 2014). The mean daily temperature in Uganda is 28˚C, varying from as low as 4˚C in south-western Uganda to over 30˚C in the north and north-eastern parts. On higher mountain ranges of Rwenzori and Elgon, temperatures are as low as 0˚C. A hot and dry season dominates most parts of Uganda during the months December to February.

Over the years since 1960, observable impacts of climate change in Uganda have included changes in weather patterns (shifts in onset of rainy seasons by 15 to 30 days earlier or later, with the length of rainfall changing by 20 to 40 days from year to year); significant reductions in seasonal and annual rainfall; higher temperatures resulting in increased outbreaks of pests and diseases and invasive weeds; and an increased frequency and intensity of extreme events such as droughts, floods and landslides (MWE, 2015; Irish Aid, 2018). Mean annual temperatures have risen by 1.3˚C since 1960 and are projected to rise between 1.0˚C and 3.1˚C by the 2060s (Irish Aid, 2018). Temperature variability and trend analysis by USAID (2013) approximates that average annual temperatures between 1951-1980 and 1981-2010 increased by 0.5˚C to 1.2˚C for minimum temperatures and by 0.6˚C to 0.9˚C for maximum temperatures. While the warming trend is expected to increase, no significant change is projected in average annual rainfall for the period 2015 to 2045, although more rainfall is expected in the months of December to February (USAID, 2013). Models used in the fifth assessment report of the IPCC project an increase in near-surface temperature for Uganda 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 Pathway (RCP) 4.5; and in the order of +2.4˚C in the next 50 years and in the order of +4.5˚C in the next 80 years under RCP 8.5 (MWE, 2015).

2.1.1 Greenhouse Gas Emissions

Uganda is among the countries with the lowest carbon dioxide emissions at 0.1 metric tonnes per capita compared to the world average of 5 metric tonnes per capita as at 2014 (World Bank, 2019). Uganda's greenhouse gas emissions mainly derive from the conversion of land (mostly forests) to cropland and grassland, enteric fermentation of ruminant animals, forest degradation (forest land remaining forests) and direct nitrous oxide (N2O) emissions from managed soils (MWE, 2019). Other sources of emissions are from road transportation, biomass fuels (under energy), and solid waste disposal, as shown in Table 3.

Table 3: Uganda's Greenhouse gas emission estimates as at 2015

IPCC Category	Greenhouse gas	2015 Year Estimate Ext (Gg CO2 Eq)	Cumulative Total (%)
Forest land remaining forest land	Carbon dioxide	39811.40099	37%
Land converted to cropland	Carbon dioxide	10611.34191	59%
Enteric fermentation	Methane (CH4)	15432.94141	65%
Land converted to grassland	Carbon dioxide	2727.190088	71%
Emissions from biomass burning	Methane	327.2401781	75%
Emissions from biomass burning	Nitrous oxide	282.7781974	78%
Solid Waste Disposal	Methane	1487.804594	81%
Other sectors- Biomass	Methane	3141.474	84%
Road Transportation	Carbon dioxide	2561.9319	87%
Energy Industries – Biomass	Methane	1390.368	89%
Direct N2O emissions from managed soils	Nitrous oxide	5595.737652	91%
Manufacturing industries and construction – Liquid Fuels	Carbon dioxide	870.7512	93%
Rice cultivation	Methane	652.5400443	94%
Indirect N2O Emissions from managed soils	Nitrous oxide	1822.618196	95%

Source: Authors' adaptation of Table 1.1 in UBOS (2019:159).

The estimated total emissions for Uganda were 77,381Gg as at 2015, of which 86.4 percent were from the Agriculture, Forests and Other Land Use (AFOLU) sector, followed by the Energy sector accounting for 10.6 percent of the total emissions (MWE, 2019). The emissions from the waste sector accounted for 2.1 percent, while Industrial Processes and Product Use (IPPU) accounted for 0.6 percent as at 2015. Trend analysis comparing the years 2005 and 2015 indicate a general upward trend in emissions from all sectors and for all gases (CO2, CH4, N2O). Between 2005 and 2015, emissions from AFOLU increased from 59,735Gg (93 percent of national emissions) to 66,839Gg (86 percent of national emissions), while emissions from the Energy sector doubled from 4,016Gg (6 percent of national emissions) to 8,452 (13 percent of national emissions). Emissions from the IPPU and Waste sectors tripled between 2005 and 2015 from 171Gg to 378Gg (IPPU) and from 490Gg to 1610Gg (Waste) respectively (MWE, 2019: 35).

2.2 The policy environment, priorities and institutional infrastructure for climate change action in Uganda

The Comprehensive National Development Planning Framework (CNDPF)[2] of Uganda acknowledges the adverse impacts of climate change on various sectors of the economy, which could constrain the attainment of socio-economic transformation by 2040. Globally, Uganda's commitment to addressing climate change is evidenced through the signing and ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and 1993 respectively; followed by the ratification of the Kyoto agreement in 2002 and the Paris Agreement in 2016, which deals with greenhouse gas emissions mitigation, adaptation and financing accordingly. Uganda has also fulfilled UNFCCC requirements by submitting its First National Communication in 2002, the National Adaptation Programmes of Action (NAPA) in 2007, the Second National Communication in 2014 and the First Biennial Update Report in 2019.

Other UNFCCC requirements that are in the process of fulfilment include the measurement, reporting and verification (MRV) of greenhouse gas emissions and emissions reductions; MRV of Nationally Appropriate Mitigation Actions (NAMAs) and MRV for Reducing Emissions from Deforestation and forest Degradation (REDD+) (MWE, 2019).

[2]The CNDPF consists of the thirty-year vision (Vision 2040), six five-year National Development Plans, Sector Policies, Master Plans and Annual Plans. At sub national level, the planning framework consists of five-year Higher Local Government and Lower Local Government Development Plans and Annual Plans.

On the national scale, the CNDPF regards climate change as a cross-cutting issue that must be integrated across key sectors of the economy. The Uganda National Climate Change Policy (NCCP) (along with its Costed Implementation Strategy) was approved in 2015 as the guiding framework for ensuring coordinated multi-sectoral action on climate change adaptation and mitigation. The NCCP aligns with the Constitution of the Republic of Uganda 1995, Vision 2040 and the National Development Plan (NDP) II 2015/16-2019/20.

Additionally, the Government of Uganda launched the Uganda Green Growth Development Strategy (UGGDS) 2017/18-2030/31 to provide guidance and describe the governance framework on priorities and strategic interventions for the implementation of the green economy, green growth and development in Uganda (Republic of Uganda, 2017).

The implementation of the UGGDS is intended to accelerate and ensure the attainment of the goals of Vision 2040 and NDP II. In 2018, the National Adaptation Plan for the Agriculture Sector was developed to guide actions aimed at reducing vulnerability to the impacts of climate change and building adaptive capacity for resilience as stipulated in the NCCP (Republic of Uganda, 2018). Subsequently in 2019, the National Environment Bill was enacted into law to provide for emerging environmental issues, including climate change; management of hazardous chemicals and biodiversity offsets; establishment of an environmental protection force; and to provide for procedural and administrative matters, among others.

Other related policy documents include the Forestry Policy 2001, which recognises the importance of forests for climate change mitigation and reducing the impacts of drought, and the Disaster Preparedness and Management Policy 2010, whose goal is to establish institutions and mechanisms that will reduce vulnerability of people, livestock, plants and wildlife to disasters in Uganda (Office of the Prime Minister, 2010).

Still under the process of review and approval is the Climate Change Bill 2018, which, once enacted, will provide the legal framework for enforcing climate change adaptation actions and the reduction of national greenhouse gas emissions. Overall, the priorities in Uganda's policy documents are linked and align strongly with the priorities stipulated in the NCCP. Table 4 highlights the priority actions for climate change for the agriculture sector according to national frameworks. Other priorities in Uganda's agenda for climate change action (in other sectors) are highlighted in Table 10 in Appendix II.

Table 4: National priorities for addressing climate change in the agriculture sector

Framework document	Specific priorities
National Development Plan II 2015/16 – 2019/20	• Increasing agricultural production and productivity by strengthening ecologically sound agricultural research and climate-resilient technologies and practices and enhancing sustainable land management practices. • Increasing access to critical inputs, notably water for agricultural production (irrigation, water for livestock, aquaculture-fishponds/caging). • Mainstreaming climate change, gender, environment, HIV/AIDS, into planning and budgeting by the Ministry of Agriculture and public agricultural agencies.
National Climate Change Policy 2015	• Promotion and encouragement of highly adaptive and productive crop varieties and cultivars in drought-prone, flood-prone and rain-fed crop farming systems. • Promotion and encouragement of highly adaptive and productive livestock breeds. • Promotion and encouragement of conservation agriculture and ecologically compatible cropping systems to increase resilience to the impacts of climate change • Promotion of sustainable management of rangelands and pastures through integrated rangeland management. • Promotion of irrigated agriculture by encouraging irrigation schemes that use water sustainably. • Promotion and encouragement of agricultural diversification and improved post-harvest handling, storage, value addition and marketing. • Supporting community-based adaptation strategies through stretched extension services and improved systems for conveying timely climate information to rural populations. • Developing innovative insurance schemes (low-premium, micro-insurance policies) and low-interest credit facilities to ensure farmers against crop failure due to droughts, pests, floods and other weather-related events.
Uganda's Intended Nationally Determined Contribution (INDC) 2015	• Expanding extension services. • Expanding climate information and early warning systems. • Expanding CSA. • Expanding diversification of crops and livestock. • Expanding value addition, post-harvest handling and storage and access to markets including micro-finances. • Expanded rangeland management. • Expanding small scale water infrastructure. • Expanding research on climate resilient crops and animal breeds. • Extending electricity to the rural areas or expanding the use of off-grid solar system to support value addition and irrigation.

Framework document	Specific priorities
Uganda Climate Smart Agriculture Programme 2015 – 2025	• Increasing agricultural productivity through CSA practices and approaches that consider gender. • Increasing the resilience of agricultural landscapes and communities to the impacts of climate change. • Increasing the contribution of the agricultural sector to low carbon development pathways through transformation of agricultural practices. • Strengthening the enabling environment for efficient and effective scaling up of CSA. • Increasing partnerships and resource mobilisation initiatives to support implementation of CSA.
National Environment Act 2019	• Addressing the impacts of climate change on ecosystems, including by improving the resilience of ecosystems; promoting low carbon development and reducing emissions from deforestation and forest degradation; sustainable management of forests; and conservation of forest carbon stock. • Advising institutions, firms, sectors or individuals on strategies to address the impacts of climate change, including those related to the use of natural resources. • Taking measures and issuing guidelines to address the impacts of climate change, including measures for mitigating and adaptation to the effects of climate change. • Liaising with other lead agencies to put in place strategies and action plans to address climate change and its effects.

Regarding the institutional infrastructure, the Climate Change Department of the MWE is the national focal point for the UNFCCC and is mandated to: coordinate all climate change mitigation and adaptation actions in different sectors; coordinate and guide on education, training and public awareness programmes on climate change; initiate, develop and review appropriate policies, strategies and programmes to ensure effective implementation ; and monitor the implementation of adaptation and mitigation activities and programmes and update government accordingly. The institutional infrastructure for climate change action consists of multi stakeholder committees, ministries and climate change focal point officers at national and sub national levels. At the district level, the Natural Resources Department is the climate change focal point, while the District Environment Committee is responsible for ensuring cross-sectoral coordination (Republic of Uganda, 2015a).

2.3 Ongoing initiatives for climate change action in Uganda

Uganda has various actors within and outside government that are engaged in addressing climate change at the national and sub-national levels. Most of the interventions have concentrated on promoting technologies and practices that support climate change adaptation, climate change mitigation and food security. According to a scoping study conducted by FAO (2016:57), the common technologies and practices being promoted across Uganda include conservation agriculture, agroforestry, soil and water conservation (through terracing, strip and contour cultivation, ridge and tie ridging practices), water harvesting for crops and livestock, intercropping, integrated soil fertility management, livestock management, improved fodder production, biogas and biogas fuel production, watershed management and livelihood diversification.

Some of the key actors supporting and/or implementing projects aimed at climate change adaptation, mitigation and food security at the national level include Government ministries, departments and agencies (Ministry of Water and Environment, Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), Ministry of Energy and Mineral Development (MEMD), National Forestry Authority (NFA), National Agricultural Research Organisation (NARO), Uganda National Meteorological Authority (UNMA), and the Office of the Prime Minister); development partners (European Union Delegation in Uganda, German Government. United Nations Development Programme (UNDP), FAO, Worldwide Fund for Nature (WWF), International Union for Conservation of Nature (IUCN); and regional and national civil society organisations and associations (Uganda Faiths Network on Environmental Action, Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and Participatory Ecological Land-Use Management (PELUM) Uganda) (FAO, 2016). Other actors include research institutes (several Consultative Group on International Agricultural Research (CGIAR) centres, Makerere University Centre for Climate Change Research, NARO) and the private sector (Balton Uganda, Uganda National Farmers Federation (UNFFE), among others). Most of the projects focus on specific climate-related challenges in a limited number of districts or sub-regions of the country, while few projects, such as the Strengthening Climate Information and Early Warning Systems for Climate Resilient Development and Adaptation to Climate Change in Uganda are nationwide.

At local government level, across the selected seven districts, a number of institutions (government and non-government) are engaged in activities including promotion of drought resistant varieties, fast maturing varieties, water harvesting techniques, watershed management, awareness creation among communities about climate change, provision of tree seedlings, training on post-harvest handling, promotion of energy saving technologies, provision of emergency relief and the promotion of agroforestry, among others. A summary of some of the organisations, their key activities and districts may be found in Table 11 in Appendix II.

3 THE NORTHERN UGANDA CONTEXT

3.1 Overview of ProCSA Districts

The seven targeted districts under the project include two districts in Acholi sub-region (Kitgum and Agago); four districts in Lango sub-region (Oyam, Lira, Amolatar and Dokolo); and one district in Karamoja region (Napak). This section provides background information on the districts, particularly the political, economic, social, cultural, environmental, biophysical and institutional conditions.

3.1.1 Historical and political context

The project area consists of a mix of old and relatively new districts. Kitgum district was established in 1980, having been carved out of Acholiland, while Lira district was formed in 1974 out of the former Lango District. The other districts in Lango sub-region are Amolatar and Dokolo that were carved out of Lira District in 2005 and 2006 respectively; and Oyam, which was carved out of Apac in 2006. Agago District was carved out of Pader District in 2010. The Acholi sub-region was most affected by the two-decade insurgency (1986-2007) by Lord's Resistance Army, particularly the districts of Gulu, Kitgum, Pader and present-day Agago (formerly part of Pader). Parts of Lira district were also affected, with the populations in the four districts relocated to Internally Displaced Persons' camps. Over the past decade the four districts have since been in recovery and are rebuilding economies and livelihoods. Figure 3 shows the districts and their respective locations.

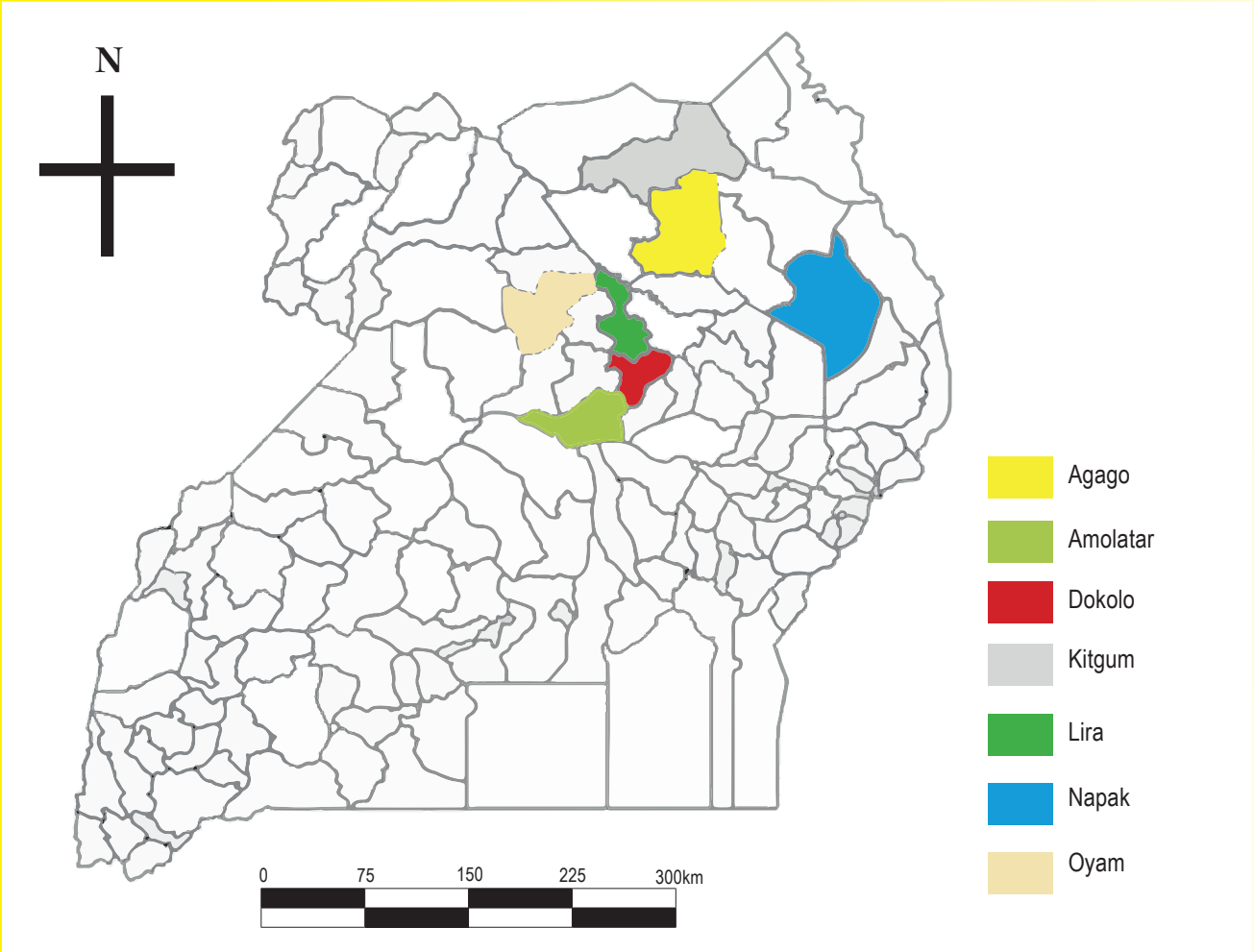


Figure 3: Map of Uganda showing ProCSA project districts

In accordance with the Local Governments Act 1997, all the districts have political and administrative structures at higher and lower levels of local government. The political head in the district is the district chairperson, who is elected by universal adult suffrage. The District Chairperson (Local Council V) heads the district council, which is made up of councillors representing electoral areas (sub counties and municipalities) in the district. At lower local government level, political leadership includes a sub county council and other local council leaders up to village level (LC I). Every district additionally has a Resident District Commissioner, who among other things, advises on, supervises and monitors the implementation of central government policies and programmes in the district. The administrative arm of leadership is headed by the Chief Administrative Officer and heads of department in different departments, with technical assistants at lower local government level.

3.1.2 Socio-cultural context

The four districts of Lango sub-region (Oyam, Lira, Amolatar and Dokolo) have the Lango people as the main ethnic group, with Lango as the language spoken. Culturally, the Lango people have a spiritual and political head, the Won Nyaci, who heads all cultural institutions in the sub-region and is based in Lira. The main ethnic group in Acholi sub region is the Acholi people who are led by a paramount chief, also referred to as Rwot. Within the two chiefdoms of Acholi and Lango are clans, which tend to be defined in terms of kinship (Hopwood, 2015). Both the Acholi and Lango people belong to the Luo group of Nilotic languages. As a result of employment, business and/or marriage, other less dominant tribes inhabit the two sub-regions, notably the Iteso, Baganda, Bagishu, Karimojong, Kumam, Jie and other nationalities. Napak District is dominated by Karimojong, the Nilotic ethnic group with two tribes, the Bokora who are mainly concentrated in the rangelands, and the Tepeth tribe who live on the mountains (UNDP, 2014). Other less dominant tribes in Napak include the Iteso, Acholi, Langi, Baganda, Bagishu, Somalis, among others.

Across the districts, the female population almost matches the male population, with females at 51 percent and males at 49 percent of the total population, except for Napak, where females comprise 54 percent of the population and males are 46 percent (UBOS, 2014). The average household size across the seven districts is five members (UBOS, 2014). In six out of the seven districts (Oyam, Amolatar, Agago, Lira, Kitgum and Dokolo), male-headed households range from 75 to 79 percent of the total households in the district, while female headed households range from 21 to 26 percent of the total households (UBOS, 2014). In Napak male headed households form 69 percent of the total households, while female headed households account for 31 percent (UBOS, 2014). In all the seven districts, the population aged 18 to 30 years is less than 25 percent, while the age group (0 to 17 years) is above 54 percent (UBOS, 2014).

The poverty level in Northern Uganda is 32.5 percent, which is higher than the national average at 21.4 percent. Within the region, Karamoja sub-region has the highest poverty level at 60.2 percent, followed by the Acholi sub-region at 33.4 percent and the Lango sub region at 15.6 percent respectively (UBOS, 2018). Linked to poverty are the high levels of illiteracy among the population across the seven districts, especially among women. Whereas the gap in illiteracy level between men and women in Napak District is narrow (74 percent male, 86.4 percent females); the gap in illiteracy levels is much wider among males and females in other districts as shown in Figure 4 (UBOS, 2016). Figure 4 also reveals that illiteracy levels are higher among males and females in Dokolo, Agago and Napak districts, compared to Amolatar, Lira, Oyam and Kitgum districts respectively.

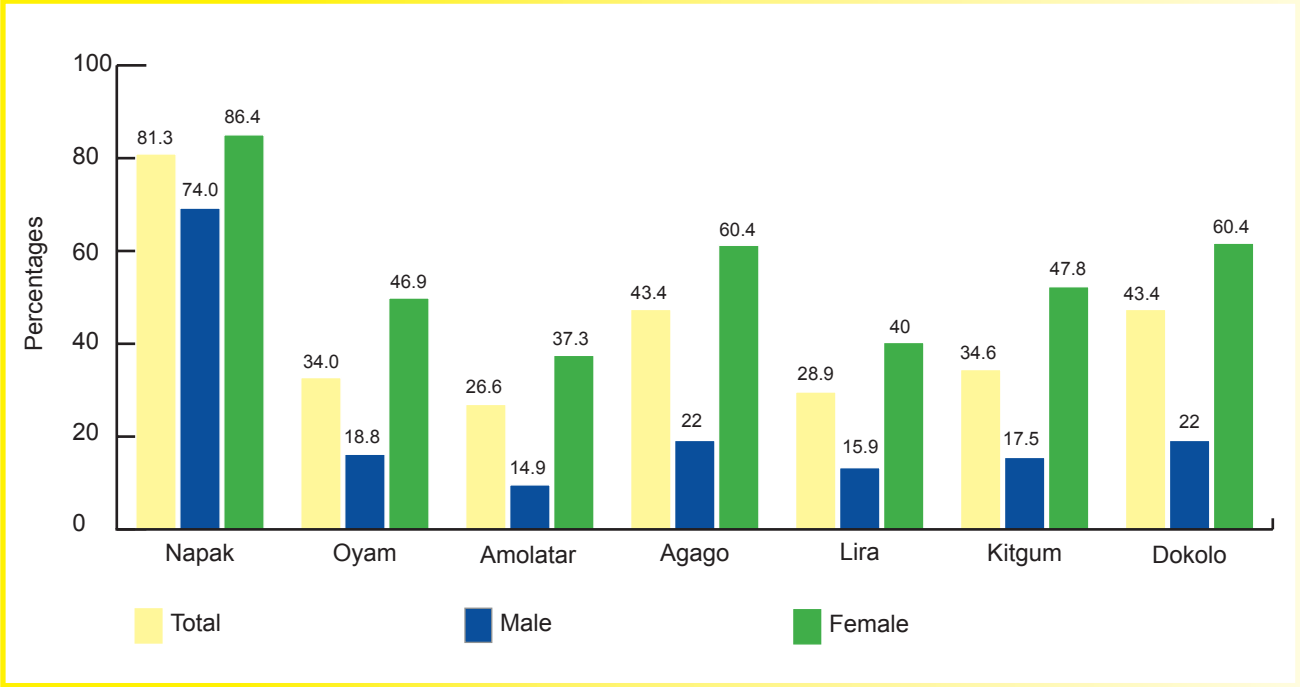


Figure 4: Illiteracy levels (in percentage terms) by gender and district

In the Acholi and Lango sub-regions, culture dictates that land is communally owned by clan members. In all the six districts, men as household heads have authority over the entire household and control land, livestock, cash crops, income and household labour. As asserted by one female discussant in Lira "the overall control rests with the men, since when a woman leaves a marriage, she leaves everything behind". Women have partial control over land use and may take decisions when the male spouse is out of the home. For instance, if a woman knows the household land boundaries, she may represent her husband in settling land disputes. Although female discussants generally expressed having joint decision-making ability with the male spouses, the final decision always rests with the male spouse. However, women's consent is normally required for the sale of major household assets like land and, in some cases, livestock, with some women seeking the intervention of clan leaders where men were insistent on selling. Similar findings were in Karamoja (Napak), with men controlling land, livestock, and income of the household owing to the popular belief that assets can be forcefully taken from women if left in their control. In Napak, women have the sole responsibility of managing the home, including construction of the house and feeding the family.

Across the districts, female discussions revealed that women in households mainly control food stocked in the house, as ascribed by their responsibility for caregiving to other household members. Women decide on what gets eaten, what gets stored for the next planting season and how much food may be sold. Many women also control some household assets such as small ruminants (goats, pigs, and sheep) and poultry and may also control the income generated from women-owned enterprises. In Oyam district, it is a common practice for land to be leased during crop seasons. Some women who rented land also had control and decision-making power over its use over the lease period.

Whereas non-agricultural livelihood activities (such as collecting firewood, fetching water, household chores) are predominantly the responsibility of women and girls across the seven project districts, some men and boys were reported to assist if women were ill. Other farming responsibilities are undertaken by different household members, with some differences across the districts as explained in Table 5.

Table 5: Farming responsibilities by gender and district

Activity	Responsibility				Districts	Remarks
	Men	Women	Boys	Girls		
Land preparation	✓		✓		Amolatar, Oyam, Lira	It is traditionally a male's role to open land.
	✓	✓	✓	✓	Dokolo, Agago, Napak, Kitgum	Every household member participates to ensure planting is done in time.
Seed acquisition	✓				Amolatar, Dokolo Napak	Men buy seed for cash crops, while women use seeds reserved from the previous harvest.
	✓	✓			Oyam, Lira Agago Kitgum	Seed acquisition is mostly done by women who are perceived to distinguish quality seed better than men. Some men buy seed for cash crops.
Planting	✓	✓	✓	✓	All	All able-bodied persons in the household participate including children if not in school. In Agago, sowing of simsim is mainly done by men who are better skilled at it.
Weeding	✓	✓	✓	✓	All	Men and boys weed cash crops, particularly those planted in rows (maize, cotton, sunflower, cassava). Women and girls mainly weed food crops and some cash crops. While millet is also a male crop in Dokolo, the weeding of millet, simsim, sweet potatoes sorghum and groundnuts is mostly done by women and girls in other districts.
Pest and disease management	✓			✓	All	Single women hire men to spray their crops. A few women participate. Men are perceived to be knowledgeable of the types of pesticides and correct mixes better than women. Men are also perceived to be better at handling toxic chemicals than women.
Harvesting	✓	✓	✓	✓	Lira, Dokolo, Amolatar, Agago, Kitgum, Napak	Men mainly harvest cash crops while women harvest food crops. For crops like simsim, men construct drying racks, while women harvest. Harvesting of crops is mainly done by women in Oyam. In Napak, men harvest maize, sorghum and women carry the crops home.
Post-harvest handling		✓		✓	All	The activities of drying, threshing, cleaning, sorting and packing are mostly done by women. Some men participate in post-harvest handling of rice in Lira; soya in Oyam; maize, sunflower and cotton in Amolatar.

Activity	Responsibility				Districts	Remarks
	Men	Women	Boys	Girls		
Marketing (produce)	✓				Amolatar, Oyam, Lira, Dokolo, Agago	Marketing is predominantly done by men. Some women sell small portions of surplus food in local markets.
	✓	✓			Kitgum Napak	Women and men participate in marketing, which is mostly done through bulking. Some farmers individually identify markets. In Napak, women mainly market crops like sorghum, while men market livestock.
Fishing	✓	✓	✓	✓	Dokolo Amolatar Oyam	Fishing in open water bodies is mainly done by men and adolescent boys. Women and some girls use baskets to fish in swamps
Building kraals	✓		✓		All	A male activity across the districts.
Acquisition of animals	✓		✓		All	Some women participate in acquisition of small animals like pigs, goats and poultry
Grazing	✓		✓		All	Some women and girls may participate in grazing where male household members are not present. Women normally tether animals, men do open grazing.
Parasite control	✓		✓		All	Some women in Napak participate in washing and injecting (treating) livestock.
Marketing of livestock	✓		✓			Some women in Dokolo participate in selling goats, pigs

Source: Authors' own summary of primary data

3.1.3 Institutional context

The institutional context of the region consists of formal institutions (laws, policies, ordinances, by-laws, regulations), whose breach is officially sanctioned; and informal institutions (socially shared rules, norms, values), which govern the acceptable behaviour of respective communities. Under Uganda's decentralised system, all district local governments are mandated to comply with relevant laws and policies set at the national level and may originate context-specific (district-level and sub-county level) ordinances/by-laws that must be scrutinised and approved at national level by the Office of the Attorney General before becoming operational.

Expert interviews across the districts, as well as a secondary search of the Uganda online law library, revealed the following formal institutions (some still under development) in some of the districts as summarised in Table 6:

Table 6: Formal institutions related to climate change by district

District	Formal institutions
Napak	• Environmental conservation ordinance awaiting approval by the Office of the Attorney General. • Communal land ordinance, which is yet to be passed by the District Council. It gazettes land for grazing only. • By-law in Lopei sub county that bans charcoal burning. • By-laws in Nabwal sub county that ban cattle theft and tree cutting • Communal grazing ordinance developed with the support of Land and Equity Management of Uganda (LEMU).
Oyam	• Ordinance meant to protect wetlands from encroachment is being drafted
Amolatar	• An Ordinance on environment and natural resource conservation is being drafted with the aim of reducing tree cutting.
Agago	• An Ordinance on environment and natural resource conservation completed in November 2018 • By-laws in some sub counties that restrict tree cutting of Afzelia africana and Shea species • By-laws in 7 sub counties on environmental conservation aimed at protecting tree water shades under the Watershed Project of the district. • East Acholi Land Management Plan (to be ratified by the district) • Acholi Sustainable Charcoal Marketing and Production (to be ratified by the district) • District climate change bill is being drafted.
Lira	• Prohibition of trade, distribution, use and possession of counterfeit agricultural inputs ordinance, 2017 • Regulation of post-harvest handling, storage and marketing of agricultural produce ordinance, 2017 • Lira Municipality solid waste management by-law 2006
Kitgum	• Acholi Sustainable Charcoal Marketing and Production (to be ratified by the district) • Crop and livestock production, marketing and trade ordinance • Indigenous tree cutting and charcoal production ordinance and by-laws. This bans charcoal burning on large scale for commercial purposes (to be ratified by the district). • By-law in Orom sub county on management of problem animals. • By-law on shea nut conservation in Omiya Anyima and Lagoro sub counties. • A Food security ordinance mandating every household to have an acre of cassava and sorghum for food security is awaiting approval by the Office of the Attorney General.
Dokolo	• Dokolo District Disaster Management Ordinance developed in 2017 was submitted to the Attorney General for approval. It is aimed at protecting wetlands and lake shores, waste management and promoting tree planting. It also includes a clause on the installation of lightning arrestors on school buildings.

As can be seen from Table 6, the policy environment regarding environmental conservation and sustainable natural resource management is largely in infant stages across the districts. Most of the ordinances are either in the process of being drafted or are awaiting approval by the Office of the Attorney General, implying that they are not yet operational. Other challenges affecting the effective enforcement of ordinances and by-laws across the districts were mentioned as follows:

- Inadequate awareness among communities of the effects of environmental degradation and its relation to climate change. District-level experts, especially from government, expressed a low turn-up by community members at sensitisation meetings organised at sub county-level, which limits the spread of information. Many community members are motivated to attend meetings if there is a reward (money, refreshments, etc) expected from attendance and tend to shun meetings where no reward is given.

- Inadequate funds, technical personnel and transport to reach all communities in the district to conduct sensitisation meetings and enforce national- and district-level policies and ordinances. In addition to the resources being inadequate, local government experts expressed a problem of late release of funds from central government which stalled the implementation of planned activities.

- Resistance among communities, especially those who depend on the sale of fuelwood, charcoal and timber as an important source of livelihood. For instance, some households in Napak do not cultivate food and rely on income from fuelwood and charcoal trade to provide for their household needs.

- Limited political will and corruption hinder law enforcement. Some leaders intentionally violate the law, while others protect the offenders in exchange for favours like bribes.

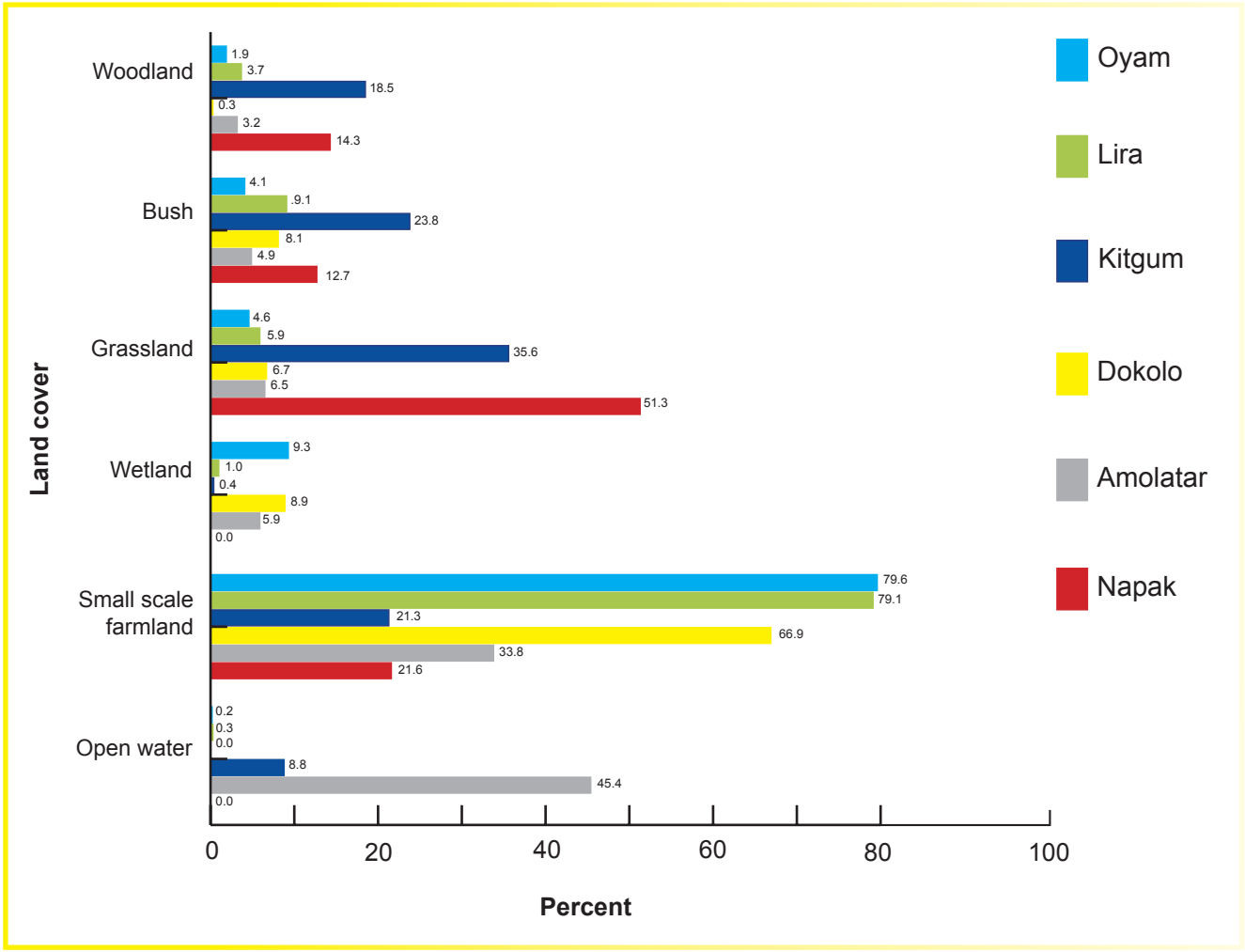
- Cheap penalties for offences. Some offenders willingly commit offences like tree cutting and mass transportation of charcoal, with the intention of knowing that they will pay a fine if apprehended.

Regarding informal institutions, cultural leaders and community members revealed the existence of informal groupings, mostly organised around clans (led by a clan head and elders), economic issues (Village Savings and Credit Associations (VSLAs), farmer groups, farmer associations, cooperatives), and social issues (saving for eventualities such as chronic illness, burials, social functions). Across the districts, no local groups were mentioned that are organised around environment and climate change issues, except for one group 'Lobulepeded' in Napak that is a water user committee[3] . According to a cultural leader in Agago, clans have rules and procedures that must be followed, with sanctions enforced on errant members. Many of the economic groups were formed with facilitation from external parties, such as NGOs and Government (Uganda Women Entrepreneurship Programme, Youth Livelihood Programme, NUSAF, and PRELNOR) with specific provisions for the inclusion and participation of women, including in group leadership roles.

3.1.4 Environmental context

The Acholi and Lango sub regions in northern Uganda are endowed with natural resources, including dry woody savanna forests, wetlands, papyrus swamps, palm trees, rivers, lakes (Kyoga and Kwania) and a National Park (Murchison falls) (Ngetta ZARDI, 2020). Across the districts, the land cover mostly comprises small scale farmland, accounting for over 65 percent of the total land cover in Lira, Oyam and Dokolo; and less than 34 percent of the land cover in Amolatar, Kitgum and Napak respectively (National Forestry Authority, 2009), Across the districts, with the exception of Napak and Kitgum, woodland, grassland and bush constitutes less than 10 percent of the total land cover; and in all the districts, wetlands constitute less than 10 percent of total land cover. Among the seven districts, only Amolatar and Dokolo have significant cover of open water as shown in Figure 5.

Figure 5: Land cover distribution by district as a percentage of total land area as at 2005[4]



Source: Adapted from National Forestry Authority (2009: 33-34).

As shown in Figure 5, small scale farmland takes precedence over other forms of land cover in the districts, apart from Napak and Kitgum, which are more dominated by grassland. Three out of the seven districts are sparsely populated, notably Napak with 29 persons per km2, Kitgum with 51 persons per km2 and Agago with 65 persons per km2 respectively. The more densely populated districts are Lira (307 persons per km2), Dokolo (182 persons per km2), Oyam (175 persons per km2), and Amolatar (127 persons per km2) respectively. The less densely populated districts (Napak, Kitgum and Agago) have lower population growth rates under 2 percent per annum (2002-2014) compared to the more densely populated districts of Lira (2.8 percent), Amolatar (3.6 percent) and Dokolo (2.9 percent). Population pressure in the latter districts is anticipated to further increase the demand for small scale farmland and

woodland for fuel, further depleting the natural resources (mostly wetlands and forests). Overgrazing, reported in Etam Sub County, Amolatar district has also contributed to environmental degradation through soil erosion while bush burning, mostly in Napak, Agago and Kitgum exposes the soil surface to erosion by strong winds and surface run-off. Table 7 highlights other environmental and bio-physical attributes of the respective districts.

[3]Local groups on environment issues might be in existence, much as discussions and interviews did not reveal them. It should be noted that the samples were not entirely representative.
[4]Agago district was not yet established by 2005, but bears similarity in characteristics as Kitgum District

Table 7: Elevation, climate and vegetation by district

District	Elevation (Average altitude above sea level)	Climate	Vegetation	Average annual rainfall (mm)
Napak	1,440m	Semi-arid with one intense hot season from November to March. The hottest months are January and February at an average daily temperature of 33.5˚C. The wet season is from April to August with a marked minimum in June and marked maxima in May and July. Average daily minimum and maximum temperatures from October to December are 15˚C and 29.5˚C respectively.	Typically, semi-arid with dry savannah tree species and predominantly grass species. Other features are forests at high altitudes (dry montane), savanna woodland, semi-evergreen thickets, deciduous thickets, riparian communities, grass steppe communities	300-1200
Oyam	1,150m	Tropical savanna climate modified by R. Nile in the south-west part of the district and swamps in most parts. The rainfall pattern is bimodal with one peak from April to May and the second peak from August to October. Rainfall is well distributed across the sub counties. Average daily minimum and maximum temperatures are 17 ˚C and 29˚C respectively	Open canopy of trees of 10-12 metres high and underlying grasses of 80cm high. Tree species are fire-resistant and able to regenerate. Common species are acacia, *Ficus Natalensis, Contyetum, Banasus, Aethicpum* (Fan palm), with increasing coverage of introduced species like eucalyptus, Jacaranda, *Cupressus, Theruvian*, pines, hibiscus, bougainvillea and flamboyant[5]	1200-1600
Amolatar	1,043m	Continental climate modified by the presence of L. Kyoga and L. Kwania. Rainfall follows a bimodal pattern with one peak in April to May and the second peak from August to October. Average daily minimum and maximum temperatures are 22.5 ˚C and 25.5˚C respectively	Typically, savannah vegetation (mainly woodland) which is fast becoming grassland.	1200-1600
Agago	1,150m	The rainfall pattern is unimodal with one wet season from April to October with the peak between May and August. The dry season runs from November to March. Average daily minimum and maximum temperatures are 17 ˚C and 29˚C respectively	The vegetation is predominantly savannah type comprising species like *Hyperhania, Terminalia, Acacia, Vitellaria paradoxa* and *Butterspermum* species. Isolated spots along the river have forest type vegetation. Rivers and streams are seasonal and normally dry up during the dry season.	1,330

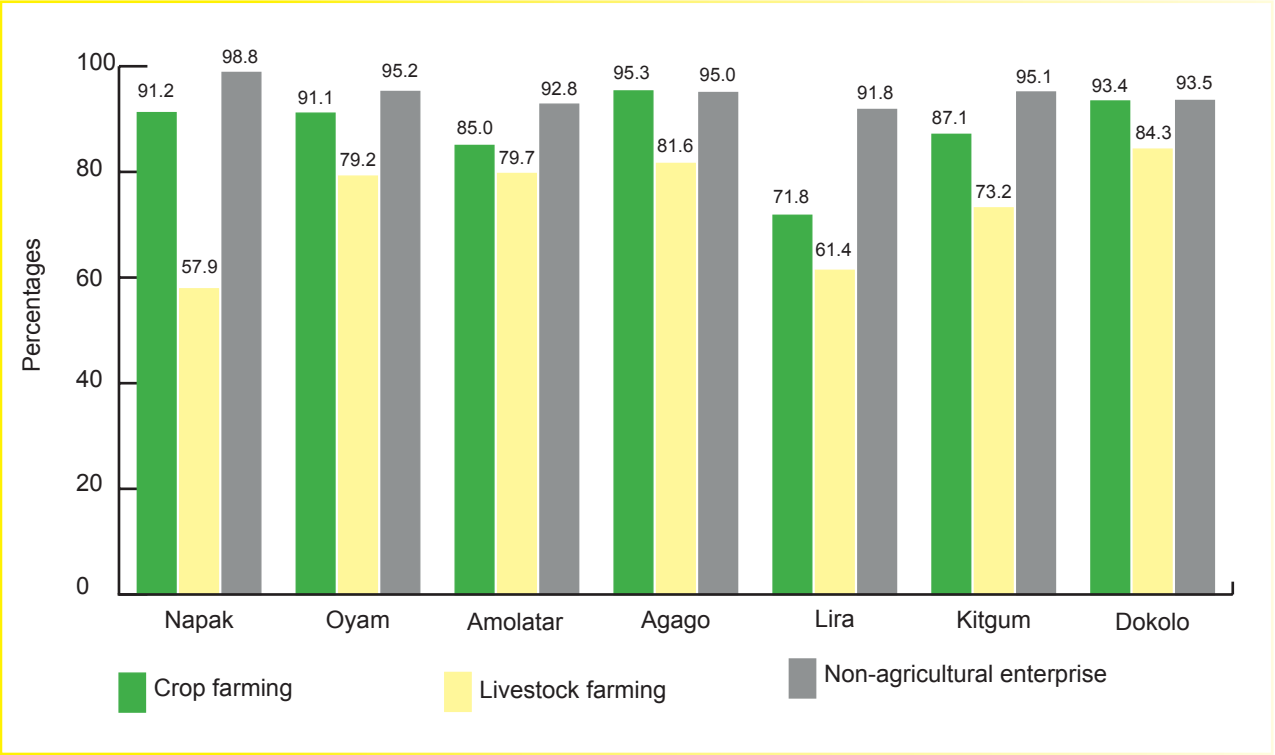
[5]Source: Republic of Uganda (2014)

District	Elevation (Average altitude above sea level)	Climate	Vegetation	Average annual rainfall (mm)
Lira	1,100m	The rainfall pattern is bimodal with one peak from April to May and the second peak from August to October. The rainfall is mainly convectional rainfall in the afternoons and evenings. Average daily minimum and maximum temperatures are 22.5 ˚C and 25.5˚C respectively.	The natural vegetation is savannah vegetation with scattered trees.	1200-1600
Kitgum	1,525m	The district has two climatic zones; a medium rainfall area receiving 800-1000mm of rainfall per annum (Akwang, Kitgum Matidi, Amida, Town Council, Lagoro, Omiya Anyima) and a low rainfall area receiving less than 800mm per annum (Mucwiny, Orom, Namakora). Rainfall follows a bi-modal pattern starting in late March to April with the peak in April to May and the second peak from July to October with the peak in August and September. Average daily minimum and maximum temperatures are 17 ˚C and 27˚C respectively	The natural vegetation is mainly grasslands, bushland and woodland. Dominant grasses are *Hyparrhenia, Panicum, Brachiaria and Seteria spp*. Dominant trees include: *Acacias, Cambreliums, Terminalia, Vitalleria Paradoxa, Bridelia and Bauhinia.*	1300
Dokolo	1,080m	Equatorial/ tropical climate with a wet and dry season. The rainfall pattern is bimodal with the two peaks in April to May and September to October. Average daily minimum and maximum temperatures are 21 ˚C and 33˚C during the dry season and 19 ˚C and 32˚C during the wet season respectively.	The whole district is mostly tropical savannah and is dominated by tree species such as *Combretum spp, Albezia spp* and *Acacia spp*.	1,307

3.1.5 Economic context

For all the seven districts, agriculture is the main source of livelihood for most households. Households mostly engage in crop farming, livestock rearing (cows, goats, pigs, and sheep) and poultry keeping (chicken, ducks, pigeons). In some of the districts with several water bodies (rivers, swamps, lakes), namely Amolatar, Agago, Lira and Dokolo, fishing (capture fishing and/or aquaculture) was reported as an important enterprise from which households derive livelihoods. Apiary was also reported as a livelihood source for some households in all the districts, apart from Napak. According to the national population and housing census of 2014, and as affirmed by interviews and guided discussions, crop farming is the main agricultural enterprise practiced by households across all districts, with livestock farming being a secondary enterprise. Over 60 percent of the households in all the seven districts depend on subsistence farming as the main source of livelihood, although almost all households (above 90 percent) have at least one household member engaged in a non-agricultural household-based enterprise (see Figure 6).

Figure 6: Sources of livelihood for households by district as at 2014



Source: Adapted from UBOS (2016)

The most common food security enterprises across the districts include millet, cassava, sesame (simsim), groundnuts, maize, pigeon peas, cow pea leaves, green gram and sweet potatoes. The dominant crops grown for income include sunflower, cotton, rice, groundnuts, maize, soybeans, sesame (simsim), chia, beans and high value vegetables such as cabbages, egg plants, tomatoes and okra. Millet is also an important cash crop in Amolatar. Table 8 presents the main crop enterprises for food security and for income by district, as mentioned by farmers in group discussions. A breakdown of crop enterprises by district, gender and age category may be found in Table 13 in Appendix II of this report.

Table 8: Main crop enterprises for food security and income by district

District	Food security crops	Income crops
Napak	Sorghum Maize Beans Groundnuts	Sunflower Sorghum Maize Green gram Vegetables (tomatoes, onions)
Kitgum	Millet Maize Groundnuts Green leafy vegetables Sweet potatoes	Sunflower Sesame (simsim) Cotton Sorghum
Agago	Millet Maize Groundnuts Sesame (simsim) Green leafy vegetables	Sunflower Cotton Soybean Sesame (simsim) Cassava
Oyam	Maize Millet Beans Cassava Sweet potatoes	Soybean Maize Sunflower Cotton Sesame (simsim)
Lira	Pigeon peas Cassava Millet Beans Groundnuts	Maize Sunflower Soybean Cotton Rice
Amolatar	Cassava Maize Millet Beans Sesame (simsim)	Sunflower Soybean Cotton Maize Millet
Dokolo	Millet Sesame (simsim) Cassava Maize Groundnuts Beans	Sunflower Soybean Maize Cotton Cassava Rice

Source: *Authors' summary of focus group and expert interview responses.*

Across the seven districts, the common non-agricultural enterprises for men and male youth were mentioned as construction work, charcoal burning and fuel wood trade, retail trade in household items, brick making, transport (bodaboda), livestock trade, produce trade and bicycle repair. Sand mining and/or stone quarrying were also reported in Agago, Napak, Amolatar and Kitgum. Other non-agricultural enterprises for men in Napak included milk trade, granary construction and the gathering and sale of building poles. The common non-agricultural enterprises that women and female youth engage in include alcohol brewing, food vending in local markets (porridge or cooked food), hair dressing, craft making, shea nut collection and processing (in Agago), and petty trade in fresh food items and silver fish.

The choice of enterprises by men was generally influenced by the need to meet major household expenses including school fees, medical expenses, clothing, feeding and investments such as purchasing land and livestock. Women, on the other hand, are influenced by the need to provide food for the family, while the youth engage in income generating enterprises to pay school fees (those in school) and meet personal needs. Male youth in the region also engage in enterprises to afford livestock for dowry. Discussions with male and female farmers revealed that men generally earn more income throughout the year than women, as they mostly engage in income generating enterprises (agricultural and non-agricultural) and can sell all their crop products after harvest. In contrast, women mainly earn from petty trade of surplus food items, which are often sold in small quantities. The women reported that they seldom accumulate large savings, as most of what is earned is spent on immediate necessities like buying salt, cooking oil and other household needs on the same day that the income is earned.

Across the districts, the main challenges to livelihoods were mentioned as follows:

- Crop losses or low yields and low incomes. These result from the unpredictability of rainfall seasons, prolonged dry spells, outbreaks of crop and animal pests/parasites and diseases, the dominance of subsistence production and the use of traditional farming practices. Household incomes are also affected by: the absence of proper storage facilities and structured markets (forcing farmers to sell at low prices without bulking); fluctuating and often low market prices offered by middlemen; lack of equipment for value addition of produce; and poor road access to markets, especially during periods of excessive rainfall, among others.

- Inadequate access to information, including good agronomic practices and livestock management, weather information, climate change and CSA, and available and/or potential markets. The high levels of illiteracy, especially among women, hinder their selection as targets for capacity building interventions and effective participation in development programmes.

- High levels of alcoholism and/or drug abuse affect household productivity and increase the dependence burden on productive household members. There are also high levels of unemployment among the youth aged 18-30, especially in Napak (31.1%).

- Inadequate access to agricultural credit and insurance services within the sub counties. Across the 28 sub counties visited under the study, observations revealed a general lack of formal banking institutions.

3.2 Farming systems

The farming systems in Uganda are closely linked with climatic differences, relief variation and socio-economic characteristics (MWE, 2019). Across Uganda, farming systems are mostly subsistence in nature consisting of mixed (crop and livestock) farming. Perennial crops are mainly grown in areas with high annual rainfall ranging from 1000mm to 2000mm, while annual crops are mostly grown in areas that receive low rainfall (500mm to 1000mm) (Mayanja et al., 2014). Different authors make varying categorisations of farming systems in Uganda, resulting in variances in the number of recognised systems. This report adopts the categorisation in Mayanja et al. (2014), which classifies the farming systems under the ProCSA project area into three: the Annual Cropping and Cattle Northern system covering the districts of Kitgum, Agago, Oyam, Lira, Dokolo and part of Amolatar; the Millet-Cotton system covering part of Amolatar; and the Pastoral-Some Annual Crops system in Napak.

According to interviews and discussions with respondents in the six districts of Lango and Acholi sub regions, crop production takes precedence over livestock rearing, with the latter regarded as a supplementary enterprise. Culturally, every household rear at least one animal, with small animals (sheep, goats, pigs and poultry) more commonly kept among households compared to cattle. The north and north-eastern parts of Napak, which are drier, are predominantly reliant on livestock rearing (East African short-horned Zebu, Karamoja goats, sheep, poultry, some donkeys) as the primary livelihood activity, while the green belt areas of the district (south and south-western parts) mainly practice crop production, with livestock rearing as a secondary enterprise. Similarly, livestock rearing as a primary enterprise is common in the drier sub counties of Amolatar, such as Etam, where open grazing is carried out for cattle, while goats and sheep are mostly tethered. Across the districts, discussions with farmers revealed the absence of fertilizer application to agricultural fields, with the exception of Dokolo and Amolatar District, where minimal use of organic fertilizer was reported; and Lira, Oyam, Dokolo and Amolatar Districts, where some farmers (especially vegetable farmers and those located around the irrigation scheme) reported the use of both synthetic and organic fertilizer inputs.

As can be seen in Table 8, the commonly grown crops in the project area are dryland cereals (sorghum, pearl millet, and finger millet), dryland legumes (groundnuts, beans, pigeon peas, and green gram), oil crops (sunflower, cotton) and root crops (cassava, sweet potatoes). Intercropping of food crops is a common practice among farmers across the districts for reasons including limited agricultural land available to households and the time saved during the crop production cycle (the land is prepared once, and different crops are planted on the same field at successive intervals). The common combinations of crops in household fields are root crops with legumes (groundnuts and cassava); cereals only (millet and sorghum, or maize and sorghum); cereals with legumes (maize and beans; groundnuts, peas and maize), among others. In contrast, cash crops such as sunflower and cotton are mostly grown as monocrops. Fruit production (mainly citrus fruits) is also common, especially among the districts in Lango sub-region.

3.3 Gendered perceptions of climate change and variability, risks and vulnerabilities

Across the seven districts, focus group discussions held with male and female farmers alike revealed some level of appreciation of the climate change concept through a description of its manifestations. Some of the descriptions of climate change given by the farmers included: *"changes in weather patterns," "too hot days and too cold nights," "too much sunshine or too much rain," "droughts and floods," "seasons with fall army worm infestation," "strong winds," "delayed onset of rains" and "changes in expected yields from one season to the next."*

The dominant climate risks across the districts were drought and floods. Across the districts, however, drought occurred more frequently and therefore affected households more compared to floods. Farmer group participants and interview respondents in the respective districts were asked to mention the observed changes in climate and associated vulnerabilities over the last decade. Table 9 summarises the responses received by district.

District	Observed climate risks	Vulnerabilities
Napak	• Drought in 2015 and 2016 • Too high temperatures in 2017 • Excessive rainfall in 2015 and 2018 • Fall army worm infestation • Flooding in Iriri Sub County in 2017 • Shift in the onset of rains from March to late April or early May	• Heavier burden on women, who bear the responsibility of providing food for the household during drought • Poorer households that are dependent on rain-fed subsistence farming for livelihoods suffer the most during drought with high food insecurity. • Domestic violence, divorce and separation during drought. Polygamous men often abandon the homes of wives who are unable to provide enough food and at times never return, leaving the entire responsibility for the home to the female spouse.
Oyam	• Shift in the onset of rainfall from March to May, with rainfall lasting longer (since 2016). • Longer dry spells (2014 to 2017). The dry spell stretches from December to May instead of only the month of June. • Hailstorms in some sub counties such as Otwal in 2018 and 2019. • Erratic rain in 2018. Rainfall started in March and lasted one month, followed by a dry spell. • Excessive rain in 2015. • Heat waves. • Strong winds	• Acaba Sub County gets most affected by hailstorms, drought and excessive rain. • Strong winds with rain destroy huts (roofs) and flood houses, causing loss of property to households residing in poor dwellings. • Women's workload increases during periods of strife. On top of the routine responsibility of the women at home and on-farm, many (poorer) women offer labour to other households to provide food for their own families. • Lower income households that are largely dependent on rain-fed subsistence lose all their crops.
Amolatar	• Excessive rainfall in 2015 and 2019 which caused flooding in some sub counties like Muntu. • Hailstorms in Muntu during 2016. • Shift in the onset of rain from March to April. • Fall army worm infestation in 2017	• Households residing in lowlands are the most affected by floods. • Poor and average income households make entire crop losses during drought. Such households plant on small plots of land and are unable to harvest anything during a poor season compared to higher income households with larger expanses of crops in the field, who may salvage some crops. • Women's workload is increased because they must move longer distances to obtain clean water.

District	Observed climate risks	Vulnerabilities
Agago	• Prolonged dry spell in 2009, 2015, 2017 and 2018 • Erratic rainfall in 2018. The rainy season was from March to June, followed by a dry spell from July to November. • Excessive rainfall in 2019. • Hailstorms in Lapono in 2019. • Changes in weather patterns. Before 2016, the rainy season was from March to June, now it is from May to October. • Famine in 2013.	• Poorer households that solely depend on rain-fed subsistence crop production using traditional methods and tools are unable to complete land preparation on time to match the erratic rainfall seasons. • Women's workload on farm is more strenuous during drought as they must till very hard ground under high temperatures. • Women also must move long distances in search of water and food during drought. Firewood is also hard to access during the periods of excessive rain.
Lira	• Drought in 2011, 2015 and 2017. • Delayed onset of rainfall in 2015 and 2019 • Excessive rainfall in 2019 • Outbreaks of pests and diseases on maize and cassava fields.	• Households in lowlands such as Agweng experience flooding of homes and fields. • Strong winds destroy household property after roofs are blown off. • Women face the increased burden of being solely responsible for feeding the household during drought, having to take on other odd jobs to provide food.
Kitgum	• Late onset of rainfall, starting in April or May instead of March • Prolonged dry spells in 2013/2014 and 2018/19. In the latter period, the dry spell was from November to May. • Excessive rain causing flooding in low-lying parts of the district.	• Women suffer from increased workloads during drought, as they must weed the garden more often; move to far-off distances in search of food and water and attend to other household chores. • Men engaged in livestock rearing must move to distant locations in search of pasture and water. • All household members are normally affected when there is excessive rain. Joint effort is required to dig channels to drain the flooded water, as well as harvest crops before they get destroyed in the field.
Dokolo	• Prolonged dry spells in 2008, 2015, 2016, 2017 and 2018. • Flooding in Kangai Sub County in 2012. • Excessive rainfall during 2019.	• Poorer households without alternative sources of income (besides agriculture) are the most affected during drought. • Some men abandon farming during drought, leaving additional responsibility to the woman to take on their tasks on-farm. • Women have limited alternative sources of income and continue with agricultural activities even under harsh weather conditions.

Source: Authors' summary of primary data.

3.4 Impacts of climate change and variability on agriculture, food security and incomes

3.4.1 Impact on agriculture

The impact of climate change on agriculture becomes evident in the agricultural production cycle and the productivity of agricultural enterprises. Across the districts, common impacts of climate change on agriculture were expressed as follows:

- Shifting onset of rains has led to false prediction of rainy seasons by farmers. Farmers plant at wrong times, resulting in to crop losses/low yields.
- Over the years, invasive weeds such as "Witch weed" (Striga Asiatica) have become prevalent in the region affecting crop growth and development. The recurrence of the weed is burdensome to farmers who expressed having to weed more often to be able to get better crop yields.
- Heat stress hampers crop growth. For instance, when there is excessive heat, rice fields are affected, and groundnuts mature without flowering (Dokolo). The resultant effect is lower than anticipated crop yields. At the onset of rains following a prolonged dry spell, diarrhoea is widespread among livestock after consuming fresh grass.
- In events of excessive rainfall, crops get destroyed in the fields. For instance, sorghum flowers too early, cassava rots in the soil, while ripe millet tend to germinate while in the field.
- Recent years have seen increasing outbreaks of crop pests (fall army worm) and diseases (groundnut rosette virus, cassava brown streak). Regarding livestock, parasites (ticks) and diseases (swine fever, foot and mouth disease) are also rampant.
- Continuous spraying has also become inevitable for farmers in order to obtain good harvests. This is particularly the case for crops like maize, beans and groundnuts. This increases the cost of crop production.
- During drought, livestock are weakened due to lack of pasture and water. In Napak, farmers are unable to use oxen to till gardens during drought, which increases the demand for and cost of manual labour.
- In the events of flooding there is increased workload involving the entire household to salvage some crops from the household fields.
- Repeated poor seasons discourage farmers from practicing agriculture. Some of the farmers (mostly men) abandon agricultural production and diversify to other activities such as charcoal burning, which are detrimental to the environment.
- Following a prolonged dry season, planting materials becomes scarce causing their prices to increase. Farmers who must re-plant suffer the seed loss and high replacement costs. Some farmers rent out portions of their land to afford seed, which reduces the household's area under crop production.

3.4.2 Impact on food security

The impact of climate change on food security is largely associated with low agricultural productivity. Across the districts, guided discussions and expert interviews revealed the following impacts:

- During drought, food stocks from the previous harvest get depleted, with pressing needs such as school fees and medical bills depleting the food stock at a faster pace.
- During drought, food becomes scarce leading to hiking of prices. Households purchase fewer quantities of food items at higher prices. The food purchased is normally insufficient to maintain the household diet. Consequently, less food is prepared (for instance one cup of beans to feed a household of five) and the number of meals consumed in a day by the household is also reduced.

- Crop failures resulting from heat stress, hailstorms or floods create food shortages among communities, which in turn increase incidences of food theft from granaries or gardens and heighten insecurity.
- Droughts and floods affect accessibility to clean water. Accessing firewood is particularly difficult during periods of excessive rain. Some households are unable to obtain wood fuel or clean water (flooded water mixed with eroded soil, as was observed in Amolatar is not fit for consumption), affecting their ability to prepare meals.
- Excessive rain affects the proper drying of crops (beans, soybean, maize) prior to storage making them susceptible to moulding and the associated aflatoxins that render the food unsafe for consumption.
- Women are also especially affected given their cultural responsibility of ensuring that the household receives meals. Women generally reported instances of having to sacrifice part of their meals during periods of food scarcity, with priority given to feeding children as well as the household head (to avoid domestic violence or desertion). Consequently, women's health is compromised, as they consume less food while performing additional tasks.

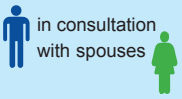
3.4.3 Impact on income

Climate change also impacts on income through reduced production (net produce of a crop farm in a farming season) and productivity (amount of output per unit input). Below are some of the impacts of climate change and variability on income, as expressed by respondents across the districts.

- Climate variability over the years has caused shifts in planting seasons, with some years experiencing only one rain season instead of two (such as 2018 in Amolatar). This affects anticipated annual incomes for farmers who are solely dependent on rain-fed agriculture for livelihoods.
- Many low-income households across the northern region derive their income from offering labour on farms of better-off households. Prolonged dry spells in the absence of irrigation facilities result in reduced farming activity. Consequently, the income source of such households is affected and by extension, food security.
- Seasonal movement of livestock in search of pasture and water during drought (especially in Napak) exposes the livestock to theft and consequently losses to the affected farmers.
- During drought, thinning of livestock is prevalent, as well as reduction in milk production. Farmers trading livestock fetch lower market prices, while farmers involved in milk trade make lower sales and ultimately low income.
- In 2017, migratory birds in Napak infested sorghum and sunflower (cash crops), leading to lost income for the affected households.
- Erratic rain seasons affect the quality and quantity of yields, fetching lower market prices from middlemen, especially for cash crops.
- Excessive rain affects the proper drying of cash crops like cotton and groundnuts causing losses to farmers at post-harvest stage.

3.5 Adaptive capacities and coping strategies of farmers

Separate guided discussions held with male and female farmers across the seven districts sought to understand the coping strategies undertaken by farmers to counter the impact of climate change and the respective adaptive capacities. The coping strategies undertaken were mostly influenced by food insecurity among households as summarised in Table 10:

Coping strategy	Persons (men/ women)
Providing labour on fields of better-off farmers in exchange for wages, food or seed for planting.	Mostly 
Migration to towns to offer casual labour (loading trucks, construction work) or security guard work.	Mostly  **18-30** years
Borrowing from VSLAs to purchase food. Repayment of the loans is normally done at the end of the year after receiving proceeds from harvests.	
Sale of portions of household assets (mostly livestock or land) to purchase food and meet other pressing household needs. This is usually done as a last resort measure.	 in consultation with spouses
Dependence on remittances from better-off relatives in form of food or money.	
Collection and consumption of wild roots and vegetables during famine.	
Sparing preparation and consumption of stocked food to ensure that it feeds the household for longer, including reducing the number of meals consumed in a day.	
Temporal migration from flooded ground to higher ground (either rented or borrowed land) until the water level recedes.	
Cultivation of vegetables in wetlands or along riverbanks for home consumption and sale during drought.	Mostly 
Diversification to non-agricultural activities such as brick making, charcoal burning, sand mining, stone quarrying	
Diversification to non-agricultural activities such as alcohol brewing, petty trade of food items (silver fish, vegetables)	
Doing nothing and waiting for handouts from government or humanitarian organisations	Mostly 

Other seemingly medium- to long-term strategies included investment in livestock as insurance for re-sale during times of strife (men and some women); storage of more food and sale of less during the harvest season (women); saving in VSLAs to accumulate money for use in the event of drought (men and women) and early marriages among female and male youth whose needs were not being met at home. Across the districts, the adaptive capacity among women was generally limited compared to men, as it was influenced by limited access to and control of resources and higher illiteracy, which in turn limited women's access to information and knowledge.

4 CLIMATE SMART AGRICULTURE OPTIONS

4.1 Existing agricultural practices in response to climate change

Across the districts, farmers were asked to describe the agricultural practices and technologies that are currently being implemented among households, farmer groups and communities in response to climate variability and change. The experts interviewed at district level also provided opinions of the practices that have been promoted and adopted among farmers in the respective districts. The common agricultural practices being implemented in Northern Uganda broadly include conservation agriculture (crop rotation and intercropping, crop residue retention), crop diversification, cultivar use; improved livestock management; soil fertility management; apiculture and agroforestry. Some variances were found in the application of practices across districts and sub-regions. While farmers in Lango sub-region (especially Lira and Oyam) had more diverse practices owing to several water bodies, Acholi sub-region (Kitgum and Agago), which is relatively drier, had more limited agricultural practices among farmers. The following practices were found in the respective districts:

1. Conservation agriculture:

The three principles of conservation agriculture are minimum tillage and soil disturbance; permanent soil cover with crop residues; and crop rotation and intercropping. Across the districts, all farmer discussions revealed the practice of permanent soil cover with crop residue following extension advice. Farmers expressed the practice of uprooting or reaping crops such as sesame (simsim), groundnuts, sorghum, and beans, leaving them to dry in the garden and later removing only the pods or grain leaving the residue in the garden to decompose and add nutrients to the soil to enhance the productivity of the next crop.

Crop rotation and intercropping was also mentioned as a practice by farmers across all the districts. Farmers intercrop legumes such as pigeon peas, sesame with cereals and root crops like sorghum and cassava, which fix nitrogen into the soil, while increasing productivity of the cereals. The major

intercrops reported include; pigeon peas and crops such as cassava, sesame, maize among others. Farmers expressed that they carryout intercropping to reduce the amount of time spent in a production field. Some intercrop combinations influence the level of resilience, for example when pigeon peas (drought tolerant) were used in combination with maize (less drought tolerant) improved productivity of the intercrop under harsh conditions.

Regarding minimum tillage, farmers in only one out of the seven districts (particularly Agali Sub County in Lira) expressed the implementation of this practice using ox-drawn rippers – mostly on maize fields – and herbicides in rice fields. In other districts (including Lira) farmers expressed the dominant use of hand hoes and ox-ploughs for opening gardens, the latter of which may be time saving but with negative effects of exposing the soil to erosion. The massive use of ox-ploughs also heightens the release of carbon dioxide into the atmosphere through the exposure of the buried soil organic carbon to oxidative conditions.

2. Stress-tolerant variety use:

Improved varieties are cultivars modified for superior traits such as tolerance to drought, pests and diseases, as well as high yields or high micronutrient density. Due to increased crop failures as a result of drought and erratic rainfall, farmers across the districts reported the increased demand for and use of improved crop varieties. Although the crops grown across these districts are majorly the same, differences exist in the varieties grown. For instance, while PAN 7057 and 7033 (sunflower) are popularly grown in Lango sub region, the two varieties were recently introduced in Acholi Sub-region and are still grown by a few farmers. In Napak, however, local varieties of sunflower are mainly planted. For soybean, older varieties namely NAMSOY1N and NAMSOY2N were mentioned among some farmers in Oyam, Lira and Amolatar, while more recent varieties such as MAKSOY3N, MAKSOY4N, to MAKSOY6N were mentioned in Oyam, Dokolo, and Lira. The latter could be explained by the presence of several agro-input dealers and agro-processors in Lira town. Similarly, while farmers in Acholi and Karamoja sub regions mentioned the use of NASE series (NASE 14, 16, 17) for cassava, farmers in Lango sub-region are using the most recent varieties, namely NAROCASS 1 and 2. The improved varieties being used, such as NAROCASS 1 and 2 and PAN 7057 and 7033 are resistant to diseases, are early maturing and high yielding. This increases farmer resilience and boosts their production and productivity.

In combination with the use of improved seed varieties, farmers across all the districts, apart from Napak, mentioned the practice of row planting for crops like soybean, sunflower, maize and cassava, with some farmers, following traditional methods where correct crop spacing was not observed. On the other hand, farmers in Napak largely expressed the practice of sowing crops like maize, sunflower, sorghum and green gram using broadcasting method. Row planting helps to improve plant population that boost yields.

3. Local Seed Businesses (LSBs):

In Amwoma sub county (Dokolo district), a few farmer groups are involved in seed production based on a local seed business model (LSB). These groups access foundation seed from different research institutions (National Crops Resources Research Institute supplies them with beans, cassava and rice while National Semi-Arid Resources Research Institute based supplies groundnuts) and produce quality declared seed, which is supplied to other community members. This has ensured wider access to improved seed, thereby contributing to increased productivity and resilience among the respective communities. In some districts, such as Oyam, farmers expressed the use of local drought tolerant crops such as "Kilimakuka," while in Dokolo and Amolatar Districts, Tapara beans, as well as a black and white stripped bean called "Ebilbil" are grown. In Kitgum and Agago Districts, Malakwang is widely planted, while the Tapara beans are also common in Napak.

4. Crop diversification:

Crop diversification refers to the production of a variety of crops on agricultural holdings (single plot or several plots). Across the districts, farmers in Oyam and Lira mentioned the most diversified crop enterprises which also included high value vegetable crops (watermelon, cabbages and tomatoes). The farmers in some of the districts, notably Agago expressed changes in the types of crops grown over the years, with the area under production for crops such as sunflower, cotton and sesame (simsim) increasing, compared to groundnuts, beans and maize. This change was attributed to better performance of the former crops under rainfall variability within seasons compared to the latter crops.

5. Soil fertility management:

Soil fertility management is a practice intended to enhance the ability of the soil to sustain crop growth and optimise yields. Across Lango sub-region (Oyam, Lira, Dokolo and Amolatar districts), farmer discussions revealed the use of synthetic fertilizers, particularly among farmers around the irrigation scheme and at the riverbanks or lake shores. Synthetic fertilizers such as NPK and foliar applications such super grow were mentioned by farmers as being used to boost crop yields, especially following a prolonged dry spell. The use of organic fertilizers (animal waste) was reported in Kitgum and Agago. In Napak, there was no mention of fertilizer application, while in Oyam, the presence of an organisation promoting organic production appears to have influenced farmers against synthetic fertilizer use. The preceding practices of fertilizer application boosts crop yields.

6. Soil and water conservation:

Soil and water conservation methods aim to control runoff, prevent the loss of top soil through erosion, maintain or improve soil fertility and reduce soil compaction, among others. Across all the districts, except for Napak, farmers mentioned the practice of mulching, especially in vegetable fields. In Napak, the farmers mentioned the practice of using green gram as a cover crop for sorghum fields to retain soil moisture. Farmers in districts such as Oyam, which is well endowed with non-seasonal rivers such as Tochi, conduct off season production of vegetables in riparian buffers. This ensures all-year production of vegetables, thereby boosting incomes.

7. Water harvesting techniques:

These involve the direct collection of rainwater and capture of runoff from the catchment and streams. Owing to the semi-arid nature of Napak district, government and development partners have constructed water for production points, including water dams, valley tanks and windmills. A prominent example is the Arecek dam, which holds water all year around that is used for watering livestock, crop production and domestic use. Water harvesting techniques were also mentioned among some farmers with iron-sheet roofs in Agago district, who store water in plastic tanks for future use.

Uganda has a total of 11,200 hectares under irrigation of which, 8,500 hectares are under Large scale irrigation with the remaining 2,700 hectares under medium to small scale irrigation. Within the project area, Olweny in Dokolo irrigation scheme has 650 hectares and Agali in Lira is estimated at around 600 hectares. The Tochi Irrigation Scheme in Myene Sub County, Oyam District is yet to be completed, while the establishment of valley tanks is planned for drier parts of Amolatar District. Irrigated crop production increases productivity as well as resilience to drought.

8. Post-harvest management practices:

Climate-smart post-harvest management practices aim to minimise crop loss, maximise efficiency and returns during the delivery of a crop from the time and place of harvest to the time and place of consumption. Across all the districts, farmers expressed the use of tarpaulins or mats or, in the case of Napak, smeared cow dung on a soil surface, as drying and threshing grounds for harvested crops.

Following adequate drying of harvested crops, the farmers universally expressed the processes of sorting, cleaning and packing in sacks, which are then stored on pallets to avoid reduce moisture absorption and moulding. The timeliness of the activities, application of appropriate technologies and good management practices in relation to the changing climatic conditions makes this climate smarts.

9. Livelihood diversification:

This refers to the engagement in a variety of enterprises in order to minimise vulnerability to shocks and decrease food insecurity among households. Besides crop and livestock enterprises, farmers in the low-lying parts of Amolatar, Oyam, Lira and Dokolo expressed the practice of capture fishing on the lakes, rivers, streams and swamps. Other non-agricultural activities practiced in the district were as highlighted under section 3.1.5 of this report.

10. Livestock production and management:

In the context of CSA, livestock production and management are aimed at increasing productivity of livestock to improve rural households and food security as well as improve resilience to climate change. In the guided discussions, farmers originating from Iceme Sub County in Oyam District expressed the practice of rearing Friesian cattle under zero grazing and the production of exotic chicken. Friesian cows have high milk production capacity, while exotic chickens are fast maturing with high live weights, which boost incomes. The practice of zero grazing affords the collection of animal waste for use in fields as manure, as well in biodigesters for household energy consumption. Having animals in a controlled environment may also contribute to animal waste management that minimises the rate of release of methane gas into the atmosphere. The process of the zero grazing and having the animal in a controlled environment becomes climate smart by reducing pressure on the Environment, recycling of matters within the closed system.

11. Agroforestry:

Agroforestry involves the growing of trees or shrubs around or among crops or pastureland and is intended to increase biodiversity and reduce erosion. Agroforestry was mentioned as a practice among farmers in Lira, Oyam and Dokolo. The common species that are grown were mentioned as *Calliandra, Gliricida* and Pine trees, which are grown for fuel wood, shade for crops, fodder and timber. In Lira and Dokolo, some farmers also mentioned growing citrus fruits among legumes such as cow peas, green grams and groundnuts. Plantation agriculture is dominated by relatively resource endowed households in Lira district and is for commercial wood production (timber). Agroforestry is known to sequester carbon, thereby reducing emissions into the atmosphere. The trees also modify the microclimate, which improves resilience of crops to risks such as drought. Farmers also derive income from the sale of wood products from mature trees.

4.2 Potential/promising agricultural practices and their contributions to CSA objectives

As was indicated in section 3.3, the most frequent climate risk that has affected farmers across the northern Uganda region has been prolonged dry spells. The consequences experienced amongst farmer households have been reduced crop yields as a result of heat stress and water stress resulting from prolonged high temperatures. In view of this, potential climate-smart practices should aim at supporting farmers to adjust soil, water and nutrient management; planting and sowing dates; plant densities and cultivars. In line with Uganda's identified priorities for CSA, and complementary to already existing options being promoted in the region by government and non-government actors, the following practices are recommended as having the potential to improve farmers' productivity, farmers' resilience to climate change and contribute to mitigation of greenhouse gas emissions in the ProCSA project area.

A. INTEGRATED SOIL FERTILITY MANAGEMENT

1 Conservation tillage:

In comparison to conventional tillage using hand hoes and ox-ploughs, conservation tillage minimises soil disturbance by retaining at least 30 percent cover of crop residue on the soil surface (Carter, 2005). Herbicides and/or cover crops are used in combination with conservation tillage to control weeds. Proponents advance that conservation tillage is best suited for steep slopes that are susceptible to soil erosion (such as parts of Kitgum and Napak) and areas with well- drained or moderately drained soils like Agago District. The merits of conservation tillage include reduced run-off and soil erosion; conservation of soil moisture; enhanced retention of soil organic matter in surface layers; reduced soil temperature oscillations; and the improvement of soil quality at the surface (Lal, 2004; Carter, 2005; Giller et al., 2009). For areas affected by climate variability (delayed onsets of rains, erratic and short rains), such as the Northern Uganda districts, conservation tillage facilitates timely planting on large proportions of land by reducing the energy and time required for land preparation by tillage (Giller et al., 2009). However, some demerits of the practice may include soil compaction at the surface horizons (especially in coarse-textured soils), which may inhibit root growth in the upper part of the soil profile and reduce plant nutrient uptake and growth. Conservation tillage may also result in the immobilisation of nutrients such as phosphorus in the soil (Carter, 2005).

- ***Contribution to CSA objectives:***

Conservation tillage potentially increases yields for crops with not so deep roots, thereby fostering food security and incomes. Resilience to heat and water stress is also boosted through improved infiltration and reduced evaporative losses, which may also improve yields in the short term (Lal, 1986). However, the costs associated with herbicide acquisition and access to equipment (such as jab planters, disk openers) may result in limited net gains for resource-constrained farmers, although may be manageable for better-off farmers. Research by Kern and Johnson (1993) found that conversion from conventional tillage to conservation tillage increases carbon retention in agricultural soils, explained by the surface residue being primarily decomposed by fungi which has a higher assimilation efficiency than bacteria that dominates the decomposition processes of residue mixed with soil (under conventional tillage).

- ***Gender impact:***

Conservation tillage reduces labour, energy and time requirements associated with land preparation, which are traditionally male roles in the Northern Uganda region (particularly Amolatar, Oyam and Lira). Considering the limited use of herbicides among farmers across the districts, conservation tillage shifts labour demands to the stage of weeding, which is predominantly done by women and girls by hand. Consequently, while the practice may favour women's increased participation in its application, it may also increase their drudgery, time and energy burden, especially among households that are unable to afford hired labour.

2 Crop residue management:

Mulching with crop residue is a relatively common practice among farmers across the Acholi-Lango sub region. The practice has the merits of increasing organic matter near the soil surface, enhancing nutrient cycling and retention, improving soil texture and maintaining soil organic matter levels (nutrient and water storage capacity), all of which foster crop growth (Reicosky & Wilts, 2005). Crop residue mulch also improves water infiltration and may prevent soil erosion caused by wind and water. The practice is recommended for farmers in all districts, and particularly the districts of Oyam, Amolatar, Dokolo, Lira and Napak that experience heat waves and/or strong winds.

- ***Contribution to CSA objectives:***

The nutrients retained from crop residue mulch may enhance the productivity and yields of succeeding crops. However, authors caution that the productivity and yield of the succeeding crop depends on a complex interaction of factors, including the crop residue quality, the health of the previous crop, soil related factors, potential susceptibility of the next crop to pest and disease outbreaks and appropriate cultivar selection, among others (Reicosky & Wilts, 2005, Giller et al., 2009). Giller et al. (2009) also add that trade-offs need to be considered between the use of crop residue as mulch or livestock feed among mixed crop-livestock farmers practicing zero grazing, as was found in Oyam. Consequently, context-specific factors and farmer objectives must be taken into consideration in the selection of this option (Reicosky & Wilts, 2005). Regarding resilience, surface residue mulch reduces high temperatures in the soil that may affect plant germination and growth (Lai, 1982), while the soil organic matter resulting from crop residue fosters the efficient absorption and storage of rainwater for use during the dry periods, thereby enhancing resilience to climate variability. As already explained, crop residue on the soil surface improves carbon sequestration (Reicosky & Wilts, 2005).

- ***Gender impact:***

The absence of investment costs associated with the implementation of the practice among predominantly smallholder crop farming households in the seven districts makes it potentially attractive for equitable female participation. Female adoption is also more likely among districts where women participate in land preparation, namely Dokolo, Agago, Napak and Kitgum. The practice also offers labour and time saving benefits for women, as less energy is expended in transferring the harvested crop from the field to the home (only pods, grain, fruits) and part of the post-harvest handling activities, notably drying are completed in the field, reducing on the chores to be undertaken at home.

3 Crop diversification with intercropping or rotation:

Crop diversification is an effective strategy to reduce risks associated with monocropping under conditions of erratic rains, extreme temperatures and floods, as experienced in all the seven districts. Crop diversification may involve intercropping (planting a mixture of two or more crop species on one field), interplanting one crop during the growth of another crop on the same field, or the rotation of crop species planted in a field from one season to the next. If done correctly (i.e with mixtures involving cereals and legumes), crop diversification has the benefits of improving soil health, protecting natural biodiversity, improving water use efficiency, suppressing weeds and breaking pest cycles (Beebe et al., 2011; Alhameid et al., 2017; Mahouna et al., 2018). The inclusion of a leguminous crop in a rotation system may also help to reduce fertilizer applications and nitrate leaching to groundwater (Arriaga et al., 2017), as is practiced in parts of Lira, Oyam, Dokolo and Amolatar. Residues from leguminous crops may be also be used as good quality livestock feed, while manure may be returned to the fields for soil fertility. This is particularly useful for mixed (crop-livestock) farming systems, which are dominant across the region.

- ***Contribution to CSA objectives:***

Crop diversification at an appropriate intercropping/ rotation combination (for example maize and pigeon peas) has been found to enhance crop yields and agroecosystem resilience (Kimaro et al., 2019). Another example is a 'doubled-up' legume combination (e.g. groundnut-pigeon pea) (Smith et al., 2016), while soybean is acclaimed for improving soil fertility. According to literature, some intercrop combinations particularly influence the level of resilience. For instance, where pigeon peas (drought tolerant) are interplanted with maize (less tolerant), there is improved productivity of the intercrop under harsh conditions (Sakala et al., 2000). Pigeon peas are also reputed to improve soil fertility and control weeds, and a good source of food for humans and livestock (Adu-Gyamfi et al., 2007; Giller et al., 2009). The taller cereal species in intercropped

gardens dominate legume species in the competition for solar radiation, causing legumes to shade leaves, which enhances their fixation of N mineral into the soil. Additionally, evidence affirms that increased crop rotation diversity plays a major role in increasing soil organic carbon storage and ecosystem functions, driven by enhanced root C input, soil microbial diversity and soil aggregate stability (Singh et al., 2018; FAO, 2013).

- ***Gender impact:***

  Crop diversification with leguminous crops is applicable on a single piece of land, making it a potential option for even smallholder farmers. The diversity in crops enhances household food and nutrition security, which are the responsibility of women. Moreover, the potential inclusion of food crops, which dominate the crop enterprises undertaken by women, assures equitable female participation in the practice. The practice of interplanting also has labour and time saving benefits, as land preparation is done once, and the activities of planting and weeding are done in tandem. Less energy is also expended in weeding, which is predominantly done by women. The combination of cereal (predominantly cash crops) with legume (food crops) on one field may also enhance opportunities for women's participation in making on-farm decisions regarding the crops to be planted.

For enhanced results, it is recommended that the above three principles be implemented alongside complementary practices, notably timely management of operations; optimal plant stand; the use of drought and heat tolerant varieties; adequate and timely weed control, integrated pest and diseases management; sufficient nutrient supply through mineral fertilizers, compost or manure and integration of other soil and water conservation measures or agroforestry components, wherever appropriate (Thierfelder et al., 2018). The availability of crop residue biomass is critical, and most benefits appear in the medium to longer term if farmers apply the conservation agriculture principles continuously with greater diversification in the system.

4 Organic manure:

Fertilizer application is a recommended practice for soils which are degraded and lack appropriate micro and macro nutrients, as was mentioned in Kitgum, Agago, Oyam and parts of Lira Districts. The practice involves the removal of crop residue from the field and allowing it to decompose before adding it back to the soil. Organic manure improves soil fertility and texture and increases the water holding capacity of soil, making it a useful practice for locations with recurrent dry spells (all districts).

5 Livestock manure management:

This practice involves the collection of livestock manure, which is properly stored and applied to crop fields and/or pasture to enhance productivity. In the districts or regions where animals are kept in confinement or grazed in paddocks, such as Lango and Acholi sub regions, such a practice should be promoted. In areas where open grazing away from crop fields and homesteads is prevalent, such as Napak and parts of Amolatar, livestock manure management may not be feasible.

6 Mineral fertilizers:

Mineral fertilizer application is useful in instances where compost and livestock manure are unavailable or in insufficient quantities. In order to increase the efficiency of fertilizer use, fertilizer application should be based on: detailed estimates of plant nutrient uses; careful timing to reduce loss; soil testing to ensure more accurate delivery; and appropriate depth for below ground delivery using slow or controlled release products (Akram et al., 2019). To summarise, the efficient use of nutrient fertilizers revolves around 4Rs, notably the Right source of nutrients, at the Right rate, at the Right time and in the Right place (Johnston & Bruulsema, 2014). Mineral fertilizers involve high costs and are more likely to be applied in locations with sustainable water for production sources, such as Lira, Dokolo, Oyam and potentially Amolatar.

- ***Contribution to CSA objectives:***

  Literature suggests that the use of either organic or mineral fertilizers that reflect soil and crop requirements; fertilizer deep placement; micro dosing application of small amounts of inorganic fertilizer with or without organic inputs like farm yard manure or compost including for crops such as millet have been found to increase crop yields (productivity). Proper timing of fertilizer application (basal application and top dressing in crops such as maize and rice has also been found to improve productivity (Tabo et al., 2011). Better yields are associated with improved food security and incomes. However, the decomposition of livestock manure and mineral fertilizers are main sources of greenhouse gas emissions. Some measures that may be undertaken to reduce greenhouse gas emissions into the atmosphere include reducing the exposure of manure to water (by dry scraping instead of washing kraals) and the use of anaerobic biodigestors for the storage and decomposition of manure, with the methane gas captured and used for energy purposes (Zhang et al., 2017; Rojas-Downing, 2017; FAO, N.D). Other measures include: fertigation (adding soluble fertilizer to irrigation water to deliver nutrients to root zone in a more precise and timely manner); adding inhibitors to slow down the conversion of urea fertilizer to ammonia, which is lost in the atmosphere; urea deep placement using super granules of urea in rice production; foliar application; and the use of coated soluble granules to allow controlled release of nutrients in the root zone (Akram et al., 2019).

- ***Gender impact:***

  Whereas fertilizer use is limited among male and female farmers across the districts, it is even more limited among female farmers. The high costs and technical knowledge requirements associated with mineral fertilizer use may limit female participation. Furthermore, the findings revealed that livestock management across the districts is predominantly a male activity, and the labour associated with transporting manure from homestead kraals to the fields, which are in many cases far-off, might also limit female participation. While organic manure may be an attractive practice for adoption by female farmers, its application is also quite labour intensive.

B. USE OF IMPROVED SEED AND PLANTING MATERIAL

7 Stress-tolerant varieties:

Cultivars that have been bred specifically to adapt to challenges in each district, notably drought, heat, floods, pests and diseases, among others should be promoted. Many of these varieties are also high yielding. Stress-tolerant varieties are currently available within research institutions for a series of crops grown in the region including: dryland legumes, NAROGRAM 1 and 2 varieties, with the highly demanded variety being NAROGRAM 2 (green gram); SECOW 2 and NAROCOWPEAS 1-5 varieties of cowpeas are all drought tolerant; while PESE 1 and 2 are also drought tolerant varieties for pigeon peas. The most recent varieties of stress-tolerant groundnuts are NARONUT 1 and 2, which mature in about 85 days and perform well in environments such as Karamoja region. The SERENUT series are also drought tolerant varieties for groundnuts, while Sesame 2 and 3 are drought tolerant varieties for sesame (simsim).

The dry land cereals include brown or red varieties of sorghum, namely SESO, SEKEDO and SEREDO. SESO 1 is very early maturing. Epuripuri is a very old variety (110-120) but is still in high demand because it provides a livelihood for those engaged in alcohol brewing. The recent varieties of sorghum include NAROSORG1-4, while finger millet has five recently released varieties named NAROMI 1-5. The latest varieties of cassava are NAROCASS 1 and 2, while for beans there is NAROBEAN 1-3, which are have a high content of iron and zinc. NAROBEAN 7 is a black bean which is popular in Northern Uganda. For maize, the WEMA varieties as well as LONGE varieties are widely available in the market and perform well in terms of productivity and resilience. The NABE series of beans, particularly NABE 4, NABE 15 and NABE 17 are high yielding, mature in 56 to 95 days, are resistant to anthracnose and bean common mosaic virus and are resistant to drought and rainfall variability.

- ***Contribution to CSA objectives:***

  The use of stress-tolerant varieties has been shown to potentially increase net crop income within a range of USD 500-864 per hectare per year (18-32% increase) in Northern Uganda, although to achieve this, there is need for strengthened capacity of the farmers to own farm assets and have access to weather information (Mwungu et al., 2019). Improved yields ensure food security of households even during poor farming seasons. The improved short cycle and stress-tolerant varieties also foster adaptation to decreases in rainfall volume and variability. However, where soils are degraded, cultivar use may require the complementary use of fertilizers, which may contribute to greenhouse gas emissions. Caution should be taken to ensure that fertilizer use is optimal (Sapkota et al., 2017).

- ***Gender impact:***

  The use of stress-tolerant cultivars offers labour saving benefits associated with manual irrigation of crops during dry spells. Household food security, which is the responsibility of women, is also assured to the extent that the acquired cultivars include food crops, or that part of the income resulting from improved yields is utilised to purchase food. The findings revealed that women in Oyam, Lira, Agago and Kitgum participate in seed acquisition of cultivars. However, female adoption of the practice may be hindered by the cost of cultivars; labour demands associated with the practice (such as row planting; information and technical knowledge of appropriate varieties; and additional requirements such as fertilizer use.

C. IMPROVED WATER USE AND MANAGEMENT

8 Water harvesting systems:

These include macro systems (dams, valley tanks, windmills) and micro systems on-farm (retention ponds, stock water, reservoirs) and at household level (roof-top rainwater harvesting and storage in water tanks). The aim of water harvesting systems is to intercept run-off water, which is then stored in the soil profile, or in the surface and groundwater aquifers for use during periods of water stress (Nangia, et al., 2018; Kumar et al., 2016). On-farm water harvesting systems serve several purposes, including detention of flood water, retention of nutrients, irrigation, supplying animals with water, recharging groundwater, and may also be used as aquatic habitats (Nõges et al., 2010). Water collection from surface flows and the excavation of water ponds can be promoted for individual farmers or large groups of farmers and this should be matched with high value crops which can improve the level of technology uptake within the communities. For farmers with iron-sheet roofs across the districts, rainwater harvesting into water tanks should also be promoted. This would support food security through the supply of water for home use, as well as for watering kitchen gardens. Small scale and medium scale irrigation systems are recommended for districts with permanent water sources, namely Lira, Oyam, Dokolo and parts of Amolatar. For districts with limited or seasonal water sources, such as Kitgum, Agago, Napak and the drier parts of Amolatar such as Etam sub county, valley tanks and/or on-farm water harvesting systems are recommended.

9 Supplemental irrigation:

This practice ensures that the minimum amount of water required at critical stages of crop growth is made available to plants to alleviate the adverse effects of moisture stress during dry spells. The practice has the benefits of increasing crop yields, reducing the risk of crop failure, stabilising crop yields and improving water productivity (amount of grain or biomass produced per unit of water) (Nangia et al., 2018; Sommer et al., 2011). A sustainable source of water, energy access (for a pressurised irrigation system), suitable cropping patterns and knowledge of crop water requirements and appropriate irrigation scheduling would be necessary to implement supplemental irrigation effectively. Surface irrigation is suited for fine textured soil types on flat land slopes to promote the lateral spread of water. Where the land is uneven, sprinkler irrigation or drip irrigation are better suited and can be used on all soil types.

10 Planting pits:

Planting pits are also referred to as Zai pits, planting pockets or planting basins that typically measure 20-30 centimetres in width and 10-20 centimetres deep, with a spacing of approximately 60-80cm (Motis et al., 2013). Each pit is filled with organic manure, compost or dry biomass (leaves, stems, crop residue) and seeds are sown into them (Motis et al., 2013). Planting pits are recommended for locations that experience short rains (limited water availability) and are aimed at conservation of water and nutrients for a longer period to enable crop growth and development. Planting pits are also an effective strategy for increasing soil fertility and restoring degraded lands and are recommended for districts such as Kitgum, Agago, Oyam and Napak, as well as other districts.

- ***Contribution to CSA Objectives:***

The objective of water management systems is to improve water use efficiency, limit water consumption and reduce loss or waste of water caused by evaporation, run-off, deep percolation and inefficient irrigation management (Lorite et al., 2018). Consequently, water management techniques foster increased productivity and yields, but are quite costly to establish and maintain (except planting pits) and may not result in high profits for farmers (Nangia et al., 2018). Planting pits have been found to improve

yields of trees and crops including maize, soybean, sunflower (Loveys et al., 2004) and sorghum, green gram, pigeon peas and millet, which are grown in the Northern Uganda region. Water management techniques also alleviate the dependence on rainfall patterns for cropping calendars by permitting planting and crop growth even under unfavourable seasonal conditions (Nõges et al., 2010). Furthermore, the increased yields achieved under supplemental irrigation, compared to rain-fed agriculture, result in higher rates of carbon sequestration in plant biomass and the build-up of soil organic carbon; and may minimise the conversion of additional areas to crop farming and the associated greenhouse gas emissions (Lal, 2004).

- ***Gender impact:***

Water management techniques are generally costly to establish in remote locations and largely unaffordable undertakings for male and female farmers without external support. Technical knowledge is also required to successfully implement the practice, as well as access to reliable technology and service technicians, all of which may not be adequate in the seven districts. The opportunities for female adoption of water management techniques are very limited without external support from government or development partners. While planting pits are a viable water management option for farmers across the districts (especially Napak, Kitgum, Agago and Oyam), involving both male and females, their application is labour intensive, particularly at the stages of land preparation and planting.

D. IMPROVED LIVESTOCK PRODUCTION AND MANAGEMENT SYSTEMS

11 Livestock breed improvement and diversification:

The genetic improvement of livestock includes hybridisation, assisted reproduction and crossbreeding with the aim of improving animal traits. Breeds are improved to increase productivity (such as live weight gain, milk yield, fertility); strengthen resistance to stress, shocks and diseases; and to foster adaption to changing environments (FAO, 2017a). In mixed crop-livestock farming systems such as those found in the seven districts, appropriate selection or breeding becomes critical. Some breeds, for instance Zebu cattle are more resistant to tick-borne disease (Berman, 2011), while crossbreeding the local Karamoja goats with Toggenberg goat breed would increase milk yield of local goats. Assisted production includes practices such as artificial insemination that may be carried out by specialised personnel across several animal types, including pigs. Breeding programs should be guided by a careful consideration of district-specific conditions and farmer needs and objectives. Research suggests that goats are better adapted to hotter and drier conditions compared to cattle, which may also justify the promotion of goat breeding in the region (Silanikove, 2000). Similarly, poultry mixes with more ducks than hens lower the carbon footprints associated with egg production (Patra, 2017).

12 Feed improvement:

Greenhouse gas emissions from livestock result from manure and enteric fermentation (FAO, N.D.). Measures to reduce greenhouse gas emissions from livestock can be achieved through manipulation of feeds to increase animal digestive efficiency (Gerber et al., 2013). Such measures include mixing grass with legumes, processing feed (chopping it or treating it with urea), mixing forage, and the strategic use of locally available feed supplements (FAO, 2017a). Caro et al. (2016) assert that adding lipids in ruminant diets can reduce methane emissions from enteric fermentation by 15.7 percent, while treating crop by-products with urea mitigates carbon dioxide, methane and nitrous oxide emissions. Another measure to reduce greenhouse gases content in manure is through diet alteration, particularly by rationing feed. By altering ration compositions and feed additives, a farmer can influence the amount of N in urine and faeces and the amount of fermentable organic matter, thereby reducing methane emissions from the manure (Zhang et al., 2017).

13 Animal health and husbandry:

One way of strengthening resilience of animal health amidst the negative consequences of climate change is through preventive veterinary medicine (Lubroth, 2012). Prompt vaccination of livestock against diseases such as tick-borne disease and foot and mouth disease strengthens their resilience climate change-related parasite and disease outbreaks (Lubroth, 2012). Other animals that are highly susceptible to disease outbreaks are the pigs and poultry that are affected by influenza. FAO (2017a) further advances that improving the reproductive efficiency of animals and extending the reproductive life of an animal results in improved lifetime performance per animal, thereby reducing greenhouse gas emission intensities from livestock.

14 Forage and rangeland management:

Whereas grazing has several beneficial ecological functions (i.e. fostering re-growth of grasslands through biomass removal that prevents the accumulation of dead material; prevention of bush fires; dispersal of seeds, organic matter and nutrients; regulation of hydrology and water quality, among others), overgrazing, on the other hand, degrades grasslands and compromises farmer's adaptive capacity to climate risk (FAO, 2017a). The restoration of degraded grazing land, improvement of forage species and conversion of marginal croplands to pasture are all important to sequestering carbon and enhancing the soil organic carbon pool. Follet et al.

(2001) suggest some measures to manage pasture, which include controlled grazing; sowing legume and grasses or species adapted to the environment, judicious use of fertilizers on pasture, improvement of soil fauna and irrigation, all of which are applicable to all districts, especially Napak and Amolatar.

15 Destocking:

This practice involves reducing the number of livestock in a herd to an optimal size. The practice has the merits of balancing resources during drought conditions, increasing the productivity of each cow and reducing the costs incurred in caring for the animals (University of Nebraska, 2020). Destocking may include strategies such as selling feeder (weaned) animals early to earn more profits; selling replacement breeding animals; or drastic measures like selling the herd and restocking later (University of Nebraska, 2020). Maintaining stocking capacity on grazing lands also contributes to mitigation by reducing the greenhouse gas emissions from a given area.

16 Integration of livestock in a circular bioeconomy:

In mixed crop-livestock farming systems like in Northern Uganda, production efficiency and resilience to climate change are enhanced through a circular bioeconomy. This entails waste from crop products (what is not consumed by humans) being utilised in livestock feed or in recycling and recovering nutrients in the field; while animal waste is used as field manure or a source of energy (biogas) (FAO, 2017a).

- ***Contribution to CSA objectives:***

Destocking and shifting the livestock population to more productive crossbreeds (i.e. with drought and heat wave tolerance) enables high production during precipitation and heat stresses, satisfies demand for animal products, improves productivity, food security and reduces the overall associated carbon footprints (Rojas-Downing, 2017; Zhang et al., 2017). Reducing the incidences and impact of disease in livestock reduces losses from livestock deaths and the unproductive animals that emit greenhouse gases. Where possible, the integration of livestock in a circular bioeconomy is the most appropriate option to enhance production and productivity, food security, climate change adaptation and mitigation.

- ***Gender impact:***

Across the seven districts, livestock production and management are predominantly the responsibility of male household members with few women participating. Livestock acquisition and routine management (especially of large ruminants like cattle) also require substantial resources, which may not be available to women. The responsibility for household chores and other unpaid care work also limits women's availability to participate in livestock management. The management of livestock is also knowledge-intensive, with extension services likely to prioritise large scale farmers, as opposed to smallholder farmers, who may also include women. However, across the region, women may participate in decisions such as destocking, as they are consulted during the sale of household major assets. The integration of livestock in a circular economy involving a mix of crops and livestock may enhance women's participation and benefits from participation.

E: AGROFORESTRY

17 Agrosilvicultural, silvopastoral or agrisilvopastoral systems:

Agrosilvicultural systems combine the production of tree crops with herbaceous crops in space or time; silvopastoral systems combine woody perennials with pasture and/or livestock; while agrisilvopastoral systems integrate trees and herbaceous crops with animals and/or pastures (Nair, 1984). Agrisilvicultural systems and agrisilvopastoral systems are recommended practices for farmers in all the seven districts, while silvopastoral systems may be adopted by the predominantly livestock farmers in Amolatar and Napak Districts. Woody perennials grown on crop fields or rangelands provide several benefits, including physical conservation of the soil; improving soil and water quality; minimising damage resulting from flooding and strong winds; minimising splash and sheet erosion; and restoring degraded land (Nair, 1984; Reppin et al., 2020). Other benefits include fuelwood production; increasing biodiversity necessary for pollinators and other beneficial insects; controlling pests; protecting fields from trespassers (live fences); and provision of shade to crops during periods of high temperature (Nair, 1984; Reppin et al., 2020). In silvopastoral systems, woody perennials grown on rangelands may serve multiple functions, including live fencing around the grazing land, shade for animals, fodder for animals, and may also provide construction material and wood fuel. Multipurpose trees can also be planted as woodlots or around homesteads in a crop/livestock/tree mix to provide shade, fruits, fodder, fuel, protective fencing, windbreaks and to mark boundary demarcations (Nair, 1984).

Agroforestry is a particularly useful practice in locations with degraded lands, high temperatures, high levels of soil erosion and flooding. Emphasis should be placed on promoting trees that simultaneously yield multiple products (food, fodder, fuel), while enriching the crop fields or rangelands with nitrogen fixation, nutrient cycling and soil conservation. However, caution should be

taken in the selection of woody perennial species to ensure that they are compatible and complementary with the respective herbaceous species; use water efficiently; and promote short-term productivity of crops and the long-term sustainability of the system (Nair, 1984; Mbow et al., 2014). Suggested species for the region include nitrogen fixing trees and shrubs such as Gliricidia sepium, Acacia albida and Cajanus cajan; woody perennials for soil conservation and mulch such as Leucaena leucocephala; fuelwood and construction materials such Albizia spp, Acacia albida; Cassia siamea; Eucalyptus saligna; Terminalia brownie; and multipurpose trees such as Vitellaria paradoxa (Shea), Combretum spp, teak tree, eucalyptus spp and the neem tree (Nair, 1984; Reppin et al., 2020; NAFORRI interview, January 2020). Other best-suited tree species for the region that are fast-growing and tolerant to pests and diseases are highly recommended and should be explored.

- ***Contribution to CSA objectives:***

Agroforestry systems, if managed well, have the potential to reduce production costs and agricultural inputs through the provision of food, fodder, mulch, fuelwood and building materials (FAO, 2020). Efficiency in land use is also promoted by the production of several goods on a single piece of land throughout the year. The combination of trees with crops and/or pasture replenishes soil fertility, controls erosion, minimises adverse consequences of flooding and affords income from diversified sources thereby strengthening resilience to the negative consequences of climate change. Agroforestry also contributes to climate change mitigation through the creation and enhancement of carbon sinks. Carbon dioxide from the atmosphere is captured through photosynthesis and stored in biomass and the soil (Reppin et al., 2020).

- ***Gender impact:***

Agroforestry enable's women's equitable participation in the practice, as women are often responsible for managing trees during the initial stages of establishment (i.e. planting, weeding, watering) (FAO, 2020). Women are also involved in tree-based enterprises such as processing and marketing indigenous fruits like Vitellaria paradoxa within the region. However, agroforestry requires the security of land tenure and technical knowledge about the right tree species that suit herbaceous plants and their appropriate management to optimise benefits, which may not be easily accessible to women (Nair, 1984). Agroforestry also has energy- and time-saving benefits for women, who may be able to obtain, food, fodder, fuel, fruits and other tree products on the same field.

18 Diversification of food systems:

One of the approaches to diversification of food systems is the inclusion of new and orphan crops (perennials). Theoretically, perennial crops provide greater yield stability than annuals over a given period of time since crop establishment, which is based on an individual season's weather at planting (a one-time event in perennials compared to annual crops whose production depends on the right conditions for establishment per season in terms of rainfall length and amounts). According to Dawson et al. (2018), there is an observed general reduction in the increase in yields of annual crops versus perennial crops in East and Southern Africa, when compared to the global averages. The integration of perennial crops into farming systems in Northern Uganda will provide market opportunities, increase resilience, and may foster mitigation through carbon sequestration. Perennial fruit trees such as mangoes and citrus are suitable for the region, as demonstrated by farmers in Dokolo (Amwoma) and the Ongom Citrus Scheme located in present day Alebtong district. The Ongom Citrus Scheme is one of the three citrus production schemes in Uganda that was established as a technology transfer centre to enable large scale production of citrus. The success of this option hinges on timely supply to farmers of planting materials, preferably through the involvement of private sector; training of local suppliers and the establishment of small-scale tree nurseries. Diversification to perennial crops may enhance the participation of women, improve food and nutrition security and provide sources of income of women from the sale of surplus fruits.

F. COMPLEMENTARY PRACTICES

19 Apiculture:

Apiculture (Beekeeping) is recommended as a complementary practice for farming households across the districts, including semi-arid areas such as Napak. Bradbear (2009) argues that the roots of nectar-bearing plants can reach the water table below the water surface, making apiculture possible in semi-arid regions. Sustainable honey production thrives on the richness of nectar and pollen sources in the natural vegetation, which derive from flowering plants in crop farms, forests or rangelands (Bradbear, 2009). The merits of apiculture include better crop and pasture yields resulting from honeybee pollination of plants; and the extra income earned from the sale of honey and beehive products (Gebru et al., 2016).

- ***Contribution to CSA objectives:***

Research has proven that agricultural and horticultural plants that are pollinated by bees provide higher yields and better-quality produce than plants pollinated by other insects. For instance, Crane (1990) found that honeybee pollination increased yields of Citrus sinensis by 30 percent, watermelon by 100 percent and tomatoes by 25 percent; while Adimasu et al. (2004) found that honeybee pollination increased onion yields in Ethiopia by 90 percent. Increased yields result in better incomes for farmers. Bee products are also a good source of nutritious food and medicine and the products from apiculture (honey, beeswax, propolis, royal jelly) are of high value when sold. Apiculture provides a safety net for farming households to earn income even during poor crop farming seasons. The harvested honey may also be stored for a long period of time and be sold or consumed during periods of scarcity, thereby strengthening resilience (Gebru et al., 2016). Wide engagement in apiculture may also influence reduced deforestation and enhance awareness of the importance of conserving the natural vegetation, ultimately contributing to climate change mitigation.

- ***Gender impact:***

Apiculture promotes equitable participation of women, especially at the higher end of the value chain, notably honey extraction from honeycombs, packaging, storage and marketing. Apiculture may also be practiced by landless households, is not labour-intensive and may be combined with other household and farming responsibilities. Women's involvement in the apiculture value chain may also enhance their decision-making and control of financial resources at household level. The returns from apiculture are also envisaged to improve household and community wellbeing (Gebru et al., 2016).

20 Community seed banks:

Seed access requires the accelerated development of improved climate-smart (best bet) varieties and their subsequent distribution through scalable, locally managed seed systems. Community seed banks serve three key functions, notably conservation of plant genetic resources (crop varieties); access and availability of diverse seeds and planting materials according to farmer needs and interests; and seed and food sovereignty (Vernooy et al., 2017). In the case of cross-pollinating crops such as maize, which is considered as a food crop and non-traditional cash crop among many households, establishing a sustainable supply system of locally managed seed as well as the output market will increase productivity among farmers and enhance food security. The establishment of demonstration plots of local varieties boosts popularisation through plant variety enhancement and uptake. It also stimulates active involvement of the private sector and increases the sustainability of technology uptake. Community seed banks enable the equitable participation of women, since in most communities, women are the custodians of traditional crop varieties. Considering the structured setting of community seed banks, women also could take on leadership roles and

participate in decision making at community level. Productivity, resilience and food security are also enhanced using quality seed.

21 Agrometeorological information:

The dissemination of agrometeorological information is also crucial to support farmers in adaptation to climate change. Short-term to seasonal climate forecasts should be provided through appropriate channels, e.g radio, climate information centres and contingency plans (Singh et al., 2007). The national population census of 2014 by UBOS revealed that at least half of the households in Oyam, Amolatar, Lira and Dokolo utilise the radio as their most important source of information, followed by the telephone; while the main sources of information for households in Agago (22.6 percent) and Napak (16.1 percent) were community announcers. The latter could include public gatherings like places of worship, cultural and traditional functions. Furthermore, effective farmer education extension systems and weather information that matches farmer needs are important factors for success. Multiple dissemination channels should be used to enhance women's participation.

22 Crop insurance:

This practice mainly seeks to cover yield loss due to weather calamity (Carter et al., 2017). The Government of Uganda, through a Public Private Partnership arrangement with the Uganda Insurers Association launched an Agriculture Insurance Premium Subsidy Scheme for a five-year period from July 2016 to June 2021, which provides affordable agricultural insurance to farmers and protects agricultural loans disbursed by financial institutions to farmers against specified effects of agricultural risks. The scheme, however, targets commercial farmers of crops including maize, rice, all horticultural crops and tree crops, among others and protects them against losses from adverse weather conditions (floods, hailstorms, and drought), fire, uncontrollable pests and theft, among others. Such schemes should also target medium scale farmers or farmer groups to strengthen farmer resilience to climate change. Its implementation has not been widespread among the small-scale farmers as most them lacks information on how this works. Such a practice would require effective and reliable yield estimations. There should also be special targeting of women farmer groups.

23 Improved energy efficiency and renewable energy:

Due to the increasing demand for fuel wood and charcoal for household energy needs in Uganda, there has been a dramatic increase in product prices. Practices such as the promotion of energy saving cookstoves and the use of charcoal briquettes, reduces on the amount of wood consumed compared to traditional energy sources. This has the positive effect of improving fuel wood efficiency (FAO, 2014); reducing household expenditure on fuel needs, and contributes to lower emissions of greenhouse gases into the atmosphere (FAO, 2014). The use of renewable energy sources should also be promoted at household level to improve productive time and reduce on energy demand for lighting. Photovoltaic energy may also be used to power early warning weather systems and on-farm irrigation systems. The use of renewable photovoltaic energy contributes to climate change mitigation by reducing the demand for fossil fuel energy and hydropower energy, whose generation emits carbon into the atmosphere (Creutzig et al., 2017).

Overall, the promotion and adoption of the recommended practices, in addition to the effective existing practices presented in section 4.2, is envisaged to enhance productivity, resilience and/or mitigation of climate change impacts on households and the environment. In accordance with the criteria in the analytical framework presented in Chapter 1, Table 14 in Appendix II summarises the climate-smartness and gender impact of the respective options.

4.3 Requirements for adoption of recommended practices

The following are considerations of enablers for the adoption of recommended CSA practices among smallholder farmers across the project districts:

- **Access to and control of land:**

  The adoption of CSA options with moderate to high investment costs requires secure tenure of land, which may be long term or temporary. Access to land and the size of land was found to influence the adoption of climate smart practices among small holder rice farmers in Vietnam (Abegunde et al. 2020). The security of land tenure encourages, among others, the investment in soil fertility improvement practices and technologies, as well as agroforestry; and the fertility of soils may also influence the decision to invest in improved varieties, which enhances the adoption of integrated CSA practices.

- **Access to water for agricultural production:**

  In drought-prone areas, such as Northern Uganda, access to water for production is critical for the adoption of high cost climate smart practices. Consequently, an accessible source of water is required for successful implementation of CSA, as well as capacity building of technical personnel within districts to ensure the sustainable design of efficient irrigation systems. Additionally, there should be cost-effective access appropriate machines and equipment to enhance adoption by farmers.

- **Access to finance:**

  The adoption of most climate smart technologies entails investment costs, which could be accessed through accumulated savings in financial institutions

and/or access to credit from formal financial institutions. A study by Mwungu (2018) found a strong correlation between access to credit and effective demand for tree seedlings. It thus becomes crucial to build the financial capacity of targeted farmers, as well facilitate linkages to credit, banking and insurance institution.

- **Access to certified inputs and markets for products:**

  The investment in climate smart technologies such as improved seed requires timely and reliable access to good quality seed in the vicinity of the farmer. Furthermore, farmers are encouraged to invest in climate smart technologies and practices if they have an assurance of markets with good prices for their produce that will enable them to make returns on their investment. Assured markets in the region may also be obtained through contract farming to supply factories and industries.

- **Labour availability:**

  For technologies and practices that are highly labour-intensive, their adoption will depend on household labour availability, the capacity to hire farm labour and the envisaged high returns on investment.

4.4 Barriers and opportunities for adoption

Across the seven districts, male and female farmers were asked to discuss the challenges faced in implementing CSA practices (for those who were implementing) and the barriers that hinder farmer adoption of CSA practices (for those who were not implementing any practice). The farmers were also asked to discuss what they considered as opportunities that would encourage them to adopt CSA practices.

4.4.1 Barriers to CSA adoption

The following barriers were expressed by the farmers in the seven districts:

- **Inadequate physical and financial capacity and availability of equipment:**

  Whereas farmer participants in the six districts

of Kitgum, Agago, Amolatar, Dokolo and Napak expressed having received knowledge on CSA practices, a good number were unable to implement some CSA options such as irrigation, partly due to the high costs of purchasing equipment and the non-availability of irrigation equipment in markets within the sub counties and/or district. In contrast, farmers in Lira (Agali Sub County) expressed the availability of irrigation equipment and other inputs in nearby markets, probably due to their proximity to the irrigation scheme and Lira main town.

- **Inadequate access to information on CSA:**

  Discussions with farmers across the districts revealed that only a few members within the sub counties have received training on CSA, signalling a gap in technical advice across the districts. This was also affirmed by district-level experts who expressed challenges in the form of funding, transport, staffing and technical capacity among technical staff to provide the required information to farmers. Among the farmers who had received training, farmers in Kitgum and Napak expressed that they had received the training after the planting season and could not implement the acquired knowledge and forgot correct implementation specifications by the next planting season (Kitgum). In Napak the farmers expressed that they had last received training on CSA in 2013 and needed refresher sessions, particularly regarding early maturing varieties, alternative viable livelihoods for diversification and how to irrigate using underground water, among others.

- **Some practices are labour intensive:**

  Farmers expressed concern with the labour and time intensiveness of implementing some CSA practices. For example, line/row planting, though admittedly loved by the farmers because of yield benefits and ease of field management, was expressed as too labour intensive. Some farmers, especially in Napak, admitted to reverting to their traditional practices of broadcasting, which is less labour intensive. Furthermore, in Dokolo District, farmers stated that some practices require hired labour which is expensive for lower income households.

- **Poor quality of some agricultural inputs:**

  Instances of purchases of adulterated seed with poor germinating ability and adulterated insecticides and herbicides were reported among farmers in Lira and Agago Districts.

- **Negative publicity about improved varieties**

  Some farmers in Oyam district expressed a belief that improved seed varieties are not as tasty as the local varieties and may take longer to cook. Others expressed that they believe only in organic farming and would not want to lose markets for organic products. An organisation has publicised organic farming and many farmers are convinced.

- **Insecure land tenure:**

  While some male farmers in Kitgum expressed having inadequate land on which to implement CSA practices, female discussions revealed that couples at times disagreed on the type of practices to implement on the household field. The women expressed that some men, as custodians of household land, were rigid towards changing from traditional practices to CSA practices, which limited the women's ability to adopt the practices.

- **Emerging pests and diseases:**

  With disasters such as Fall Army Worm invasions and locust invasions more prevalent, some farmers expressed the fear of making losses by investing in climate smart practices like improved varieties and later losing the entire crop to pests. Such farmers indicated that they would suffer double losses.

4.4.2 Opportunities for CSA adoption

Across the districts, the following were expressed as opportunities that could promote the adoption of CSA practices:

- **Group Cohesiveness:**

  The farmers across the districts expressed their membership to farmer groups and associations, which afforded the combination of resources to implement different practices. For instance, financial capital was raised in groups through the collection of member contributions, which was used to purchase equipment like ropes for row planting and spray pumps for pest and disease management. Such equipment is owned by the group (VSLA) and hired out to members at very affordable rates per day.

  Focus group participants also expressed social capital among members; whereby group members jointly provided farm labour on member fields on a rotational basis to, for instance, implement practices like row planting. While some groups would receive payment for their efforts in form of money at the harvest period from each farmer, other groups expressed getting rewarded for their efforts through a meal or local brew at the end of the field day.

  Farmers who are members of VSLAs also expressed that they routinely deposited money on their group accounts, which could also be withdrawn for purposes of acquiring improved inputs, hiring farm labour or acquiring personal equipment. The accumulation of savings overtime permits individual investment by smallholder farmers (including females) in CSA practices.

- **Change agents:**

  Across the districts, farmer participants expressed the opportunity for wider dissemination of CSA information among households and neighbours beyond the trained persons. At household level, farmers expressed that if one spouse from a household participated in CSA training, he/she normally passed on the knowledge and skills to the second spouse, other household members and community members in the neighbourhood. While this enhances the possibility of popular adoption,

it faces the risk of wrong information being passed on in cases where the agent was not well-trained. Follow-up visits to trained participants may help to check and correct the implementation of CSA practices.

- **Extension services:**

  In Amolatar and Kitgum Districts, farmers expressed that they had received free extension advice from sub county extension staff on CSA, while farmers in other districts also received advice from some extension workers and non-government organisations. The existence of such services in an area may encourage wider adoption among farmers. Some organisations have demonstration plots in communities, where farmers obtain first-hand training on how to implement different practices. Some farmers who have never received training attested to having replicated observed practices on demonstration plots on their own farms to get better yields.

- **Labour abundance:**

  Across the seven districts, farmers expressed the abundance of farm labour for hire, given that most of the poorer households maintain their livelihoods by offering farm labour. Consequently, the adoption of labour-intensive practices may be plausible if farmers (including women) are able to afford hired help.

- **Provision of free or subsidised inputs:**

  Across the districts, especially Napak, farmer participants expressed the existence of non-government organisations that provide farmer groups with equipment for use amongst members on rotational basis. Other organisations, including Operation Wealth Creation provide improved breeds of livestock, whose offspring are given out to other households on rotational basis.

- **Observable benefits from adoption:** Across the districts, farmers expressed instances of having adopted practices like row planting and drying produce on tarpaulin after having seen better yields and better prices received for clean produce by other farmers. Similarly, albeit the tedious or labour intensiveness of some practices (especially row planting), some farmers expressed having continued to implement following the benefits enjoyed.

4.5 Gender implication of transitioning to CSA

Following FAO (2013), an assessment of the gender responsiveness of CSA interventions and ultimately the equitable adoption of CSA practices among men and women requires a thorough consideration of aspects, including: individual vulnerability to climate risks; access to and control over assets and productive resources; access to climate information, services, information and markets; willingness and capacity to take on risk; specific needs and participation rates; and power relations within households and communities accordingly. Drawing from the findings of this study, the following aspects are noted:

Across the districts, while men and women are equally exposed to climate risks and hazards, women are more vulnerable to climate risks, owing to their gender role as caregivers, which includes ensuring that the entire household obtains food. Women: suffer from a heavier work burden than men (i.e. working under harsh conditions on the household farm, offering farm labour on other farms to supplement food for the household; moving longer distances to collect clean water and food); have to at times sacrifice their meals for other household members thereby compromising their health; and have limited adaptive capacity to climate risk. Women engage in lower income generating activities (food crops and earning from the sale of surplus food) while men earn more income throughout the year from engaging in more lucrative enterprises, which may be undertaken alongside agriculture all year-round. Across the districts, the findings also affirm that women lack control over valuable assets such as land and cattle and have limited decision-making ability regarding the control of income and decisions on expenditure of the household. Men also predominantly take decisions on how the household land is utilised and, in many cases, also control household labour. Moreover, women across the region have higher illiteracy rates compared to those of men, which might affect their participation in trainings.

Under the preceding conditions, gender implications for CSA adoption signal that women's ability and rate of adoption of climate smart practices is much lower than that of men across the Northern Uganda region. Considering the nature of the power relations gap, gender-equitable transition to CSA will require the following: (i) a focus on promotion of technologies and practices that reduce women's labour and time burden; (ii) challenging negative practices that are rooted in socio-cultural (informal) institutions, which stifle women's access to and control over resources and decision-making ability; (iii) enforcing legal (formal) rights to access assets like land; and (iv) providing context-specific and suitable capacity building on CSA for women. Women groups may also benefit from seed funding and/or the provision of CSA technologies at subsidised rates to boost their adoption capacity.

5 CONCLUSION AND RECOMMENDATIONS

This report sought to provide an analysis of the political, social, cultural, institutional, environmental, agricultural and economic context of seven districts of Northern Uganda region (Kitgum, Agago, Oyam, Lira, Amolatar, Dokolo and Napak), with a view of compiling a basket of climate smart agriculture options that are gender-responsive and suitable for the conditions of the respective districts. From the foregoing findings, the following conclusions may be drawn:

1. Climate change is a fundamental concern for Uganda and the Northern Uganda region in particular because of its effects (especially drought) on the agriculture sector which is a mainstay for rural households in the country and the region.

The increasing rate of degradation of land cover for conversion to agricultural land and grasslands is largely driven by high population growth rates within the region and the demand for wood fuel for energy needs. Within the region, higher rates of population growth are seen in Lira (2.8 percent), Amolatar (3.6 percent) and Dokolo (2.9 percent) which are also the most densely populated districts in the region (Lira 307 persons per km2, Amolatar 127 persons per km2; and Dokolo182 persons per km2). This potentially signals growing rates of land conversion for agricultural use and energy, thereby justifying the need for urgent climate change action, notably the promotion of climate-smart agriculture.

2. In Uganda, climate change is regarded as a cross-cutting issue that is intended to be mainstreamed across different sectors to ensure the attainment of sustainable socio-economic transformation. However, issues such as

i the delayed approval of a legal framework (the Climate Change Bill that would hold government MDAs and other stakeholders accountable for climate change-related actions);

ii inadequate funding, with a huge reliance on external funding for climate change action; and

iii inadequate technical staff at national and sub national levels to ensure enforcement of existing policies, makes the Ugandan climate change policy environment weak. At sub national level across the districts, the findings similarly revealed that district-level formal policies (ordinances and by-laws) are largely at infant stages and are not effectively enforced, leaving loopholes for increased environmental degradation without punitive measures.

3. Whereas numerous and diverse actors are engaged in environment and climate change-related actions that are aimed to enhance the adoption of CSA practices, there is limited collaboration amongst actors (organisations) at district level and within sub counties. This has led to duplication of efforts (i.e. the promotion and implementation of similar CSA practices in some communities), with gaps in terms of reach and variety of options promoted in other communities. The overall effect would be limited rates of CSA adoption amongst farmers in the districts despite several interventions.

4. Across the districts, whereas male and female farmers were generally familiar with the climate change concept and its impacts on the environment, agriculture, food security and incomes; fewer farmers have adopted CSA approaches.

The adoption rates of CSA options are perceived to be lower among the women than the men across the districts, with key factors including limited access to and control over land; deeply-rooted cultural practices that limit women's ability to take strategic decisions; and lower adaptive capacities among women, which result from limited diversified sources of livelihood. and lower incomes earned throughout the year compared to the men. Consequently, women in the region are more likely to adopt short term, low cost intensive technologies and practices compared to men.

In addition to the recommendations on potential CSA options for the region already presented, and drawing from the study findings and conclusions, the following are proposed recommendations to enhance gender-responsive CSA adoption and development across the districts:

1. In districts such as Lira, Amolatar and Dokolo, whose population and socio-economic trends portray a potential for increased land degradation, relevant Government departments and development partners should prioritise the promotion of appropriate sustainable intensification climate-smart approaches among small holder farmers. This should result in increased productivity per unit area combined with lower emissions per unit of output. This is also envisaged to contribute towards reductions in land area conversion from woodlands and wetlands to small scale agriculture. Sustainable intensification climate smart agriculture options should be promoted alongside cost-effective energy efficiency options, as well as potential diversification enterprises (possibly in value addition) which are less destructive to the environment.

2. Political and technical actors in government at national level and across the districts should commit to fast-tracking the enactment of the climate change bill at the national level and the environmental ordinances and by-laws that are either still under development or awaiting approval by the Attorney General. This will strengthen the climate change policy environment by legitimising the enforcement of actions against environment and natural resource degradation. Additionally, staff filling of key natural resource management positions at the district and sub county level; technical capacity building in climate change of key district local government staff ; and climate change mainstreaming with specific actions in plans and associated budget allocations are all crucial to ensure the enforcement of policies and laws to effect the required change.

3. Climate change actors within the districts should increase collaboration through the establishment (or revival) of climate change multi-stakeholder platforms, combined with regular periodic meetings. This would minimise the duplication of efforts, enhance knowledge and information sharing amongst diverse actors and strengthen the development of effective and coordinated climate change actions for farmers.

4. Increasing women's participation in CSA and enjoyment of the benefits accruing from CSA adoption requires transformative approaches that challenge unfavourable practices that constrain women's decision-making ability and control over resources. This will require strategic engagement with cultural leaders, who would be used as champions for change. Furthermore, given that women are organised in groups such as VSLAs, financial support from development partners is envisaged to boost women's groups and empower them to adopt CSA practices.

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APPENDIX

GLOSSARY OF KEY CONCEPTS RELATED TO CLIMATE CHANGE

Climate change: a change in the statistical properties of the climate systems when considered over long periods of time regardless of the cause.

Adaptive capacity: the ability or potential of a system to respond successfully to climate change (including variability and extremes) to moderate potential damages, to take advantage of opportunities and cope with consequences. It includes adjustments in behaviour, resources and technologies and varies with social characteristics such as gender.

Climate smart agriculture: agricultural practices that optimise synergies among the three interlinked objectives of productivity incomes and food security; resilience of farming systems to climate change and variability; and the reduction and/or removal of greenhouse gas emissions

Resilience: the amount of change a system can undergo without changing state. It is the ability of individuals, groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change.

Vulnerability: the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including variability and extremes

APPENDIX II TABLES

Table 11: Uganda's priorities for climate change action in the CNDPF

Framework document	Priorities
Constitution of the Republic of Uganda 1995 **(Objective XXVII; Art 249 [1])**	• Promotion of sustainable development and public awareness of the need to manage land, air, water resources in a balanced and sustainable manner for future generations. • Sustainable management of the utilisation of Uganda's natural resources by taking all possible measures to minimise damage and destruction to land, air and water resources resulting from pollution and other causes. • Promotion by the state and local governments of the rational use of natural resources so as to safeguard and protect the biodiversity of Uganda • Institution of a Disaster Preparedness Management Commission to deal with both natural and man-made disasters.
Vision 2040 **(Par (27), (202), (307), (308), (309))**	• Sustainable development through preservation of natural resources such as forests and wetlands • Promotion and harnessing of other renewable forms of energy including wind, solar and biogas. This includes investment in research and development and provision of incentives to encourage the use of renewable energy. • Development (by all sectors) of appropriate adaptation and mitigation strategies on climate change to increase the country's resilience to the impacts of climate change. • Development of policies and organisation structures to address climate change, with emphasis on strengthening of coordination systems at national and local levels and capacity building of local governance and decision-making bodies • In liaison with development partners, reducing the level of vulnerability [to climate change] by increasing the capacity to cope through upsurge of funding to climate change initiatives. This includes participation in and benefiting from international arrangements on climate change and variability – particularly global climate change funding mechanisms. • Establishment of a comprehensive Monitoring and Evaluation mechanism to observe the implementation of national guidelines, which will have clear milestones and analytical tools.

Framework document	Priorities
National Development Plan II 2015/16 – 2019/20 **(Objectives [502], [516], [524], [539], [571], [636], [660])**	• Petroleum and gas sector: - Improving protection of the environment against oil and gas activities and mitigate the likely effects of GHG emissions • Environment and natural resources sector: - Restoring and maintaining the integrity and functionality of degraded fragile ecosystems - Increasing the sustainable use of the environment and natural resources - Increasing wetland coverage and reducing wetland degradation - Increasing the functionality and use of meteorological information systems - Increasing the country's resilience to impacts of climate change - Increasing afforestation, reforestation, adaptation and mitigation of deforestation for sustainable forestry - Improving the climate change legal and institutional framework. • Industrial development sub-sector of Trade and Industry: - Promotion of green industry and climate-smart industrial initiatives, including popularisation and encouragement of efficient and zero waste technologies and practices; and establishment and support of climate innovation centres that support investment in industries producing and adopting green technologies. • Health sector: - Building community resilience to health disasters through promotion of disaster risk reduction and management strategies. • Public sector management sector: - Coordinating the development of capacities for mitigation, preparedness and response to natural and human-induced disasters - Coordinating regular disaster vulnerability assessments at community level, hazard forecasting and dissemination of early warning messages. • Local government sector: - Improving environmental and ecological management in local governments by promoting climate change resilience; promoting wetlands and conservation management; establishing and maintaining waste management systems for local governments; and mainstreaming climate change adaptation and mitigation in the District Development Plan, Annual Work Plans and Budgets.
National Climate Change Policy 2015	• Identifying and promoting common policy priorities to address climate change in Uganda • Identifying and promoting sector-specific adaptation policy responses for increasing resilience to the impacts of climate change. Specific priority sectors include agriculture and livestock; water; fisheries and aquaculture; transport and works; forestry; wetlands; biodiversity and ecosystem services; health; energy; wildlife and tourism; human settlements and social infrastructure; disaster risk management; and vulnerable groups under cross-cutting priorities. • Identifying and promoting mitigation policy responses for Uganda. Sector-specific priorities include Land Use, Land-Use Change and Forestry (LULUCF); Reduced Emissions from Deforestation and Forest Degradation (REDD+); wetlands; agriculture; energy generation; energy utilisation; transport; waste management; and the industrial sector. • Identifying and promoting monitoring, detection, attribution and prediction policy responses for Uganda

Framework document	Priorities
Uganda Green Growth Development Strategy 2017/18 – 2030/31	• Creation of an updated inventory of greenhouse gas emissions by sector • Preparation of various Nationally Appropriate Mitigation Actions (NAMAs) • Distribution of free tree seedlings under the community tree planting project • Development of a national REDD+ strategy • Institution and enforcement of an environmental tax on old vehicles with large emission • Addressing the fiduciary issues to make Uganda qualify for climate finance from the various climate finance windows • Distribution of efficient charcoal saving cook stoves • Undertaking studies that quantify the economic cost of the climate change response compared with the cost of inaction.
Uganda's Intended Nationally Determined Contributions 2015	• **Forestry sector:** - Promoting intensified and sustained forest restoration efforts (afforestation and reforestation programmes, including in urban areas). - Promoting biodiversity and watershed conservation (including re-establishment of wildlife corridors). - Encouraging agro-forestry. - Encouraging efficient biomass energy production and utilisation technologies. • **Water sector:** - Improving water efficiency. - Ensuring water supply to key economic sectors, especially agriculture and domestic use, including water harvesting and storage. - Managing water resource systems, including wetlands, particularly in cities, in such a way that floods are prevented, and existing resources conserved (through the establishment of an Integrated Water Resources Management System). - Extending electricity or expanding use of off-grid solar system to support water supply. • **Infrastructure (including human settlements, social infrastructure and transport):** - Ensuring that land use plans and building codes reflect the need to make public and private buildings more climate resilient. - Investing in making existing and new buildings more resilient. - Updating transport codes and regulations and implementing measures to ensure compliance with them. - Improving water catchment protection. • **Energy sector:** - Increasing the efficiency in the use of biomass in the traditional energy sector. - Promoting renewable energy and other energy sources. - Increasing the efficiency in the modern energy sector, mainly of electricity. - Ensuring the best use of hydropower by careful management of the water resources. - Climate-proofing investments in the electricity power sector,

Uganda's Intended Nationally Determined Contributions 2015	• **Health sector:** - Conducting vulnerability assessments of the health sector to climate change impacts. - Assessing the impacts of climate change on human health and well-being. - Improving early warning systems for disease outbreaks. - Putting in place contingency plans to develop climate change-resilient health systems. - Strengthening public health systems by building hospitals (including regional referral hospitals) and supplying them with medicine, equipment and well-trained personnel. - Making provision of a safe water chain and sanitation facilities to limit outbreaks of water-borne diseases and implement strong public awareness programmes to promote better hygiene. • **Risk management (particularly urban areas):** - Mainstreaming climate resilience in all sectors. - Developing vulnerability risk mapping based on better data on climate change impacts at sectoral and regional level. - Identifying better drainage plans. - Building more effective early warning system. - Improving emergency related institutions and establishing a contingency fund to take care of emergency needs following an extreme climate event.

Table 12: Core areas of some institutions implementing actions related to climate change and food security in ProCSA districts

Organisation	Core areas related to climate change and food security	District
District Local Government, Operation Wealth Creation	• Promotion of drought resistant varieties, fast maturing varieties, water harvesting techniques, establishment of a weather station • Sensitisation of communities on climate change • Provision of extension advice • Provision of improved seed varieties	All
District local government	• Provision of water for production through irrigation	Amolatar, Dokolo
Third Northern Uganda Social Action Fund (NUSAF 3)	• Developing integrated sub water sheds, including terraces, bunds, flood and gully control structures) • Provision of tree seedlings to communities	Amolatar
Action for Development (ACFODE)	• Training women in alternative energy sources, namely making briquettes.	Amolatar

Facilitation for Peace and Development (FAPAD)	• Capacity building of farmers on disaster management • Sensitising communities on climate change	Amolatar
Project for the Restoration of Livelihood in Northern Uganda Region (PRELNOR)	• Building capacities of farmers in relevant climate resilient crop production systems. • Implementing natural resource management initiatives which complement resilient crop production systems. • Collecting, analysing and disseminating agro-metrological information. • Establishing and operationalising a biophysical monitoring system	Agago, Kitgum
Samaritan's Purse	• Crisis and disaster response, providing emergency relief including food aid, medicine, shelter and household items • Provision of livestock, beehives, training, fishponds to impoverished farmers, herdsmen and fishermen	Napak
Caritas Uganda	• Provision of emergency relief and rehabilitation • Promotion of agroforestry • Provision of seed banks in case of failed crops • Linking farmers to financial institutions for soft loans • Organising open markets for information exchange • Provision of micro finance	Moroto (Napak)
International Institute of Rural Reconstruction (IIRR)	• Promoting food security and resilient livelihoods. • Disaster risk reduction and climate change adaptation • Supporting the formation of VSLA groups with a focus on women's empowerment	Moroto (Napak)
Karamoja Integrated Development programme	• Environmental conservation and natural resource management • Food security • Sustainable land management (focusing on soil erosion)	Napak
Lutheran World Federation	• Promotion of integrated projects on Disaster Risk Reduction and livelihoods • Introduction of climate-resilient crop varieties and cultivars • Awareness raising on climate change risks	Kitgum
Sasakawa Global 2000	• Promotion of productivity improving technologies, climate change resilient technologies and post-harvest management. • Promotion of early maturing varieties of maize and soybean • Provision of climate information, weather forecasts and market information to farmers	Lira

Table 13: Crop enterprises by district, gender and age category

District	Crop enterprises		
	Male	Female	Youth
Napak	Sunflower Cassava Sweet potatoes Beans Sorghum Maize Green gram Vegetables (egg plants) Fruits (oranges, pawpaws)	Sunflower Maize Sorghum Sesame (simsim) Beans	Maize Sunflower Sorghum Beans Sweet potatoes Cassava
Oyam	Sunflower Cotton Sesame (simsim) Soybean Rice Cassava Chia Sweet potatoes Sugarcane Eggplants (commercial) Cabbage (commercial)	Sunflower Rice Millet Maize Cotton Beans Sesame (simsim) Groundnuts Sweet potatoes Okra Cabbage	Cotton Sunflower Cassava Soybean Sesame (simsim) Tomatoes Onions Cabbage
Amolatar	Sunflower Soybean Cotton Sesame (simsim) Cassava Millet	Millet Sorghum Pigeon peas Sweet potatoes Cassava Groundnuts Green leafy vegetables Eggplants	Maize Cotton Soybean Cabbage Sesame (simsim) Cassava Beans Tomatoes
Agago	Sunflower Cotton Sesame (simsim) Soybean Rice Cassava Chia Sweet potatoes	Millet Maize Cotton Beans Sesame (simsim) Groundnuts Sweet potatoes Okra Cabbage Sunflower Rice	Cotton Sunflower Cassava Soybean Sesame (simsim) Tomatoes Onions Cabbage

Lira	Cotton Rice Soybean Sunflower Maize Tomatoes Cabbage Eggplants Water melon	Cassava Beans Pigeon peas Sorghum Sesame (simsim) Groundnuts Millet Maize Cabbage Okra Green leafy vegetables	Soya Maize Sunflower Cassava
Kitgum	Sunflower Cotton Sesame (simsim) Soybean Maize	Sesame (simsim) Cotton Millet Maize Beans Groundnuts Okra Cabbage Cowpeas Hibiscus spp	Cotton Cassava Soybean Maize Sunflower
Dokolo	Cotton Sunflower Soybean Cassava Maize Chia Sesame (simsim) Rice	Millet Sweet potatoes Beans Groundnuts Cow peas Sorghum Cabbages Tomatoes	Maize Sunflower Sesame (simsim) Soybean

Table 14: Analysis of climate smart agriculture options in relation to climate-smartness and requirements for adoption

Practice	Contribution to CSA objectives			Gender impact		Requirements for adoption				
	Agricultural productivity, food security & incomes	Adaptation & resilience to climate change	Mitigation	Women's participation relative to men	Women's productivity relative to men	Secure tenure of land	Labour availability	Access to water for production	Investment costs	Access to information and extension
A. Integrated soil fertility management										
Conservation tillage	Moderate	High	High	High	Low	Moderate	Moderate	Low	Moderate	Moderate
Crop residue management	High	High	High	High	Moderate	High	Moderate	Low	Low	Low
Crop diversification, intercropping/rotation	High	High	High	High	Moderate	Low	Moderate	Low	Moderate	High
Organic manure	High	Moderate	Moderate	Moderate	Low	High	High	Moderate	Low	Low
Livestock manure	High	Moderate	Low	Low	Low	High	High	Moderate	Moderate	Low
Mineral fertilizers	High	High	Low	Low	Low	High	High	High	High	High
B. Use of improved seed and planting material										
Stress-tolerant varieties	High	High	Moderate	Low	Moderate	Moderate	Moderate	Moderate	High	High
C. Improved water use and management										
Water harvesting systems	Moderate	High	Low	Low	High	High	Moderate	High	High	High
Supplemental irrigation	High	High	Moderate	Low	High	High	Moderate	High	High	High
Planting pits	High	High	Moderate	High	Low	High	High	Low	Moderate	Moderate
D. Improved livestock production and management systems										
Breed improvement & diversification	High	High	Low	Low	Low	Low	Moderate	Moderate	High	High

Practice	Contribution to CSA objectives			Gender impact		Requirements for adoption				
	Agricultural productivity, food security & incomes	Adaptation & resilience to climate change	Mitigation	Women's participation relative to men	Women's productivity relative to men	Secure tenure of land	Labour availability	Access to water for production	Investment costs	Access to information and extension
Feed improvement	High	Low	High	Low	Low	Moderate	High	Moderate	High	High
Animal health & husbandry	Moderate	High	High	Low	Low	Moderate	Moderate	Moderate	High	High
Forage and rangeland management	Moderate	Moderate	High	Low	Low	High	Moderate	Moderate	High	High
Destocking	High	High	High	Low	Low	High	Moderate	Moderate	Low	Moderate
Integration of livestock in a circular bioeconomy	High	High	Moderate	High	Moderate	High	High	Moderate	Moderate	High
E. Agroforestry										
Agrosilvicultural/ Silvopastoral/ Agrisilvopastoral	High	High	High	High	High	High	High	Moderate	Moderate	High
Diversification of food systems to perennials	High	High	High	Moderate	Moderate	High	Moderate	Low	Moderate	High
F. Complementary practices										
Apiculture	High	High	High	High	Moderate	Low	Low	Low	Moderate	High
Community seed banks	High	High	Low	High	Moderate	Low	Moderate	Moderate	High	High
Agrometeorological information	Moderate	High	Low	Moderate	Low	Low	Low	Moderate	High	High
Crop insurance	Low	High	Low	Low	High	High	Moderate	Moderate	High	High
Improved energy efficiency and renewable energy	Moderate	Low	High	High	High	Low	Low	Low	High	Moderate

Photo Captions

Page 9: A farmer inspects her garden affected by the fall army worms.

Page 14: A cleared field affected by running water.

Page 17: Wetland protection is important in tackling climate change in Uganda.

Page 22: The ProCSA project works closely with the local governments to mainstream climate smart agriculture into their budgeting processes.

Page 27: ProCSA interacts closely with farming communities in the project area to promote climate smart agriculture practices.

Page 41: A farmer in Lira District weeds her beans garden.

Page 47: Tree seedlings growing in nursery bed.

Page 48: Contours in the garden meant to prevent soil erosion.

Page 51: Agroforestry in practice in Northern Uganda.

Page 52: A properly spaced soybean garden. Spacing boots productivity.

Page 60: Mixed crop-livestock farming systems promotes food security and resilience of farmers.

Page 62: Agroforestry involves the planting of trees and crops in the same field. It is one of the recommended smart agriculture practices.

Page 66: Women involvement in farming promotes household income and food security.

Page 67: The ProCSA project works towards enabling farmers to have access to good quality seed.

Page 68: Fall army warms are a challenge to adoption of climate smart agriculture practices.

Page 70: A group of farmers consulting each other. Group cohesion among farmers provides the needed labour for implementing smart agriculture practices.

Page 71: A ProCSA staff interacts with farmers in Lira district. The project offers technical support to the farmers.

Page 72: Equal participation of men and women is important in promoting climate smart agricutlrue.

Page 75: Farmers learn how to graft a young shea tree to reduce on it's maturity period. Shea trees are popular in Northern Uganda. These have nutritional and commercial value.

Photo Credit: GIZ staff

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