University of Natural Resources and Life Sciences, Vienna

Adoption of Conservation Agriculture in Uganda

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Doctoral Thesis

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Vienna, Austria, November 2020

A dedication

This thesis is dedicated to all my family, and in a special way to you Omukadde Ow'edda for making everything beautiful in its time.

Declaration

I declare that this Thesis is an original work and no material has been submitted to any other university. The work of other authors is referenced and acknowledged.

Acknowledgment

The PhD studies were financed by the Austrian Partnership Programme in Higher Education and Research for Development - APPEAR, a programme of the Austrian Development Cooperation (ADC) and implemented by the Austrian Agency for International Cooperation in Education and Research (OeAD). The grant specification number is OEZA Project number: 0894-00/2014.

Worthy achievements and successes result from the efforts of a number of people all working together towards a common end. This work is a result of the special contribution and efforts of the great people and teams mentioned below.

Dr Robert Nabanyumya, Dr Drake Mubiru, Prof. JS Tenywa, and Dr Richard Miiro at Makerere University and Ven. John Gitta Kavuma and Prof. Wilson Muyinda Mande of Nkumba University. Thank you all for playing an instrumental role especially in the very early stages of this work. Thank you, Dr Anthony Mugeere, for inspiring and encouraging me along this academic journey! Thank you, Dr Joshua Zake, for heeding the call! And to the anonymous reviewers, thank you too!

I am deeply indebted to my doctoral father, Univ. Prof. i. R. Dr. nat. techn. Willibald Loiskandl. Thank you, Professor, for walking alongside and guiding me. I have benefited from your wisdom. Univ. Prof. Dipl. Agr. Biol. Dr. Ing Michael Hauser and Univ. Prof. Dipl. Agr. Biol. Dr. Ing. Bernhard Freyer thank you for supporting my work. Dipl. Ing. Dr. Andreas Melcher, thank you for encouraging me. All my colleagues at Institute for Development Research, BOKU, thank you for your input. Prof. Emeritus Erwin Lautsch, thank you for the statistical expertise.

DI Elke Stinning and the entire team at OEAD, thank you for your kindness.

I am grateful to the A Rocha Uganda team; Rev. Festo Kalungi, Prof. Eseza Kakudidi, Pr Mark Wamala, Ms Gertrude Kayaga; and Adrine M. Twumwesigye, Dylis Ndibaisa, Susan Kasiita, Ephraim Kategegaya, Vanessa I. Mulindwa, and Kawuma Henry, thank you, my people.

My sincere appreciation goes to the field research assistants Babirye Pauline, Janet Mutebi, Agnes Ateng (RIP) and the people of Lira, Dokolo and Alebtong. Thank you for sharing your life experiences, time and expertise.

Special thanks go to my family scattered all over this earthly home. Dad and Mum Kefa and Solome Kaweesa, I love you. To my siblings Cathy, Brian, Susan, Diana and Hope and my ever-sweet nieces and nephews Jed, Jackson, Liana Queen Jemimah, Brandon, Hailey2, Avery, Aven, Hannah, Hailey, Hazel and Annabel; No wonder, Jesus told us to be like children! My family in Vienna, Angela and Wolfgang, MJ, Miriam and Serena, Bernie, Esther Adomako. I am grateful to you. The members of God's household at Makerere Full Gospel Church, what could I have done without you? Pr. Dr. Fred Wantaate, Papa David Kamugisha and cell, Makula Solome, Mulembe Gwe, G. Mayanja, Mwanje Buddo and Patu Byakyiika, you are God sent. Maria Nartey, thank you for showing me grace. Betty Navuga, Liz Katigo and Erwin Szlezak, thank you! I have reserved (and maybe forgotten) some names, nevertheless, you are all invaluable to me.

Abstract

Conservation agriculture (CA) is a farming system that is based on three principles. (1) Minimum soil disturbance; (2) maintaining a soil cover through mulching with crop residues or planting cover crops; and (3) practicing crop rotation. CA is practiced in many parts of the world for its multiple benefits such as soil and water conservation and the ability to increase economic benefits. CA practice contributes towards combating land degradation, reducing poverty, and improving food security.

CA has been a profitable and sustainable farming system in many parts of the Americas and Australia where it has been practiced for many decades. However, adoption of CA in Africa has been very slow. Efforts to understand the low and slow adoption of CA in Sub-Saharan Africa is controversy-laden, because the arguments for and against CA are polarised. One of the tensions stems from the definition of CA that remains nearly undebatable (Giller et al., 2015a). This goes on further to questions on research quality and the methodologies employed in CA studies when assessing adoption in Africa (Glover et al., 2016). The second argument has to do with the appropriateness of CA across Sub-Saharan Africa (Stevenson et al., 2014a, Stevenson et al., 2014b).

The goal of this research was to address and quantify context specific reasons for slow adoption. This case study was carried out in Uganda to determine strategies for accelerating and effectively scaling up CA beyond the national targets. The study aimed at understanding the extent of CA adoption in relation to the socio-economic status of the farming population in the Lango region, located in Mid-Northern Uganda. Both qualitative and quantitative data were collected using four methods at different levels. Examples of qualitative data included why farmers practiced CA and how they practiced CA while examples of quantitative data included how often they practiced CA, on how much land and how much money they spent when doing CA. Semi-structured questionnaires were used to conduct interviews for 417 households. The non-discriminative snowball sampling technique was used to select the households that were spread over three districts namely Lira, Alebtong and Dokolo. The questionnaires collected demographic information, CA practices and the economic, institutional, and socio-cultural factors likely to affect CA uptake. Secondly, ten (10) key informant interviews were conducted with individuals at the political level. Thirdly, ten (10) focus group meetings with a total of 52 participants were conducted to generate information at the village and community level. The generated information included the history of CA in the region, community perceptions, the political environment of CA, agricultural service provision at local government level and any other information that the participants voluntarily gave the researcher. Key informants rendered a wide range of information based on their expert knowledge of the community.

To better understand adoption in the Lango regional context, the **Q**ualitative Expert **A**ssessment **To**ol for **CA** (QAToCA) was used. QAToCA is an expert-based, qualitative, self-assessment guide for determining the relative likelihood of CA adoption within a site-specific context. Based on diffusion theories and conceptual models, the tool analyses adoption determinants at farm, community and regional levels and contexts. It further assesses the socio-economic, institutional, and cultural conditions that support or hinder CA adoption in the African rural context.

The two main stimuli that influence farmers to adopt CA techniques were the dissemination strategy as well as the provided information about CA. Farmers' uptake of CA at the household level was also related to benefits that were observed in their fields such as bigger crop yields. The QAToCA tool highlighted that the prevailing volatile climate and market conditions are the main constraints to adopting CA at household level. Some farm-level constraints in the region included the diminutive ratio of shared tools and equipment; the minimum presence and involvement of extension services; and seasonal rural markets that are dominated by middlemen.

The study showed that to increase CA uptake in the Lango region, access to CA information through the already existing farmers' groups, the village savings and loans associations, and provision of frequent and timely agricultural extension and advisory services will be important. The results are unique for this region given the regional agro-ecological, social, and economic context that is characterized by demographic dynamics, post war effects, high poverty rates and the shortage of basic services in this part of Uganda. The CA adoption pattern in Lango is promising because it is stable enough for a sustainable intervention to be made. This stability is seen from two results. One of these is that farmers were still practicing CA on their own without follow up and long after projects had long exited the area. Second is the farmers' demand for more CA training, regular and affordable extension services, CA equipment and machinery that are also an entry opportunity point for institutional support. This study recommends the purchase of equipment that can be shared and operated by the communities could improve the regional agricultural practice. As a result, smallholder farmers would take advantage of CA and eventually increase CA uptake rate in the region. Contributions towards improved livelihoods, price protection and safety nets for farmers are critical, just as are credit and cooperative unions and small financial institutions like village loans and saving associations.

Zusammenfassung

Die konservierende Landwirtschaft (Conservation Agriculture CA) beruht auf drei Prinzipien: (1) der minimalen Bodenbeeinträchtigung; (2)der Bodenbedeckung durch Mulchen mit Ernterückständen oder der Anpflanzung von Zwischenfrüchten; und (3) der Fruchtfolge. CA wird in vielen Teilen der Welt wegen seiner vielfältigen Vorteile, wie der Boden- und Wasserkonservierung und der Ertragssteigerung praktiziert. CA trägt auch zur Verringerung von Armut und zur Verbesserung der Ernährungssicherheit bei. Jedoch ist die Einführungsrate diser bodenkonservierenden landwirtschaftlichen Praxis in Subsahara-Afrika, wegen der kontrovers geführten Diskussion, sehr gering und langsam.

Das Forschungsziel war das Ausmaß der CA-Akzeptanz in Bezug zum sozioökonomischen Status der bäuerlichen Bevölkerung in der Region Lango - im mittleren Norden Ugandas - zu verstehen. Sowohl qualitative als auch quantitative Daten wurden anhand von 417 Haushaltsbefragungen, 10 Interviews mit Schlüsselinformanten und 10 Fokusgruppensitzungen mit 52 Teilnehmern erhoben. In der Studie wurde gezeigt, dass zur Verbesserung der Akzeptanz von CA der Zugang zu Information durch die bereits existierenden Farmergruppen, die Unterstützung durch dörfliche Spar- und Kreditvereinigungen und die häufige und rechtzeitige Betreuung durch Beratungseinrichtungen notwendig sind.

Als Haupthindernisse wurden das wenig vorhanden gemeinsam nutzbare Werkzeug, die geringe Präsenz und mäßiges Engagement der Berater, sowie die Abhängigkeit von saisonale Märkten, die von Zwischenhändlern dominiert werden, genannt. Positiv für CA sprach vor allem die Ertragssteigerung. Auch eine angepasste Wissensvermittlung kann die Akzeptanz dieser landwirtschaftlichen Praxis steigern.

Die Ergebnisse für diese Region sind angesichts des regionalen agro-ökologischen, sozialen und wirtschaftlichen Kontextes, der durch eine hohe demographische Dynamik, vergangene Konflikte, einer großen Armutsrate und dem Fehlen von Grundversorgungen gekennzeichnet ist, einzigartig. Abschließend kann festgehalten werden, dass die Voraussetzungen für eine nachhaltige Intervention zu Gunsten von CA erfolgversprechend sind.

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List of Abbreviations and acronyms

ASSP	Agricultural Sector Strategic Plan of Uganda
ACT	Africa conservation Tillage network
CA	Conservation Agriculture
CAADP	Comprehensive African Agriculture Development Programme
COMESA	Common Market for Eastern and Southern Africa
CBO	Community based Organisation
CCD	Climate Change Department
CSA	Climate Smart Agriculture
CSO	Civil Society Organization
DFID	Department for International Development
DSIP	Development Strategy and Investment Plan
EAC	East African Community
EU	European Union
FAO	Food and Agricultural organization
FDGs	Focus Discussion Groups
GDP	Gross Domestic Product
ha	Hectares
HH	Household
KI	Key Informant
KP	Kyoto Protocol
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
M ha	Million hectares
MLP	Multi-Level Perspective
MoFPED	Ministry of Finance, Planning and Economic Development
MUCCRI	Makerere University Centre for Climate Change Research and Innovations
MWE	Ministry of Water and Environment
NAADS	National Agriculture Advisory Services
NAPA	National adaptation Programme of Action
NARO	National Agricultural Research Organisation

NCSA	National Climate Smart Agriculture Taskforce
NEPAD	New Partnership for Africa's Development
NgeZARDI	Ngetta Zonal Agricultural Research and Development Institute
NGO	Non-Governmental Organization
OWC	Operation Wealth Creation
PMA	Plan for Modernization of Agriculture
QAToCA	Qualitative Expert Assessment Tool for CA adoption
SACCOs	Savings and Credit Cooperative Organizations
SDG	Sustainable Development Goals
SLM	Sustainable Land Management
SSA	Sub-Saharan Africa
TerrAfrica	Partnership between FAO, World bank, NEPAD and other agencies
$t \cdot ha^{-1} \cdot y^{-1}$	Metric tons per hectare per year
UBOS	Uganda Bureau of Statistics
UNDP	United Nations Development Programme
UNFCCC	United Nations' Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNFF	Uganda National Farmers Federation
USIF	Uganda Strategic Investment Framework
VLSA	Village Loans and Savings Association

Structure of Thesis

The thesis consists of two parts, A and B.

Part A provides the background and conceptual framework of the study.

Part B comprises the cumulative papers elaborated during the course of study and the published papers listed hereafter.

Kaweesa, S., Mkomwa, S. & Loiskandl, W. 2018. Adoption of Conservation Agriculture in Uganda: A Case Study of the Lango Subregion. *Sustainability,* 10**,** 3375.

Kaweesa, S. H., Ndah, H. T., Schuler, J., Melcher, A. & Loiskandl, W. 2020. Understanding the conditions of conservation agriculture adoption in Lango region, Uganda. *Agroecology and Sustainable Food Systems***,** 1-20.

Kaweesa, S. H., Bilali, H. E., Loiskandl, W. 2020. Analysis of Transition to Conservation Agriculture in Uganda through the Lens of the Multi-Level Perspective on Socio-Technical Transitions, accepted 06 August 2020. *Environment, Development and Sustainability (2020)*

Kaweesa, S.H, Loiskandl W, Mkomwa S, Gitta E, Melcher A 2018: Conservation Agriculture Adoption in Mid-Northern Uganda. Conference paper submitted at The Second Africa Congress on Conservation Agriculture (2ACCA) 9-12 October 2018, Johannesburg, South Africa. *Making Climate-Smart Agriculture Real in Africa with Conservation Agriculture "Supporting the Malabo Declaration and Agenda 2063"* Condensed Papers Book https://www.africacacongress.org/

Additional relevant information is provided in the appendices.

1. Introduction

Agriculture accounts for most of the Gross Domestic Product (GDP) in many developing nations and is, by far, the largest employment sector. Its importance for future development in these emerging economies cannot be overemphasized (FAO, 2015). Uganda's large dependence of employment in agriculture is one of the highest in the Sub-Saharan Africa region (UNDP, 2018).

In Uganda, the agricultural sector statistics include fisheries and forestry data. In 2012/13, the agricultural sector employed 72% of the total working population with 43.2% of the working population being employed in subsistence farming. The sector contributed 24.7% to the nation's GDP. (UBOS, 2017).

The agricultural sector in Uganda is sustained, largely, by smallholder farmers, 95% of whom have land holdings less than 2 hectares (ha). This is similar to other developing nations (Baker et al., 2015, Salami et al., 2010, Zorya et al., 2012).

Several complex problems like land degradation and vulnerability to climate change threaten agriculture worldwide. The effects of climate change threaten and reduce crop yields in rain-fed agriculture systems by up to 50% (Bernstein et al., 2008). Given that almost all of Uganda's agriculture is rain-fed, seasonal variability, vulnerability to climate change and weather-related challenges pose a major threat to production and productivity of the sector.

Uganda is located along the Equator and has a humid, tropical climate. The annual rainfall and its distribution throughout the year is influenced by the surface temperature of the Indian Ocean which absorbs, retains and distributes heat (Stocker et al., 2014). In-country regional weather is in-turn influenced further by several large water bodies, local vegetation and the varied topography. The varied topography includes high mountainous regions around the Mufumbiras, the Rwenzoris and Mount Elgon, and the low-lying Eastern Rift Valley and areas north of Lake Kyoga. The country is vulnerable to seasonal rainfall variability such as intermittent dry spells, long droughts and floods (Ssentongo et al., 2018). These fluctuating and harsh climatic conditions together make rain-fed agriculture rather unpredictable as the rainfall patterns are increasingly unpredictable as climate change becomes more apparent.

However, poor agricultural-land management has gradually led to reduced yields due to poor soil health and land degradation. Soil erosion, degradation and nutrient depletion are some of the limiting factors for crop production (Nkonya et al., 2008). 39% of arable land is degraded, and a further 10% is severely degraded. These problems are now compounded by increased occurrence of extreme weather events as a result of climate change in some regions (NEMA, 2016, Mubiru et al., 2012, Hisali et al., 2011, Okonya et al., 2013, Kaser and Noggler, 1991, Funk et al., 2012). In this regard, Uganda ranks high among the most vulnerable countries and yet the least prepared. Uganda ranks high as the 14th most vulnerable country (World, 2016) and yet is one of the countries that are least prepared to address the effects of climate change (Nkonya et al., 2016, Mubiru et al., 2015).

Human induced changes in vegetation cover like deforestation and large-scale clearing and replacement of swamp vegetation affect ground water dynamics and localised rainfall patterns. This adds further stress to the already fragile agricultural sector.

Traditional shifting agriculture is no longer an option particularly in light of rapid population growth, which has led to land fragmentation and increased competition for the arable land. This situation necessitates a shift to sustainable intensification of production in order to meet food demand while at the same time adapting to climate change. This shift, however, must be within reach of the smallholder farmers that have limited capacity to invest in improved land management and farming systems.

Soil erosion, degradation and nutrient depletion are some of the limiting factors for crop production (Nkonya et al., 2008). Poor agricultural land use and management has gradually led to declining soil fertility and land degradation all of which consequently create a major impediment to growth in the agriculture sector.

Land degradation occurs in various degrees because of the different farming systems and practices, population pressure, local relief and soil variability. 36% of the country is affected by severe land degradation and a further 10% by very severe land degradation (UNDP, 2014a). Severe land degradation means that strong degradation affects 25-50% of the mapping unit area while very severe land degradation refers to extreme degradation affecting 50-100% of the mapping unit respectively (Oldeman, 1992). Degradation is a risk to food security because it affects land productivity directly (Shepherd et al., 2015). This means that there is decreasing crop productivity and that the soils are depreciating due to soil erosion and other causes. Some of the degradation arises from poor farming methods like burning and monocultures (Nkonya et al., 2008, Nkonya et al., 2016). Decreased productivity puts poor households at a risk of food insecurity and it leads to economic distress. Low productivity affects other agriculture dependent industries and economic activities finally impacting the entire nation's GDP.

In Uganda, a recent soil erosion prediction showed that the mean rate of soil loss risk in the country's erosion-prone lands was 3.2 $t \cdot ha^{-1}\ y^{-1}$, resulting in a total annual soil loss of about 62 million tons in 2014. About 39% of the country's erosion-prone lands were comprised of unsustainable mean soil loss rates >1 $t \cdot ha^{-1} \cdot y^{-1}$. Out of 112 districts in Uganda, 66 districts were found to have unsustainable estimated soil loss rates >1 $t \cdot ha^{-1} y^{-1}$ (Karamage et al., 2017). Earlier studies done in 1991 estimated that soil erosion alone accounted for over 80% of the annual cost of environmental degradation representing, as much as US$ 300 million per year (NEMA, 2016). In 2003, the annual cost of soil nutrient loss, due primarily to erosion, was estimated at US$ 625 million per year. Environmental degradation causes 4-12% losses of GDP (Nkonya et al., 2016).

Besides these biophysical limitations and risks, there is a host of socio-economic factors that currently prevent Uganda´s transition to technological innovations such as conservation agriculture. These other impediments include, amongst others, low adoption of agricultural mechanisation; low fertilizer use; ineffective and limited extension services (Kuteesa et al., 2018); seed gap (Mbowa and Mwesigye, 2016); counterfeit inputs (Bold et al., 2015, Mbowa et al., 2015); and land fragmentation (Mwesigye et al., 2017).

Therefore based on the need for sustainable land management (Nkonya et al., 2015), the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) included conservation agriculture (CA) as part of the Uganda Climate-Smart Agriculture (CSA) 2015-2025 program (Ministry of Agriculture Animal Industry and Fisheries 2015-08-12) and the Agricultural Sector Strategic Plan of Uganda (ASSP).

Owing to the proven benefits of CA, the Government of Uganda considers CA as a viable response to the challenges of this very important sector.

1.1 Conservation Agriculture policy in Uganda

In the Climate-Smart Agriculture (CSA) policy environment, government institutions are responsible for the implementation of the policies and other actions that follow on after government decisions (FAO, 2010, Ministry of agriculture animal industry and fisheries (MAAIF) and Ministry of water and environment (MWE), 2015, CIAT and BFS/USAID, 2017). MAAIF plays a leading role in developing and promoting climate change policies. Other ministries, which include Ministry of Finance, Planning and Economic Development (MoFPED) and the Ministry of Water and Environment (MWE) also mainstream climate change adaptation and mitigation strategies into national policy frameworks. The relevant policies are outlined in Table 1. Uganda also made commitments to the Sustainable Development Goals (SDGs) and to implement the Rio Declaration, Agenda 21 and its outcomes. Others include the New Partnership for Africa's Development (NEPAD), Environment Action Plan and the Comprehensive African Agriculture Development Programme (CAADP). CSA is an approach that guides strategic actions needed to sustainably increase agricultural productivity and incomes, adapt and build resilience to climate change, and also reduce greenhouse gas (GHG) emissions. It contributes to the achievement of the Sustainable Development Goals (SDGs) 2 (Zero hunger), 13 (Climate action) and 15 (Life on Land), among others.

Table 1: Key policies relevant for CSA implementation and scale-up in Uganda

Africa	
Comprehensive Africa Agriculture Development Programme (CAADP)	It is based on four reinforcing pillars for investment in agriculture to improve performance ✓ strengthening country presence, ✓ focused lending program based on coordinated sector plans, ✓ enhanced capacity for policy analytical work, and ✓ knowledge/partnership management (NEPAD, 2003).
Uganda - Agricultural Sector	
Plan for Modernisation of Agriculture (PMA)	Since 2000, investments in agriculture were guided by the Plan for Modernization of Agriculture (PMA) whose main objective was to reduce poverty through agricultural commercialization (Uganda. Ministry of Agriculture and Uganda. Ministry of Finance, 2000).
Agricultural Sector Development Strategy and Investment Plan (DSIP)	The PMA has since 2010 been replaced by the DSIP. The DSIP is based on a vision of the future, which is to have 'a Competitive, Profitable and Sustainable Agricultural Sector.' Investments under DSIP have been packaged under four programmes representing the key areas of opportunity. ✓ Enhancing production and productivity ✓ improving access to markets and value addition ✓ creating an enabling environment; and ✓ institutional strengthening in the sector (MAAIF, 2016).
The National Agricultural Policy 2013	The vision of the National Agriculture Policy is 'a Competitive, Profitable and Sustainable Agriculture Sector.' The overall objective is to promote food and nutrition security and to improve household incomes through coordinated interventions that will: -

	✓ enhance sustainable agricultural productivity and value addition ✓ provide employment opportunities; and ✓ promote agribusinesses investments and trade (MAAIF, 2013).
Uganda - Environment and Climate Change	
National Climate Change Policy	The policy is to ensure that all stakeholders with a role to play in the development of Uganda address climate change impacts and their causes through appropriate measures while promoting sustainable development (Ministry of agriculture animal industry and fisheries (MAAIF) and Ministry of water and environment (MWE), 2015).
National Adaptation Programme of Action (NAPA)	The program of action contains nine (9) priorities focusing on building community and ecosystem resilience to adverse impacts of Climate Change (MWE, 2007).
Uganda - Land, Land Use and Forestry	
Uganda Strategic Investment Framework for Sustainable Land Management (U-SIF SLM) 2010 – 2020	The goal of the USIF SLM is to promote cooperation of key sectors in order to improve natural resource-based livelihoods and other ecosystem services. It is a national, multi-sectoral (agriculture, water and environment, lands, energy and trade) initiative spearheaded by MAAIF to implement the CAADP and TerrAfrica. The U-SIF SLM aims at ✓ providing an integrated cross-sectoral approach to investing in solutions to crosscutting SLM challenges; and ✓ scaling-up and mainstreaming SLM into the centre of the national development agenda (UNDP, 2014b).

Conservation Agriculture was introduced in Uganda in the early 2000s as one of the more resilient production technologies under the Climate-Smart Agriculture umbrella (MAAIF, 2016). Some of the key events are highlighted in Table 2. In Uganda, CA is among the priority practices for sustainable land management. There are plans for scaling up through the Government of Uganda's Inter-Ministerial Strategic Investment Framework and in accordance with the National Development Plan (NDPII). There have been two national targets for achieving land under CA. One target was 250,000 hectares of land under CA by 2016 and the second is 1,000,000 hectares by 2025 farmers using CA (UNDP, 2010).

Table 2: Timeline for CA introduction in Uganda

Time	Key message/ remarks
June 1998	Pan-African workshop on CA in Harare. MAAIF & NARO became increasingly aware of the CA potential in Uganda
2000	CA introduced in Bisheshe Sub-County, Ibanda District by a Sida-funded project, Uganda Land Management Project (ULAMP)
November 2001	A World Bank funded study tour in Brazil by high ranking Government officials
2002	Government of Uganda with FAO technical and financial support implemented one of the initial CA pilots using farmer field schools (FFS) in Mbale (Busano and Busiu) and in Pallisa (Budaka and Petete).
2003 to date	• A national multi-stakeholder CSA taskforce created in 2013 by MAAIF as the focal point • Several ongoing projects under a variety of frameworks by different actors including NARO, CSOs, NGOs, donors, etc., particularly in Eastern Uganda

Source: Author's own illustration

Initial consultations were carried out at the Agricultural Produce Department, MAAIF in Lira together with some members of Uganda's national CSA task force who are responsible for monitoring CA in the country. The study was carried out in three districts, namely Lira, Alebtong and Dokolo. Primary data were collected from these three districts. In Lira, data were collected from farmers in the sub-counties of Amach and Agali. In Dokolo, the chosen respondents were from Batta and Amwoma sub-counties. The rest of the respondents were from Awei sub-county in Alebtong.

CA generally involves low cost technologies and is already yielding benefits in fragile and highly degraded ecosystems elsewhere in the world. Lango sub-region was chosen because it is vulnerable and prone to climate change hazards or unpredictable weather as are many other areas. Secondly, Lango being one of the poorest regions of Uganda is representative of the socio-economic constraints generally faced by farmers even in other areas of the country. Both reasons justified the choice of site as the most representative site to use for a study on socio-economic constraints. In addition, the study was done in this region because of its prior exposure to a CA project from August 2011 until December 2015. Upon project completion, farmers were left to carry on the practice on their own after exit of the development partners and as such, the farmers would be expected to have common farming practises.

1.2 Description of the study site

The study was carried out in Lango sub-region located in mid-Northern Uganda. Lango sub-region used to be one large administrative district. Currently, Lango consists of nine districts namely, Alebtong, Amolatar, Apac, Dokolo, Kwania, Kole, Lira, Otuke, and Oyam. The study was carried out in three districts namely Alebtong, Dokolo and Lira, which is also the main town of the sub-region (Figure 1).

According to the 1995 statistics, the northern region covers about 35.5% of the total area of Uganda and has 1,520 km^2 of open water. The northern region is also estimated to be the residence of 20.8% of the population of Uganda (Ubos, 2017, UBOS, 2018).

Alebtong measures about 1,534 km^2 and has a population of 227,541 with a population density of 148/km^2 (380/sq. mi), (UBOS, 2015). The district lies west of Lira along the coordinates 02 18N, 33 18E. Dokolo measures about 1,073 km^2 and has a population of 183,093. It lies along 1°54'0"N 33°43'0"E below Lira and Alebtong districts. Lira has a total land area of 1,330.2 km^2, lies along 02 20N, 33 06E and at an elevation of 1,080 m or 3,540 ft. The district has a total population of 408, 043.

The northern region around Lango is one of Uganda's poor regions and experiences a high level of living standards inequality. According to the Uganda National Household Survey UNHS (2016/2017), northern Uganda has the lowest working population in 2016/17 in the country and a 32.5% poverty rate, which is the second highest after the Eastern region with 35.7%. The national average poverty rate stands at 21.4% corresponding to eight (8) million people. The number of poor persons in northern Uganda was 2.3 million people in 2016/17 (UNHS, 2017). Escaping poverty is difficult as the risk of rebounding into poverty stands at 43%. Figures reveal that there is an increasing number of poor people in the region, for example from an index of 2.8 in 2009/10 to 3.1 in 2012/13. The same trend is true of high inequality represented by a Gini coefficient that rose from 0.331 in 2005/06 to 0.378 in 2012/13.

The region experiences tropical climate with two wet and two dry seasons. The rainfall pattern is generally bimodal with one peak during April-May and the other in September-October; the average annual rainfall varies between 1,200 and 1,600 mm. The rainfall decreases northward to about 800 mm annually. The hottest months of the year are December, January and February. Temperatures range from 21°C and can reach 30°C or higher. The dry season is often governed by prolonged dry spells and mainly drought tolerant annual crops are cultivated. Low, unreliable and lumpy rainfall coupled with alluvial soils of low soil fertility can cause chronic food insecurity in the area (GOU, 2009).

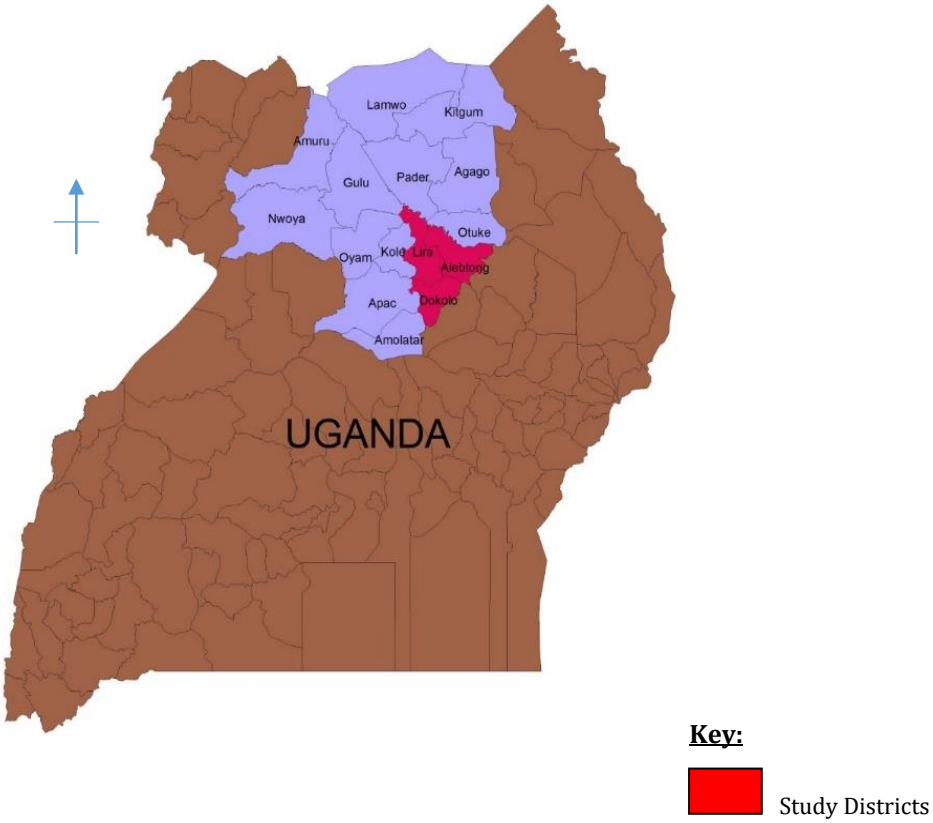


Figure 1: Map of Uganda showing the area of study in Mid-Northern Uganda

The major economic activity is farming (Table 3). Most people are peasant farmers engaging in subsistence agriculture using land that is owned communally. Land disputes are also an emerging problem in the area. The farming system can be described as the typical annual cropping and cattle farming system in northern Uganda. This region is recognized for its potential of becoming the country´s grain basket and concomitant positive impact on the country's GDP. The main cereal crops grown there are maize, finger millet, sorghum and sesame seed or *simsim* as it is commonly known in East Africa. These are the staple foods for people. These crops also provide additional income since surplus produce or harvest can be sold to neighbouring regions, exported or processed to add value before sale. Increased production and entering markets are a real opportunity for the rural households to increase their income. This also applies to the other crops like rice, cassava and cotton that are grown in the region.

Table 3: Percentage of peasant households doing farming

District	% of HH farmers	Notes
Alebtong,	94.9	Growing mostly beans, cassava, millet and maize
Dokolo	94.1	
Lira	72.1	

It is also worth noting that the mid-northern region has also been plagued by conflict and gruesome violence. Notable was the historical war between the Ugandan governmental troops and the Lord´s Resistance Army (LRA) that lasted about 20 years from 1986 to 2006. During that LRA insurgency some families were forced into internally displaced persons (IDP) camps. They farmed intensively around these camps and this resulted in high rates of environmental degradation. There were grave human atrocities e.g. child soldiers and other war crimes (Zeller et al., 2020, Pham et al., 2008) committed that have since continued to undermine development and particularly affected the girl children (Denov and Lakor, 2019, Ertl et al., 2014). Climate change vulnerability is a more recent factor that portends a potentially negative impact on development.

1.3 Research Objectives and Questions

Overall objective

The aim of the study was to explain the slow adoption of CA in the Lango sub-region of mid-northern Uganda with the purpose of determining context-specific strategies for accelerating and effectively scaling out the uptake of CA.

Specific objectives

1. Determine the extent of CA adoption in Mid-Northern Uganda

a) The study aimed at determining the extent of CA adoption in the Lango sub-region in relation to the socioeconomic status of the farming population. Experiences and insight of farmers' perceptions on the appropriateness and impact of CA within their context were gathered.

b) To identify the underlying factors that caused and/or prevent farmers from taking up this technology.

c) To suggest a relevant strategy for accelerating CA uptake specific to the region.

2. Determine the likelihood of CA adoption

The research also applied the Qualitative Expert Assessment Tool for CA adoption (QAToCA). QAToCA is a systematic, qualitative expert-based self-assessment guide for determining the relative likelihood of CA adoption within the rural African context. Based on diffusion theories and conceptual models, the tool analyses adoption determinants at farm, community and regional levels and contexts. The tool was used for the second objective because it further assesses the socio-economic, institutional and cultural conditions that support or hinder CA adoption in the rural African context.

Research questions

1. **What is the state and extent of CA adoption in the Lango sub-region in relation to the socio-economic status of the farming population?**

The objective of this paper was to determine the extent of CA adoption in relation to the socio-economic status of the farming population and to suggest a relevant strategy for accelerating CA uptake that is specific to the region. The study gathered experiences and farmer's perceptions on the appropriateness and impact of CA.

2. **What is the likelihood of CA adoption in Lango sub-region in Uganda?**

The objective of this paper was to determine the likelihood of adoption and to explore the hindering and enabling factors among smallholder farmers in mid-northern Uganda.

2. Literature Review

The agriculture, forestry and fisheries sector in Uganda is still an important sector as it provides livelihoods to 64.6% of the population. It contributes 24.2% of GDP and brings in 52% of the country's total export earnings. The agriculture sector employs a large percentage of Ugandans with 39.3% working in subsistence agriculture alone. This number, which translates to 6 million people, is high compared to the total employed population that is estimated at 9 million people (UBOS, 2018). Uganda's smallholder farmers still rely on weather conditions like rainfall patterns when doing farming. This is in addition to using outdated tools and equipment, and old traditional farming methods like burning fields to open up the land. The poor agricultural practices lead to low agricultural productivity and land degradation. The current situation demands better farming methods for sustainable land use and management like conservation agriculture that can be a viable response to some of these challenges.

Conservation agriculture (CA) is a farming system that is based on three principles; (1) minimum soil disturbance, (2) maintaining a soil cover through mulching with crop residues or planting cover crops and (3) practicing crop rotation (FAO, 2015). The three principles, in combination, distinguish CA from other agronomic practises. Some studies suggested the inclusion of the use of mineral fertilizer as a fourth CA principle (Vanlauwe et al., 2014). This is in response to the second principle of maintaining a soil cover. Fertilizer use would improve foliage and the harvest of both the crops and the cover crops. In addition, fertilizers would also ensure that sufficient post-harvest crop residue is left over to provide adequate ground cover through mulching. However, (Sommer et al., 2014) opposed the inclusion of a fourth principle citing that non-utilization of fertilizer is just one of the many challenges of CA adoption.

CA has several benefits (Giller, et al., 2009). These include increasing food production, improving food security, soil and water conservation (Hobbs et al., 2008); reduction of land and soil degradation; alleviation of the effects of floods and prolonged droughts; and recently acknowledged for its high potential to sequester carbon in Africa (Gonzalez-Sanchez et al., 2019) CA also reduces labour requirements and increases yields under certain conditions. In southern Africa, studies indicate that

practising CA increases productivity and profitability. An increase in crop yields is seen but only in dry climates (Rusinamhodzi et al., 2011, Pittelkow et al., 2014). However, the yield benefit is seen within a time period of 2- 5 years at least as observed with maize (Thierfelder et al., 2013, Thierfelder et al., 2015a). For cereals, the benefits are reflected after practising CA for 5 years because these do not respond to soil quality improvements immediately (Thierfelder et al., 2016c). Among other results, the CA meta-regression analysis on maize in tropical and sub-tropical environments done by (Steward et al., 2018) emphasized that CA maize yields outperform those of conventional practice in drought conditions, even without using fertilizers.

Results from southern Africa show that CA offers adaptation to climate variability effects to some degree (Thierfelder et al., 2017). This is associated with the already widely known CA benefits such as increased water infiltration and biological activity within the crop residues. The study of (Nkala, 2012) also showed improved livelihoods, household incomes and food security in central Mozambique.

In Uganda, CA has been shown to provide soil and water benefits (Mubiru et al., 2017), reduce labour requirements in the long term and increase yields in fragile ecosystems that are highly degraded and vulnerable to climate change, such as in Nakasongola District. The yield increase is associated with ripping and/or permanent planting basins. Permanent planting stations mean that farmers do not have to open up the entire land for sowing again in the subsequent planting seasons.
Based on these benefits, CA should be relatively appealing for farmers to transit from conventional agriculture to CA. This, however, is not the case in Sub-Saharan Africa (SSA) where adoption rates are low unlike on other continents like South America where CA has been practiced for close to four decades, (Farooq & Siddique, 2015; T. Friedrich, Derpsch, & Kassam, 2012). (Giller, Witter, Corbeels, & Tittonell, 2009). Originally, a meagre 0.3% of the land in Africa was under CA (Friedrich et al., 2012b) but more recent studies have put the figure higher, at 1.32% (Kassam et al., 2017). However, these low adoption rates in Africa do not seem to acknowledge the success seen on other continents.

CA adoption is complex because the factors influencing non-adoption have not yet been studied extensively. Nevertheless, there are several studies on the low use of CA, and these reveal context-specific constraints. These include complexities within African smallholder-farming systems; unfavourable institutional policy approaches (Andersson & D'Souza, 2014); lack of appropriate extension (Nicol et al., 2015); limited access to credit; underdeveloped input and output markets (Baudron et al., 2015a Thierfelder et al., 2016b, Thierfelder et al., 2016a); competition for crop residues for use as animal fodder or mulch (Giller et al., 2009); and the approach of CA promotion as a package (Rusinamhodzi, 2015) (Rusinamhodzi et al., 2011), and the inappropriateness of the technology to the target group (Giller et al., 2011)

There are also other factors like peer influence (Kassie et al., 2015, Brown et al., 2018c, Bell et al., 2018) and information availability (Ngwira et al., 2014) that have enabled farmers to take up CA. In order to understand farm-level constraints and why adoption is low in SSA (Andersson & D'Souza, 2014) proposed that a thorough analysis of contextual factors such as socio-economic and institutional conditions, is

needed. Earlier on (Giller et al., 2009) called for critical assessment of ecological and socio-economic conditions for CA within smallholder farming in SSA. Later (Giller et al., 2015b) call for context-sensitive approaches to explore sustainable intensification of agriculture. (Giller et al., 2015b)argue that CA is more manageable for large commercial farms rather than smallholder farmers given the large investment in mechanization and agro-chemicals incurred by the former. Sarah you really need to qualify this statement. Are mechanization and agro-chemicals required for CA or is it a case of the benefits are more dramatic if done on a large scale and therefore mechanization and agrochemical would be of benefit?
The meta-analysis of (Corbeels et al., 2014a) highlighted several findings among which is that CA increases crop yields only on fields with erratic rainfall and that this comes gradually, over time. The impact on incomes depends on the type of the farm, a factor that might explain dis-adoption of CA on smallholder farms. The article of (Pannell et al., 2014) also gives evidence that economic factors affect farmers' decisions to adopt CA and that farmers with meagre resources might take up CA only partially.

(Corbeels et al., 2014a, Ndah et al., 2015) applied the QAToCA tool to investigate CA as an emerging innovation and the wider institutional context in East Africa. Their results showed a relatively high adoption potential in Kenya and Tanzania. The study also concluded that access to markets and other basic infrastructure like roads is important for enhancing the efforts to increase CA uptake.

There are also claims that partial adoption might have poor outcomes just like 'pseudo adoption' which means that adoption only happened during a project life cycle (B. Brown, et.al., 2017). Studies in Malawi also showed that incentives hardly distort adoption patterns and that lead farmers play an influential role in increasing the uptake of CA (Holden et al., 2018). Owing to this, efforts in SSA are more than ever before being focused on means of increasing the wider uptake of CA by farmers (Kassam et al., 2017) .

In 2015/16, the global area under CA was 180 Mha. Africa's estimated portion of this was only 0.3%. (Friedrich, Kassam, & Taher, 2009; (Friedrich et al., 2012b). Recent studies, however, show that the land under CA in Africa has since increased slightly to 1.32% (Kassam et al., 2017) of the global total. Most of Africa's 1.2 Mha under CA are located mostly in South Africa, Zimbabwe and Zambia with a very small portion in other countries as shown in the Figure 2.

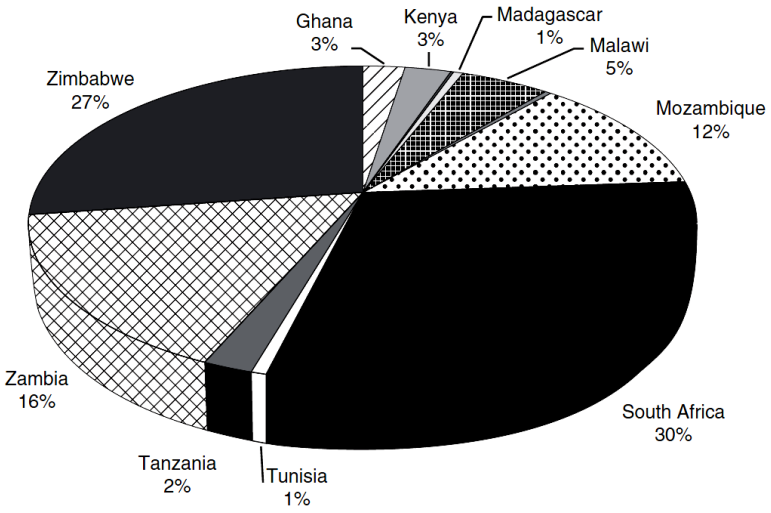


Figure 2: CA area in African countries as a percentage of the total 1.2 Mha (Kassam et al., 2015).

The statistics in Figure 2 are rather not representative of the true African CA picture. For instance, Uganda is not included although, as shown in Table 3, other studies highlight some figures on CA in Uganda. However, overall differences in the level of CA practice would be expected i.e. whether or not all three principles are adhered to by the farmers, given their socio-economic contexts.

Table 4: CA statistics in Uganda , (year of CA data 2016)

Parameter	Stat
CA cropland area (ha)	7,800
CA area under small holders or scale <5 ha	5,800
No. of small-holder farmers (on average 0.5 ha)	11,000
Large-scale farmers (400-1,600 ha)	20
Medium scale 5-100 ha	0
CA area under large scale >100 ha	2,000
CA area as % of total cropland	0.11

Source: Adapted from http://www.fao.org/nr/water/aquastat/countries_regions/UGA/print1.stm

CA, as a best practice, is often piloted and demonstrated on small plots before farmers decide on taking up the innovation in its fullness. Farmers are generally keen on seeing tangible results quickly. These may include improved quality and quantity of yields, improved soil fertility, and the accompanying improved livelihood through better incomes. However, even though these benefits would be factors for driving change, in practise smallholder farmers experience other particular difficulties in applying the technique and because of that, adoption is slow.

There is a need for a much better understanding of the social factors of low and slow adoption of CA in Sub-Saharan Africa (SSA). Studies such as (Ngwira et al., 2014, Moore et al., 2014, Derpsch et al., 2010) identified numerous barriers to the adoption of CA faced by subsistence farmers in Africa. The results of many of those studies also apply to Uganda but only in general because they hardly address the socio-

economic constraints that are unique to the country. Due to Uganda's multiple, unique agro-ecological zones and cultural diversities, differences in adoption are expected. Therefore, studies on reasons for CA uptake and/or hindering factors that could inform the adoption process are needed for each specific zone. For example, a study carried out in Eastern Uganda showed differences in farmers' preferences based on gender, costs, location, and prior knowledge of farming practices (Nyende et al., 2007, Vaiknoras, 2014). The study of (Farris et al., 2017) on the expected profits from practicing CA in a small area, showed that CA reduces poverty at the household level. Such information and differences in preferences affect the likelihood of adoption even within the same region. Such studies are needed to inform the adoption processes and strategies to make effective progress (Farooq and Siddique, 2016).

The study aimed at determining the extent of CA adoption in the Lango sub-region in relation to the socio-economic status of the farming population and to suggest a relevant strategy for accelerating CA uptake that is specific to the region. The study gathered experiences and insights of farmers' perceptions on the appropriateness and impact of CA within their context. It identified the underlying factors that caused and/or prevented farmers from taking up this technology. The study site is a post-war zone on top of having one of the highest poverty rates in the country. The data captured the respondents' estimated use of CA on their land, the frequency of use, and their individual reasons for adopting CA. Other factors explored included economic and social factors in order to form a background for further promotion of CA in the region.

On the other hand, some literature criticises CA research as being short of methodologies and conceptual frameworks and that this often leads to skewed results and misleading figures on adoption (Glover et al., 2016). Methods of studying adoption hinder understanding of what exactly is going on (B. Brown, et.al., 2017). There are hardly any systematic analyses to assess adoption of the institutional perspective. For instance, the few studies done in southern Africa, mainly Malawi, Zambia and Zimbabwe are, criticised for lack of methodological competence (Andersson & D'Souza, 2014).

2.1 Theory of Adoption

This chapter explains the both the theoretical background of the study and the conceptual framework derived to analyse the research questions on social drivers of CA adoption. E. M. Roger´s social science theory of change, also popularly known as the Diffusion of Innovation Theory (1962), evolved to explain how with time, innovations spread through a population and become the new norm of a given people or community. The theory is made up of stages that altogether attempt to analyse and understand why some people more willingly and quickly embrace change than others. Although people generally adopt an innovation after perceiving it as new, the process and rate of adoption generally differs depending on certain characteristics of these people. Rogers categorised some dissimilar traits that, overall, help or hinder adoption. See *Table 4.*

Table 5: Population traits along the adoption gradient

Category	Estimated % population	Adopter Traits
Innovators	2.5	▪ First ones to try the innovation ▪ Enterprising people ▪ Risk takers
Early Adopters	13.5	▪ Opinion Leaders ▪ Opportunists ▪ Only need guidance to do the innovation
Early Majority	34	▪ Adopt only after seeing the evidence e.g. success stories
Late Majority	34	▪ Sceptical to change ▪ Adopt depending on the number of successful adopters
Laggards	16	▪ Traditional and conservative people

Rogers furthers expounds on the stages through which a person adopts an innovation and whereby diffusion is eventually accomplished (Figure 3).

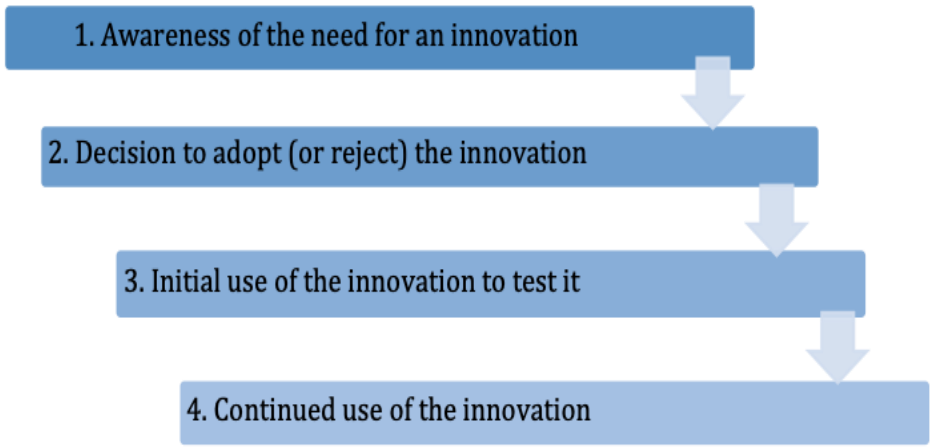


Figure 3: The stages of diffusion (Adopted from Everett, 1972)

According to Rogers' theory, diffusion is a very social process. This means that most individuals depend on the subjective evaluation conveyed to them by their peers that are similar to themselves and that have adopted an innovation. Transfer could happen between homophilious individuals, given that they have similar social status, beliefs and other attributes. This way communication about CA is sure to be effective. Factors like peer influence (Kassie et al., 2015, Brown et al., 2018c, Bell et al., 2018) and availability of information (Ngwira et al., 2014) enable farmers to take up CA.

The established behavioural patterns of members of a social system are called norms. Rogers notes that a given system´s norms, like cultural and religious norms regarding food habits, can be a barrier to change. These norms operate at village, community, national or any other level. Opinion leaders serve as social models in their networks and are change agents in their domain of influence.

The factors influencing adoption, mostly related to technology innovation, include relative advantage, compatibility, complexity, trialability and observability. Although there are some limitations like an individual's resources in the adoption process, the theory has been used successfully in a variety of fields in agriculture that aim at behaviour change of a social system

2.2 Factors considered for assessing adoption

Relevant factors were selected from these concepts and condensed to derive questions and variables for the data collection exercise. The factors considered for assessing adoption are explained hereafter. For example, understanding and/or grasping the knowledge of CA depends on several factors. Factors like farmer training and available household or community labour were investigated in the study. Benefits of CA were explored during trainings, demonstrations and observations on neighbours' fields. Possible options on how CA can be extended gradually from small plots to larger areas on the farmers' fields were analysed. The capacity to verify if CA can easily be modified to suit the ecological and socio-economic circumstances of the prevailing farming practices and production system is also key information. The criteria used for assessing is explained in the following discussion.

2.2.1 Farm and Household Characteristics and Constraints

The ability of the average farmer to meet the cost of CA from their own financial resources is evaluated based on the criteria relating to farm and household limitations. The same criteria are used for assessing whether they have a good handle on knowledge about CA or if they have a good grasp of alternative traditional or indigenous knowledge that is similar to CA and that is already common knowledge among farmers in the region. An assessment of the existing social networks within the community and their level of organisation is also made. The assessment covers their ability to meet CA goals like access to initial inputs for CA like seeds and crop residues for covering the soil, and access to market networks. An evaluation is also made of the competition between utilization of crop residue as animal fodder and its utilization as mulch or soil cover. Further examination is made to determine whether there will be additional land required or if the CA methods can be adapted to the land already owned by and therefore available to individual households. Last but not least, as recommended by various authors, the relation between CA, natural resource use and conflicts between different users is also assessed (Corbeels et al., 2014b, Giller et al., 2015b, Giller et al., 2009).

2.2.2 Economic Condition

The availability and accessibility of markets for CA products, the interest of other CA economic actors, the availability of basic infrastructure, and control structures are examined. Limited access to credit and underdeveloped input and output markets also affects adoption and are, therefore, included. (Baudron et al., 2015a, Thierfelder et al., 2016b, Thierfelder et al., 2016a).

2.2.3 Knowledge of CA

It was also necessary to consider the knowledge about the advantages of CA when compared to conventional agricultural practices. Knowledge on the differences between the yield and return is important. Dissemination factors that were assessed are number of trainings that might be needed to ensure the understanding of the complexity of CA; determination if household or available labour within a community is sufficient for CA implementation; if demonstrations are needed or if they exist in nearby fields. Lastly checked is if CA can be readily adapted to suit the ecological and socio-economic circumstances of the farming and production system in the short term.

2.2.4 Institutional and Political Framework

The indicators in relation to institutional and political issues are assessed at the regional level. They include the political situation of the region; the government policies; the government attitude towards CA research; the state of administrative setup; structure of governance system; and the level of tolerance of civil society. At the village level, local governance structure, presence of supportive local organisations, compatibility of CA to local community rules, land access and ownership, and the community settlement pattern are also influencing criteria. Does the government have an efficient administration system which facilitates (or does not hinder) dissemination activities? The administrative system at the national level has relevant agencies for agriculture and development issues which are easily accessible for farmers. There are stable and effectively implemented government programs/policies which provide incentives for the spread of CA /or sustainable agriculture in general. The administrative system at the national level has relevant agencies for agriculture and development issues which are easily accessible for farmers. The government promotes CA adoption through its integration in formal research and/or extension programs. Farmers are free to and have organised themselves in interest groups of their choices.; such groups can exert pressure (lobby) on policy makers to adjust policies to their favour.

2.2.5 Community Perspectives

Over and above individual farmer engagement and perspectives, the farming community perspectives about CA needed to be explored. The community includes leaders, women, youth and target farmers. For example, a study carried out in Eastern Uganda showed differences in farmers' preferences in terms of gender, costs, location and prior knowledge of farming practices (Vaiknoras, 2014, Nyende et al., 2007). Another study on the profits expected from practicing CA on a small area showed that it made a difference in poverty reduction at household level (Farris et al., 2017) while (Mubiru et al., 2017) showed that yield increases were associated with ripping and/or permanent planting basins on degraded soils in the cattle corridor of Uganda. Ripping is a practice where an ox is yoked with plough drags and draws through the soil opening up narrow and shallow lines also called rip lines. These rip lines are planting points where seeds are sown.

3. Conceptual Framework

This chapter introduces the conceptual framework that was developed to summarise and show how the study was organised based on the analysis of the available information. The CA adoption conceptual framework (figure 4) was developed based on Roger´s theory of diffusion, the multi-level perspective (MLP) and the Qualitative Expert Assessment Tool for CA adoption (QAToCA). The study employs the Multi-Level Perspective (MLP) to analyse CA as a niche and to understand the dynamics and processes leading to the transition to CA.

3.1 Qualitative Expert Assessment Tool for CA adoption (QAToCA) Tool

The QAToCA tool is a qualitative expert-based self-assessment guide for determining the relative likelihood of CA adoption in addition to diagnosing the factors supporting or hindering CA adoption within a site specific context and/or project area for the African context (Corbeels et al., 2013; Hycenth Tim Ndah et al., 2014). The QAToCA tool provides a conceptual framework and was applied successfully in Africa in some countries like Kenya, Tanzania, Zambia, Zimbabwe, Malawi and Burkina Faso (H. T. Ndah et al., 2015). The framework is based on three steps. The first step consists of selected theories of adoption and conceptual models, a review of CA adoption literature (Rogers & Everett, 1983; (Rogers, 2003, World-Bank, 2006, Lundvall, 2004, Triomphe et al., 2007a, Sieber et al., 2015b) and expert evaluation and pre-testing. The second step is made up of thematic areas as outlined in the section 2.2. The third and final stage is made up of analysis and visualization of results.

The guide has several excel sheets, which have a list of operational questions with corresponding statements, indicators for assessing dissemination potential and scores along with an allowance for expressing explanations. The tool assesses factors categorised under nine thematic topics that could influence CA adoption at community, local and regional levels. These include the characteristics of CA, the capacity of the promoting organisation, attributes of the dissemination strategy, institutional frame conditions at the village and regional level, market conditions at the village and regional levels and the community´s attitude towards CA. Questions are rated by a scale of 0 to 5. The number of questions determines the maximum points to be achieved. Responses are compiled in points according to the statements related to the operational questions within a thematic area. The questions are discussed by the participants and their responses are written down in the scale. Points for the thematic areas are normalized in percentage to be equally weighted. QAToCA assumes that CA adoption is influenced by the farming system context, the trade-offs and opportunities at the farm and village scale and the benefits of CA in the field as seen by farmers. The tool also diagnosed the factors supporting or hindering CA adoption in Lango district in Mid-Northern Uganda.

The Qualitative Expert Assessment Tool for CA adoption (QAToCA) was also utilized to assess the likelihood of adoption in Northern Uganda. Additionally, the tool also diagnosed the site specific factors supporting or hindering CA adoption (Corbeels et al., 2013; Hycenth Tim Ndah et al., 2014). QAToCA is a qualitative expert-based self-assessment guide for determining the relative likelihood of CA adoption

within a specific site context. The framework is based on conceptual models and theories of adoption, explicitly explained in most adoption decision studies e.g. (Rogers and Williams, 1983, Triomphe et al., 2007b, World, 2006). The tool assesses factors categorised under nine thematic areas that could influence CA adoption at community, local and regional levels. The themes (Table 5) show the various scales of implementation of a project from farm level to village/local and regional levels. The QAToCA guide is operated using several Excel sheets with a list of questions that are discussed as well as statements that are rated by the participants while also allowing for their explanations. The statements are ranked on a scale ranging from 0-5, '5' being ' strongly agree' with the statement provided, thus indicating the likelihood of CA adoption. Points for the thematic areas are normalized as percentages and equally weighted (Sieber et al., 2015a, Ndah et al., 2014). With the tool the supporting and hindering factors of CA adoption in Lango region in mid-northern Uganda were diagnosed.

Table 6: The nine thematic areas of QAToCA

Theme	**Some key points/indicators for assessing dissemination potential of CA**
Object of Adoption (CA) at farm and village levels	Number of trainings needed for CA to be understood Exploring the labor needed for CA implementation Exploring observable benefits of CA Adaptability to suit the ecological and socio-economic context
Farm and household characteristics and constraints	Ability to meet the financial cost of CA Possession of traditional knowledge similar CA Presence of social networks Access to initial inputs like seeds and land requirements Relation between CA and natural resource users
Capacity of implementing organisation at village and regional level	Profile of CA implementing organization Quality and availability of relevant technical expertise Linkages to other CA implementing organizations in the region Relevant stakeholder collaboration and cooperation
Attributes of scaling up at village and regional level	Dissemination objectives and dissemination strategies Communication types and strategies
Political/institutional framework at regional level	The political situation of the region The government policies and research efforts The administrative setup and structure of governance system The level of inclusion of civil society
Political/institutional framework at village level	The local governance structure Presence of supportive local organisations Compatibility of CA with local community rules Land access and ownership, and the community settlement pattern
Economic conditions at village and regional levels	Availability and accessibility of markets The interests of CA economic actors Availability of basic infrastructure and quality implementation control structures
Community's attitude towards CA at regional level	CA acceptability
Knowledge of the role of CA in climate change and other ecological benefits	Advantages of CA over conventional agricultural

3.2 Multi-Level Perspective (MLP)

The multi-level perspective (MLP) is one of the current heuristic theoretical frameworks that helps to explain how societies change and develop (Geels, 2002, Geels and Schot, 2007, Geels, 2010, Geels, 2011). The MLP framework was originally applied to the energy and transport industries but has recently been used to study other sectors like agriculture (Sutherland et al., 2014, Darnhofer et al., 2012, El Bilali, 2018). It has proven to be key in understanding pathways in sustainability transitions.

The MLP is made of three (3) components. Niches (where new ideas develop), the regime (mainstream activities and structures) and the landscape (society trends and global changes) that influences the former. A niche is a small specialized space that allows new ideas or innovations to develop, grow, and function freely while being protected from the mainstream society (Smith et al., 2010, Geels, 2011). The regime is a way of doing things (i.e. how things are organized or arranged to operate in each setting) and the mainstream activities and structures. This basically means that the regime refers to people´s interaction with technology including the network of social groups and actors, and the rules (formal and informal) that they support to remain dominant. Studies show that although people's behaviour is influenced by social norms and technical structures, global trends and changes at the landscape equally influence them (Geels, 2011). The regime tends to change only incrementally (Lachman, 2013) under the influence of the landscape. It includes trends and events such as macro-economic trends, demographic trends, political and ideological developments, deep changes in societal values, climate change (Lachman, 2013, Smith et al., 2010). The landscape is the external global level that influences and appears to set world trends and the factors that put pressure on the regime to create opportunities for the niches.

MLP was recently used to study transition in food and agriculture. For example, (El Bilali, 2018, El Bilali et al., 2017) suggested an integrated analytical framework for understanding transitions in food systems in the context of the global south. Analysing the CA niche in Uganda followed guidance in the study of (Isgren and Ness, 2017) and (Geels, 2012, Geels, 2018a) on six dimensions of the socio-technical regime, namely guiding principles, practices/technologies, knowledge, market relations, policy, and culture.

In the MLP, transition is defined as the shift from one regime to another and it results from the interaction processes at niche-regime-landscape levels (Geels, 2011, Geels, 2018c, Geels, 2018b, Geels, 2006, Grin et al., 2010, Markard and Truffer, 2008). However, a more nuanced conceptualisation of transition that was recently presented by (Geels, 2018a) suggests to move from "*bottom-up disruption (driven by singular niche-innovations) to gradual system reconfiguration, which represents a more distributed, multi-source view of change*" (p. 86). In this respect, different processes and mechanisms have been suggested to describe the interactions between niches and the socio-technical regime. (Elzen et al., 2012) use the term 'anchoring' to refer to niche-regime interaction that leads to durable, long-term niche-regime linkages. Indeed, niches can anchor to regimes by proposing new institutions or rules, fostering new technical systems (e.g. technologies, practices, processes,) or building new social networks and groups. The MLP stresses the importance of the alignment of processes at niche, regime and landscape levels for a transition to happen (Geels, 2011, Geels, 2012, Geels, 2018a). Depending on the nature

(symbiotic/competitive) and the timing of the multi-level interactions between the MLP elements (i.e. niche, regime, landscape), (Schot and Geels, 2007) distinguish between different transition pathways, namely reproduction (cf. stable regime, no transition), transformation, de-alignment and re-alignment, technological substitution, and reconfiguration.

In this context, El Bilali (2019a) shows that MLP was used to analyse the emergence and/or development of different niches such as agro-ecology, organic agriculture, permaculture, urban agriculture, conservation agriculture, integrated farming, care farming, alternative food networks. Analysing the CA niche in Uganda followed guidance in the study of (Isgren and Ness, 2017), (Geels, 2012, Geels, 2018a) on the dimensions of the socio-technical regime (hereafter named 'regime dimensions'), namely guiding principles, practices/technologies, knowledge, market relations, policy, and culture. Indeed, the validity of the approach used stems from the fact that (Isgren and Ness, 2017) used the same regime dimensions in their analysis of agro-ecological transition in Western Uganda; a context that is very similar to that of the present study. As pointed out by (Isgren and Ness, 2017), "*Applying regime dimensions to a niche-level phenomenon might seem contradictory; however, the point was to anticipate regime level implications of scaling up the niche*" (p. 7). Also, (Smith, 2007) refers to 'socio-technical dimensions' and underline their usefulness in making explicit not only the composition of regimes but also how they contrast alternative niches.
CA sustainability transition in this article uses the MLP as an orienting framework to analyse the alignment of processes within and between the three levels viz. niche-innovations, socio-technical regimes and exogenous socio-technical landscape. We discuss the phases, actors involved and challenges in order to understand the complexity of CA transition and to provide policy advice and provide analytical traction, i.e. moving away from focussing on farmers and the green economy and instead offer wider integrative views in broader societal context.

The MLP simulates the process of transition sustainability innovation pathways and provides strong starting point for explaining complex processes through a historical approach. It accommodates broad patterns and appears to consider most of the important factors that are important for transformation to happen. For instance, at the regime it points out the centres of power and influence like the media, academic institutions, businesses, national and Global policies at the landscape. MLP was also recently used to study transition in agriculture; for example, (El Bilali, 2018, El Bilali et al., 2017) suggested an integrated analytical framework for understanding transitions in food systems. This study analysed the CA niche with guidance from (Isgren and Ness, 2017) and (Geels, 2012, Geels, 2018a) to study the socio-technical regime dimensions namely guiding principles, knowledge, practices, market relations, policy and culture. The result of study helps to build a picture that could be useful in explaining a genuine pathway of CA adoption right through the phases of experimentation, stabilisation, diffusion and finally anchoring over time.

The MLP literature was examined under the empirical data as a means of attempting to understand how, in practice, future transformation could happen and thus lead to scaling up in all dimensions. The link with

power as seen and understood from farmer behaviour change, social relation in the Lango context was explored. The study considered power relations, important interactions and how they could influence a realistic sustainable transformation. An attempt to describe the process at the niche and regime interaction was made. Some cardinal rules of interactions or rules of thumb on transformation from a historical perspective for the area were suggested.

3.3 ADOPT Tool

The Adoption and Diffusion Outcome Prediction Tool (Adopt tool), (Kuehne et al., 2011) was designed based on four aspects. These adoption aspects include the characteristics of the innovation, characteristics of the population, actual advantage of using the innovation and learning of the actual advantage of the innovation. The Adopt tool predicts the likelihood time of the adoption reaching its peak extent while at the same time engaging all stakeholders. The model has a wide perspective of the adoption process and is unique in its estimation of the importance of various factors influencing adoption. It is also unique in its inclusion of time as a variable among its wide range of 20 variables that are related to economics, risk, environmental outcomes, farmer networks, characteristics of the farm and the farmer, and the ease and convenience of the new practice.

The conceptual framework shows that the two left-hand quadrants—*Population-specific influences on the ability to learn about the innovation* and the *Learnability characteristics of the innovation*—only influence the time taken to reach peak adoption; they do not influence the peak adoption level (Griliches, 1957).

It assumes that the influencing factor can also be characterised as being related to the population or to the innovation. Thus, this makes the Adopt tool usable at policy dialogues, in research and development by scientists and practitioners as it seeks answers to the main question of what needs to change in order to increase the speed of adoption.

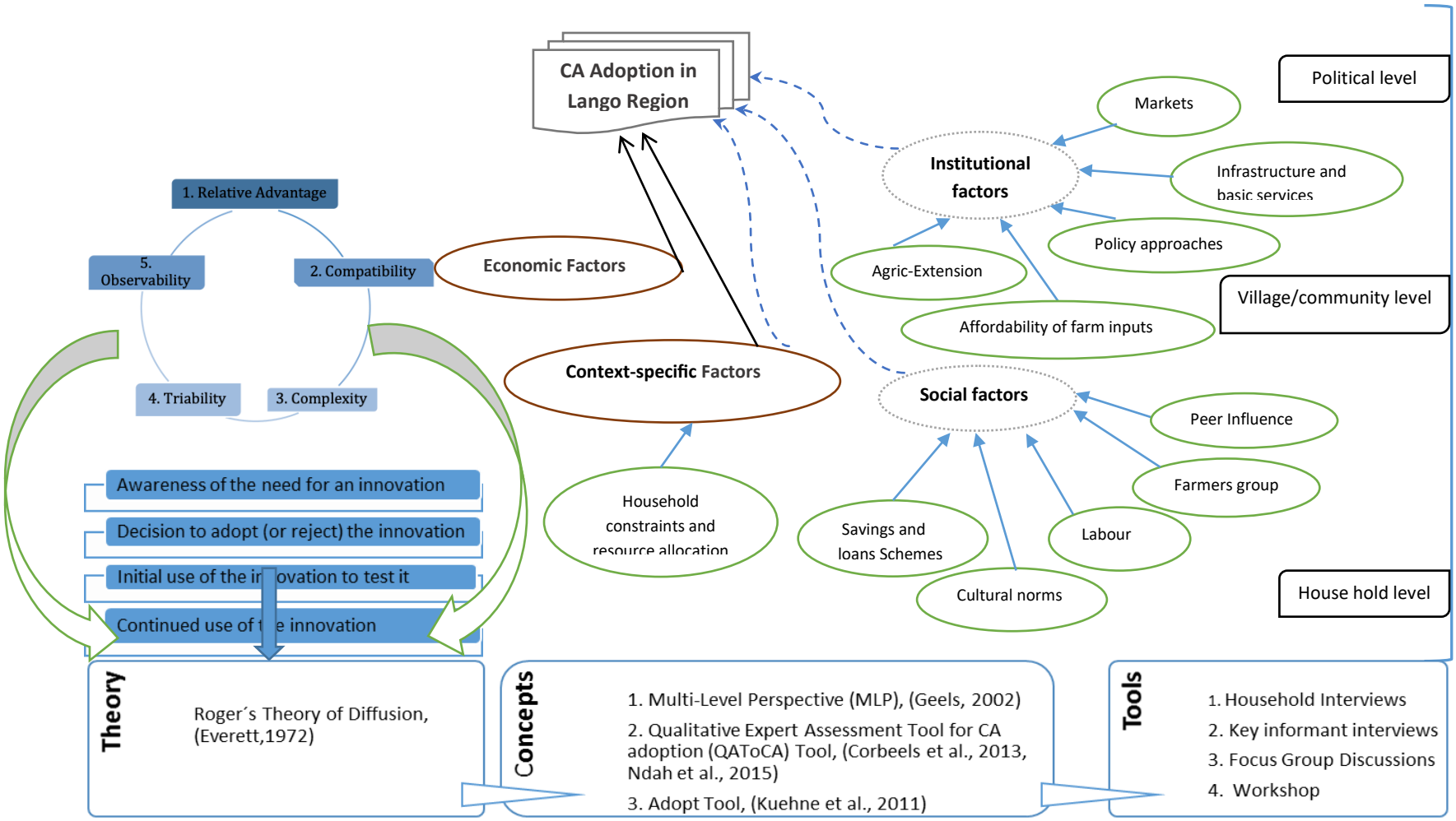


Figure 4: Illustrating the conceptual framework used for the study

4. Methodology

The study was carried out in three districts in mid-northern Uganda in the period January to July 2017, using both qualitative and quantitative methods. These methods included semi-structured interviews administered through household surveys, key informant interviews, focus group discussions, observations and a multi stakeholder workshop where preliminary findings were discussed further. The QAToCA tool was also administered at the same workshop.

4.1 Questionnaire design and testing

In this study, a semi-structured questionnaire that was organized under six different sections with matching questions was used. These was a mix of multiple-choice and open-ended questions. There were also statements that required ranking. The six sections were demographic characteristics and farming practices, financial support, CA knowledge, sociocultural issues, economic factors, and institutional factors. The section on the sociodemographic characteristics of the respondents required biographical data and a description of the respondents' farming practices. The financial section required information on receipt of external funding and sources of finances. The third section required a description of how respondents understood and practiced CA, the frequency of performing CA, explanations of the respondents' CA practices, and their estimated amount of land portion under CA. This section also included open-ended questions on community perceptions, benefits, constraints at the farm level and they perceived as requirements for increasing CA adoption in their community. This was followed by a section on socioeconomic issues, which, in this case, referred to land ownership, and access to and control of use of land. They, in addition, had to rank statements on typical factors that could influence their CA uptake, such as personal decisions, farmer-group dynamics, and/or cultural expectations. The section on economic factors allowed respondents to estimate the amount of money that they invested in their venture and evaluate statements that could influence their CA uptake. The final section, on institutional factors, required information on government programs and extension services. The final open-ended question required respondents to give any additional information and/or make recommendations on how CA uptake could be increased in their region. The above sections and their subsequent questions were guided by other adoption surveys, for example, the CIMMYT 1993 survey program and Rapid Appraisal of Agricultural Innovation Systems (RAAIS), which is a diagnostic tool useful in analysing agricultural problems (Schut et al., 2015a, Schut et al., 2015b).

The questionnaires were β-tested by enumerators on 50 farmers and re-adjusted considering the meanings of words in the local Langi languages. Enumerators were supervised by a team of 4 supervisors who could speak both Langi and English. These also ensured data integrity by cross-checking the questionnaires at the end of each interview. They were responsible for translating the questions into the local language, posing the question and recording the responses. The completed answers were submitted to the team leader twice a day. They were then checked for gaps, inconsistencies or any other issue that was to be immediately addressed. Where possible coding and data entry was done in the field but due to time constraints and unreliable electricity supply this was often not possible and delayed until supervisors returned to the research station.

4.2 Sampling

The snowballing non-probability sampling technique was employed during the household survey as a means of reaching the respondents. The snowball technique involves using a known contact person to identify other persons to be considered as subjects in a given study. The method was employed because the area is hard-to-reach and information about the respondents was not easily accessible (Atkinson and Flint, 2001, Ellard-Gray et al., 2015). The starting point was with the female agricultural officer identified at the local government together with a project officer who introduced the researcher to the local leader of the villages where CA was implemented. He in turn identified the other lead farmers and subsequently the 417 respondents. The selection of respondents was subjective in a way that the pre-defined group sought was that of farmers that had ever experienced CA, that is, those that had practiced it themselves or had received training on CA. The sample was heterogeneous in that it aimed at getting views, opinions and ideas and not so much representing the respondents' numbers proportionately.

The sampling technique allowed us to reach the target sub-category of the farmers in a quick manner particularly because sampling for proportionality was not the main concern. It was subjective in a way. However, the pre-defined group sought was that of farmers that had heard of CA. In order to verify this criterion, the respondents were asked and if they did not know about it, the interview was stopped hence forth. The sample was heterogeneous in that the study was aimed at getting views, opinions and the broad ideas and not so much representing the respondents' numbers proportionately. For the key informants, expert sampling was used to select respondents as a way of eliciting expertise of CA and their knowledge, insight and experience of farming in the region. This group also provided evidence for the HH survey.

4.3 Selection of household survey respondents (Household interviews)

After further discussions at the agricultural department at MAAIF and the main CA implementing institution in Lango, the researcher was led to one of the 25 CA field officers in the region that had last promoted CA until 2015 in the region. The female field officer helped identify past voluntary extension workers and along with the head of the NGO and other project staff. Areas considered to have the highest numbers of CA famers were chosen. The existing and available voluntary group leaders were contacted and they in turn identified their group members from whom the respondents were randomly selected. The farmers that were selected were those that were available self-motivated and had practiced CA on their fields for at least two years. In total there were 417 participants altogether that were mobilised and called upon by the leaders.

4.4 Selection of key informants

The key informants were chosen from Lira district, as it is the location of all the main administrative structures of the sub-region. The criteria of choosing the participants was based on the incumbent socio-technical regime including policy, technology, culture, agricultural research agency, market and industry. In addition to this list two more key informants were interviewed, an expert on economic policy at the ministry of finance and one of the pioneering CA agricultural officers. There were 10 interviews conducted by the researcher and administered to the following personnel.

1) The main agro-input supplier in Lira. She was also a medium scale woman CA farmer.
2) The Agricultural Extension worker at sub-county level.
3) The Lira district secretary for production and marketing.
4) A male local government representative from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) of the Government of Uganda.
5) The woman district agricultural representative from MAAIF.
6) A supervisor of Operation Wealth Creation (OWC) in Lira. OWC is a representative of the former National Agriculture Advisory Services (NAADS) is a statutory semi-autonomous body under the MAAIF. This body has a mandate to manage the distribution of agricultural inputs to farmers.
7) A leader of a Non-Governmental Organisation (NGO) implementing CA in the region.
8) The Agriculture Officer in charge of promoting CA from Ngetta Zonal Agricultural Research and Development Institute (NgeZARDI). NgeZARDI is an agent for technology development and agricultural information dissemination under the National Agricultural Research Organisation (NARO). NARO is a public institution responsible for guidance and coordination of all agricultural research activities in Uganda.
9) Another relevant stakeholder was a policy analyst from the Ministry of finance.
10) A pioneering CA implementing Officer who worked for the Food and Agricultural Organization (FAO) in 2000.

The informants shared their knowledge and experiences though lengthy discussions that lasted on average one hour. There were ten face to face interviews conducted by the researcher and administered to the personnel.

4.5 Focus discussion groups

The researcher randomly selected participants from each of the three districts to participate in the FDGs. There were 6 focus group discussions that were conducted. However, the women were separated from the men. The comprised the following.

Table 7: Showing focus discussion groups and number of participants

District	Sub-county	village	No. of men	No. of women	No. of FDGs
Alebtong	Awei, Acede Parish	OkwaloAgabo B	7	6	2
Dokolo	Bata, Alapata Parish	Anyangocoto	9	6	2
Dokolo		Alanyi B	Mixed		1
Abia cooperative	Control group		6	6	2
Lira	Agali , Adyaka Parish	Anyapo	6	6	2
Total			28	24	9
Workshop in Lira			14		

4.6 Summary of data Collection

A desktop literature review of the available and most current published documents on CA was completed and supplemented by non-published data in Uganda to ferret out essential information. This approach led to synthesizing the information and narrowing it down to the East African region and finally to Uganda. Some of the documents accessed and studied included government reports, scientific and project reports, journal articles and the latest books on conservation agriculture. The information gathered was further narrowed down to CA in Northern Uganda were the study was soon carried out.

Following literature review and subsequent critique and development of the research tools following the same process, the latter were employed for gathering data and information during the field studies that lasted seven months. The tools included the following; a questionnaire comprising of both semi-structured and open questions to guide household interviews; a check list of open-ended questions to guide key informant interviews; a list of open-ended questions to guide focus group discussions and the Qualitative Expert Assessment Tool for CA adoption (QAToCA 2.0). A workshop was also carried out at the end of the field work to assess the likelihood of adoption in the region and validate the initial results.

Table 8: Summary of data collection

Methods	Brief description	Main focus
QAToCA assessment	Workshop with 14 participants	The likelihood potential of CA adoption at farm, village/ community and regional levels
Semi-structure qualitative survey	417 household interviews	Household level
Key informant interviews	10 key informant interviews	Political level
Focus group discussions	10 focus groups (total of 52 participants)	Village/community level
Participant observations	fields visited	Structured field observations

4.7 Data Management

Statistical analyses for the household interviews were done using IBM SPSS version 24 (Inc, 1990, Pallant and Manual, 2010). Information from the interviews was summarised to highlight the stories and experiences from the groups. Data was altogether analysed to help understand the farm level constraints and the conditions under which CA could be adopted at a farm level and to generally assess adoption.

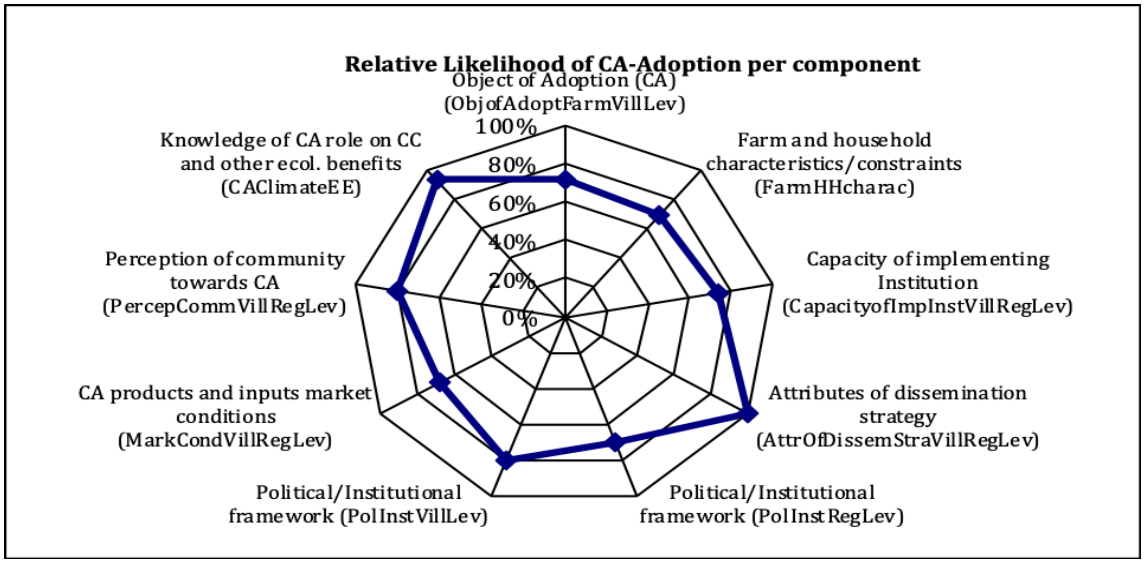
5. Results and discussion

The results of CA uptake in Lango region provide evidence of context-specific constraints compounded by adverse circumstances. The latter included impacts of the Post civil war in Northern Uganda (Finnström, 2008, Branch, 2011) and living through inequality, high poverty rates, increasing climate variability and vulnerability to extreme weather events. Although these in themselves add to the complexity of the situation. Nevertheless, the farmers show a resilience as they endure the challenge and still produce the much-needed food. Their responses show that CA is way better than conventional agriculture. This is unlike some studies that suggest that CA in the SSA is top-down (Brown et al., 2018b) and perceived to be a mismatch for semi-arid ecological zones.

Exposure to information played a key role in enabling individual farmers and communities to adopt CA as a preferred method of farming. The knowledge farmers gained enabled them to understand why and how to practice CA, unlike other programs. The farmers grasped the technical information about CA, thus providing a contrast with other findings suggesting that CA knowledge was too complicated a package for ordinary rural small-scale farmers to understand. The results showed that it was about providing learning opportunities and exposure to people to enable technology uptake. The extent of CA adoption (Kaweesa et al., 2018) in the region therefore presents a promising attempt at CA uptake that is steady enough to be built upon and sustained. The need for more CA training, extension services, equipment, and machinery provide a good opportunity for institutional support to be provided through appropriate partnerships to enable the purchase of capital assets that can be shared within the communities. A technological innovation that manages the dissemination approach and diffusion strategies criteria would go a long way in spreading and subsequently increasing adaptation rates. This would allow more smallholder farmers to take advantage of the technology and eventually scale up.

The assessment using the QaToCA tool gave results showing the dissemination (diffusion) strategy at the village level having the greatest impact on increasing or decreasing the likelihood of CA adoption in Langa sub-region. The attributes of dissemination strategy at the village level had the highest influence on the likelihood of adoption, Figure 7 below.

Figure 5: Spider diagram showing the relative likelihood of CA adoption from QaToCA



Other important factors necessary for effective scaling up included the clarity of the objective, dissemination activities which the respondents called learning units, the communication strategy of the implementation organisation, the use of incentives in the initial stages, the flexibility in facilitating knowledge exchange between farmer groups and enabling regular evaluation, frequent meetings between the target group and other stakeholders in the community. Networks of smallholder farmers were shown to increase diffusion of CA technology. Farmers got their knowledge from within their networks e.g. at village meetings, local radio, ; also demonstration plots and local media (Moore et al., 2014) shows that there are gaps between services sector and farmers.

In an ideal situation, the role of national government agencies in agriculture would be to support and promote local efforts to achieve soil protection, increased productivity, market protection, among many other responsibilities. However, in the study sit*e* CA uptake in the region took place amid minimum intervention; there was hardly any extension service or government program on CA in the study locations. Nevertheless, this bottom-up breakthrough of CA niche innovation to the socio-technical regime serves not only as an example but also as a timely window of opportunity for stimulating for a transition process from conventional agriculture to CA. The bigger shift demands a policy adjustment to demonstrate government support, an enablement to enhance farming practices of farmers and infrastructure investment to start with among other requirements. Transitions from the stable conventional agriculture regime to CA are inevitable given the pressure to enhance productivity on ever diminishing size of land among other challenges. A key institutional factor for increasing CA uptake in the area is improving extension-service delivery.

Results showed that more than 80% of the respondents spent less than US$50 per season from their own savings to finance their farming activities. This insufficient financial investment that the farmers put into their CA activities reflects poverty in the region (Kaweesa et al., 2018). Additionally, the use of Village Savings and Loans Associations (VSLA) offered group accountability and generally meant lower risks of loss of capital assets in the case of a failure to repay loans. This also reflects the tendency for farmers to shy away from formal financial institutions such as banks for fear of loss of their property like land. As such farmers can hardly invest in better technologies.

However, agricultural productivity can lag due to poor technology (Bategeka et al., 2013, Kasirye, 2013). Discussions revealed that farmers were in position to meet the manageable repair and maintenance costs small manual CA tools and equipment. For instance, in one village where one manual ripper was shared between 105 farmers, farmers contributed to replacement of the plough and pay for mechanical repairs when need arises. This ability to meet a small percentage of costs is an indication of willingness to pay but also a reflection of circumstances and external pressures that are beyond the farmers e.g. affordability of the initial large capital costs to purchase the equipment. An effective strategy in this case would involve creating partnerships like public-private partnerships or joint entrepreneurships to provide mutual benefits within conducive conditions of those involved. Otherwise farmers quickly steer off unfair deals and are eventually forced opt to out of technologies. Therefore, for CA scaling up, such efforts can be enhanced through the farmers' groups to achieve a common end. Promotion of increased CA uptake in the

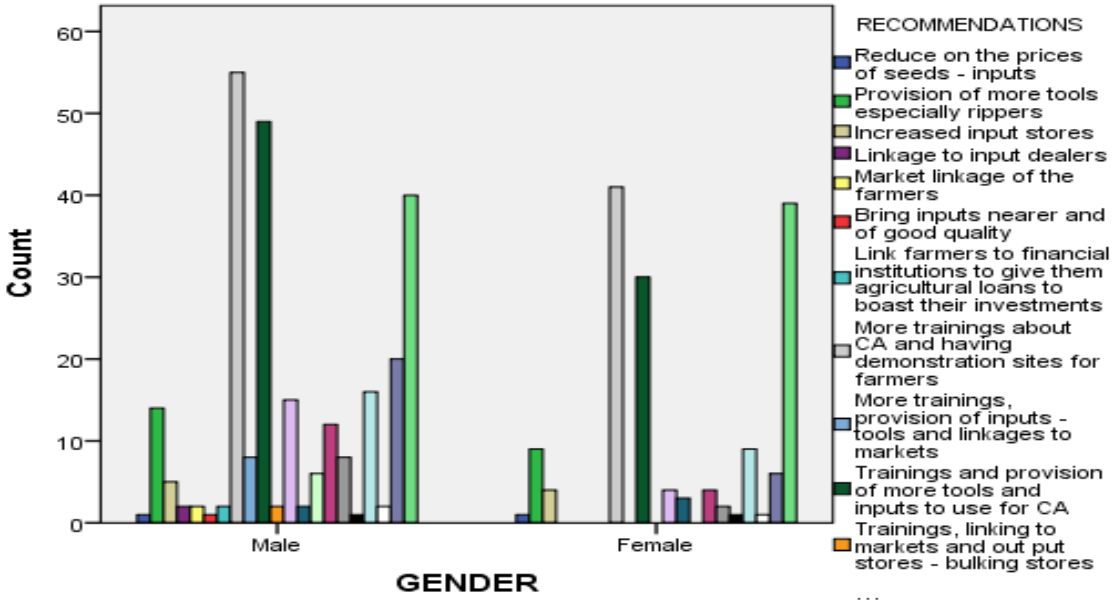
Lango region would require better financial investment, as the work of (Sims and Heney, 2017) explicitly showed elsewhere in similar conditions.

The extension services provided by the extension workers of the implementing organisations motivated the take up of CA in this region. This reason for CA adoption in a similar study in Swaziland showed that advice from NGOs played a major part in increasing likelihood of adoption (Mlenga and Maseko, 2015). On the hand, results further showed little government communication about CA ,22.4%, there were hardly any CA programs or projects implemented by the government in the area 16.8% and only 9.1% of farmers had ever received extension service from the government, (Kaweesa et al., 2018). Discussions with some government personnel showed that extension services are demanded driven due to limited personnel, restructuring of the entire service in the country and insufficient budget allocation. However, in an ideal situation, the national government agency would be the promoting agency and creating an enabling environment for CA uptake as per the country strategy on climate smart agriculture and sustainable land management. Therefore, rethinking of the broader policy on support for agriculture for instance public private partnership could enhance the cause of sustainable land management and eventually CA uptake as one of the via options for increasing productivity and thereby reducing hunger, environmental protection, reducing unemployment among several other things that are in line with the sustainable development goals for transformation. More so studies give evidence of successful public private partnership business models for availing tools and equipment led by the private sector for instance from Ghana (Diao et al., 2014). This and a few others provide an example that could perhaps be a consideration for what machinery funding mechanisms might work more appropriately for Africa (Baudron et al., 2015a, Baudron et al., 2015b).

Perceptions of the farmers are important in increasing the likelihood of CA uptake. Results from the household interviews show that farmers believe in training and demonstration of CA, *Figure 8 below*. From 57.% of respondents view point, other people in their community were not doing CA because they had not been trained 46%. However 42.2% thought that others were doing CA because they had received traineing and so were knowldgebale in the technique about the CA practices and the higher yields realized from the practice, this was 14.9% and 15.6% respectively. Results also show that 76.7% of the respondents said that more trainings and massive sensitization about CA plus having demonstration sites for farmers would encourage the whole community practice CA, this was followed by more training and equipment/inputs (17.3%) and the provision of inputs and equipment to use for CA (3.6%).

The study of (Mwangi and Kariuki, 2015) on community attitudes also showed that it was important to explore the farmers' perceptions in order to fully understand technology adoption among smallholder farmers. The study of (Ntshangase et al., 2018) likewise also showed that farmers with positive perceptions will most likely adopt CA. The chart below represents individual recommendations given by farmers interviewed at household level. 76.7% of the respondents said that more trainings and massive sensitization about CA plus having demonstration sites for farmers would encourage the whole community practice CA.

Figure 6: Farmer recommendations grouped by gender to promote CA



The respondents were requested to give any further information regarding CA. The responses were summarized, coded and analysed. The greatest majority 45% mentioned that more trainings and information about CA were needed while others 19% gave no recommendations. The same pattern was similar across gender.

About half of the respondents consistently mentioned and recommended that more trainings and information about CA were needed coupled with increased access to genuine inputs and specific tools to implement CA.

Increase in income household is an important factor that has the potential to increase CA uptake as another study shows clearly across some SSA countries including Uganda (Tambo and Mockshell, 2018). A key finding from the focus discussion groups showed that women had more tangible achievements as a reflection of an improvement in their livelihoods due to benefits accrued from adopting CA. Some of the achievements included better food production especially during periods of prolonged dry spells and droughts, increased ability to afford and construct better housing using bricks instead of mud and wattle, ability to pay fees for tertiary education of their children, ability to invest in diversified income generating activities such as small retail shops and generally being able to afford medical expenses, utility bills especially in female headed households; all of these viewed as better living standards and more so for households where the head, who is usually man, is not in position to take care of their families. A key factor of such women FDGs benefited from strong relationships and a social support system where members catered for the disadvantaged ladies like widows, single mothers and the elderly. This social structure helped the women take up CA through peer training and that they implement minimum tillage with help of their self-organised revolving labour groups that dig up permanent planting stations popularly known as 'basins'. As respondents' quotations below suggest.

'Sometimes we help our fellow women dig up basins, like one of us Florence who is a widow'. 'We have a culture here of working hard long hours under the hot sun, the darker you are the more respected you are in the community because it shows you are a strong man' Omoro Village CA lead farmers.

This social structure can be supported to enhance effective CA uptake in the region and could be used for channelling agricultural incentives through these groups.

Photos below show the cultural norms and gender differences: Women sit behind men and they hardly speak in presence of men unless when on their own.

In relation to this, other social issues that can positively enhance CA uptake are summarised below. Close to 70% of the land was owned by men, while 25% was jointly owned by a married couple and family land inherited from the man's family. Women owned only 5% of the land. Priority of access to land usage was mostly to men and the entire household that was mostly members from the man's family; only 4% of women had access to use the land. The same applied to decisions regarding which crops were to be planted in each season. Nearly all decisions on which crops to plant in each season were made either jointly between the man and the woman or solely by the man. Few decisions (8%) were made solely by the women.

The Pearson correlation of CA adoption and sociocultural factors in the communities where it was promoted was r = 0.236, p-value = 0.000. In conclusion, the correlation indicates that strength of association between the variables was low (r = 0.236), and correlation coefficient was significant (p < 0.000). It is also shown that 5.5% (0.2362) of the variation in CA adoption is explained by sociocultural factors in the communities where it is promoted.

5.1 Field work limitations

There were some field limitations to the study. These included limited access due to limited means of public transport, impassable roads for instance sudden weather changes and abrupt heavy rains made access to the community very problematic during and after the rains. The study also had to follow traditional community protocol where community leader's permission had to be sought in order to be able to access the village and even then, homesteads were located far apart and so needing a lot of time to access them. At time there was a communication setback due to the language barrier and so an interpreter who could speak both English and Langi was invaluable particularly when speaking with the women who were shy and could hardly say anything until they were fully convinced of the intensions of the research.

HH interviews were carried out nearly at the time of planting and the FDGS after planting while also observations were also done after that to verify some of the responses from them. The timing of the surveys was in-between preparing the fields and planting as the onset of rains was uncertain. Social cultural settings and values of the community also slowed activities down for instance burials led to cancellation of pre-arranged appointments and meetings as participants hardly showed up.

5.2 General Conclusion

Mid- Northern Uganda is a viable niche for CA given that CA increases yields in drier environments. Secondly the farming population is aging and machinery are scarce; this means that there are time and energy limitations and disadvantages in the already harsh conditions.

Strategies for increasing effective uptake of CA in Lango would include social information dissemination, investing a financial stimulus in the existing VSLA for instance to facilitate Agri-equipment and service provision, services for warehousing or post-harvest handling. At higher levels, institutional changes are long overdue. The latter would be more relevant if they rationally fulfilled their official role of basic service provision, policy implementation and addressed the market irregularities.

The results are similar to the global lessons of (Brown et al., 2018a) that social development needed for CA to be used. This includes financial access and affordability at the household level, and institutional changes among other factors. Also the results concur with (Baudron et al., 2015b) on targeted locations for CA in Eastern and Southern Africa. The study rightly argues that CA increases yields in areas with water limitations or where potential delayed planting times leads to lower yields. And in these cases, CA is time and energy saving, controls soil erosion, and promotes water use efficiency. This PhD has provided evidence of local adaptation of CA, where there is peer to peer transfer of knowledge. The barrier to be addressed in the community are the markets, storage or warehouses for post-harvest handling, credit affordability through the VLSA and basic service provision in the region including road infrastructure that need to be upgraded. The key results also farmers are doing permanent planting stations and those that can afford are ripping. This means that there is less unhealthy soil tillage on these degraded soils, a CA factor that is vital for sustainable production of field crops (Wall et al., 2013).

For scaling up CA, strategies will be unique for each context since adoption patterns are unique for each region, even within the same country. In Lango, the information dissemination strategy is key. Public-private partnership to provide sustainable mechanization sharing options and to cover the initial costs of a community bulking system in order to offer price protection and safety nets for farmers are some of the relevant strategies that can accelerate a steady uptake of CA would be extremely beneficial. Agricultural extension services, credit and cooperative unions and small financial institutions like the village loans and saving associations would play major/important/crucial roles.

More information is needed to consider factors such as social networks in this post-insurgency area, gender issues, land issues, machinery sharing options, and viable markets that could absorb the CA produce. These would include analyses of farmer typologies and their decision-making processes; gender

limitations, land issues and diagnosing the factors that support, among other contextual factors, effective scaling up of CA in the region.

CA may even become more attractive if future research provides quantification of annual yield increases, reduced input and manual labour costs for elderly farmers, and increased financial returns. Other analyses could include farmer typologies and their decision-making processes, gender limitations and land issues.

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Part B: Published papers and submitted manuscripts

Paper 1: Adoption of Conservation Agriculture in Uganda: A Case Study of the Lango Sub region

Sustainability **2018**, *10*(10), 3375; **https://doi.org/10.3390/su10103375**

A special issue of *Sustainability* (ISSN 2071-1050). This special issue of Governance for Climate Smart Agriculture belongs to the section "Sustainable Agriculture, Food and Wildlife".

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Received: 8 August 2018; Accepted: 18 September 2018; Published: 20 September 2018

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Abstract: Conservation agriculture (CA) is based on three principles: minimum soil disturbance, maintaining a soil cover through mulching with crop residues or planting cover crops, and practicing crop rotations. CA is practiced in many parts of the world for its benefits to soil and ability to improve yields, among others. There is little documented information on the status of CA adoption in the Lango region in mid-Northern Uganda. This study aimed at determining the extent of CA adoption in relation to the socioeconomic status of the farming population and suggesting relevant strategies for accelerating CA uptake specific to this region. A non-discriminative snowball-sampling technique was used to gather data from 417 households spread over three districts. Semi-structured interviews were conducted using household questionnaires. Farmers' uptake of CA was related to information gained from training and the benefits that were observed in their fields. Some farm-level constraints in the region included the diminutive ratio of shared tools and equipment; the minimum presence and involvement of extension services; and seasonal rural markets that are dominated by middlemen. The impact that was attributed to the use of CA at the household level was improved yields. The strategy that was used to spread CA information to farmers also played a key role in increasing CA uptake in the region. This information is important for increasing CA adoption in this context given the socioeconomic status of the region.

Keywords: conservation agriculture; information; adoption; socioeconomic; farmers' perceptions; minimum tillage; crop rotation

1. Introduction

The population of Uganda in 2014 was 34.9 million and is forecast to reach 40.4 million in 2020 [1]. Notable still is the high annual population growth rate of 3.2%, and the youth population, marked by 48% being people under the age of 14 [1]. This has contributed to a high dependency ratio and inevitably exerted pressure on the available resources needed for livelihoods, employment, economic development, and family welfare. Another key feature of this demography is that the proportion of the population in waged employment stands at 18.5%, and the remaining majority are engaged in agriculture.

Agriculture in Uganda is sustained by smallholder farmers, 95% of whom have landholdings of less than 2 ha. The agricultural sector is highly considered as one of three growth sectors with high job-multiplying effects, as it mainly provides livelihoods and forms the biggest household enterprises. In 2014/2015, more than 64% of the working population was employed in subsistence agriculture and contributed 24% of the GDP in that period [1]. However, poor agricultural-land management has gradually led to reduced yields due to poor soil health

and land degradation. Degradation is one of the factors impeding productivity [2]; 39% of arable land is degraded, and a further 10% is severely degraded. At the same time, farmers are already experiencing extreme-weather events in some regions [3–8]. In this regard, Uganda ranks high among the most vulnerable countries [9] and yet the least prepared [10,11]. Therefore, based on the need for sustainable land management [12], the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) considered conservation agriculture (CA) as part of the climate-smart agriculture 2015–2025 program [13] and the Agricultural Sector Strategic Plan of Uganda (ASSP).

Conservation agriculture is based on three principles, namely, minimum soil disturbance, maintaining a soil cover through mulching with crop residues or planting cover crops, and practicing crop rotations [14]. We restricted the conceptual definition of CA in this study to two principles, namely, minimum tillage (ripping and/or permanent planting basins) and crop rotation. In this region, farmers are not mulching and, hence, this principle could not be evaluated. The yield increase associated with ripping and/or permanent planting basins on degraded soils was documented by Mubiru et al. [15]. The study explored the extent of practice of these principles and related them to the socioeconomic status of the population. Other benefits of CA are documented, including soil and water conservation [16], labor reduction, recovery of degraded fields, improved food security, and soil-erosion control [15,17]. However, low adoption rates, particularly in Africa, do not seem to reflect this success. Originally, a meagre 0.3% of the land in Africa was under CA [18], but more recent studies have put the figure higher, at 1.32% [19].

CA adoption is complex because the factors influencing non-adoption are not well-studied. Nevertheless, there are several studies on the low use of CA, and these reveal context-specific constraints. These include complexities within African smallholder-farming systems, unfavorable institutional policy approaches [20], lack of appropriate extension [21], limited access to credit and underdeveloped input and output markets [22–24], competition for crop residues for use as animal fodder [25–27], the approach of CA promotion as a package [28–30], and the inappropriateness of the technology to the target group [31–33]. There are also factors that have enabled farmers to take up CA, for instance, peer influence [34–36] and information availability [37].

At present, greater emphasis on Sub-Saharan Africa is placed on the means of increasing the wider uptake of CA by farmers [19]. Due to country diversity, studies on reasons for CA uptake and/or hindering factors that could inform the adoption process are needed [38]. Looking at Uganda, which has several agro-ecological zones and cultural diversities, differences in adoption can be expected. For example, a study carried out in Eastern Uganda showed differences in farmers' preferences in terms of gender, costs, location, and prior knowledge of farming practices [17,39]. There is also a study on the expected profits from practicing CA in a small area, shown to make a difference in poverty reduction at the household [40]. Such information and differences in preferences affect the likelihood of adoption even within the same region.

The study aimed at determining the extent of CA adoption in the Lango sub-region in relation to the socioeconomic status of the farming population and to suggest a relevant strategy for accelerating CA uptake specific to the region. The study gathered experiences and insight of farmers' perceptions on the appropriateness and impact of CA within their context. It identified the underlying factors that caused and/or prevented farmers from taking up this technology. The study site is a post-war zone, besides having one of the highest poverty rates in the country. The data captured the respondents' estimated use of CA on their land, the frequency of use, and their individual reasons for adopting CA. Other factors explored included economic and social factors to form a background for further promotion of CA in the region.

2. Materials and Methods

2.1. Description of Study Site

The Lango sub-region is situated within the annual cropping and cattle-farming systems that are primarily found in Northern Uganda (2.8780°N, 32.7181°E) (Figure 1). The region is dry compared to the rest of the

country and experiences one long rainy season also called the unimodal type of rainfall, yet farmers can still grow two crops in a year. Although still recovering from war and related effects, such as ecosystem degradation, the region is recognized for its potential of being the country's grain basket and in fact contributing to the GDP. Farmers grow cereal, oil crops, pulses, and root tubers, in addition to rearing cattle and small ruminants such as goats. The main cereal crops grown there are maize, finger millet, sorghum, and rice; other crops grown are cotton, sweet potatoes, and cassava. The region is also notable for growing oil crops such as sesame, sunflower, ground nuts, and other legumes, such as pigeon peas, soybeans, and beans. These provide the staple food for people beyond the region and play a role in income generation for rural households, with a substantial contribution to the national economy. Soil types are ferralsols, alisols, and plinthosols [41]. Traditionally, farmers rely on family labor, and use the rudimentary hand hoe for land opening, soil inversion, and production after burning vegetation. Under CA in the region, farmers aim for minimum tillage with either hoes to make permanent planting stations, also called basins, or oxen draft power for digging rip lines.

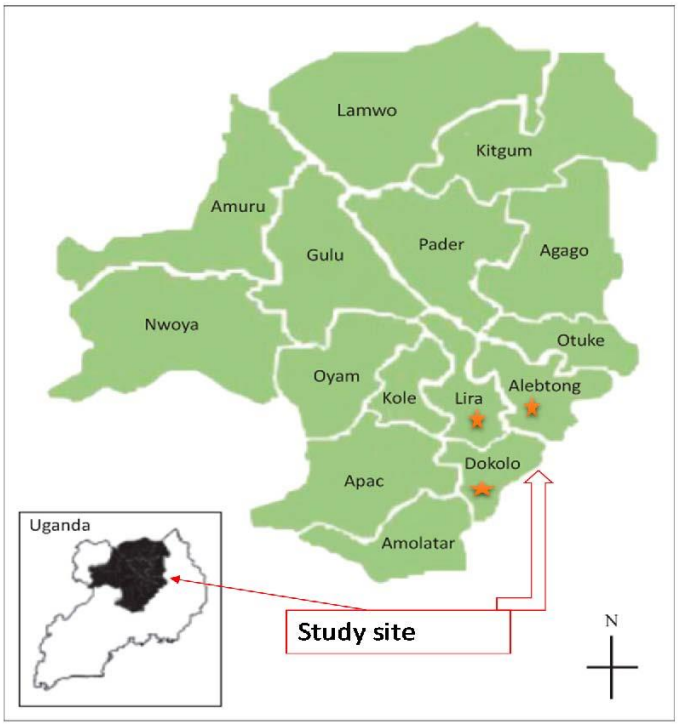

Figure 1. Study-site locations in the three districts in the Lango sub-region in mid-Northern Uganda. Map source: Adapted from Kasuse et al. [42].

2.2. Data Collection

There were initial consultations with members of Uganda's national climate-smart agriculture taskforce responsible for monitoring CA in the country, followed by meetings at the local government's agricultural-produce department at the sub region's administrative headquarters in Lira. The information gathered and the discussions held led to identifying Lango as a study site because of the need for data on the region. Lango was a major area in Northern Uganda where CA was promoted and supported from August 2011 to December 2015. Primary data were collected in 2017 over a seven-month period from three districts, namely, Lira, Alebtong, and Dokolo. In Lira, data were collected from farmers in the sub-counties of Amach and Agali; in Dokolo, the respondents were chosen from the Batta and Amwoma sub-counties; and the rest were taken from the Awei sub county in Alebtong.

The snowballing nonprobability sampling technique was employed to reach the respondents. The snowball technique involves using a known contact to identify other persons to be considered as subjects in a given

study. The method was employed because the area is hard-to-reach, and information about the respondents was not easily accessible [43,44]. The starting point was with a female agricultural officer identified at local government together with a project officer who introduced the researcher to the local leader of the villages where CA was implemented. He, in turn, identified the other lead farmers and, subsequently, the 417 respondents. The selection of respondents was subjective, in the sense that the predefined group sought was that of farmers that had ever experienced CA, i.e., those who had practiced it themselves or had received training on CA. The sample was heterogeneous in that it aimed at getting views, opinions, and ideas, and not so much proportionately representing the respondents' numbers.

The study made use of a semi-structured questionnaire that was organized under six different sections; these had matching questions and were a mix of multiple-choice and open-ended questions, and statements that required ranking. The six sections were: demographic characteristics and farming practices, financial support, CA knowledge, sociocultural issues, economic factors, and institutional factors. The section on the sociodemographic characteristics of the respondents included biographical data and a description of the respondents' farming practices. The aid-dependence section required information on receipt of external funding and sources of finances. The third section required a description of how respondents understood and practiced CA, the frequency of performing CA, explanations of the respondents' CA practices, and their estimated amount of land portion under CA. This section also included open-ended questions on community perceptions, benefits, and constraints at the farm level and their perceived requirements for increasing CA adoption in their community. This was followed by a section on socioeconomic issues, which, in this case, referred to land ownership, and access and control to use the land; they additionally had to rank statements on typical factors that could influence their CA uptake, such as personal decisions, farmer-group dynamics, and/or cultural expectations. The section on economic factors allowed respondents to estimate the amount of money that they invested in their venture and evaluate statements that could influence their CA uptake. The final section, on institutional factors, required information on government programs and extension services. The final open-ended question required respondents to give any additional information and/or make recommendations on how CA uptake could be increased in their region. The above sections and their subsequent questions were guided by other adoption surveys, for example, the CIMMYT 1993 survey program and Rapid Appraisal of Agricultural Innovation Systems (RAAIS), which is a diagnostic tool useful in analyzing agricultural problems [45,46].

Due to the language barrier with most respondents, interpreters were used in these cases to translate information between English and Langi and other related dialects for the exercise. Information in the coded questionnaires was cross-checked in the field to ensure that questions had duly been responded to and clearly filled in. Information from open-ended questions was summarized, categorized, and coded depending on similarity. Data were initially entered in Excel sheets before analysis using SPSS version 21.

3. Results

3.1. Sociodemographic Characteristics and Farming Practices

The farmers that practiced CA had low education and were mostly married people above 30 years of age. Out of the sample population of 417 people, two-thirds were male, and close to 90% were married. The data showed that respondents' households had 5–8 people; one-fifth of them had 1–4 people; and just under a third had ≥9 people. These numbers are higher than the national average household size of 4.8 and 5.1 for this region, as reported in the UNHS 2016/2017 survey. On education, more than 60% of the respondents only had primary-school-level education as the highest level of education. Thereafter, numbers drastically dropped, with rising education levels.

Data on farming practices are typical of the region. Most of the respondents practice mixed-farming activities and, contrary to being subsistence-only, 94% of respondents practiced subsistence farming and sold agricultural produce. They mostly depended on household labor, but could also afford to use hired labor, for

instance, from revolving community members and other community-service providers who had trained oxen for ploughing. The northern farming system is characterized by rain-fed crop cultivation on generally flat land.

3.2. Financial Support

This section required information on whether the respondents were dependent on external funding and, if not, the sources of their finances. More than two-thirds (70%) used their own savings to finance their farming activities, and nearly all respondents relied on the village loans and saving schemes as their main financial institution. More than 80% of the respondent invested less than US$50 per season on their land for either purchasing seeds or hiring labor (Figure 2). A third of the respondents received their technical advice from NGOs.

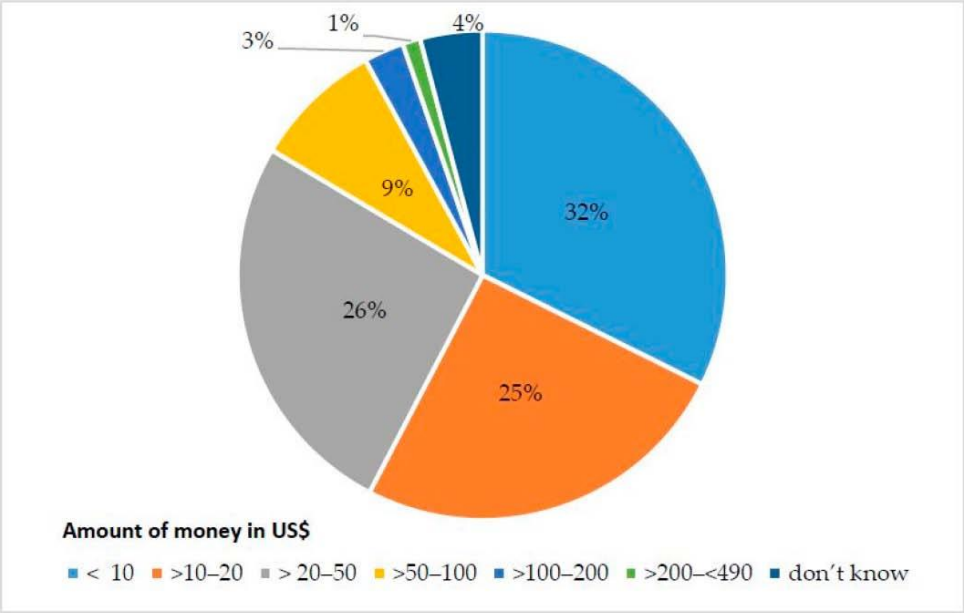

Figure 2. Amount of financial investment that respondents put into conservation agriculture (CA) farming (n = 417).

3.3. CA Package

This section gathered data on how the respondents understood and practiced CA, i.e., mentioning seasons when they did or did not practice CA. They gave explanations for their CA practices and estimated the land portion under CA; community perceptions, benefits, and constraints at the farm level; and what they perceived as important requirements for CA to be done by more members in their community.

On assessment of their knowledge and patterns of CA practices, 45% of the respondents knew all three principles of CA, although they were only able to apply two of these, i.e., crop rotation and minimum tillage. Twenty-two percent of the respondents did not know all principles of CA, while 33% neither agreed nor disagreed that they knew all three principles of CA. However, they ranked the statement on knowledge gained from training as the most important factor that motivated them to take up CA. In traditional farming practices, farmers open up their land by burning vegetation and crop residues. Farmers then carry out deep ploughing, which leads to soil inversion to loosen the soil, and thereafter they sow the seeds. Under CA practices, rip lines are made into the land with the help of oxen. To practice crop rotation, depending on what farmers planted, they alternate the crops grown in the following season with either a legume or cereal different from the previous season. Under CA, new cropping patterns have been adopted, for example, pigeon peas with maize or sorghum, contrary to traditional cropping patterns where farmers grow one crop, for example sorghum or maize, for two or more consecutive seasons.

The respondents also stated how often they practiced CA and on what portion of their fields they did this. All respondents practiced CA every season but to a different extent on their fields. They estimated the portion of their fields that was under CA to either be their entire field, three-quarters, half, or a quarter of their land. Most respondents had less than 2 ha of land available for farming, on at least half of which 30% of them applied CA. This gave an estimated total of 800 ha under CA held between the respondents that were interviewed. Respondents' perceptions on why farmers in their region use CA were attributed to knowledge and awareness of CA as a farming technique for farming ($CHI^2 = 361.424$; df. = 8; $p = 0.000$; Cramer V = 0.931).

The challenges faced when practicing CA were the lack of follow-up for tracking progress, little interaction with extension officers, for instance, when they needed to ask questions, the need for further training, and little equipment. One of the lead farmers, who was also a service provider for his peers, claimed that 105 farmers had to share one manual ripper. This not only delayed planting but also frustrated other farmers who would have been willing to join the group to take up CA and access the service. Other challenges included few pairs of oxen that were specifically trained and yoked together for ripping, and markets that were dominated by middlemen who dictated the price of produce from CA fields. Forty percent of the respondents found CA easy to apply on their land, while 16% felt that CA was not easy to apply. Overall, 46% agreed that they had enough knowledge to enable them to apply CA on their land; 40% stated increased yields as the main reason for practicing CA; and 20% noted that their reason was because CA improved soil fertility. To increase the uptake of CA in the region, most respondents suggested the provision of training and tools (Figure 3).

Women were usually shy and did not say much unless probed, which is why at least 25% of them gave no recommendation for the above question. It was also noted during the interview process that women sat by themselves and hardly spoke in the presence of a male.

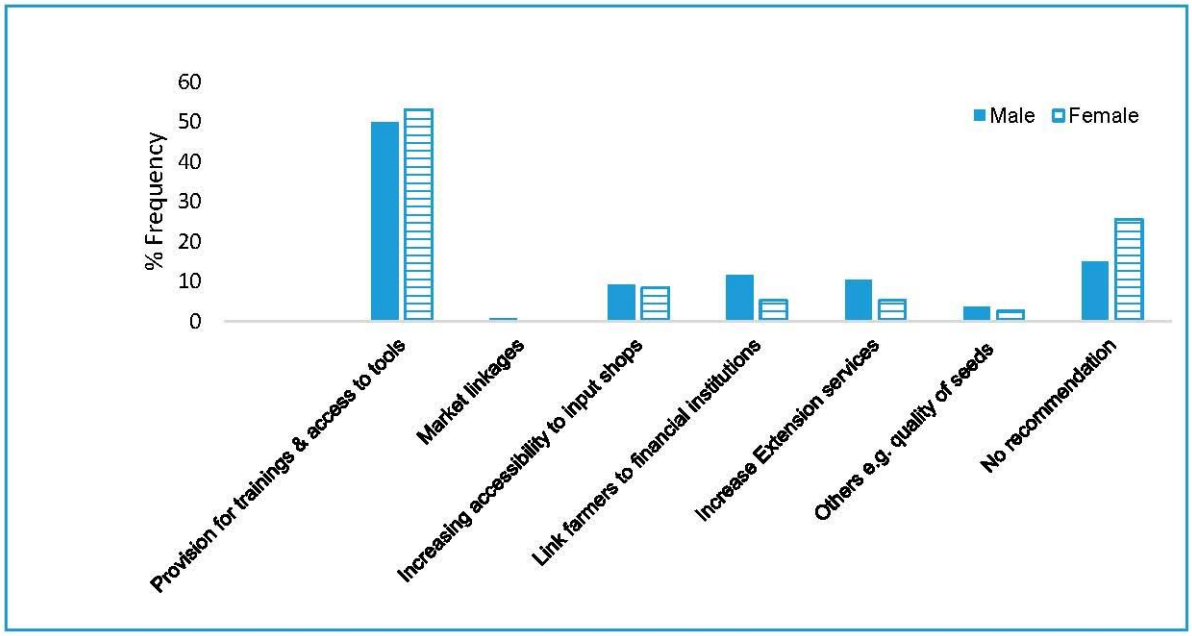

Figure 3. Gender-based recommendations for increasing CA adoption (n = 417).

3.4. Social Factors

Additionally, respondents ranked statements on typical factors that could influence their uptake of CA, such as partners, religious beliefs, cultural norms, technical training, and other factors as shown in Table 1.

Table 1. Social factors influencing CA uptake by individuals (frequency: subset of positive answers divided by sample size, n).

Sociocultural Issues	% Frequency (n = 417)
Partner	73.6
Religious beliefs	40.0
Cultural norms	65.5
Technical training	75.8
Market demands	63.1
Land ownership	56.8
Technical aid	56.1
Group dynamics	73.1
Group leader	27.8
Personal decision	88.7

Close to 70% of the land was owned by men, while 25% was jointly owned by a married couple and family land inherited from the man's family. Women owned only 5% of the land. Priority of access to land usage was mostly to men and the entire household that was mostly members from the man's family; only 4% of women had access to use the land. The same applied to decisions regarding which crops were to be planted in each season. Nearly all decisions on which crops to plant in each season were made either jointly between the man and the woman or solely by the man. Few decisions (8%) were made solely by the women.

The Pearson correlation of CA adoption and sociocultural factors (Table 2) in the communities where it was promoted was r = 0.236, *p*-value = 0.000. In conclusion, the correlation indicates that strength of association between the variables was low (r = 0.236), and correlation coefficient was significant ($p < 0.000$). It is also shown that 5.5% (0.236^2) of the variation in CA adoption is explained by sociocultural factors in the communities where it is promoted.

Table 2. Pearson correlation test (CA adoption and social factors).

Correlations

		CA Adoption	Social Factors
CA adoption	Pearson correlation	1	0.236 **
	Sig. (two-tailed)		0.000
	N	417	417
Socio cultural factors	Pearson correlation	0.236 **	1
	Sig. (two-tailed)	0.000	
	N	417	417

** Correlation is significant at the 0.01 level (two-tailed).

3.5. Economic Factors

Economic factors allowed respondents to estimate the amount of money that they invested in their venture, and mainly ranked statements that could influence their CA uptake. Respondents made payments to buy seeds themselves, and only 2% would pay for machinery such as ox-ploughs and rippers. However, profit expectations (Table 3) from increased yields motivated the farmers to take up CA.

Table 3. Economic factors affecting CA uptake by respondents at household level.

Economic factors	% Frequency (n = 417)
Profit expectations	84.4
Market places	58.5
Cash at hand	72.4
Group negotiation	42.7
Donations	36
Access to loans	27.8
Nearby market	65.2
Availability of input shops	63
Social trust	57.6
Involvement of women and youth (labor)	58.8

Most respondents were influenced by profit expectations and their available cash, and hardly relied on loans or even donations. This is contrary to the view that farmers in the region rely on aid for their livelihood. Due to previous experiences where group members left the village and the breakdown of cooperatives, half of the respondents were not so keen on trusting group negotiations for the sale of their produce or bulking. They claimed that each household had its unique set of livelihood problems that necessitated them to sell their produce whenever they felt the need, for instance, to send a child to school or access medical services for a sick household member. They sold their CA produce depending on these needs.

3.6. Institutional Factors

Institutional factors required information on government programs and extension services. Although central institutions play an important role in the uptake of technologies, the results from the region clearly showed (Table 4) that there was less involvement of these stakeholders in CA. The results show little evidence of government involvement and commitment to CA in the area.

Table 4. Institutional factors affecting CA uptake.

Institutional Factor	**%Frequency (n = 417)**
Government communication on CA	24.2
Conducive political environment	81.8
Government programs on CA	16.8
Government agencies promoting CA	9.1
External assistance for promoting CA	18.9
Government responsibility on CA performance	3.1
Traditional practices encouraging CA uptake	58.3
NGOs promoting CA	64.7

4. Discussion

Adoption of CA among smallholder farmers in this region offered promising prospects for developing and enhancing effective strategies for scaling up the technology. This is crucial because each region is context-specific, thus demanding a unique understanding of what might work to achieve the required responses. The study has provided empirical evidence for the positive uptake of CA in the marginalized sub-region of Lango in mid-Northern Uganda. Lango experiences increasing vulnerability to adverse weather conditions related to climate change, perverse poverty, historical inequalities besides its remoteness, and other post-war effects.

The major reason for adoption of CA in this region was attributed to the information gained through training provided by Rural Enterprise Development Services (REDS), a nongovernmental organization. It is evident that

exposure to information played a key role in enabling uptake of CA. The knowledge that farmers gained about CA enabled them to understand why and how to practice CA, unlike other programs that simply required them to follow instructions. The farmers grasped the technical information about CA, thus providing a contrast with other findings suggesting that CA knowledge was too complicated a package for ordinary rural small-scale farmers to understand. The results showed that it was about providing learning opportunities and exposure to people to enable technology uptake. These low education levels could reflect the interruptions caused during the conflict and insecurity period of 1986–2006.

The farming system of mid-Northern Uganda was dominated by annual cropping and cattle raising; farmers practiced subsistence agriculture but also sold their produce. This showed an attempt at striking a balance between providing food for their households and earning an income. However, keeping livestock presents challenges related to the competitive use of plant residues for fodder versus mulching. This probably explains, to an extent, why farmers easily applied the other principles of crop rotation and minimum tillage. Farmers desisted from cutting and carrying mulch between fields due to an incident when one of them was bitten by a poisonous snake that was hiding in the material.

The meagre financial investment that the farmers put into their CA activities reflects poverty in the region. The use of Village Savings and Loans Associations (VSLA) offered group accountability and generally meant lower risks of loss of capital assets in the case of a failure to repay loans. Farmers could hardly afford mainstream financial institutions such as banks, located more than 60 km away in the main town of Lira. Poor infrastructure (road coverage estimate = 19%) and lack of public transport meant that most services were out of reach for these farmers. This implied high transportation costs and, perhaps, the encouragement of middlemen to take advantage of the situation. It is worth noting that Uganda has a high cost of credit, ranking 125th out of 137 countries in affordability of financial services [47]. These factors imply that there is a high financial barrier for smallholder farmers that needs to be addressed. Promotion of increased CA uptake in the Lango region would require better financial investment, as the work of Sims and Heney [48] explicitly showed.

The social perspective explored in the study seems to be supportive of CA uptake. Social issues are already known to be useful in changing attitudes and gradually causing a shift away from conventional agriculture over time. Institutional support and incentive programs could certainly be used in this region to effectively increase further adoption in the region, for instance, in providing access to machinery, social learning, social development, and other social benefits. Further empirical studies are needed to further explore the role of social networks in the adoption of CA in similar areas and which social factors are at play in the region. Land-access rights, particularly for women and the youth, need to be further explored.

In terms of economic factors, further CA uptake can be motivated upon seeing profits from extra produce that normally arise from applying the technology. For farmers to benefit from market prices, they would need to improve their group negotiation power, as opposed to letting middlemen take advantage of them. However, given the high poverty levels and heterogeneity of households, exploitation by middlemen is a risk unless there is market regulation through government and private-sector engagement. To add value at the village level, other actions, such as agro processing plants, have the potential to increase farmers' selling options and prices for CA produce. These small-income increments could further motivate CA uptake.

Finally, the role of government institutional factors in implementation needs to be more visible. The adoption pattern would be a good opportunity for the government to show its commitment to the rural farmers of this region through, for instance, supporting CA scaling-up, as highlighted earlier. A key institutional factor for increasing CA uptake in the area is improving extension-service delivery. Because the region is post-war, the community appears reluctant toward the new arm of extension-service deliveries. In addition to limited coordination and coverage of extension services, Operation Wealth Creation (OWC), formerly the National Agricultural Advisory Service (NAADS), the current model of the Uganda Peoples Defence Forces (UPDF) undertaking input and service delivery, is still unclear to the farmers in the region. This is perhaps due to the

post-war history and would thus need further research. The government extension system would have to streamline CA into their program in the region.

5. Conclusions

The CA adoption pattern in the region presents a promising attempt at CA uptake that is steady enough to be built upon and sustained. The demand for more CA training, extension services, equipment, and machinery provide a timely opportunity for institutional support to be provided through appropriate partnerships to enable the purchase of capital assets that can be shared within the communities. This will allow smallholder farmers to take advantage of the technology and eventually scale up. CA may even become more attractive if future research provides quantification of annual yield increases, reduced input/labor costs, and increased financial returns. Further research also needs to consider factors such as social networks in this post-war area, gender issues, land issues, machinery-sharing options, and viable markets that could absorb CA produce.

Author Contributions: S.K. conceived, designed, and carried out the fieldwork, and wrote the paper. L.W. supervised the work and, together with S.M., contributed to the writing of the manuscript.

Funding: PhD studies are financed by the Austrian Partnership Program in Higher Education and Research for Development (APPEAR), a program of the Austrian Development Cooperation (ADC) and implemented by the Austrian Agency for International Cooperation in Education and Research (OeAD). Special thanks are given to Erwin Lautsch and Andreas Melcher for their statistical expertise. There were no funds received for covering the costs to publish in open access.

Conflicts of Interest: The authors declare no conflict of interest.

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Paper II: Understanding the conditions of Conservation Agriculture adoption in Lango region, Uganda

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Citation: KAWEESA, S. H., NDAH, H. T., SCHULER, J., MELCHER, A. & LOISKANDL, W. 2020. Understanding the conditions of conservation agriculture adoption in Lango region, Uganda. *Agroecology and Sustainable Food Systems*, 1-20. https://doi.org/10.1080/21683565.2020.1751769

Abstract

To better understand Conservation Agriculture (CA) adoption in mid-northern Uganda, a successfully tried method, the **Q**ualitative Expert **A**ssessment **To**ol for **CA** (QAToCA) was used. QAToCA is an expert-based, qualitative, self-assessment guide for determining the relative likelihood of CA adoption within a site-specific context. The results show that CA adoption in the region is highly probable. The two main reasons farmers adopt CA techniques are the dissemination strategy as well as the provided information about CA. The tool also highlighted that the prevailing volatile climate and market conditions are the main constraints to adopting CA at household level.

Keywords: QAToCA tool, adoption, Northern Uganda, Lango sub-region, conservation agriculture

Introduction

Uganda's Agricultural Sector Plan focuses on scaling up climate change resilient technologies as a means of accelerating production and productivity at national and household levels. The Lango sub-region in Northern Uganda is one of the agro-ecological hotspots targeted by government and NGOs (local and international) for scaling up priority technologies. Although the violent 20-year conflict in the region resulted in environmental degradation and persistently high household poverty levels (NPA, 2015), this sub-region, nevertheless, has a high potential of being the grain basket of the entire country (NEMA, 2016, UNDP, 2014b). Because small scale Ugandan farming households have limited ability to invest in soil and water conservation measures, the rain-fed farming system of this region is subject to seasonal weather conditions, resulting in risks of food shortages and food insecurity.

This situation is worsened by global climate change (Ssentongo et al., 2018) leading to land degradation and other human-induced deficits. For example, the 2016 food shortage in Uganda was caused by the El-Nino rains that ravaged Eastern and Southern Africa. In order to mitigate these climate impacts, in the last decade, Sub-Saharan Africa (SSA) governments, through their various instruments and political frameworks, have embarked on the process of implementing climate-smart agriculture (CSA) at national, regional and cross border levels. Amongst various forms of CSA practices is Conservation Agriculture (CA). CA contributes to climate change adaptation by reducing crop vulnerability and mitigating droughts

and flood events (Lipper, 2010). Given the agro-ecological conditions, the rising land degradation and climate related challenges, CA is considered an appropriate and resilient production technology for Uganda (MAAIF, 2016).

The adoption rates of CA on other continents have been remarkably positive (Friedrich et al., 2012a), while in the case of Africa, its slow adoption rate beckons for more investigation and analysis. The barriers to CA adoption in Africa require further specific analysis. In past studies, barriers have been categorised as social, financial, political and institutional. More concretely, some of these identified obstacles are: the multi-varied African smallholder farming systems; lack of appropriate extension services; unequal resource distribution; limited access to affordable loans; and underdeveloped input and output markets (Giller et al., 2009). Literature provides widespread views ranging from incompatibility of CA technology with the current farming systems, to methodological and conceptual framework ineptitude (Brown et al., 2017, Andersson and D'Souza, 2014, Glover et al., 2016). It appears, however, that the potential to adopt CA does exist in many African countries (Ndah et al., 2014, Simtowe et al., 2016). Earlier works like those of (Knowler and Bradshaw, 2007, Program et al., 1993) have acknowledged, understood and concluded on the lack of universal variables that could expressly explain the adoption of CA. CA adoption varies from country to country and even region to region within some countries (Mkomwa et al., 2017). Promoting CA must inevitably be tailored to local conditions, which, in turn, depend on the respective bio-physical and socio-economic environments (Baudron et al., 2015b, Thierfelder et al., 2016b, Corbeels et al., 2014a). There is a need to understand the farm level constraints to CA adoption and the conditions under which CA can be adopted.

The promotion of CA as a package has often led to smallholder farmers rejecting it (Andersson and D'Souza, 2014, Ndah et al., 2018, Rusinamhodzi, 2015). For instance, labour shortages in rain-fed systems makes weed control laborious and expensive where chemicals and minimum tillage equipment could be more appropriate; competition for crop residues used as animal fodder in contrast to mulching (Giller et al., 2009). Elsewhere, limited adoption seems to be rooted in agro-ecological and socio-economic constraints (Arslan et al., 2014, Friedrich et al., 2012a, Friedrich et al., 2009, Kassam et al., 2017). More recent publications like (Kassam et al., 2017) seem to shift from the rather academic debates on socio-economic obstacles to emphasis on more pragmatic technical ways to increase actual uptake of CA in order to combat the threat of food insecurity on parts of the continent. There is evidence that CA is already taking root and the critical question that remains is how to enhance and accelerate these efforts (Derpsch et al., 2010, Nyanga et al., 2012, Nyanga, 2012, Ndah et al., 2018).

Nevertheless, the few studies on farmers' uptake of CA in Uganda reveal different reasons, which probably indicates that a unique adoption pattern for each agro-ecological zone exists. Although most of the country's farming population comprises smallholder farmers, the motivation to adopt technologies by smallholder farmers varies markedly. For example, the study done by (Mubiru et al., 2017) in Uganda's cattle corridor showed that employing CA resulted in erosion control and increases in yields. A recent study in the same region showed that education played a key role in promoting CA among farmer groups (Kaweesa et al., 2018). The study done by (Vaiknoras et al., 2014), in Eastern Uganda showed that the farmers adopted CA for economic benefits and were willing to adopt CA if input costs were met. The same study also showed that women deliberately considered the costs before deciding to adopt the technique.

These, and other studies in Uganda, show that scaling up of CA, along with other sustainable land management strategies, is a pressing need (Eneku et al., 2013).
The objective of this paper is to determine the likelihood of adoption, and to explore the factors enabling or hindering adoption among smallholder farmers in Mid-Northern Uganda. Proposed are ways to accelerate adoption in order to increase yields, reduce soil degradation and achieve other ecological benefits.

Methodology and Case description

Delimitation of the case study

Lango sub-region, in Northern Uganda (Figure 1) has seven districts, where all farmers practice the same annual cropping and cattle farming system. The sub-region is one of Uganda's environmental degradation hotspots. It has a very high rate of poverty (43.7%), compared to the national average of 19.7% (UBOS, 2017). Lango was also heavily impacted by the war in the Acholi sub-region and currently experiences land tenure conflicts. The latter issue affects ownership, access to loans and long-term investment in CA. Despite its ecologically challenging nature, farmers manage to grow cereals and oil-producing crops that provide the staple food and income for their rural households as well as contribute to national food security and to the national economy (UBOS, 2018). The main cereal crops grown there are maize, simsim, finger millet (*Eleusinecoracana)* and sorghum. Other crops include rice, cassava and cotton. Finger millet is the second most significant cereal after maize in Uganda. *The region also grows grain sorghum, a staple food of the people and* the third most important cereal crop in Uganda. Sorghum is more tolerant to drought than maize or finger millet thus it is critical for food security and for providing income for rural households. More recently, fruit and sunflower growing has been taken up by many farmers.

Lango was identified by the agricultural ministry as a major area in Northern Uganda for CA promotion, which took place from August 2011 to December 2015. CA was implemented by the Rural Enterprise Development Services (REDS) Ltd., contracted by the Conservation Farming Unit (CFU) Zambia and funded by the Ministry of Foreign Affairs of the Norwegian Government. The sub-region was also selected for the study because it already had farmers practicing CA.

The REDS programme took a social approach in implementing CA. Traditional village structures of community leadership together with the already existing farmer groups were the main avenues for relaying CA information to the farmers in their respective communities. Lead farmers represented their members at meetings. Selected extension workers from the community were trained and assigned to their respective areas to attend to farmers' questions and offer services whenever needed by the farmers. They also taught farmers how to keep written records of yields; to report crop growth challenges and were additionally encouraged to share information with their peers. Each community had demonstration sites for educational use, usually located at the lead farmer´s field. During exchange visits both rip lines opened by animal draught power and permanent planting stations, also called basins were promoted. This allowed farmers to choose between rip lines or basins depending on their financial capacity. Some could

afford to pay for trained oxen pulling a ripper to open their land while others opted for traditional cooperative work groups to dig the basins with hoes.

Figure 1: A map of Uganda showing the Northern region and the three districts where the study was carried out.

Data Collection

Prior to the field work, a desktop literature review of the most currently published documents on CA was performed both in Austria and in Uganda. Some of the documents accessed and studied include government reports, scientific and project reports, journal articles and the latest books on CA. Information on CA in Northern Uganda was focused on.

Data were collected from Mid- Northern Uganda (Figure 1) in the period January to July 2017 using both qualitative and quantitative methods (Table 1). These included semi-structured interviews administered through household surveys, key informant interviews, focus group discussions, participant observations and a multi-stakeholder workshop where preliminary findings were discussed for triangulation and validation.

Table 1: Summary of data collection

Methods	Brief description	Main focus
QAToCA assessment	Workshop with 14 participants	Discussed the likelihood potential of CA adoption at farm, village/ community and regional levels
Semi-structure qualitative survey	417 household interviews	Household level
Key informant interviews	10 key informant interviews	Political level
Focus group discussions	10 focus groups (total of 52 participants)	Village/community level
Participant observations	fields visited	Structured field observations

The Qualitative Expert Assessment Tool for CA adoption (QAToCA)

For data collection, we used the Qualitative expert-based, self-assessment guide for determining the relative likelihood of CA adoption. QAToCA tool, which has been used widely for the diagnosis of supporting and hindering factors for CA adoption (Corbeels et al., 2014a, Ndah et al., 2015) across SSA. The QAToCA approach serves as a conceptual and analytical framework and has been applied successfully in several African countries such as Kenya, Tanzania, Zambia and Burkina Faso, which share similar agricultural contexts. The framework is based on conceptual models and theories of adoption, explicitly explained in most adoption decision studies e.g. (Rogers and Williams, 1983, Triomphe et al., 2007b, World, 2006). The tool assesses factors categorised under nine thematic areas that could influence CA adoption at community, local and regional levels. The themes (Table 2) show the various scales of implementation of a project from farm level to village/local and regional levels. The QAToCA guide is operated using several Excel sheets with a list of questions that are discussed as well as statements that are rated by the participants while also allowing for their explanations. The statements are ranked on a scale ranging from 0-5, '5' being ' strongly agree' with the statement provided, thus indicating the likelihood of CA adoption. Points for the thematic areas are normalized as percentages and equally weighted (Sieber et al., 2015a, Ndah et al., 2014).

The tool was carried out in a multi-stakeholder workshop made up of 14 participants selected from Lira, Dokolo and Alebtong districts. The participants included agro-input suppliers; agricultural extension workers at sub-county level; the secretaries for production and marketing at the district level; the woman district agricultural representative; the supervisor of the government extension programme also known as Operation Wealth Creation (OWC), but formerly the National Agricultural Advisory Services (NAADS); leaders of non-governmental organisations implementing CA; the CA Agronomist from Ngetta Zonal Agricultural Research and Development Institute (NZardi), an agent of the National Agricultural Research Organisation, CA rip line service providers, adopters and non-adopters.

Our study explores the overall adoption potential, as assessed using the tool in these districts. Workshop participants were randomly divided into two groups to discuss findings and unanimously share views on thematic statements listed in the QAToCA tool. They discussed the various indicators and agreed on an assessment for each indicator on a scale of 0-5 (Ndah et al., 2015). A qualitative summary on specific adoption indicators was then provided per thematic category.

Table 2: The nine thematic areas of QAToCA

Theme	**Some key points/indicators for assessing dissemination potential of CA**
Object of Adoption (CA) at farm and village levels	Number of trainings needed for CA to be understood Exploring the labor needed for CA implementation Exploring observable benefits of CA Adaptability to suit the ecological and socio-economic context
Farm and household characteristics and constraints	Ability to meet the financial cost of CA Possession of traditional knowledge such as CA Presence of social networks Access to initial inputs like seeds and land requirements Relation between CA and natural resource users
Capacity of implementing organisation at village and regional level	Profile of CA implementing organization Quality and availability of relevant technical expertise Linkages to other CA implementing organizations in the region Relevant stakeholder collaboration and cooperation
Attributes of scaling up at village and regional level	Dissemination objectives and dissemination strategies Communication types and strategies
Political/institutional	The political situation of the region

framework at regional level	The government policies and research efforts The administrative setup and structure of governance system The level of inclusion of civil society
Political/institutional framework at village level	The level of local governance structure Presence of supportive local organisations Compatibility of CA with local community rules Land access and ownership, and the community settlement pattern
Economic conditions at village and regional levels	Availability and accessibility of markets The interests of CA economic actors Availability of basic infrastructure and quality implementation control structures
Community's attitude towards CA at regional level	CA acceptability
Knowledge of CA role in climate change and other ecological benefits	Advantages of CA over conventional agricultural

Results

In this paper, data from the QAToCA tool assessment are presented and discussed. The QAToCA tool results show a high likelihood potential of CA adoption in the region. The reasons are that CA implementing organisations used successful communication strategies and effectively transferred the technical knowledge and skills to the farmers who in turn, practiced what they had learned. In addition, farmers were linked to the providers of information and knowledge as well as of extension support services, which allowed for CA to become a reality. Farmers also readily shared the learned techniques with their peers. The knowledge system in this context was enhanced by the method of education, which was characterised by participatory learning, and regular extension service offered during implementation. Data from household interviews were presented in a separate article (Kaweesa et al., 2018). The following sub-section highlights the thematic influence on adoption potential and details the specific indicators that serve as hindering and supporting factors.

Overall thematic influence on adoption potential

Results of the thematic categories from which the specific hindering and supporting indicators have been extracted are presented in Figure 2. The attributes of dissemination strategy scored 100% at the village level had the highest influence on the likelihood of adoption. This included issues such as the clarity of the objective; dissemination activities; the communication strategy; the use of incentives in the initial stages; the flexibility in facilitating knowledge exchange among farmer groups; and, enabling regular evaluation, frequent meetings between the target group and other stakeholders in the community. Farm and household characteristics scored the lowest value 69% (Table 3) meaning that they have less effects on adoption.

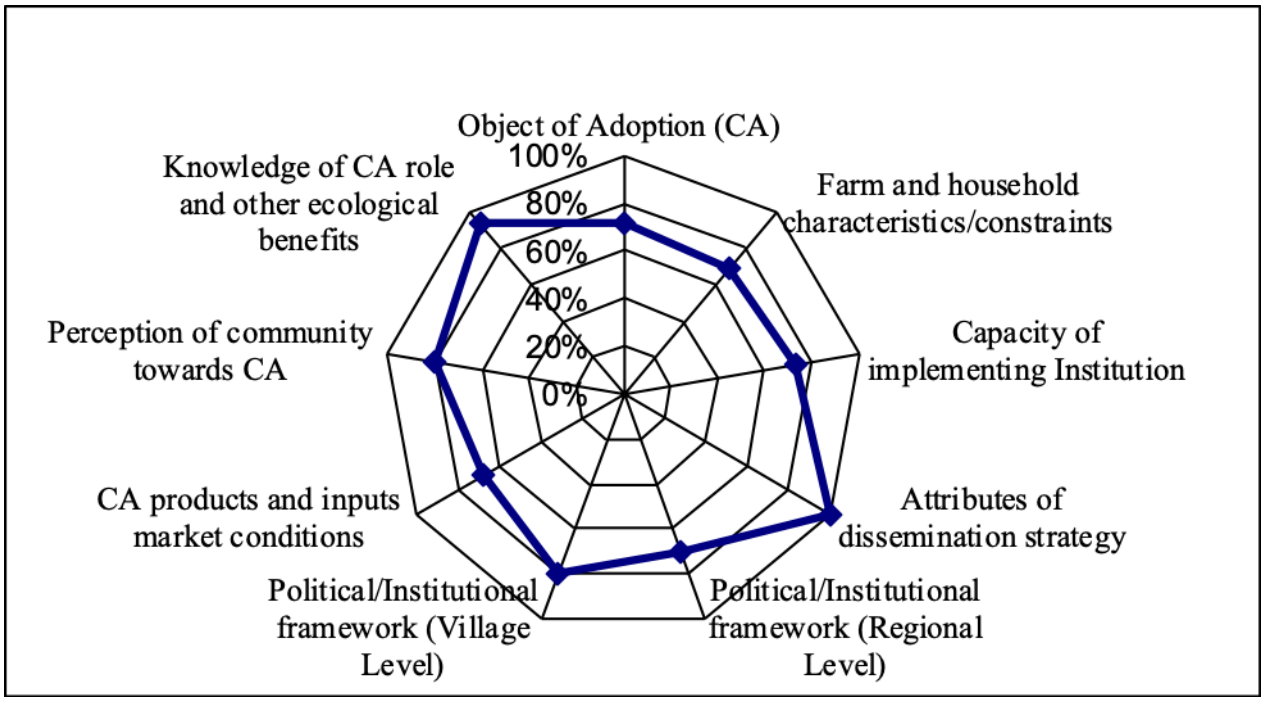

Figure 2: QAToCA tool Relative adoption of CA-Adoption per component

Results on specific indicators to adoption potential

Object of Adoption (CA)

72% of the respondents agreed that not more than two trainings per season are needed for proper understanding of CA. They confirmed that benefits of CA can be observed clearly on both trial plots and on other neighbouring fields; furthermore, that CA can be tried on small plots, can be partially adopted and gradually extended in stages. They disagreed, however, on whether there is sufficient household and community labour for CA implementation; on whether CA can be adapted readily to the existing farming system; and on whether the efficiency of the production system can be improved short term. One respondent said, "*In conventional agriculture we did not practise minimum tillage but rather we were used to burning crop residues, broadcasting seeds and deep-ploughing to invert the soils. Traditionally, farmers considered burning efficient when broadcasting seeds as a way of quick planting.*"

Table 3: Summary of Results from the QAToCA thematic worksheets

	Thematic area (A....I)	**MPP**	**TPA**	**PA %**	**PAW%**	**MV**	**NQ**	**NA**
A	Object of Adoption (CA)	25	18	72	72	0	5	0
B	Farm and household characteristics/constraints	45	31	69	69	0	9	0
C	Capacity of implementing institution	30	22	73	73	0	6	1
D	Attributes of dissemination strategy	50	50	100	100	0	10	0
E	Political/Institutional framework at Regional level	30	21	70	70	0	6	0
F	Political/Institutional framework at	25	20	80	80	0	5	0

	Village level							
G	CA products and inputs market conditions	25	17	68	68	0	5	0
H	Perception of community towards CA	30	24	80	80	0	6	0
I	Knowledge of CA role on CC and other ecol. benefits	15	14	93	93	0	3	0
	Total	275	217	79	78	0	55	1

Notes:

MPP - Maximum possible points; TPA - Total points achieved; PA - Percentage achieved (unweighted) (Points achieved/total points); PAW - Percentage achieved (weighted with equal strength for each level); MV - Missing values; NQ - Number of questions; NA - Number of N.A.

In table 4 results from the thematic areas are presented while providing some of the important statements within the QAToCA sheets that participants agreed with and ranked positive (5). The statements that participants disagreed with are ranked negative (2).

Table 4: QAToCA statements with strong value as ranked by participants

Code	Indicators for assessing dissemination potential	Statement	Value
A2	Labour requirements Vs endowments	*Households/Communities labour is naturally sufficient for CA implementation*	2
A5	Flexibility/adaptability	*CA fits into the existing farming system and efficiency of the production system is improved in the short term*	2
B5	Machinery, fuel requirement and herbicides availability	*Household members have access to technical inputs and such inputs are available on-farm*	2
C4	Organisational linkage to other CA organisations in the region	*The organisation has branch offices and extensive network to other CA promoting institutions working in the same region and uses such contacts to broaden its efficiency and scope*	2
E5	System of administration practiced in the region	*There exist decentralised structures within the administration which allow locally adapted and timely solutions to farmers problems*	2
E6	Tolerance of civil society to the formation of interest groups	*Farmers are free to and have organised themselves in interest groups of their choices.; such groups can exert pressure (lobby) on policy makers to adjust policies to their favour*	2
G5	Availability of quality implementation control structures	*There are quality implementation structures for CA principles and producers can afford and have access to such structures allowing them to improve on the implementation process*	2

A3	Observability of CA	*Output of CA is easily observed through increased yields demonstrated either during trainings or on trial plots or on other (neighbouring) fields*	5
A4	Trialability	*CA can be tried out on a small plot of the farmers' fields, partially adopted and extended in stages*	5
B6	Land requirement and availability	*CA is adapted to land owned by households*	5
B8	CA and Social status + prestige of farmers	*Introduction of CA has led to improve social status of farmers and reduce dependence on external inputs*	5
C2	Availability and Quality of human resources	*The promoting institution has employed a multi-disciplinary team consisting of technical staff with expertise in project management*	5
C3	Leadership and Reputation	*The leadership of the organisation is trustworthy, has managerial competence and a good reputation among the beneficiaries, donors and staff*	5
C6	Organisational linkage with other stakeholders in the CA innovation systems	*The organisation is able to identify and collaborate with relevant cooperation partners/networks (donors, policy makers and researchers)*	5
D1	Dissemination (Scaling up) area, target groups and characteristics	*The target group/s and geographical area/s for dissemination are thoroughly identified by locality and number as well as types of farmers*	5
D2	Clarity of dissemination (scaling up) strategy	*There is a clear and realistic time frame for dissemination of activities and a detailed, long-term action plan and an exit strategy exists*	5
D3	State and level of documentation, monitoring and evaluation	*Objectives and indicators regarding outputs are defined, sound and coherent; time frame for planning, monitoring and evaluation is defined and documented and there exists a strategy for systematic collection of required data for M&E*	5
D4	Usage of established communication channels	*The promoting organisation acknowledges and takes advantage of already established networks and information channels*	5
D5	Diffusion strategy and use of CA champions	*The promoting organisation in close collaboration with the farming community selects CA champions (facilitators) that act as disseminators/diffusion leaders of CA; such key persons possess adequate technical knowledge about CA, rhetoric skills and they receive adequate incentives.*	5
D6	Compatibility of selected diffusion strategy with the target groups	*The identified means of dissemination are efficient and adjusted to the size and educational level, gender, culture and social status of the target group*	5

D7	Linkage of promoting organisation with farmers	*A shared development vision and trust exists between the organisation and the farmers, participatory learning and reliable feedback mechanisms equally exist*	5
D8	Organisation and level of involvement in capacity building	*The promoting organisation supports local/regional level organisations (e.g. farmers groups) to become sustainable and independent from the implementing agency, such as capacity building*	5
D9	Type of communication channel	*The promoting organisation has a strategy and the technical capability to promote CA through mass media; the target group can access such mass media, and the promoting institution has experience in public campaigning*	5
D10	Usage of incentives in the diffusion process	*The organisation initially equips farmers only with an absolute necessary set of (technical) inputs and does not provide any monetary incentives to the farmers such as subsidies or funds; emphasis of project activities is on capacity building in order to keep dependency of farmers upon the organisation minimal*	5
E3	Government attitude towards CA research	*The government promotes CA adoption through its integration in formal research and/or extension programs*	5
F2	Presence of supportive local organisations	*There exist effective formal and informal local organisations that are willing to support dissemination of CA.*	5
F3	Compatibility of CA to local customs and/or norms and rules	*The local formal/informal rules do not hinder the introduction/dissemination of CA practice; these rules allow women and men to adopt CA and reap benefits from its practice*	5
H5	Social acceptability of individuals engagement in CA	*There is freedom of individuality in the community; CA practice introduced by individual farmers are accepted by the rest of the community and those farmers are not excluded from the community*	5
I2	CA and yield gains	*There is sufficient knowledge or sensitization of the community with regards to potential yield gains from CA explain partly by the fact that the period in which available nutrients can be taken up by plants is extended under CA, increasing the efficiency of use - hence a chance for higher yields*	5
I3	CA yield response and time	*First returns from CA practice are witnessed within one agricultural season*	5

Farm and household level characteristics

69% of the respondents agreed, in part, on six indicators, namely: that there are sufficient resources for an average farmer to cover the cost of CA; that some farmers already have information on CA; that social networks and organisations for the implementation are available; that the economic risk for farmers is low; that CA can be implemented without endangering the existence of farms; and lastly, on the pressure of CA practice on natural resources and conflicts between resource users. They partly agreed that the wrong application of herbicide has negative impacts on natural resources; for example, one farmer addressed his concern about "*spraying herbicides in windy conditions, near wetlands or around fishponds*". Respondents agreed that household members have access to crop residues and seeds as these are available on the farm. They, at the same time, disagreed with the statement that they have technical inputs and that these are available on-farm. They strongly agreed on two statements: "CA practice is adaptable to the land currently owned by households and can be implemented on existing farms, initially, without requiring additional land." Both statements are reflected in *Table 4 row B5* and *B6* respectively.

Specific indicators relating to capacity of implementing organisation(s)

The participants did not rank the concept, the transparency of the framework, and the common vision and goal of the promoting institution/organisation asserting that it was not applicable to them, because "MAAIF and NARO had the sustainable land management (SLM) programme funded by the World Bank."

They strongly agreed that the promoting institution had employed a multi-disciplinary team consisting of technical staff with expertise in project management and that they had well educated, readily available, high quality technical and management staff during project implementation, *Table 4 row C2*. They also strongly agreed that the leader had a good reputation, was trustworthy and had managerial competence, a good and healthy relationship with the community and the farmers, donors and organisation staff, *Table 4 row C3*. "*REDS programme ended earlier in 2015."* They, however, disagreed that the REDS organisation had effective organisational linkages in the region. They had hardly any branch contact offices in the region and were not linked to other networks, *Table 4 row C4*. They strongly agreed, however, that the same NGO had worked in the area and was well known and respected by the target group; that the NGO had access; and that it was linked to CA donors, policy makers, researchers and the private sector, *Table 4 row C6*. *"It was so, even though the project had ended."*

Specific indicators relating to attributes of dissemination (diffusion)

All the participants strongly agreed with all statements made in response to all the operational questions and with all indicators for assessing dissemination potential. These included, among others, clarity in communication, documentation, compatibility and diffusion of the strategy with the target group, *see Table 4 statements with value 5*. However, they commented that, ***"Adopters continuously trained other farmers"*** with the help of visual aids and that they ***"…refer to learning units in REDS project and … look out for literature on learning units". REDS had clear documentation that included the monitoring and evaluation frameworks; communication strategies on matters such as "using Lead Farmers; Training of Trainers (TOT) by the DC extension officers; TOTs among farmer groups; school gardens; meetings with district local governments; field days; review meetings; post-harvest meetings; end of season and pre-season meetings".*** The participants also succinctly stated that, "There was minimal support but only at the start (of the project) in form of a few pieces of equipment that included knapsack sprayers and rippers." "Farmers met the full costs after that."

Specific indicators relating to institutional framework at regional level

At a regional level, 70% of the respondents agreed that their region is politically stable saying, "***Lango is stable politically except for other areas***"; and that the government policies in support of CA are available. It should be pointed out, however, that the implementation was done solely by NGOs. "***Government is in support of CA but most of the implementation is done by NGOs."*** It was agreed that the government administrative set up at the national level was in place. **"*The administrative units are in place, but too far away from farmers to access technologies."*** The respondents disagreed on the existence of decentralised structures within the administration, which allow locally adapted and timely solutions to farmers' problems *Table 4 row E5*. **"*The institutions locations are not accessible for some farmers."*** Respondents disagreed that farmers had been free to organise themselves in interest groups of their choices. ***"Some technologies are linked to donors' programmes and so it is not easy for the farmers to provide their input".***

Indicators relating to institutional framework at village level

It was agreed that there is a local government with strong leadership committed to developing objectives and a functional, local-level governance structure that could act as cooperation partners for scaling up. ***"Sometimes the number of extension officers are not adequate to reach many farmers."*** 80% of the respondents strongly agreed on presence of supportive local organisations.; "***The many organisations have their own mandates but if supported would support CA."*** The local formal and informal rules do not hinder the introduction and dissemination of CA, i.e. women and men can adopt CA and reap benefits from its practice. However, respondents only partly agreed that land access and usage rights support the introduction of CA. ***"Some civil society organisations do not support the use of herbicides and fertilizers, yet these inputs are part of the CA package".*** This lack of support probably arises from the indiscriminate outcome of herbicide use that affects herbs, shrubs and plants that might be animal fodder. This means that livestock such as goats would not have access to feeds.

Lastly, it was only partly agreed that the settlement pattern supports CA adoption. In the local system of land inheritance, customarily, only male children inherit land from their parents. This results in the rather predominant setting where extended family units live and farm within the same locality. However, owing again to the customary land tenure system, there are many instances of scattered extended family units with large distances between them. This means that "There is generally no organized settlement pattern to support CA." This, along with the poor physical infrastructure and inadequate extension infrastructure, makes it hard to spread CA because planning and clustering becomes more difficult.

Specific indicators relating to economic conditions

Regarding availability of local market structures with sound local management strategies, only 68% of the participants partly agreed because "***there are very few organised farmer groups to access good markets"***. They agreed on the accessibility of markets for CA products but further explained that, "***farmers were unwilling to engage because of the poor leadership of the market authorities."*** It was strongly agreed that there was enough interest and support for the spread of CA via other economic stakeholders such as service providers. "***Actors are available to provide services, but networks need to be strengthened"***. Respondents partly agreed that all general infrastructural necessities for the adoption of CA practice were available at the locality of adoption. However, they disagreed that there were quality

implementation structures for CA principles that producers could afford and have access to the said structures, allowing them to improve on the implementation process, *Table 4 row G5*. ***"Most farmers are not able to afford tools and equipment."***

Specific indicators relating to community´s attitude towards CA

Regarding the community attitude towards CA practice, 80% of the participants partly agreed explaining that ***"farmers' input is not always considered during implementation."*** However, the village leaders, young farmers and target farmers all accepted CA activities. The general perception was that "***There is support of CA because it is generally good for all people, but adoption is gradual".*** Moreover "***The young farmer service providers were only active and employed during the life span of the project."*** The target farmers considered CA to be ***"only concepts that are capital intensive but are now being adopted".*** Respondents strongly agreed on the social acceptability of individual engagement in CA. Lastly, the participants agreed that the community members were already engaged in innovative farming and related entrepreneurial activities that were not specifically part of CA.

Role of the 'knowledge of CA' on climate change and other ecological benefits

There were three indicators to assess dissemination potential in this theme. 93% of the participants agreed that regarding climate change farmers were aware of the advantages of CA practice over conventional agriculture practice. "***Farmers are aware of CA, but adoption of CA principles is not wholly carried out".*** They strongly agreed that farmers were aware of the potential yield gains under CA and that the first returns from CA practice can be witnessed within one agricultural season, *Table 4 row I2*.

Discussion

The assessment using the QAToCA tool showed that village level dissemination has the greatest impact on the likelihood of CA adoption in Lango sub-region. Community trainings provide the learning space to harness what works and to identify what does not work; furthermore, providing the opportunity to make necessary adjustments, particularly in this post war and social context. The organisational and staff capacity is important for CA scaling up. There is need for trust and confidence building for slow adopters to take up CA. The results from the region highlight the significance of effective knowledge transfer and learning. The study has revealed that farmers were able to grasp the knowledge within two sessions if information was provided adequately. This is contrary to previous assertions that CA is knowledge intensive and cannot be grasped easily by farmers (Giller et al., 2009, Andersson and D'Souza, 2014). The study showed that although most of the farmers have low education levels, learning CA is feasible. A technological innovation that manages the dissemination approach and diffusion strategies criteria would go a long way in spreading and subsequently increasing adaptation rates.

On the other hand, one of the hindrances mentioned was the limited access to affordable equipment that would reduce the drudgery. Agricultural productivity can lag due to poor technology (Bategeka et al., 2013, Kasirye, 2013). Although the respondents mentioned this problem, discussions revealed that many farmers were in a position to meet the repair and maintenance costs once the large initial capital costs to purchase the equipment were met. For instance, in one village where one ripper was shared among 105 farmers, farmers contributed to the replacement of blades when the need arose. This however was not enough to cover all farmers and, in most cases, caused frustrations to farmers due to missed planting dates as a result of long periods of waiting for the service. It would thus require a high initial capital

investment to provide equipment that then could be managed by the existing organised groups who already have demonstrated the ability to do so. The other issue to be addressed is training local artisans to fabricate the affordable versions locally and provide the raw materials needed for such ventures.

At the political/institutional level, it was evident that access to extension services and the number of extension workers greatly affected the take up of CA in this region. At the time of the study, there were hardly any services except upon demand with the costs being shared by the farmers that could afford the services, particularly in times of dire need like during disease outbreaks and pest infestation. This is different from when farmers were regularly visited by private extension workers during the project implementation period. The reasons for adoption in a similar study in Swaziland showed that advice from NGOs played a major part in increasing likelihood of adoption (Mlenga and Maseko, 2015). The results of the study are comparable to the study on demands of smallholder farmers (Anderson et al., 2016). Also, where respondents reported donor funded NGOs as the main or even only actors implementing technological advances like CA activities, we recommend a rethinking of the broader policy on support for agriculture. For effective and long-term CA up-take presumably, national government intervention would be needed, given that the area is one of the poorest in the country.

In a similar way, as it was shown that farmers used their personal savings and the village level financial schemes to finance their activities, calls for intervention from national financial institutions would be needed. Customised regulations and arrangements to support these efforts as a means of improving affordability of services to the farmers would yield more serious achievements. On a political level, it became clear that the agriculture budget needs to increase and, preferably, will include funding for agricultural research.

On community attitudes, the study by (Mwangi and Kariuki, 2015) showed that it was important to explore the farmers' perceptions in order to fully understand CA adoption among smallholder farmers. Perceptions of the farmers are important in increasing the likelihood of CA uptake. Farmers in the study were keen on increasing their yields and so their personal experience is important in influencing future adoption of CA by more farmers in the region. This coincides with the study by (Ntshangase et al., 2018) which also showed that farmers with positive perceptions will most likely adopt CA. For the farmers in the region, the top priority after acquiring CA knowledge is machinery supply and repair. However, as other studies such as (Diao et al., 2014) indicate, there are a number of successful public private partnership business models, led by the private sector, to enable farmers acquire tools and equipment. These present what might be a workable model for machine and technology acquisition for East Africa (Baudron et al., 2015a).

Increase in household income was also an important factor that had the potential to accelerate CA uptake as clearly shown by another study (Tambo and Mockshell, 2018) across some sub-Saharan countries that included Uganda. The same appears to be a major influencing factor for the study region and could therefore be taken up by policy makers.

Conclusion

The QAToCA tool was used to assess the likelihood of adoption in the Lango sub-region of Uganda. Its results revealed that the dissemination strategy is a major factor in increasing likelihood of CA adoption in the region. Given that a prime obstacle for scaling up CA in the area was unaffordable equipment, it would pay off in the long term if the high initial capital costs of the equipment were invested by the government or private sector. Labour reduction and time saved due to use of machinery are direct, observable benefits that farmers would appreciate first-hand. This would create a window of opportunity for farmers to balance their finances as they use the equipment making time to recoup the expense via recovered shared costs and allowing for the technological shift to occur sooner. Coupled with the already established increase in yield, this would further enhance CA adoption by other farmers. In addition, such a window of opportunity can act as a buffer for sceptical farmers to realise and compare the benefits of CA with what they know from their conventional practices. Once farmers witness personal gain, they can make a conscious choice of CA adoption, which is more sustainable than project or input instigated choice for adoption, which is often short-lived. This would effectively reduce the financial burden and minimize the risks taken on by individual farmers.

Considering that the QAToCA Tool focuses mostly on organisations that promote CA while treating all criteria equally without giving priorities, further research into other factors that are known to limit CA adoption is needed. These would include analysis of farmers' typologies and their decision-making processes, gender limitations, land issues and identifying factors that support effective upscaling of CA in the region.

Funding

The PhD studies are financed by the Austrian Partnership Programme in Higher Education and Research for Development - APPEAR, a programme of the Austrian Development Cooperation (ADC) and implemented by the Austrian Agency for International Cooperation in Education and Research (OeAD)

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Paper III: Analysis of Transition to Conservation Agriculture in Uganda through the Lens of the Multi-Level Perspective on Socio-Technical Transitions

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Citation: Kaweesa, S.H., Bilali, H.E. & Loiskandl, W. Analysing the socio-technical transition to conservation agriculture in Uganda through the lens of the multi-level perspective. *Environ Dev Sustain* (2020). https://doi.org/10.1007/s10668-020-00936-2

Received25 July 2019 | Accepted06 August 2020| Published15 September 2020
DOI https://doi.org/10.1007/s10668-020-00936-2

Abstract: Conservation agriculture (CA) is based on three principles namely minimum tillage, crop rotations and maintaining a soil cover. The research used the Multi-Level Perspective on socio-technical transitions (MLP) to analyze the dynamics of transition to CA in Uganda. The analysis of the development of the CA niche is structured along the dimensions of the socio-technical regime (viz. guiding principles, practices and technologies, knowledge, market relations, policy, and culture) and explores the impact of transition. Data were gathered from Alebtong, Dokolo and Lira districts in mid-Northern Uganda. Results indicate a steady transition towards CA that can be supported to eventually scale up. The legitimization process of CA transition involved wider implementation by farmers on their fields, validation through adoption by the wider communities and at the national level. The process seeks policy and institutional promotion, more scientific publications of local research findings, validation by legal standards and judicial reasoning, raising civic awareness, stakeholder dialogue and mobilization of political will advance the purposes of CA in contrast to conventional agriculture. CA caused changes in practices, perceptions, and motivation among the niche actors with respect to agricultural sustainability. However, scaling up could further be enhanced when market policies, credit and financial environment are reconciled.

Key words: Socio-Technical transition, Transformation, Agriculture transition, Sustainability, Conservation agriculture.

1. Introduction

Agricultural production needs to grow to meet the demand of population growth amidst farm labor shortages, changes related to climate change, rural to urban migration of young people, and changes in consumer preferences. It is necessary to shift farming practices from conventional practices to those that sustainably allow for higher yields and increased productivity especially in agrarian based economies. Increasing resilience to extreme weather patterns in rain-fed agricultural areas is also of vital importance.

Technologies generally help farmers to make necessary improvements in agriculture. There are several technologies that have readily been taken up elsewhere unlike in Sub-Saharan Africa where the rate of adoption of technologies is slow and low. Conditions remain to be understood. Conservation agriculture is considered as one of the novelties (cf. niches) and has been analyzed in studies on sustainability transitions in agriculture (Vankeerberghen and Stassart, 2016). Therefore, the present study looks at the conditions around the uptake of conservation agriculture (CA) in Northern Uganda.

CA is a low input technology based on three principles namely, minimum soil disturbance, maintaining a soil cover through mulching with crop residues or planting cover crops and practicing crop rotations. The technique has several benefits such as conserving soil and water (Mubiru et al., 2017), reducing labour in the long term, increasing yields and reducing the effects of climate change variability (e.g. floods, droughts) (Hobbs et al., 2008). CA also addresses soil degradation over the long term, increases food production while ensuring protection of natural resources and enhancing the conservation of biodiversity, two advantages that are critical in the developing world (FAO, 2015, Corbeels et al., 2015). Based on this evidence and approved benefits, it would relatively be easy to make a transition from conventional agriculture to CA yet this is not the case as is seen on other continents like South and North America where it has been practiced for close to four decades (Friedrich et al., 2012a, Giller et al., 2009).

In Uganda, CA is already yielding benefits in fragile ecosystems, which are highly degraded and vulnerable to climate change, such as in Nakasongola district (Mubiru et al., 2017). Other benefits from CA are reported in Eastern Uganda (Vaiknoras et al., 2014) and in Mid-Northern Uganda (Kaweesa et al., 2018). The study of (Nyende et al., 2007) is perhaps one of the early works showing the status of CA in Eastern Uganda. It would therefore be necessary to enhance the uptake of CA in the country given that these benefits are already evident but on a few farms and small scale. Also, CA seems a good fit to the small land holdings as all those that had adopted it were smallholders. There are several small pockets of CA being implemented in several parts of the country. The pattern of these findings is no different from several other African countries (Kassam et al., 2017) where CA is awaiting scaling up. This can be enhanced, for instance, because actors that are willing to provide the hands-on experience increase likelihood of scaling up. This strategic action of pioneers is like the emergence of niches in organic agriculture (Hauser and Lindtner, 2017) in Northern Uganda. However, these need to be brought to speed in order to address the looming food security and environmental challenges. Almost 70% of Uganda's land was degraded by soil erosion and soil nutrient depletion between 1945 and 1990 especially in hilly and mountainous areas and highly populated areas. Moreover, more than 20% of agricultural land and pastures in the country have been irreversibly degraded (Dregne, 1990). Studies also show soil nutrient depletion, mostly nitrogen among others, mining and little or no replenishment of nutrients (Nkonya et al., 2005). Ranking 104th in Global Hunger Index 2019, food insecurity in some regions of Uganda is between serious and alarming (Von Grebmer et al., 2019). Indeed, regional inequalities in food and nutrition security critically persist as well as pockets of chronic food insecurity and undernourishment among children under 5 years, refugees and vulnerable groups. Maize, beans and bananas remain important for food security (UBOS, 2018).

2. Methodology

2.1. Theoretical framework: Multi-Level Perspective on socio-technical transitions (MLP)

The study employs the Multi-Level Perspective (MLP) to analyse CA as a niche and to understand the dynamics and processes leading to the transition to CA. MLP is one of the current heuristic theoretical frameworks that helps to explain how societies change and develop (Geels, 2002, Geels and Schot, 2007, Geels, 2010, Geels, 2011). The MLP framework was originally applied to the energy and transport industries but has of recent been used to study other sectors such as agriculture (Sutherland et al., 2014,

Darnhofer et al., 2012, El Bilali, 2018). It has proven to be key in understanding pathways in sustainability transitions.

The MLP is made of three (3) components; niches (where new ideas develop), the regime (mainstream activities and structures) and the landscape (society trends and global changes). A niche is a small specialized space that allows new ideas or innovations develop, grow, and freely function while being protected from the mainstream system (Smith et al., 2010, Geels, 2011). The socio-technical regime is a way of doing things (i.e. how things are organized or arranged to operate in each setting) and the mainstream activities and structures. It is the network of social groups and actors, the rules (formal and informal) they maintain to run a dominant socio-technical system, and related material/technical artefacts (Geels, 2011). The regime tends to change only incrementally (Lachman, 2013) under the influence of the landscape. The landscape is the external level that influences and sets world trends. It refers to factors that put pressure on the regime and create opportunities for the niches. The landscape includes trends and events such as macro-economic trends, demographic trends, political and ideological developments, deep changes in societal values, climate change (Lachman, 2013, Smith et al., 2010). In the MLP, transition is defined as the shift from one regime to another and it results from the interaction processes at niche-regime-landscape levels (Geels, 2011, Geels, 2018c, Geels, 2018b, Geels, 2006, Grin et al., 2010, Markard and Truffer, 2008). However, a more nuanced conceptualisation of transition was recently presented by (Geels, 2018a) that suggests to move from "*bottom-up disruption (driven by singular niche-innovations) to gradual system reconfiguration, which represents a more distributed, multi-source view of change*" (p. 86). In this respect, different processes and mechanisms have been suggested to describe the interactions between niches and the socio-technical regime. (Elzen et al., 2012) use the term 'anchoring' to refer to niche-regime interaction that leads to durable, long-term niche-regime linkages. Indeed, niches can anchor to regimes by proposing new institutions or rules, fostering new technical systems (e.g. technologies, practices, processes) or building new social networks and groups. The MLP stresses the importance of the alignment of processes at niche, regime and landscape levels for a transition to happen (Geels, 2011, Geels, 2012, Geels, 2018a). Depending on the nature (symbiotic/competitive) and the timing of the multi-level interactions between the MLP elements (i.e. niche, regime, landscape), (Schot and Geels, 2007) distinguish between different transition pathways, namely reproduction (cf. stable regime, no transition), transformation, de-alignment and re-alignment, technological substitution, and reconfiguration.

MLP was recently used to study sustainability transitions in agriculture and food systems (El Bilali, 2018, El Bilali et al., 2017). In this context, El Bilali (2019a) shows that MLP was used to analyse the emergence and/or development of different niches such as agro-ecology, organic agriculture, permaculture, urban agriculture, conservation agriculture, integrated farming, care farming, alternative food networks. Analysing the CA niche in Uganda followed guidance in the study of (Isgren and Ness, 2017) and (Geels, 2012, Geels, 2018a) on the dimensions of the socio-technical regime (hereafter named 'regime dimensions'), namely: guiding principles, practices/technologies, knowledge, market relations, policy, and culture. Indeed, the validity of the used approach stems from the fact that (Isgren and Ness, 2017) used the same regime dimensions in their analysis of agro-ecological transition in Western Uganda; a context that is very similar to that of the present study. As pointed out by (Isgren and Ness, 2017), "*Applying*

regime dimensions to a niche-level phenomenon might seem contradictory; however, the point was to anticipate regime level implications of scaling up the niche" (p. 7). Also, (Smith, 2007) refers to 'socio-technical dimensions' and underline their usefulness in making explicit not only the composition of regimes but also how they contrast alternative niches.

CA sustainability transition in this article uses the MLP as an orienting framework to analyse the alignment of processes within and between the three levels viz. niche-innovations, socio-technical regimes and exogenous socio-technical landscape. We discuss the phases, actors involved and challenges to understand the complexity of CA transition and to provide policy advice and provide analytical traction i.e. moving away from focussing on farmers and the green economy and instead offering wider integrative views in broader societal context.

2.2 Data collection

The research was carried out in three districts in Mid-Northern Uganda. The sub-region is one of Uganda's poverty and environmental degradation hotspots. It has the highest incidence of poverty at 43.7% compared to the national average of 19.7%. The households there are mostly female-headed, and they are very poor; 43% of the population is at risk of rebounding into poverty. The same trend is true of high inequality represented by a Gini coefficient that rose from 0.331 in 2005/06 to 0.378 in 2012/13 (UBOS, 2017). Having suffered war for two decades added complexity and left the region characterized by regression. The area is additionally notable for land use conflicts.

Data were collected in the period January to July 2017. The used qualitative methods included focus discussion groups (FDGs), key informant (KI) interviews and a workshop to discuss and validate preliminary findings while still in the field.

For the KI interviews, expert sampling was used to select respondents as a way of eliciting expertise of CA and their knowledge, insight and experience of farming in the region. The KI were selected from Lira district because it is the main administrative structure in the region. The respondents were composed of relevant persons from different institutions. There were 10 interviews conducted by the researcher and administered to the following personnel.

1. The main Agro-input supplier in Lira. She was also a medium scale woman CA farmer.
2. The Agricultural Extension worker at sub-county level.
3. The Lira district secretary for production and marketing.
4. A male local government representative from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) of the Government of Uganda.
5. The woman District agricultural representative from MAAIF.
6. A supervisor of Operation Wealth Creation (OWC) in Lira. OWC is a representative of the former National Agriculture Advisory Services (NAADS) and a statutory semi-autonomous body under the MAAIF. This body has a mandate to manage the distribution of agricultural inputs to farmers.
7. A leader of a Non-Governmental Organisation (NGO) implementing CA in the region.
8. The Agriculture Officer in charge of promoting CA from Ngetta Zonal Agricultural Research and Development Institute (NgeZARDI). NgeZARDI is an agency for technology development and agricultural information dissemination under the National Agricultural Research Organisation

(NARO). NARO is a public institution responsible for guidance and coordination of all agricultural research activities in Uganda.

9. A policy analyst from the Ministry of finance.
10. A pioneering CA implementing Officer who worked for the Food and Agricultural Organization of the United Nations (FAO) in 2000.

The researcher randomly selected participants from each of the three districts to participate in six FDGs. The FDGs were gender biased given the social and cultural setting of the area where the study was done. Below is a summary (Table 1).

Table 1. Number and gender of participants to focus discussion groups (FDGs) and workshop

District	Sub-county	Village	No. of men	No. of women	No. of FDGs
Alebtong	Awei, Acede Parish	OkwaloAgabo B	7	6	2
Dokolo	Bata, Alapata Parish	Anyangocoto	9	6	2
Dokolo		Alanyi B	Mixed		1
Abia cooperative	Control group		6	6	2
Lira	Agali , Adyaka Parish	Anyapo	6	6	2
Total			28	24	9
Workshop in Lira			14		

Both the KI interviews and FDGs were guided by a checklist of open-ended questions drawn from the MLP levels with a reference to the regime dimensions. These included policies, institutional factors, social cultural factors, markets and generally questions on knowledge and practices and constraints of CA adoption specific to the region. In some of the FDGs where the participants could hardly speak English, a local field research assistant, who could speak both English and Langi (local language/dialect), facilitated the discussions.

Interview and FDG data were transcribed and analyzed. Some of the audios that were in Langi or some other local dialects were transcribed by a field assistant that could directly translate the information into English. The content on the transcripts was checked, grouped under the different themes from where it was analyzed for main points that the respondents discussed. This information was combined and forms the results and discussion section below.

Data were also analysed for possibilities of CA to attain 'thick legitimacy' based on the study of Montenegro (de Wit and Iles, 2016). Indeed, Montenegro (de Wit and Iles, 2016) put it that "*both agro-ecological and scientific legitimacy grows out of a web of legitimation processes in the scientific, policy, political, legal, practice, and civic arenas*". Therefore, the paper analyses the legitimisation process used by the actors supporting CA in Uganda by focusing on the following processes: carrying out research on the knowledge and practices of CA; extending its influence in the power arena particularly under policy, practical and civil arenas; and, thirdly, stressing the ethical legitimacy of CA.

3. Results and discussion

The MLP explains change in society at three levels starting, first, with the innovation itself also called the niche. Secondly, the socio-technical regime which is influenced by policy, culture, science, market, industry and technology. If the niche innovation is to be successful it has to break through this dominant level. And thirdly, the socio-technical landscape which is simply external global factors that pressure the dominant regime. Our results are presented in that order using synthesised information from both the KI and the FDGs.

3.1 CA Niche

CA is a niche because it breaks away from conventional agriculture that involves the tradition of burning of crop residues and deep ploughing. This CA knowledge generally exists but only in numerous small pockets scattered around the country, i.e. from the NGO dissemination and training workshops, government and donor funded projects in selected areas of operation. It was clear regardless of circumstances that farmers were ahead on CA information unlike some of their political leaders. For example, some of the key informants, who were political representatives, showed less knowledge of CA although their opinions on transitions greatly differed. The more highly political informants were of the view that for a meaningful transition to be made at a country level, agriculture would have to become commercialized. For some, this includes introducing activities and programs that would eventually cause smallholder farmers to move away from farming their small pieces of land in search of off-farm work like factory work.

Although FDGs were organised according to gender, both male and female FDG participants expressed positive opinions of CA just like they did in the workshop. However, they equally referred to inadequate access to training and extension services as one workshop participant stated below:

"I would even say that the extension workers are having the training gap e.g. on the changing climatic patterns. They need relevant knowledge and skills in responding to these challenges because it is very vital. I am doing a masters in sustainable agriculture and rural development but when I see the problems farmers face, I remember that the gap is still very big"

However, due to post-war events and other factors, like high inequality and poverty in the area, participants expressed little trust in relevant government agencies. Participants cited the fact that there was hardly any agricultural extension except upon farmers' demand.

3.2. CA knowledge

At higher and tertiary institutions of learning, such as universities and agricultural colleges, there is hardly a CA curriculum. There is even hardly a module on CA. However, there are demonstration plots in some primary schools and in lead farmers' fields in the communities. In the past, there was some CA research undertaken at the Ngetta Zardi and at other NGOs that promoted CA. These had some project reports for the areas where their projects were implemented but largely remain unpublished. Given this reality, there is inadequate access to the necessary information. Except for information sequenced around world environment related events and days, there is hardly any information dissemination over the media or

even from the government extension services. The only information readily available to the farmers is that given by NGOs that run projects on CA. Other than that, there is peer education (cf. farmer-to-farmer extension) where farmers pass on the information to those in their circles such as friends and neighbours and or demonstration plots situated on roadsides to catch the attention and generate interest of passers-by.

It was evident that farmers were well versed with CA knowledge and could clearly point out to some of the technology benefits and achievements so far attributed to revenues from the venture. Some of the women in the FDGs recounted their sources of information, peer support and showed off their achievements and are quoted below.

Female Respondent 1: "We have been hearing on our community radio and the REDs cap project came in; they stayed with us, taught us, trained us and told us what CA is all about. This plot of land with my shop there, I bought it from CA. The very first crop that I grew was maize, I mulched and then sprayed on one acre, the maize was up there and the yield you cannot imagine. I got 600,000 UgX from the maize. So that is the foundation."

Female Respondent 2*: "My story was just like that of Anna; do you see that building foundation over there? While she was growing maize, I grew soya. We were doing it together".*

Female Respondent 3: *"For me I planted maize and it yielded very well which enabled me get some money to pay for school fees for the children. The technology is quite cheap and with proceeds I have been able to build a house"*

Female Respondent 4: *"saw Anna and as she was trained by her, she grew maize which gave her bigger yields. After a few seasons, she bought a cow out of that money. When the cows were many she sold and then constructed for her mother a house".*

On the whole, several other projects followed in many parts of the country albeit under different circumstances for instance from school demonstrations, observations between neighbouring farmers and learning between group members, friends and neighbours; seeing their results and asking them to share their knowledge. Farmer group members shared their knowledge coupled with the results of their demonstration plots. When the farmers tried the technology, they got results. There were also records kept so that farmers would see the changes themselves and in a way be motivated by the observed higher yields.

However, given the weak extension system, the above efforts are still way below expectation. At the time of study, there was hardly any extension services being offered to the farmers in the area of study. Results showed that 90% of the farmers had never had an extension worker telling them about climate change or even CA. An interview with the KI who was an extension worker confirmed farmers' opinions regarding the few extension workers. Although figures vary across Uganda, the ratio of extension worker to farmers is approximately 1:2500 to 1:1800 compared to the recommended global figure of 1:500.

3.3 CA technologies and practices

CA practice is relevant to the farmers in most of the agro-ecological zones in Uganda. Studies so far indicate increases in yields and associated increased incomes profits and reduced soil erosion on degraded soils (Mubiru et al., 2017, Vaiknoras et al., 2014). Discussions with participants (cf. FDGs and KI) in the study area show that farmers find CA applicable, except for one principle of mulching that is rather demanding and nearly not practical. Mulching in most cases remains a challenge due to the competition with fodder for livestock. In this case, some farmers resort to planting cover crops that provide a soil cover and at the same time fodder for animals. Smallholder farmers, who are the majority in the study area, practice the CA principles albeit at different degrees. They use hand hoes and/or ox-ploughs to dig permanent planting stations, rotate their crops, broadly speaking, between legumes and cereals.

At an advanced level up from hoes, manual rippers and ox-ploughs would be the appropriate step. Better still, affordable motorised rippers suitable for the predominate small farms would enable farmers to catch up with the rains in the planting season. These and other current technologies would attract the younger generation of the currently jobless farmers and at the same time ease the workload of the aging population of rural farmers. In Lango, the mere fact that farmers were able to repair their current rippers when they broke down is a sign alone that they are committed to their farming work.

Observations in the field showed some problems like few shared ploughs for those who could afford to hire them while the vast majority resorted to manual revolving community groups. But, at the same time, many farmers were frustrated as they could hardly access the hire services and so these fell back to conventional agriculture even if they knew the benefits.

Most farmers chose the technique after being taught either by NGOs or their peers and this shows that knowledge played the greatest key in the switch to the technology. This peer-to-peer exchange provides informal learning for other farmers who are interested to receive knowledge. Most farmers also practiced at least two principles of CA for labour reasons viz. minimum tillage and crop rotation; these were readily done because of the social or community labour dynamics i.e. through the revolving self-help groups made up of trusted friends. The farmers are organized in their respective groups and with administrative structures all in place and receive available information and services through this arrangement. However, it might be worthwhile to create space to allow these and more informal small technological growth process.

3.4. Markets

Market availability of CA products does not differ from that of conventional agriculture products. However, perhaps as consensus is built with numbers of CA rising through increasing adoption and expanding the acreage of CA, volumes of products from CA could be an advantage in the market. FDG participants decried a challenge of market that is dominated by middlemen. One male respondent commented as below:

"I studied in Soroti in Arapai Agricultural college, but after finishing my studies I failed to find a job. However, with my knowledge of agriculture I started growing soya beans. The challenge was that the market was not good. In the meantime, I recalled from school, the teachers told us that one of the benefits of being in a

cooperative was the bargaining power. I therefore decided to join a farmers' group so that in case the buyers come to us we would be together set a better price other than them exploiting us."

Another respondent added:

"*While in Aterayong, I was with my members and we were very strong, but after this cooperative was disbanded, I went back home started producing my crops but the pricing wasn't okay so I saw that it wasn't good to stay like this, so I decided to go back and call my people to join the cooperative, because of the benefits that I knew I would get was more than when am alone, so that was the reason why I called them back to the cooperative."*

Farmers in the FDGs clearly explained how they end up selling their CA products to middlemen at rock-bottom prices due to the widespread poverty. On the other hand, markets are also affected by other factors. For example, there was hardly a functional bulking system in the communities let alone appropriate post-harvest handling facilities. And then again rural households are unique in terms of needs, expenditure and how they respond and or meet their responsibilities. For instance, without affordable health insurance and a general lack of decent public facilities (e.g. education, rural infrastructure), farmers' productivity and incomes are badly compromised.

3.5. Policy

The agriculture sector employs the greatest percentage of Ugandans (UBOS, 2018) and so investing in the same is key to achieving poverty reduction and food security in Uganda. Since the year 2000, agricultural investment has been guided by the Plan for the modernisation of agriculture (PMA). But even so, the expenditure was below the recommended 10% of annual government expenditure to the agriculture sector based on the Maputo Declaration, 2003. For example, in 2014/2015, it was 5% of the total domestic budget. In the 2020/2021 budget framework, the sector will receive $255M that is expected to come from external sources like donors. Most of this amount is expected to be spent on large investments that would be considered of little value to smallholder farmers; for example, support to cooperative unions, which faded out as one FGD participant who was a renowned leader in the past government regimes asserts below:

"I was under Aterayong cooperative and also chairman of the Lango cooperative union if you can remember. The government came up with their policy to try to deny cooperatives support, so they left them to stand on their own. As a result, Lango cooperative struggled on its own, especially with the then huge debts from the other banks. Eventually these banks came and took everything from the cooperative so this led to its collapse, so up to now its non-existent, that is what I can talk about Lango cooperative"

3.6 Landscape

CA would have a positive impact of landscape pressures such as climate change variabilities and other factors like land and soil degradation that require sustainable methods of farming. At the global level, there are also international agreements and treaties that signatories, such as Uganda, have to comply with. Uganda is signatory to international treaties that are relevant to agriculture such as the constitution of FAO, which leads efforts on fighting hunger; the Right of Association (Agriculture); the United Nations Framework Convention on Climate Change (UNFCC) that deals with climate change action; the

International Seed Treaty that guarantees food security through biodiversity conservation; Agreement establishing the African Development Bank; Constitution of the United Nations Industrial Development Organization (UNIDO); the East African Community (EAC) Treaty that established cooperative commercial and political relations for their citizens among other agreements. Uganda also made commitments to the Sustainable Development Goals (SDGs) and to implement the Rio Declaration, Agenda 21 and its outcomes. Others include the New Partnership for Africa's Development (NEPAD), Environment Action Plan and the Comprehensive African Agriculture Development Programme (CAADP). The country has also taken steps towards achieving sustainable land management (SLM). Altogether, these efforts are geared towards increasing investments and ensuring sustainable growth, productivity, economic development and scaling up SLM practices, improving research and knowledge and coordination of the stakeholders. Climate Smart Agriculture (CSA) is promoted by MAAIF with support from COMESA, FAO through UNDP and other donors including the European Union (EU), the Department for International Development (DFID, UK) and the Government of Norway. CSA is an approach that guides strategic actions needed to sustainably increase agricultural productivity and incomes, adapt and build resilience to climate change, and also reduce greenhouse gas (GHG) emissions. It contributes to the achievement of the Sustainable Development Goals (SDGs) 2 (Zero hunger), 13 (Climate action) and 15 (Life on Land), among others. In Uganda, the CSA program is aimed at developing technical, policy and investment conditions to achieve food security, strengthen livelihoods, management of natural resources and adoption of agricultural technologies.

Table 2: Key policies relevant for CSA implementation and scale out in Uganda

Regional - Africa	
Comprehensive Africa Agriculture Development Programme (CAADP)	Based on four reinforcing pillars for investment in agriculture to improve performance through strengthening country presence, focused lending program based on coordinated sector plans, enhanced capacity for policy, analytical work, and knowledge/partnership management (NEPAD, 2003).
Uganda - Agricultural Sector	
Plan for Modernisation of Agriculture (PMA)	Since 2000, investments in agriculture were guided by the Plan for Modernization of Agriculture (PMA) whose main objective was to reduce poverty through agricultural commercialization (Uganda. Ministry of Agriculture and Uganda. Ministry of Finance, 2000).
Agricultural Sector Development Strategy and Investment Plan (DSIP)	The PMA has since 2010 been replaced by the DSIP. The DSIP is based on a vision of the future, which is to have "a Competitive, Profitable and Sustainable Agricultural Sector". Investments under DSIP have been packaged under four Programmes representing the key areas of opportunity: (i) Enhancing Production and Productivity; (ii) Improving Access to Markets and Value Addition; (iii) Creating an Enabling Environment, and; (iv) Institutional Strengthening in the Sector (MAAIF, 2016).

The National Agricultural Policy 2013	The vision of the National Agriculture Policy is 'a Competitive, Profitable and Sustainable Agriculture Sector'. The overall objective is to promote food and nutrition security and to improve household incomes through coordinated interventions that will enhance sustainable agricultural productivity and value addition; provide employment opportunities and promote agribusinesses investments and trade (MAAIF, 2013).
Uganda - Environment and Climate Change	
National Climate Change Policy	The policy aims to ensure that all stakeholders with a role to play in the development of Uganda, address climate change impacts and their causes through appropriate measures while promoting sustainable development (Ministry of agriculture animal industry and fisheries (MAAIF) and Ministry of water and environment (MWE), 2015).
National adaptation Programme of Action (NAPA)	The Program of Action contains 9 priorities focusing on building community and ecosystem resilience to adverse impacts of Climate Change (MWE, 2007).
Uganda - Land, Land use and Forestry	
Uganda Strategic Investment Framework for Sustainable Land Management (U-SIF SLM) 2010 – 2020	The goal of the Uganda Strategic Investment Framework (USIF) for SLM is to promote key sectors cooperation to improve natural resource-based livelihoods and other ecosystem services. The U-SLM SIF is a multi-sector (agriculture, water and environment, lands, energy and trade) national initiative spearheaded by MAAIF to implement the CAADP and TERR Africa (a partnership between FAO, World Bank, NEPAD and other implementing agencies for sharing lessons and developing tools and learning materials for scaling up and mainstreaming SLM). The U-SIF SLM aims at providing an integrated cross-sectoral approach to investing in solutions to crosscutting SLM challenges. It also aims at scaling-up and mainstreaming SLM into the centre of the national development agenda (UNDP, 2014b).

In the CSA policy environment, government institutions are responsible for the implementation of the policies and actions following government decisions (FAO, 2010, Ministry of agriculture animal industry and fisheries (MAAIF) and Ministry of water and environment (MWE), 2015, CIAT and BFS/USAID, 2017). MAAIF plays a leading role in developing and promoting climate change policies. Other institutions - that include the Ministry of Finance, Planning and Economic Development (MoFPED) and the Ministry of Water and Environment (MWE) - also mainstream climate change adaptation and mitigation strategies into national policy frameworks.

Policy makers on the whole need to implement a variety of measures to ensure that CA inputs and machinery are made more affordable and available to the farmers and collaborating stakeholders in the private sector. This has to do with the trade policy and import duty tax on inputs like the rippers produced within Africa; direct seeders, two-wheeled tractors, spare parts and other raw materials for producing mechanization equipment designed in Uganda like the Kabanyolo tractors for land preparation.

High tariffs and long delays experienced during processing import machinery and other inputs also need to be lowered or at best removed. This would enable local repair shops and manufacturers handle their customers especially in the peak seasons. Additionally, when these trade barriers are addressed, just like credit and micro-credit institutions could reduce their high interest rates so farmers can access the services to make more sustainable progress.

Table 3: Some of the stakeholders influencing CA transition in Uganda

	Government Institutions	**Private sector organizations**	**Local governments**	**Parastatals**
Actors	▪ MAAIF ▪ Ngeta (NARO) ▪ Operation Wealth Creation (OWC)	▪ Insurance Companies ▪ Financial Institutions ▪ Input dealers ▪ produce buyers ▪ Service providers ▪ Farmers' organisations e.g. UNFF, farmers' groups	▪ Local Councils ▪ District Technical Departments	• Development Partners • Faith Based & Cultural Institutions, • NGOs, civil society organizations (CSOs), community-based organizations (CBOs)
Services	▪ Policy implementation ▪ Coordination ▪ Resource mobilisation ▪ Extension services ▪ Regulation ▪ Standards ▪ Early warning information ▪ Research	▪ Provision of financial services, credit and banking services ▪ Provision of market ▪ Facilitation of group formation/Savings and Credit Cooperative Organizations (SACCOs) ▪ Awareness, mobilisation ▪ Advocacy & coordination of partnerships ▪ Implementation of CSA activities ▪ Promotion of group marketing and warehouse receipt systems	▪ Mobilise farmers' participation in CSA programs, plans	▪ Contribution towards policy development ▪ Advocacy ▪ Capacity building ▪ Support implementation of CSA interventions
Interests	▪ Research for development and innovations ▪ CSA knowledge, extension and agro-weather services ▪ Institutional coordination	▪ Improved incomes & productivity ▪ Value chain integration	▪ Budget and implementation of CSA	▪ Financial support for development ▪ Build local capacity & implementation

So far, there are limited studies on sustainability transition in general in Uganda, such as (Isgren and Ness, 2017), and a few studies on CA in Africa, such as (Odhiambo et al., 2015). However, one of the key things central to sustainability transitions are power and politics (Kern and Markard, 2016) because both factors greatly affect the overall nature of transformation. Due to vested interests of the stakeholders involved, there are winners and losers; for example, stakeholders that can also form coalitions and alliances depending on their agenda and the amount of collective influence among themselves. Some of the CA stakeholders in Uganda laid out in Table 2 are already informally working together to some extent. Understanding political opinions and creating avenues for engagement and dialogue are important for the vision as (Martin et al., 2018) clearly illustrated.

3.7 Transition outcomes and impacts on the food system

The conventional agriculture regime is being challenged by the practices of the CA niche through minimum tillage, crop rotations and mulching or planting a permanent cover crop. When CA farmers get better yields and/or better survival crops during long dry spells among other benefits, their conventional agriculture counterparts would seek to follow suit.

Looking at the social pillar of the CA initiative, the niche contributes to improving food security through improved yields, informal knowledge enhancement through farmer field schools, exchange visits, field visit days, CA training workshops, CA pilots and demonstrations and labour opportunities e.g. community service providers.

Thanks to the self-help community groups that provide labour on a revolving group system, CA has also improved livelihood resilience and at the same time promoted diversification of income sources as extra money are invested in other off-farm ventures. Lastly but not least, the rural farm group members-built trust among themselves as they collaborate and this further strengthened the indigenous community leadership structure headed by the village chief. One FGD respondent emphasised this below:

"Bad leadership is what brought the downfall of the Lango cooperative and during that time the regime used to support the co-operative, but the current regime does not support it at all for the reasons we don't know. So, this new one that we have begun, we hear that the government is following it up very much either to support or for some reason we don't know. For us we started Abia cooperative deriving from Aterayong which was older but went away with the Lango cooperative:"

During the focus group discussions, women reported support for one another especially the widows and elders whom they helped to dig the basins or rip their pieces of land in preparation for the planting season.

Due to the culture of people working hard long hours, CA appreciates this cultural value of the labour requirements involved. CA farmers had the opportunity to participate in the multi-stakeholder dialogues during workshops and the monitoring and evaluation missions undertaken by members of the National Climate-Smart Agriculture (NCSA) task force.

On the ecological pillar, CA niche uses ecological production practices through soil and water conservation as met by all three CA principles. It is in line with water strategies for areas that experience water stress periods, and of late unreliable rainfall pattern, yet the area practices rain-fed agriculture. In the long run, it contributes to soil health by minimising soil disturbances. Also, it raises resilience capacity through enhanced ability to cope and adapt to climate change impacts.

Economically, the CA niche has more positive attributes including increase in yields and subsequent farm profitability, opportunity for off-farm investments and diversification. The niche also created jobs for youths and yet still generating financial capital. On the underside, infrastructures in form of transport, irrigation, storage and value addition; machinery and poor market linkage still haunt the niche and thus compromise the overall economic performance.

With respect to the sustainability of the food system, the farmers as one of the main actors of the CA initiative, have demonstrated changes as follows; they are more aware of landscape pressures such as climate change variabilities and others like land and soil degradation that require sustainable methods of farming. Their motivations are also based on the benefits observed on their lands particularly better yields in times of prolonged droughts and dry spells. Their expectations are also for more updated knowledge such as weed management, crop spacing in their agro-ecological zone, machinery acquisition and sharing options and value addition of their products among others.

3.8 Niche-regime interaction mechanisms and legitimization process

CA niche in Uganda used the knowledge development and knowledge diffusion through networks as the innovation system functions to actively collaborate with the regime actors. Based on the work of (Elzen et al., 2012), the CA niche used the technological and network anchoring mechanisms in view of transforming the conventional agriculture. The new technical practice of CA involves digging permanent planting stations (Kaweesa et al., 2018, Mubiru et al., 2017), unlike conventional agriculture that involves deep ploughing. Secondly, the practice involves maintaining a crop cover through mulching or planting a cover crop that can double as animal fodder. This is also unlike the conventional practice where land is left bare, open or 'naked'. Lastly, the CA niche is also characterised by crop rotations unlike conventional agriculture that might be only monocrops every season. The second mechanism is ‘network anchoring’; CA farmers through their farmers’ groups access knowledge and farming services such as spraying and reduced tillage using the shared animal drawn ox plough. The farmer groups offer support for their members for on-farm problems, labour and knowledge sharing. Due to strong community relationships, farmers transformed their farming to CA.

The main niche pioneers and supporters of CA included NGOs and donors that implemented and provided budgets for CA pilots and project demonstrations respectively. The latter are also relevant in that they have power to dialogue with high-level stakeholders (this attitude perhaps arises from their ability to fund incentives) and better access to research, knowledge and technologies. Some of the support is perhaps in the interest of meeting international treaties and agreements.

The connection that the CA initiative is making across niches, regimes and the landscape is through the National climate-smart agriculture task force that is made up of various stakeholders that represent these three socio-technical levels. These include the CSA focal point from MAAIF together with senior agricultural officials, the FAO, CSOs and NGOs implementing CA, NARO regional representatives, academia, private sector, UNDP.

Mechanisms used by the CA niche to anchor to regime included formation of partnerships and collaborations between several stakeholders within and outside Uganda and coordination to reduce duplication of efforts. There is high momentum of infrastructures such as the Africa Conservation Tillage

network (ACT) and others that share research, best practices and CA experiences thus facilitating knowledge exchange between its members.

The NARO facilitates the adoption of CSA practices; Makerere University Centre for Climate Change Research and Innovations (MUCCRI) is a hub of academic, professional development, and research excellence in climate science, climate adaptation and related disciplines; the Climate Change Department (CCD) is responsible for strengthening Uganda's implementation of the United Nations' Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (KP). The various bodies named above indirectly enhance the farmers' capacity to manage climate risks by developing context-suitable agricultural practices, and sustainable value chains.

Political will in advancing the aims of the CA initiative will perhaps be evidenced by the budget allocated to cover initial high capitals that cannot be met by smallholder farmers, the enablement to mechanize. Since one of the challenges is the fake inputs on the market, if the relevant political authorities addressed these weak policy implementations that are under their jurisdiction this might as well be a sign of political will. For the local artisans, the taxes on materials used for local agricultural machinery production could be waived in order to encourage mass production in the small local hubs. Markets would also be encouraged for the farmers to benefit from their products when sold at equitable prices if regulated fairly.

Based on the study of Montenegro (de Wit and Iles, 2016), the CA niche is following a scientific mode of seeking legitimacy in the form of peer-reviewed publication of local research findings to validate the goal of the technology. The practice mode of legitimacy is also already in play through farmer adoption and sharing of knowledge. Other legitimation processes include civic arenas through public awareness; policy and institution, for instance through the formation of National Climate-Smart Agriculture (NCSA) taskforce; engagement of the wider public through every possible avenue, for example the Uganda faiths network that is promoting the CA through raising awareness of their faithful followers. This borders with the ethics mode as the faithful believers centre their attention on the ethical legitimacy of the food production system.

Changes in practices have also revealed the gender societal rules; for instance, women stuck with their fellow women on sharing knowledge and information rather than approach their male counterparts. CA women showed better group dynamics when left on their own. They also expressed themselves better that way.

4. Conclusion

Unlike many other previous sustainability transitions studies that are often criticized of being limited to the developed countries, this study is original as it takes place in the Global South. This serves to remove this bias and even more so the lack of methods in adoption studies in Sub-Saharan Africa (SSA). Our study also adds value to adoption studies as it uniquely applies the MLP, unlike the other CA studies in Uganda and perhaps elsewhere. Learning from the transport and energy transition, as explicitly covered by the work of (Schot and Geels, 2007, Geels and Schot, 2007), there are several transition pathways. Nevertheless, in the past, agriculture took a reproduction process pathway; farmers practiced conventional agriculture and still got their yields. This locked the farmers into unsustainable methods of farming, as there was hardly any need to change. Our study reveals that farmers are capable and are

making a transition to the state-of-the-art sustainable alternatives in remote or hard-to-reach areas in SSA. The case study results show that a leap transition is possible. Niches might not have to follow prescribed step-by-step procedures. Just like masses in SSA have mobile phones without necessarily having owned home telephones with masts, the same is possible with agricultural technologies in developing, non-OECD, countries. Landscape developments are in the process of exerting pressure on the regime and are already cracking down the system lock-in.

In general, technological change is indeed happening in several areas albeit sporadically in the country. The study reveals a new transition that is definitely shifting between the technological substitution and reconfiguration pathways in the Lango region. For farmer groups that received knowledge and training or even awareness, either directly or indirectly, CA has slowly replaced their conventional practices at farm level. This continues to happen as farmers realize benefits themselves through better yields and incomes, neighbours seeing plant growth differences between the CA fields and non-CA fields. This breakthrough will eventually replace the conventional agriculture regime. Landscape pressures could quicken the transition. More shifts can be expected in other hard-pressed areas such as those experiencing effects related to climate change, soil and environmental degradation. CA as a niche-innovation can be expected to solve problems such as soil erosion, long dry spells, that cause crops dyeing prematurely, and for others it is a matter of belief. For the latter, this means sacredly doing farming, treating the soil and generally natural resources with respect believing that human beings are only custodians of these and that ultimate ownership lies beyond the physical realm.

Making CA attractive as other technologies would in effect enhance demand for it. The high initial capital costs need to be covered by both the government as a social protection measure and by the private sector as a business case. This could be a win-win situation albeit in the long term.

Further unlocking the potential of CA transition demands a power shift and education is a good starting point. Infrastructure needs to be put in place to facilitate the transformation. The actors could pave a transition pathway by catalysing the power to change. There is a big demand for an interface with the politics if the spick-and-span national documents and plans are anything to go by. Adoption of CA is site specific and the adoption patterns across the country appear to be different. In Northern Uganda, CA adoption happened because farmers had access to information, and they were trained in the technique of CA. This could also be attributed to the history of the area that was marred by violence and conflict and so a lack of trust of external activities related to government programs. The farmers were ready to take on technologies only after they had clearly understood how CA works and how it would help them improve their livelihoods.

The policies that are needed to favour CA development in Uganda include the National Land Use Policy for Uganda (2008), CSA and SLM policy, Agriculture Policy (2013), climate change policy and the National Agricultural Research (NAR) policy (2003). The policy recommendation would be to target the whole agricultural chain as a more feasible pathway. However, coordination of stakeholders and re-structuring to reduce on unnecessary staff costs and avoid duplication can be a means of redirecting political power to bring about transition. As the most important documents are available at national level, these need technocrats to implement without or at least less interference of political interest. Dissemination of information remains pivotal for the transition; linkages between farmers' groups, researchers and

extension agents are vital. CA is a long-term strategy and so investment in the sector needs to be done in the same manner.

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Appendix

Key informant interview guide

Self-introductory remarks

Key informant interviews will generate information on the general outlook of CA in the region and the historical agricultural context of the area. Some of the interviewees will include community elders, local traditional chiefs, historians, experts such as academia on the region, district Local Government officials and technical staff and representatives from FAO, MAAIF, Farmer Field School among others. This information will provide some input into the MLP theoretical framework. There will be a minimum of six and up to ten interviews. The overall o**bjective of the exercise is to** explore and determine the impact/role of stakeholder contribution (combinations of) to the uptake, scaling up or refusal to take up and scaling up of CA among selected farmer typologies.

Research questions:

i. Does CA adoption depend on socio-cultural factors in the communities where it is promoted?
ii. What are the institutional processes that determine CA adoption in NU?
iii. What are the institutional factors that might be relevant for a socio-technical transition in CA adoption in Uganda?

Questions to guide interview

1. When did CA start in Dokolo? Who are some of the key service providers for CA? And what are their roles?2. Are farmers given any incentives or assistance to enable them do CA? What type of farmer is likely to adopt the practice? If they were never given any incentives, would they still do CA?

3. What factors are hindering taking up of CA as a technology; does government have a budget marked for doing CA?

4. What would be necessary for a long-term shift in attitudes and perceptions necessary for accelerating CA scaling up?

5. What are some of the sociocultural issues that need to be addressed for uptake of CA?

6. What are the institutional changes that are needed to promote CA?

7. Are there any key political challenges affecting replication and diffusion of the CA technology? If so, how can they be addressed?

8. Are the power structures in the area sufficient for transformation in agriculture to take place?

9. What do you foresee as a future challenge for scaling up technologies? How can it be backstopped?

10. Is there any additional information that you would like to highlight for the study?

PAPER IV CONFERENCE SUBMISSION

Kaweesa S.H[1], Loiskandl W[1], Mkomwa S[2], Gitta E[3], Melcher A[1], 2018: Conservation Agriculture Adoption in Mid-Northern Uganda. Conference paper submitted at **The Second Africa Congress on Conservation Agriculture(2ACCA) 9-12 October 2018, Johannesburg, South Africa.** ***Making Climate-Smart Agriculture Real in Africa with Conservation Agriculture*** *"Supporting the Malabo Declaration and Agenda 2063"* Condensed Papers Book
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Keywords: CA adoption, focus group discussions, gender, education, socio-cultural factors

Introduction

The mid-northern region of Uganda, Lango, is under the traditional annual cropping and cattle farming system. The region is recognized for its potential of being the country´s grain basket and so greatly contributing to the GDP. The main cereal crops that include maize, finger millet, sorghum and rice are the staple food for people even beyond the region in addition to providing a source of income for the rural households. However, unlike the rest of Uganda, the region has high levels of inequality and poverty (UBOS, 2016; NPA, 2015); this means households have even less ability to invest in soil and water conservation measures and are thus prone to food insecurity. Moreover, the country at large is vulnerable to climate related changes such as rainfall variability, long dry spells, droughts and floods (Ssentongo et al. 2018) besides land degradation and other human induced disasters (FEWS NET, 2012).

In Uganda Conservation Agriculture (CA) is considered to be one of the resilient production technologies under climate smart agriculture (MAAIF 2016). However, the extent and rate of CA adoption in the country is yet to be researched because adoption is site specific (Kassam et al. 2017, Thierfelder et al. 2016). CA adoption also remains complex because factors influencing non-adoption are not well studied (Andersson and D'Souza, 2014). Seven years prior to the study, CA was introduced to three districts within the region - Lira, Dokolo and Alebtong and since then farmers left on their own upon exit of the project. The study explored the extent and reasons for CA adoption; whether adoption of CA could be due to exposure to NGOs and if this contributed to increased adoption and whether differences in density of the farmers across the region played a role in the observed adoption.

Material and Methods

Nine focus group discussions (FGDs) as listed in (Table 1) were conducted starting on 21 July 2017 and ending on 25 July 2017. The FGDs had participants that were randomly selected from each of the three districts. Except for one control group, it was necessary to conduct gender based FGDs as it was quickly realised at the beginning that women were not free to speak when placed in the same space together with the men. This was an important socio-cultural factor identified right away from the onset of the exercise. Additionally, 417 household (HH) interviews were conducted using purposive non-probability sampling as a means of reaching the targets. Sampling was selective in that the pre-defined group sought was that of

farmers that were aware of CA. To verify these criteria, the respondents were asked in the initial stage and if they did not know about CA, the interview was stopped henceforth. However, the non-proportional quota sampling method was used and the minimum for each quota of gender was 150. The sample was heterogeneous and aimed at getting views, opinions and broad ideas without so much representing those numbers proportionately. The snowball technique was used by the leaders to reach the respondents because the area is hard to reach, in terms of the means of transport thus making communication difficult over and above the scattered homesteads due to unplanned settlements. For the key informants, expert sampling was used to select respondents as a way of eliciting their expertise, knowledge and insight on the performance of CA in the region and, this group also provided evidence for the HH survey.

Results and Discussions

Empirical results showed that CA adoption was due to information and knowledge gained by the farmers; CA was the best alternative for a post war conflict zone that had limited presence of agricultural extension. Although the farmers generally had low education levels and were mostly elderly people, they easily took up CA. They also described some of the outcomes of this adoption for example increased ability to pay school fees and afford further education and construction of better houses using proceeds from CA. The comparative advantage of CA came from better yields in a region that receives less rainfall as characterised by the unimodal pattern. The critical issue that needed addressing was the scarcity of equipment and a means of persuading the youth to join the venture given the high unemployment rate and idling in their communities.

Adoption barriers and drivers

Adoption results showed differences between the three districts of Lira, Alebtong and Dokolo, (Table 2). This could be due to differences in farmer densities as all three were exposed to the same CA information. The perceptions of those farmers that were practicing CA were relevant for CA uptake in the socio-cultural context of their area. CA was the best option to manage farming in that system due to the CA knowledge received by the farmers, i.e. information and knowledge increased adoption. Under harsh conditions, access to information, attitude and proper knowledge are some of factors that positively influenced CA uptake. A legacy of post-war conflict, food insecurity, poverty and livelihood stress incentivized people to absorb anything to improve their well-being. Farmer motivations did not have the support of CA extension service, which was nearly absent. The respondents clearly demonstrated that CA had the capacity to improve their economic livelihoods, improve access to basic services such as construction of better housing, education access for their relatives and starting to lift themselves out of poverty. *Focus group discussions*. FGDs results showed views on the impact of CA on livelihoods across genders. Women appeared to be benefitting more from CA and the critical feature that they continued to face was lack of machinery to make their efforts more efficient and productive. Although the HH survey sample had a disproportionately larger sample of men than what is represented in the national farm labour population statistics; the women in the FGDs could recount more the positive impacts and benefits that they had gained because of doing CA. Unlike their male counterparts, women had houses being constructed (an

improvement from grass thatched huts), the ability to send their children to tertiary institutions and starting small-scale business-like shops, a sign of diversifying their income. The males on the other hand explained that their proceeds were used to meet the basic needs of their households. Women and youth generally play leading roles in agriculture and it might be expected that they could influence the accelerating adoption and upscaling of CA. Gender differences in CA adoption could also be influenced by sociocultural factors. This result was similar to the study in west Africa on gender differences in rates of adoption (Adesina and Baidu-Forson 1995) and (Koohafkan and Stewart 2008).

Reason for adoption. Adoption of CA is site specific and the adoption patterns across the country appear to be

different. In Northern Uganda, CA adoption happened because farmers had access to information, and they were trained in the technique of CA. This could also be attributed to the history of the area that was marred by violence and conflict and so a lack of trust of activities related to government programs. The farmers were ready to take on technologies only after they had clearly understood how they work and how they could be applied to help them improve their livelihoods. Other results showed that adoption in the same region was positively influenced and explained by sociocultural factors (Kaweesa et al. 2018). This is unlike in Kapchorwa and Tororo in eastern Uganda where farmers took up CA for economic benefits and improved yields (Vaiknoras et al. 2015). According to the Multi-Level Perspective (MLP) theory innovations go through a process to change the regime. The network actors in this case were made up of CA experts, district officials, input markets, NGOs and lead farmers' representatives who were also the key stakeholders with the relevant information needed as one of the requirements for change. These networks if strengthened could influence the implementation of new or dominant policies that support CA in the long term.

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Tables

Table 1: The structure of focus group discussions held in the field

District	Sub-county	village	# men	# women	# FDGs
Alebtong	Awei, Acede Parish	OkwaloAgabo B	7	6	2
Dokolo	Bata, Alapata Parish	Anyangocoto	9	6	2
Lira	Agali, Adyaka Parish	Anyapo	6	6	2
Dokolo	Control group	Alanyi B			1
	Control group (Abia cooperative)		6	6	2
Total number of participants			28	24	9
Workshop in Lira			10	4	

Table 2: Extent of farmer adoption of CA in sampled areas within the districts

Adoption Extent	Lira	Alebtong	Dokolo
Full adoption (%)	35%	25%	40%
Overall Gender	62.4% male		37.6% female

Appendix 1: Other General Results

3.1 Results from the household interviews

42.9 percent of the respondents mentioned that they applied CA mainly because of the increased production while the major two constraints experienced were the labour intensity if one were to hole out basins as opposed to ripping and the expensive equipment needed for one to be effective in terms of time and energy spent.

The estimated total acreage under CA for the respondents is 784.25. This is mostly done by those with less than a total farmland of 10 acres. 13.7 percent of the those doing CA used the technique on all their farmland, 34 percent used it on 50% of their farmland which was ranging between one and six acres. Although all respondents were aware of CA and 92.5 %, mentioning also that this was done between the years 2000 and 2015, only 73.9 percent of those interviewed always practiced CA.82.9% of the respondents mentioned NGOs as the main source of CA knowledge.

Results indicate that the respondents practiced three principles of CA, i.e. minimum tillage, crop rotations and mulching or planting cover crops. The intensity varies as per land available and so does the frequency. CA adoption seemed to refer to the practice of ripping or permanent planting basins (81.1%) and the practice of crop rotations (98.8%). Observations showed some fields with residues while most of the others were bare. Observations also showed some degree of crop rotations such as with cotton, sunflower and pigeon peas. E.g. a field of pigeon but with residues of maize stalks.

3.1.2 Gender dynamics

More females agreed that they had a lot of knowledge about CA,while more males practiced minimum tillage. However more males practiced minimum tillage than female respondents while more females mulched their fields than male respondents.

Adoption across gender showed some differences across the age brackets, for instance the respondents below the age of 30 agreed that they had a lot of knowledge about CA more that those between 31 and 50 years. The former agreed that they practiced more CA on their farms than thoe above 51years. Those below 25 years agreed that they mulched less and that they practiced less crop rotations while the age category 31-39 practiced mulching the most. Those between 31 till 50 years practised crop rotations the most.

Table 1: Gender and CA Practices

Crosstab

			Qn1 GENDER		
			1 Male	2 Female	Total
CLU5_1 Ward Method (C8_1 bis C8_8)	1 : 2 3 3 1 1 3 3 1	Count	40	41	81
		% within Qn1 GENDER	15%	26,6%	19%
	2 : 2 1 3 1 1 2 1 2	Count	54	23	77
		% within Qn1 GENDER	21%	14,9%	18%
	3 : 1 1 1 1 1 1 1 2	Count	76	30	106
		% within Qn1 GENDER	29%	19,5%	25%
	4 : 2 1 1 3 1 2 1 2	Count	55	41	96
		% within Qn1 GENDER	21%	26,6%	23%
	5 : 1 1 1 1 1 1 1 3	Count	38	19	57
		% within Qn1 GENDER	14%	12,3%	14%
Total		Count	263	154	417
		% within Qn1 GENDER	10...	100,0%	10...

In order to understand the respondent scores on C8 (CA principle applications, ease and challenges), D10 (social-cultural factors), E2 (Economic factors) and F4 (institutional factors), the study conducted and interpreted a profile analysis separately on each of these factor scores. This was useful in ranking the respondent and helps to analyse the patterns of the scores. The profiles showed the differences in scores for each of the factors. These are then used to predict CA adoption behaviour and performance.

Profile analysis done based on gender respondents and or other groupings made among the respondents come out as a significantly different profile. Analysis was done between groups and across the scores of the individual respondents. Profile question: Do the respondents that practice CA at different levels (sometimes, every season, never, etc.)

The questions are designed to have a correlation among themselves i.e. they are not independent, so the profile graphs are a plot of the mean scores of one group with the other group however in case of problems they are treated as a paired sample. Statistically the Profile Analysis is like a repeated measures ANOVA.

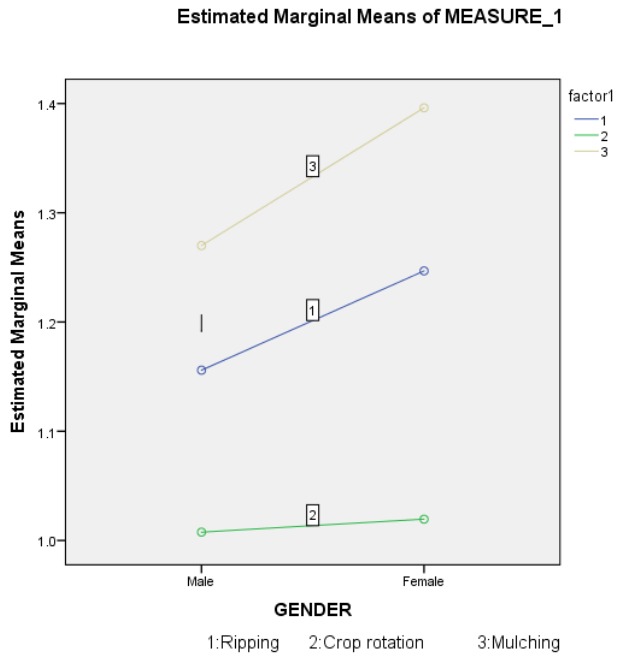

Table 2: A Pearson Correlation test of CA use and the number of service providers giving incentives to farmers.

Correlations			
		CA adoption	Actors or service providers giving incentives to farmers
CA adoption	Pearson Correlation	1	.132**
	Sig. (2-tailed)		.007
	N	417	417
Actors or service providers giving incentives to farmers	Pearson Correlation	.132**	1
	Sig. (2-tailed)	.007	
	N	417	417

**. Correlation is significant at the 0.01 level (2-tailed).

Pearson correlation of CA adoption and the agencies that have promoted CA r =.132. P-Value = .007, in conclusion, the correlation indicates that the strength of association between the variables is low (r = .132), and the correlation coefficient is not significantly different from zero (P < 0.007). Also, the 1.7% (.132 ^{2}) of the variation in CA adoption is explained by the number and diversity of actors or service providers giving incentives to farmers. It appeared from the results that the respondents that did CA were told about it, trained and less because of the inputs they received.

Long Term Aid Dependence and Adoption of Sustainable Agricultural Practices

To analyses this research question (*Does long term aid dependence lead to adoption of sustainable or superficial agricultural practices such as CA?),* a number of questions were asked to farmers about aid dependence, the farmers were first asked ether they receive external assistance to help operate their farm.

Most respondents noted that they do not receive external assistance to help them operate their farms (70.3%) and only (29.7%) noted that they had received external assistance to help them operate their farms. They noted that their major source of aid was NGOs (56.5%), Friends/relative had (13.7%) and Microfinance had (9.7%) seems they use banks less as (0.8%) of the respondents used this source.

The inputs (29.8%) was the most common type of aid received by the farmers, this is followed by training (21.8%), tools like rippers (16.9%), loan and cash (12.9%) each respectively. However, the main reason why respondents felt they would continue doing CA if aid was withdrawn was because they felt equipped with enough knowledge about CA now (40.7%) and also their experience that CA gave high yields (36.2%).

4.1.1 CA adoption and attitudes and choices and decisions of the farmers

The second objective of the study was to explore the dependence CA adoption by farmers on their beliefs, values and attitudes and their decisions. Under this objective, the study explored which factors might influence farmers' decisions and the socio-cultural factors that might be at play in the communities where CA is being done.

4.1.2 Social factors

This was explored by ranking using statements below and the respondents chose what they felt was appropriate to describe their situation, these are given below.

Table 3: CA Adoption and Socio-Cultural Factors

Socio-cultural Factor	N	Minimum	Maximum	Mean	Std. Deviation
My partner determines the method of farming we use on the land and what we grow	417	1	3	1.98	.885
My religion/beliefs support and encourage me to adopt CA	417	1	3	1.49	.835
My cultural norms and practices encourage CA adoption	417	1	3	1.64	.902
The farming methods I use require technical training to apply them well	417	1	3	1.41	.757
The market demands require me to use better methods of farming in order to get better yields	417	1	3	1.66	.896
The ownership of land and other resources does not influence on the farming practices and type of crop to plant in a season	417	1	3	1.78	.936
The available technical aid influences the method of farming I use	416	1	3	1.81	.946
I belong to a farmers group and we are able to organize ourselves	417	1	3	1.50	.838
The farmers group leaders decide what and how we plant crops	417	1	3	2.33	.883
I make decisions on whether to apply CA or not	417	1	3	1.17	.494

Respondents 40% seem to agree that their partners determine the method of farming they use on the land, (25.9% male and 14.1% female agree that their partner determines the method of farming we use on the land and what we grow) with a mean of 1.98 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a significant deviation value of .885. This shows that there is a significant variation in the responses provided by the respondents about their partners determining the method of farming they use on the land and what they grow.

Respondents (73.6%) seem to agree that their religion/beliefs support and encourage them to adopt CA with a mean of 1.49 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .835.

Respondents (65.5%) seem to agree that their cultural norms and practices encourage CA adoption with a mean of 1.64 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a significant deviation value of .902. This shows that there is a clear variation in the responses provided by the respondents about their cultural norms and practices encourage CA adoption.

Respondents (75.8%) seem to agree that the farming methods they use require technical training to apply them well with a mean of 1.41 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .757. This shows that there is a variation in the responses provided by the respondents about the farming methods they use which require technical training to apply them well.

Respondents (63.1%) seem to agree that the market demands require them to use better methods of farming in order to get better yields with a mean of 1.66 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .896. This shows that there is a variation in the responses provided by the respondents about the market demand requiring farmers to use better methods of farming in order to get better yields

Respondents (56.8%) seem to agree that the ownership of land and other resources doesn't influence on the farming practices and type of crop to plant in a season with a mean of 1.78 which appear to be slightly tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .936. This shows that there is a clear significant variation in the responses provided by the respondents about the ownership of land and other resources does not influence on the farming practices and type of crop to plant in a season.

Respondents (56.1%) seem to agree that the available technical aid influences the method of farming they use with a mean of 1.81 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .946. This shows that there is a variation in the responses provided by the respondents about the available technical aid influences the method of farming they use

Respondents (72.9%) seem to agree that farmers belong to a farmers group and they are able to organize themselves with a mean of 1.50 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .838. This shows that there is a variation in the responses provided by the respondents about farmers belonging to a farmers group and they are able to organize themselves to benefit as a group.

respondents (61.2%) seem to disagree that farmer's group leaders decide what and how they plant crops with a mean of 2.33 which appear to be tending to the maximum rank of 3 which is disagree. However, the corresponding standard deviation also revealed a deviation value of .883. This shows that there is a clear variation in the responses provided by the respondents about the farmer's group leaders decide what and how we plant crops

respondents (88.7%) seem to agree that they make their own decisions on whether to apply CA or not with a mean of 1.17 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .494. This shows that there is a slight variation in the responses provided by the respondents about making their own decisions on whether to apply CA or not.

Table 4: CA adoption and Beliefs

Correlations			
		CA adoption	beliefs
CA adoption	Pearson Correlation	1	.211**
	Sig. (2-tailed)		.000
	N	417	417
Beliefs	Pearson Correlation	.211**	1
	Sig. (2-tailed)	.000	
	N	417	417
**. Correlation is significant at the 0.01 level (2-tailed).			

The Pearson correlation of CA adoption and attitudes and or choice or decisions of the farmers is r .211. P-Value = .000. The correlation indicates that the strength of association between the variables is low (r = .211), and the correlation coefficient is significant (P < 0.000). In addition, it could be that 4.4% $(.211)^2$ of the variation in CA adoption is explained by the attitudes and or choice or decisions of the farmers.

Table 6: Pearson Correlation test (CA adoption and socio-cultural factors in the communities where it is promoted)

Correlations

		CA adoption	Sociocultural factors
CA adoption	Pearson Correlation	1	.236**
	Sig. (2-tailed)		.000
	N	417	417
sociocultural factors	Pearson Correlation	.236**	1
	Sig. (2-tailed)	.000	
	N	417	417

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation of CA adoption and socio-cultural factors in the communities where it is promoted is r .236. P-Value =.000. In conclusion, the correlation indicates that the strength of association between the variables is low (r = .236), and the correlation coefficient is significant (P <.000). Also, we can say that 5.5% ($.236^2$) of the variation in CA adoption is explained by socio cultural factors in the communities where it is promoted.

4.1.1 Impact of Economic factors on doing CA

Respondents were asked to rank on a scale of 1 to 3 for agree neutral and disagree with given statements. They were also asked to give comments if any for their choice of response.

4.1.2 Institutional factors that might be relevant for CA adoption in Lango

Table 6: the institutional factors and socio-technical transition in CA adoption

Factors	N	Minimum	Maximum	Mean	Std. Deviation
The political environment in my area is conducive for me to practice CA	417	1	3	1.29	.641
There is information about government programs on CA running in my area	417	1	3	2.53	.766
There are enough government agencies and extension workers that are available to help the farmers do CA	417	1	3	2.71	.622
Farmers groups receive assistance from government and others for doing CA	417	1	3	2.52	.794
The government officials give us accountability and performance of CA	417	1	3	2.89	.399
The traditional rules of our community encourage farmers to do CA	417	1	3	1.72	.897
There are NGOs that promote doing CA and they always assist us	417	1	3	1.63	.885

(81.8%) respondents seem to agree that the political environment in their area is conducive for them to practice CA with a mean of 1.29 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .641. This shows that there is a slight variation in the responses provided by the respondents about the political environment in their areas being conducive for them to practice CA.

Most respondents (68.5%) seem to disagree that there is information about government programs on CA running in their areas with a mean of 2.53 which appear to be tending to the maximum rank of 3 which is disagree. However, the corresponding standard deviation also revealed a deviation value of .766. This shows that there is a slight variation in the responses provided by the respondents about information about government programs on CA running in their areas.

(80.6%) respondents seem to disagree that there are enough government agencies and extension workers that are available to help the farmers do CA with a mean of 2.71 which appear to be tending to the maximum rank of 3 which is disagree. However, the corresponding standard deviation also revealed a deviation value of .622. This shows that there is a variation in the responses provided by the respondents about enough government agencies and extension workers that are available to help the farmers do CA

(70.7%) seem to disagree that farmers' groups receive assistance from government and others for doing CA with a mean of 2.52 which appear to be tending to the maximum rank of 3 which is disagree. However, the corresponding standard deviation also revealed a deviation value of .794. This shows that there is a variation in the responses provided by the respondents about farmers' groups receive assistance from government and others for doing CA

(92.23%) seem to disagree that the government officials give them accountability and performance of CA with a mean of 2.89 which appear to be tending to the maximum rank of 3 which is disagree. However, the corresponding standard deviation also revealed a deviation value of .399. This shows that there is a variation in the responses provided by the respondents about government officials gives farmers accountability and performance of CA

(58.3%) seem to agree that traditional rules of their community encourage farmers to practice CA with a mean of 1.72 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .897. This shows that there is a variation in the responses provided by the respondents about the traditional rules of farmer's community encouraging farmers to practice CA

The (64.7%) respondents seem to agree that there are NGOs that promote practicing CA and they always assist farmers with a mean of 1.63 which appear to be tending to the maximum rank of 1 which is agree. However, the corresponding standard deviation also revealed a deviation value of .885. This shows that there is a variation in the responses provided by the respondents about the NGOs that promote doing CA and their assist to farmers.

Summary

Based on the currently available literature and research findings, is it clear that adoption of CA is hindered by a complexity of interacting factors and as such a better understanding of the dynamics driving adoption of CA in Uganda is a prerequisite. This would enhance adoption by informing key political leaders about key constraints so that they are empowered to formulate and implement policy that will ultimately reduce land degradation, increase food security people livelihoods and make affordable and appropriate agricultural investments.

The data captured the respondents' estimated use of CA on their land, the frequency of use, and their individual reasons for adopting CA. Other factors explored included economic and social factors to form a background for further promotion of CA in the region.

There were four data sets that were collected from three districts in Mid-Northern Uganda. The set comprised of 417 household interviews conducted using semi-structured questionnaires administered using a non-discriminative snowball-sampling technique. There were also ten selected key informant interviews and nine focus group discussions held in the communities. A validation workshop at the end of the exercise also conducted in Lira.

Appendix 2 : Data collection Tool for households

HH Questionnaire on Conservation Agriculture

Introductory remarks

Good morning / Good afternoon Madam/ sir. I am …… We are conducting an assessment on conservation agriculture in Lango Sub region for study purposes. You have been selected to participate in this review because we feel that you as one of the CA farmers have important information. I, therefore, kindly request you to share your honest views. Participation in this study is totally voluntary. I would like to assure you that if you accept to participate, the information you give me shall be kept strictly confidential and will only be used for academic purpose. Do you agree to participate? 1. Yes 2. No

Date of interview----------Name of Interviewer: _____Code----------

Name of village----------Parish----------Sub-county----------

District_____

SECTION A. Demographic Characteristics of the Respondent

Circle the response

Qn1.Sex of the respondent

1. Male
2. Female

Qn2. Age of the respondent

1. Below 25years
2. 26-30 years
3. 31-39 years
4. 40-50 years
5. 51+ years
6. I do not know/ not sure

Qn3. Status of respondent

1. Single
2. Married
3. Widowed
4. Separated/ divorced
5. Other_____

Qn4.Highest education level of the respondent

1. No formal education
2. Primary
3. Secondary (O Level)
4. College Certificate / A level
5. Diploma
6. Degree (and Postgraduate; PGD, Masters, PhD)
7. Informal education

Qn5.Total number of household members in the household ☐

Qn6. Nature of farming activities practiced (Multiple Mention)

1. Growing crops for subsistence
2. Growing crops for sale
3. Keeping livestock
4. Growing crops for subsistence and sale
5. Pastoralism and agriculture
6. Any other: _____

Qn7. Type of labour force used in farming

1. Hired labour
2. Household members
3. Community volunteers/Revolving group
4. Mechanized equipment
5. Animal drawn power

Qn8. Source of financing to the farming practices of the household

1. Farmer´s own savings
2. Loan
3. Donations from Organizations / associations or individuals
4. SACCOs or revolving fund
5. Both savings and SACCOs/ VSLA
6. Others; _____

Qn9. Source of technical Advice to the farming practices of the household/farmer

1. Family members
2. Friends and community members
3. Government agencies
4. NGOs
5. Others (specify)_____
6. None

The farming practices of the household

Do you practice any of the following on your farm? Please tick appropriately			
Practice	**YES**	**NO**	**Remarks /comment**
Qn10_1: I plough my farm			
Qn10_2: I burn the residues on the farm			
Qn10_3: I use fertilizers and or manure			
Qn10_4: I mulch my farm			
Qn10_5: I practice ripping or permanent planting basins			
Qn10_6: I use a hoe			
Qn10_7: I use a tractor			
Qn10_8: I practice crop rotations			

SECTION B. AID DEPENDENCE

B1. Do you receive external assistance to help operate your farm?

1. Yes 2. No

B2. If yes, what is the source of your aid?

Source of aid	Tick where appropriate
1. Microfinance	
2. NGO	
3. Friends/family/Relative	
4. SACCO/VSLA	
5. Government	
6. Government and NGOs	
7. Bank	
8. Not applicable	

SECTION C. Conservation Agriculture package adoption

CA Awareness

C1 Have you ever heard about Conservation Agriculture

1. Yes
2. No

CA TIME

C2 If yes, when did you first hear about CA?

1. Before 2000
2. Between 2001 to 2005
3. Between 2006 to 2010
4. Between 2011 to 2015
5. After 2016

CA SOURCE

C3 Who told you about CA? (multiple mention)

1. The government extension worker
2. District Agricultural Officer
3. NGOs
4. Others specify

CA Specific NGOs

C3_1: Name the Specific NGOs that told you about CA

CA Practice

C4: Do you practice conservation agriculture?

Response	**Explain why?**
1. Yes	
2. I tried it but no longer practice it	
3. Never done it	
4. Sometimes	

Farmland (in Acres)

C5: Approximately, how many acres do you use for farming?

..... Acres

C6:CA Land Usage

On how much of your land do you practice conservation agriculture?

100% of my land	50% of my land	¾ of my land	¼ or less

C7_1: INTENSITY

C7_1: How often do I practice conservation agriculture?

1. Sometimes
2. Every season
3. Rarely
4. I use it once in a while(sometimes)

C7_2: Give reasons (explain)

_____
_____

C8: Rate the following arguments below (using the code1-3) whereby; 1=Agree 2. Neutral 3. Disagree

Practice	1.Agree	2.Neutral	3.Disagree	comments
C8_1:I have a lot of knowledge about CA				
C8_2:I use CA on my farm				
C8_3:I practice minimum tillage				
C8_4:I always mulch my land				
C8_5:I practice crop rotations				
C8_6:I know how to apply all the CA principles and I always use all of them on my land				
C8_7:I find CA easy to apply on my land				
C8_8:I find CA challenging to use on my land				

C9: Benefits of using CA

What are some of the benefits of doing CA?

1. **----------**
2. **----------**
3. **----------**

C10: Challenges of CA

List some of the constraints of doing CA on your farm

1. **----------**
2. **----------**
3. **----------**

C11: DIVERSITY OF ACTORS AND FARMERS DEPENDENCE

C11_1: Would you adopt CA if many NGOs told you about it?

1. Yes 2. No

C11_2: Did you adopt CA because of the inputs (seeds, fertilizers, rippers) you received from the NGOs other actors?

1. Yes 2. No

C11_3: Do you practice CA because of the training you received from the NGOs?
1. Yes 2. No

C11_4: Did you adopt CA because of many service providers told you about it?
1. Yes 2. No

C11_5: Do you think most people in this community are doing CA?
1. Yes
2. No

C12: Give reasons for your answer

_____
_____

COMMUNITY PERCEPTION

C13: What can be done for the whole community to practice CA? -
_____
_____-
_____

C14: DURATION OF AID DEPENDENCE

Would you continue doing CA If AID was withdrawn?
1. yes
2. No

C15: Give reasons for your answer
_____
_____
_____
_____

SECTION: D Socio-cultural Issues

D1. Who owns the land? **[Ownership of land]**

1. Man
2. Woman
3. Joint ownership between man and woman and or family land
4. Child/youth
5. Any other? _____

D2. Who uses the land? **[land usage]**

1. Man
2. Woman
3. Our household
4. Neighbours
5. Others (specify)_____

D3. Who determines what to be planted in a season? **[Land use decision making]**

1. Man
2. Woman
3. Joint man and woman
4. Child/youth
5. Any others; specify_____

D4. What or who determines what technology you use on the farm? **[Technology use decision making]**

1. The type of technology available
2. The organizations / service providers that give us the technologies
3. The extension worker from government
4. Any other factor. If so specify: _____

D5. The community leader determines my use of CA **[Influence of community leader on land usage]**

1. Yes2. No

D6: Explain how

_____-
_____

D7: Generally, women and youth like farming and practicing CA**[Community Perception]**

1. Yes
2. No
3. None
4. I do not know

D8: Why: -

_____
_____

D9: What other socio-cultural issues facilitate or hinder CA adoption in your area? **[Other hindrances, Community Perception]**

_____

_____

_____

_____

_____

D10: Rate the following arguments below (using the codes1-3) whereby 1=Agree2= Neutral

3=Disagree

Socio-cultural Factor	1.Agree	2.Neutral	3.Agree	Comments or any remarks
D10_1: My partner determines the method of farming we use on the land and what we grow**[Partner]**				
D10_2: My Religion/beliefs support and encourage me to adopt CA **[Religion]**				
D10_3: My cultural norms and practices encourage CA adoption **[cultural Norms]**				
D10_4: The farming methods I use require technical training to apply them well**[Farming methods]**				
D10_5: The market demands require me to use better methods of farming in order to get better yields **[Market]**				
D10_6: The ownership of land and other resources does not influence on the farming practice and type of crop to plant in a season**[land ownership]**				
D10_7: The available technical aid influences the method of farming I use**[Technical Aid]**				
D10_8:I belong to a farmer´s group and we are able to organize ourselves**[farmer´s group]**				
D10_9: The farmers group leaders decide what and how we plant crops**[Group Leader]**				
D10_10: I make decisions on whether to apply CA or not. **[Personal choice]**				

SECTION E: ECONOMIC FACTORS

Payment for CA: Who pays for the equipment and material needed for doing CA?

E1_1: Who pays	E1_2:What things do they pay for?	E2_3: Approx. how much do they pay/give? (UGX)	Comments / Remarks
1. My partner			
2. Government			
3. NGOs			
4. Myself			
5. Any Other			

E2. Rate the following arguments below (using codes1-3) whereby 1=Agree 2= Neutral 3=Disagree

Factor	1.Agree	2.Neutral	3.Disagree	Remarks or comments
E2_1: My profit/financial expectations from the farm influence my use of CA**[Financial Desires]**				
E2_2: The market prices for the farm products influences my practices **[Market prices]**				
E2_3: The cash at hand for farm investment in a season influences my farming practices **[Cash at Hand]**				
E2_4: Through my group we can negotiate prices of our products **[Group negotiation]**				
E2_5: The available financial donation influences the method of farming I use on my farm **[Donations]**				
E2_6: The availability and access to loans from any lending institution influences my practices **[Access Loans]**				
E2_7: The availability of nearby markets for my farm outputs influences my farming methods**[Nearby market]**				
E2_8: The availability of input shops encourages me to use CA **[Farm Input]**				
E2_9: There is social trust among us farmers, so we decide what to grow. **[Social Distrust]**				
E2_10: Generally, it is women and youth who like farming and are doing CA**[Women and Youth]**				

SECTION: F Institutional factors

F1. List some of the agencies that are promoting CA **[List of Agencies]**

_____
_____

F2. Has the extension worker from government ever told you about how CA? **[government communication]**

1. Yes 2. No

F3. Has the extension worker from government ever told you about weather and climate changes? **[government extension]**

1. Yes
2. No

Rate the following arguments below (using codes1-3) whereby 1=Agree 2= Neutral 3=Disagree

Factor	1.Agree	2.Neutral	3.Disagree	Comments/ remarks
F4_1: The political environment in my area is conducive for me to practice CA**[political environment]**				
F4_2: There is information about government programs on CA running in my area **[Government Programs]**				
F4_3: There are enough government agencies and extension workers that are available to help the farmers do CA**[Government Agencies]**				
F4_4: Farmer groups receive assistance from government and others for doing CA**[External Assistance]**				
F4_5: The government officials give us accountability and performance of CA**[Government accountability]**				
F4_6: The traditional rules of our community encourages farmers to do CA **[Traditional rules]**				
F4_7: There are NGOs that promote doing CA and they always assist us**[NGO promotion]**				

F5: Is there any additional information you would like to share with me regarding CA? **[Recommendations]** -
_____

_____

Thank you

Appendix 3: QAToCA Tool

QUALITATIVE EXPERT ASSESSMENT TOOL for CA ADOPTION (QAToCA 2.0)

Names :	Respondent's role in project/case study :

Phase of CA project (Initial adaptation, development Vs actual scaling-up) :	
Status of project (finished, ongoing, planned) :	
CA principles under promotion; minimum or zero tillage, Soil cover, rotation/sequencing or all? Please indicate!	
Country :	
INCAA Platform :	

Instructions for QAToCA 2.0

The objective of QAToCA is to determine the relative likelihood of CA adoption in the different regional case studies of the INCAA project. The intention is to administer QAToCA 2.0 with the regional partners in their respective promoting organisations and regions. Results obtained will then be compared and conclusions drawn as to which region based on the administered questions has a high or low relative likelihood for CA adoption in Africa.

QAToCA 2.0 is meant for a qualitative assessment of all the factors (mostly at the higher or regional level) that influence the adoption of CA. The results give a relative indicator for likelihood of adoption. Relative since it produces a percentage which gives not necessarily the likely actual extent of adoption.

QAToCA 2.0 questions have been grouped under specific thematic areas with a careful consideration of the different scales of implementation of INCAA project from Farm level to Village/Local and Regional levels as follows:

Scale: Richter Scale

The scale (v) from 0-5, indicates the legitimacy (strength) of the suggested statement (iii) with respect to its influence on the likelihood of adoption for the case study area, where:

- Þ 0 = Not sure, has no positive effect on adoption likelihood (even negative)
- Þ 1 = Strongly disagree, has limited positive effect on adoption,
- Þ 2 = Disagree
- Þ 3 = Partly agree
- Þ 4 = Agree
- Þ 5 = Strongly agree, has maximum positive influence on adoption likelihood

A	CA as an Object of Adoption (ObjofAdoptFarmVillLev)
B	Characteristic attributes of CA as an object of adoption
C	Capacity of implementing institution (CapacityofImplInstVillRegLev)
D	Attributes of dissemination strategy (AttrOfDissemStraVillRegLev)
E	Political/Institutional framework on Regional Level (PolInstFramRegLev)
F	Political/Institutional framework on Village Level (PolInstFramVillLev)
G	CA products & inputs Market conditions (ProInpMarkCondVillRegLev)
H	Perception of community towards CA (PercepCommVillRegLev)
I	Knowledge of CA's role on climate change and other ecological benefits

Þ N= if you think, the statement is not applicable in this case or appropriate. please leave a comment

Decision rule (see example below):
By filling an "X" in any of the empty boxes under the statements: Strongly agree; Agree; Partly agree; Disagree; Strongly disagree; Not sure, (in response to the questions) - this implies you have agreed that the corresponding statement above which then translated into the selected figure in (V) is closest to the observed situation in your region.
For instance, for A1 in ObjofAdoptFarmVillLev, by filling in X under "Strongly agree" imply that in my case, I strongly agree to the statement that " Not more than two trainings per season are needed for proper understanding of CA by farmers " in my region. Consequences of this answer to the indicator and question is that, for my case, CA is less complex (ii) and is easy to understand and to implement (i)

A…Object of Adoption Farm/Village level									Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	Comments: Please state any supportive comment(s) to your judgement in (iv)
Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree		Partly disagree	Strongly disagree	Not sure		
(i)	(ii)	(iii)							(v)	(iv)
Is CA easy to understand and to implement?	Complexity of CA as a practice	Not more than two trainings per season are needed for proper understanding of CA by farmers							**please enter x**	
Is CA initially adapted to labour endowments of farms?	Labour requirements Vs endowments	Households/Communities labour is naturally sufficient for CA implementation							**please enter x**	
Are the benefits of CA practice easily observed by farmers?	Observability of CA	Output of CA is easily observed through increased yields demonstrated either during trainings or on trial plots or on other (neighbouring) fields							**please enter x**	
Can CA be tried out and verified on a small scale? And extended in stages, partially	Trial ability	CA can be tried out on a small plot of the farmers' fields, partially adopted and extended in stages							**please enter x**	

adopted?													
Is the implementation of CA flexible, i.e. can it be easily adapted to suit different ecologic and socio-economic circumstances ?	Flexibility/adaptability	CA fits into the existing farming system and efficiency of the production system is improved in the short term									**please enter x**		
											0		

		B…Farm and household characteristics/constraints Farm/Household level									Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	Comments: Please state any supportive comment(s) to your judgement in (iv)
		Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure		
OLD		(i)	(ii)	(iii)							(v)	(iv)
A1	**B1**	Are farmers able to meet the financial cost of CA in your case study?	Cost of CA and Liquidity issue	There are sufficient own financial resources by average farmers to cover cost							**please enter x**	

A2	**B2**	Is CA practice/knowledge already known to the farmers of your region?	Availability of owned CA knowledge	Majority of farmers have knowledge of CA or traditional/indigenous knowledge similar to CA							**please enter x**		
A5	**B3**	Is the required social organisation for CA implementation in the community available? (e. g marketing networks, etc.)	Availability of Social networks/org.	Level of social organisation within the community meets CA's requirements							**please enter x**		
A6	**B4**	Are the initial inputs (crop residues, seeds, fertilizers, Herbicides etc.) available in the region and do farmers have access to, for successful implementation of CA?	Residue and Seeds Requirements Vs availability	Household members have access to residue and seeds and such inputs are available on-farm							**please enter x**		
A7	**B5**	Are the mechanization related inputs (no till equipment, fuel, etc.) required by CA practice initially available to farmers?	Machinery, fuel requirement and herbicides availability	Household members have access to technical inputs and such inputs are available on-farm							**please enter x**		
A8	**B6**	Can CA practice initially be implemented on existing farms without additional land requirement OR is the required additional land available to the farmers?	Land requirement and availability	CA is adapted to land owned by households							**please enter x**		

A11	**B7**	Is the economic risk for farmers comparatively low? what is the certainty of yield? what are the consequences of failure?	Relative economic risk	Economic risk for farmers is low and CA practice can be implemented without endangering the existence of farms							**please enter x**		
A14	**B8**	Does CA contribute to the farmer's autonomy, prestige and independence?	CA and Social status + prestige of farmers	Introduction of CA has led to improve social status of farmers and reduce dependence on external inputs							**please enter x**		
A15	**B9**	Does CA practice affect pressure on natural resources such as water, land and residue?	CA and conflict over resources	The introduction of CA practice does not increase the pressure on natural resources and does not lead to conflicts between different resource users (e.g. pastoralist and farmers							**please enter x**		
											0		

C…. Capacity of implementing institution													
Village/Regional level													
Operational Question	Indicators for assessing dissemination potential	Statement									Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	Comments: Please state any supportive comment(s) to your judgement in (iv)	
			Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure					
(i)	(ii)	(iii)									(v)		

C1	Has the organisation a well-designed overall concept, e.g. a binding rule system and a transparent structure?	*Concept of Organisation*	The promoting institution has a clear, transparent and binding framework of rules and a common vision and goal and there is a common strategy to achieve stated objectives							**please enter x**		
C2	Has the organisation well-educated technical and management staff?	*Availability and Quality of human resources*	The promoting institution has employed a multi-disciplinary team consisting of technical staff with expertise in project management							**please enter x**		
C3	Has the organisation a strong leadership with good reputation among the beneficiaries?	*Leadership and Reputation*	The leadership of the organisation is trustworthy, has managerial competence and a good reputation among the beneficiaries, donors and staff							**please enter x**		
C4	Has the promoting organisation access to an already existing structure of branch offices or other organisations and stakeholders based in the target area?	*Organisational linkage to other CA organisations in the region*	The organisation has branch offices and extensive network to other CA promoting institutions working in the same region and uses such contacts to broaden its efficiency and scope e.g. farmers organisations, extension workers, CA research bodies etc.							**please enter x**		
C5	Does the promoting organisation have experience with the CA target group?	*Organisational linkage with target group (CA and non-CA farmers)*	The organisation has worked in the area before and is known and respected by the target group							**please enter x**		

C6	Has the promoting organisation access to well-established networks to CA donors, policymakers, researchers and the private sector?	*Organisational linkage with other stakeholders in the CA innovation systems*	The organisation is able to identify and collaborate with relevant cooperation partners/networks (donors, policy makers and researchers)							**please enter x**	
										0	

	D…. Attributes of dissemination (diffusion) strategy Village/Regional Level											
	Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure	Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	**Comments:** Please state any supportive comment(s) to your judgement in (iv)
	(i)	(ii)	(iii)							(v)	
D1	Is the objective of dissemination clearly defined?	*Dissemination (Scaling up) area, target groups and characteristics*	The target group/s and geographical area/s for dissemination are thoroughly identified by locality and number as well as types of farmers							**please enter x**	
D2	Does the organisation have a clear strategy to reach the objective (cp. C1) by defining the type, sequencing and means employed for scaling-up their CA activities?	*Clarity of dissemination (scaling up) strategy*	There is a clear and realistic time frame for dissemination of activities and a detailed, long-term action plan and an exit strategy exists							**please enter x**	

D3	Has the organisation a well-established and effective documentation, monitoring and evaluation system (M&E)?	*State and level of documentation, monitoring and evaluation*	Objectives and indicators regarding outputs are defined, sound and coherent; time frame for planning, monitoring and evaluation is defined and documented and there exists a strategy for systematic collection of required data for M&E							**please enter x**	
D4	Does the promoting agency use already existing information channels?	*Usage of established communication channels*	The promoting organisation acknowledges and takes advantage of already established networks and information channels such as self-help groups, traditional organisations, schools, religious groups, etc. at the local and regional level							**please enter x**	
D5	Does the promoting agency use effective and efficient dissemination channels to promote/disseminate CA?	*Diffusion strategy and use of CA champions*	The promoting organisation in close collaboration with the farming community selects CA champions (facilitators) that act as disseminators/diffusion leaders of CA; such key persons possess adequate technical knowledge about CA, rhetoric skills and they receive adequate incentives .							**please enter x**	
D6	Does the organisation use efficient means of spread of information adequate to each type of target audience?	*Compatibility of selected diffusion strategy with the target groups*	The identified means of dissemination are efficient and adjusted to the size and educational level, gender, culture and social status of the target group							**please enter x**	

D7	Has the organisation a high-quality partnership with farmers, e.g. regular feedback mechanisms and exchange of experience?	*Linkage of promoting organisation with farmers*	A shared development vision and trust exists between the organisation and the farmers, participatory learning and reliable feedback mechanisms equally exist							**please enter x**		
D8	Is the organisation engaged in capacity building and the implementation of sustainable supportive activities at the local and regional level?	*Organisation and level of involvement in capacity building*	The promoting organisation supports local/regional level organisations (e.g. farmers groups) to become sustainable and independent from the implementing agency, such as capacity building							**please enter x**		
D9	Does the promoting organisation promote CA through mass media, such as radio, TV or newspapers?	*Type of communication channel*	The promoting organisation has a strategy and the technical capability to promote CA through mass media; the target group can access such mass media, and the promoting institution has experience in public campaigning							**please enter x**		
D10	Does the organisation use only minimal incentives to introduce CA /Project activities?	*Usage of incentives in the diffusion process*	The organisation initially equips farmers only with an absolute necessary set of (technical) inputs and does not provide any monetary incentives to the farmers such as subsidies or funds; emphasis of project activities is on capacity building in order to keep dependency of farmers upon the organisation minimal							**please enter x**		
										0		
	E…. Political/Institutional framework (Context of adoption)									Decision rule:	**Comments**:	

	Regional level										Please enter "X" in the scale on left to which extent you agree with the statement.	Please state any supportive comment(s) to your judgement in (iv)
	Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure			
	(i)	(ii)	(iii)								(v)	
E1	Is there political stability in the region/Country?	*Political situation of the region / Country*	There is no social, political or ethnic tension in the CA project region; the political situation is calm								**please enter x**	
E2	Does the regional government promote a supportive land, water and agricultural policy which facilitates the introduction/dissemination of CA activities among the target group/within the target region?	*Availability of enabling government policies*	There are stable and effectively implemented government programs/policies which provide incentives for the spread of CA /or sustainable agriculture in general								**please enter x**	
E3	Does the government support CA practice through research and/or extension?	*Government attitude towards CA research*	The government promotes CA adoption through its integration in formal research and/or extension programs								**please enter x**	

E4	Does the government have an efficient administration system which facilitates (or does not hinder) dissemination activities?	*State of administrative set up*	The administrative system at the national level has relevant agencies for agriculture and development issues which are easily accessible for farmers							**please enter x**		
E5	Is the governance system structured in an adequate, decentralised way?	*System of administration practiced in the region*	There exist decentralised structures within the administration which allow locally adapted and timely solutions to farmers problems							**please enter x**		
E6	Is the situation of the civil society conducive to scaling-up of CA practice at the local and regional/national level?	*Tolerance of civil society to the formation of interest groups*	Farmers are free to and have organised themselves in interest groups of their choices.; such groups can exert pressure (lobby) on policy makers to adjust policies to their favour							**please enter x**		
										0		

F**…..**Political/Institutional framework (context of adoption)		Decision rule:	**Comments:**

	Village level										Please enter "X" in the scale on left to which extent you agree with the statement.	Please state any supportive comment(s) to your judgement in (iv)
	Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure			
	(i)	(ii)	(iii)								(v)	
F1	Is there a functioning local level governance structure which can act as cooperation partners for scaling-up?	*Availability of local level governance structures*	There is a local government with a strong leadership that commits itself to development objectives								**please enter x**	
F2	Are there already local organisations which can be used during the process of scaling-up to facilitate the dissemination of CA practices?	*Presence of supportive local organisations*	There exist effective formal and informal local organisations that are willing to support dissemination of CA.								**please enter x**	
F3	Are there local rules which support or do not hamper dissemination of CA	*Compatibility of CA to local customs and/or norms and rules*	The local formal/informal rules do not hinder the introduction/dissemination of CA practice; these rules allow women and men to adopt CA and reap benefits from its practice								**please enter x**	

F4	Do the access and/or usage rights to land support the introduction of CA ?	*Land access, ownership and used*	Regulations concerning private land rights and usage/access rights for communal land are clearly formulated and effectively implemented, they do not hamper the implementation of CA practice and do not lead to conflicts between community households							**please enter x**		
F5	Is the Settlement pattern supporting CA adoption?	*Types of settlement pattern and CA dissemination activities*	The settlement pattern is clustered, and all members of the community can easily and rapidly access localities particularly relevant during project activities such as community halls, meeting rooms, etc.							**please enter x**		
										0		

G…..CA products and inputs market conditions (Adoption Context)											
Village/Regional level											
Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure	Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	**Comments**: Please state any supportive comment(s) to your judgement in (iv)
(i)	(ii)	(iii)							(v)	

G1	Is there an existing stable market to absorb the products of CA?	*Availability of Markets for CA products*	Physical local market structures are available with sound local management strategies							**please enter x**		
G2	Are markets and marketing facilities easily accessible by farmers?	*Accessibility of markets for CA products*	Markets and marketing facilities for CA produce are easily accessible by farmers at reasonable time and cost							**please enter x**		
G3	Is there interest/support for the spread of CA practice by other economic actors e.g. machine producers, herbicides and legume seeds providers?	*Availability of interest from CA economic actors*	Other private economic actors than farmers benefit economically from the adoption of CA and are able to provide supporting services and/or inputs on transparent markets e.g. CA machine producers/tools, herbicides and legume seeds providers etc.							**please enter x**		
G4	Is the necessary infrastructure such as access to farm-to-market roads, irrigation possibility, No-till equipment, legume seeds, etc. available to target group?	*Availability of basic infrastructure for CA adoption target group*	All general infrastructural necessities for the adoption of CA practice are available at the locality of adoption							**please enter x**		
G5	Are there mechanisms that will enable farmers to eventually meet particular implementation standards required by regional/national/international markets?	*Availability of quality implementation control structures*	There are quality implementation structures for CA principles and producers can afford and have access to such structures allowing them to improve on the implementation process							**please enter x**		

											0

	H…….Perception of community towards CA (Subject of adoption)										
	Village/Regional level									Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	Comments: Please state any supportive comment(s) to your judgement in (iv)
	Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure		
	(i)	(ii)	(iii)							(v)	
H1	Is CA practice welcomed by the majority of the community?	Acceptability of CA by Community	Project activities do not interfere with economic activities of non-participants, and participatory planning of scaling-up has ensured the support of the majority of the community; mechanisms to avoid conflicts (e.g. Farmers-grazer conflicts) do exist							**please enter x**	
H2	Is CA activities/practice accepted by village leaders?	Acceptability of CA by Village leaders/elders	The promoting organisation has identified and contacted village leaders/elders of the community and they accept and support activities							**please enter x**	

H3	Is CA practice and activities welcomed by young farmers ?	Acceptability of CA by young farmers	Young farmers are willing to participate in CA project activities and CA practice creates employment opportunities for them							**please enter x**		
H4	Is the target group willing and able to actively participate and cooperate in the introduction of the CA practice?	Acceptability of CA by target group (farmers)	The target group is self-reliant, willing to participate and to provide self-contribution either financially and/or labourwise; they possess time resources to fully participate in CA project activities such as training sessions, project meetings, etc.							**please enter x**		
H5	Is individual engagement in project activities socially accepted?	Social acceptability of individuals engagement in CA	There is freedom of individuality in the community; CA practice introduced by individual farmers are accepted by the rest of the community and those farmers are not excluded from the community							**please enter x**		
H6	Is there entrepreneurial/innovative behaviour within the community to be found?	Availability of a dynamic and innovative community	Members of the community are already engaged in entrepreneurial activities and have experience in general farm management and trading/marketing issues; there is curiosity for and interest in new ways to achieve income and to improve the own economic situation							**please enter x**		
										0		

	I….Knowledge of CA role on climate change and other ecological benefits Village/Regional level											
	Operational Question	Indicators for assessing dissemination potential	Statement	Strongly agree	agree	Partly agree	disagree	Strongly disagree	Not sure	Decision rule: Please enter "X" in the scale on left to which extent you agree with the statement.	Comments: Please state any supportive comment(s) to your judgement in (iv)
	(i)	(ii)	(iii)							(v)	
G1	To what extend are the farmers of the community aware of the advantage of CA over tillage agriculture?	Advantage of CA over tillage agriculture	There is sufficient knowledge or awareness of the benefits of CA over tillage agriculture in terms of greater soil moisture-holding capacity etc. under CA compared to conventional tillage.							**please enter x**	
G2	Are farmers aware of the potential yield gains under CA?	CA and yield gains	There is sufficient knowledge or sensitization of the community with regards to potential yield gains from CA explain partly by the fact that the period in which available nutrients can be taken up by plants is extended under CA, increasing the efficiency of use - hence a chance for higher yields							**please enter x**	

G3	Can farmers quickly reap benefits from CA practice?	CA yield response and time	First returns from CA practice are witnessed within one agricultural season							please enter x		
										0		

Results

	Thematic area (A….I)	Maximum possible points	Total points achieved	Percentage achieved (unweighted) (Points achieved/total points)	Percentage achieved (weighted with equal strength for each level)	Missing values	Number of questions	Number of N.A.
A	Object of Adoption (CA) (ObjofAdoptFarmVillLev)	25	0	0%	0%	5	5	0
B	Farm and household characteristics/constraints (FarmHHcharac)	45	0	0%	0%	9	9	0
C	Capacity of implementing Institution (CapacityofImpInstVillRegLev)	30	0	0%	0%	6	6	0
D	Attributes of dissemination strategy (AttrOfDissemStraVillRegLev)	50	0	0%	0%	10	10	0
E	Political/Institutional framework (PolInstRegLev)	30	0	0%	0%	6	6	0
F	Political/Institutional framework (PolInstVillLev)	25	0	0%	0%	5	5	0
G	CA products and inputs market conditions (MarkCondVillRegLev)	25	0	0%	0%	5	5	0
H	Perception of community towards CA (PercepCommVillRegLev)	30	0	0%	0%	6	6	0
I	Knowledge of CA role on CC and other ecol. benefits (CAClimateEE)	15	0	0%	0%	3	3	0
	Total	275	0	0%	0%	55	55	0

Appendix 4: Curriculum Vitae

Sara Helen Kaweesa

Email: shkaweesa@gmail.com

Educational Background

Doctoral Candidate	03/2016- To date	University of Natural Resources and Applied Life Sciences, Institute of Development Research, Vienna, Austria. https://www.boku.ac.at/en/personen/person/AC770180160766B8/ **Thesis Topic:** Adoption of Conservation Agriculture in Mid-Northern Uganda
MSc. Mountain Forestry	10/2003- 10/2005	University of Natural Resources and Applied Life Sciences, Vienna, Austria. (Master's Thesis; Colonial breeding in a presumably non-colonial breeder - a pilot study on the Hamerkop, *Scopus umbretta*
BSc. Education	1997 – 2001	Makerere University Kampala, Uganda. Major: Biology, and minor: Chemistry
A' Level Certificate	1995- 1997	Uganda Advanced Certificate of Education (UACE), Makerere College School, Kampala, Uganda. Subjects done: Biology, Chemistry, Physics, Subsidiary Mathematics and General Paper
O' Level Certificate	1991- 1994	Uganda certificate of Education (UCE), Mt. St. Mary's College Namagunga, Uganda. Subjects done: A total of 12 Arts and Science subjects

Employment History and Experience

08/2006- 03/2016 **National Director,** A Rocha Uganda, a conservation organization affiliated to A Rocha International, https://www.arocha.org/en/a-rocha-uganda/

- Making presentations and giving lectures in various settings for example at conferences, workshops and universities on topics related to the sustainable development goals
- Designing short courses

Training trainers in development initiatives e.g. sustainable land management, entrepreneurship and income generating innovations

01/2001- 09/2003 **Secondary School Teacher**- at Green Hill Academy, Uganda https://www.greenhillacademy.ac.ug/kibuli/secondary-school.html

- Assume responsibilities of a regular class teacher including communications with parents and school board of governors, assessments of students and staff meetings.
- Collaborate with department teachers to design school curriculum, schemes of work, lesson plans and delivering biology & chemistry lessons at both ordinary and advanced levels

1998- 2003 **Volunteer** at Nature Uganda, the Birdlife International partners in Uganda. http://www.natureuganda.org/

- Research assistant on bird counts and waterfowl inventories
- Amateur bird guide at nature walks and on tour expeditions

Publications

Kaweesa S.H, El Bilali H, Loiskandl W. Analysis of Transition to Conservation Agriculture in Uganda through the Lens of the Multi-Level Perspective on Socio-Technical Transitions; ***Environment, Development and Sustainability Journal,*** **August** 2020. DOI: 10.1007/s10668-020-00936-2

Sara Helen **Kaweesa,** Hycenth Tim Ndah, Johannes Schuler, Andreas Melcher & Willibald Loiskandl (2020): Understanding the conditions of conservation agriculture adoption in Lango region, Uganda, *Agroecology and Sustainable Food Systems*, DOI: 10.1080/21683565.2020.1751769

Kaweesa, Sara, Saidi Mkomwa, and Willibald Loiskandl. "Adoption of conservation agriculture in Uganda: A case study of the lango sub-region." *Sustainability* 10, no. 10 (2018): 3375.

Ndah HT, Probst L, **Kaweesa S**, Kuria P, Mkomwa S, Rodrigues P, Basch G, Uckert G, Sieber S, Knierim A, Zander P. Improving farmers' livelihoods through conservation agriculture: options for change promotion in Laikipia, Kenya. International Journal of Agricultural Sustainability. 2020 Mar 31:1-20.

Conference & Workshop Proceedings, Paper, Abstract

Ndah, HT; Uckert, G; Schuler, J; **Kaweesa, S**; Probst, L;, Kuria, P; Mkomwa, S; Rodrigues, P; Sousa, J; Basch, G(2017): Feeding the Soil and Feeding the Cow – Conservation Agriculture in Kenya. [Poster] [Tropentag, Bonn, GERMANY, SEPT 20-22, 2017] In: E. Tielkes (Ed), Book of Abstracts of Tropentag 2017 "Future Agriculture: social-ecological transitions and bio-cultural shifts". ; ISBN: 987-3-7369-9612-0

Kaweesa, S; Latifi, S; Probst, L(2016): Institutional learning is critical for Conservation Agriculture innovation: Evidence from Iran, Uganda, and Burkina Faso . Poster presentation at the Tropentag, Vienna, September 18 - 21, 2016,] In: ATSAF, Tropentag 2016 "Solidarity in a competing world — fair use of resources"

September 2020, April 2018 & 2019 made oral presentations respectively at the 25th, 26th and 27th Conferences of the Working Group Sustainability of the Danube Region, organized by the Agricultural

District Authority of Lower Austria. http://www.unserboden.at/953-0-26th+Conference+of+the+Working+Group+Sustainability+Soilprotection+.htm

08-12.10.2018, made a presentation of the paper "*Conservation agriculture adoption in mid-northern, Uganda* "at the Second Africa Congress on Conservation Agriculture(2CCA); http://act-africa.org/ACT_Database/ACT_KnowledgeHub/database/assets/book/2ACCA%20Book%20of%20Condensed%20Papers_2018.pdf

Co-Authorships

A book Chapter: Kassam, Amir. "Advances in Conservation Agriculture: Volume 2 Practice and benefits." (2019). Chapter 12: *Social benefits of Conservation Agriculture systems*: Rafael Fuentes Llanillo, Tiago Santos Telles, Dimas Soares Junior, **Sara Kaweesa** and Anne-Marie B Mayer: Publisher, Burleigh Dodds Science Pub (GB).

A report, Probst, Lorenz. "INnovative Conservation Agriculture Approaches: Food Security and Climate Action Through Soil and Water Conservation (INCAA)." (2018). "Developing pathways for improving farmers' livelihoods using a Transformative Learning Approach –Conservation Agriculture in Kenya" led by ZALF. Lorenz Probst and **Sara Kaweesa** are co-authors of this study. https://typo3.oead.at/fileadmin/Dokumente/kef-research.at/02_sichtbarkeit/03_publikationen/01_projektpublikationen/2018_03_05_INCAA_Final_report_KEF_addendum_binder.pdf

September 18 - 21, 2016, **Moderating Co-Chair,** at the TropenTag, organised by the University of Natural Resources and Life Sciences (BOKU Vienna), Austria. The theme was Solidarity in a competing world — fair use of resources. And made both oral and poster presentations as scientific contributions at this conference.
http://www.tropentag.de/2016/proceedings/proceedings.pdf
http://www.tropentag.de/2016/abstracts/links/Kaweesa_6nSHJnmU.php

Non-scientific publications

Kaweesa, Sara Helen, Dip. Ing. "Agricultural sustainability in Uganda." (2019).
http://www.unserboden.at/files/kaweesa_uganda_case 26th_danube_conference.pdf

2010, A case Study, Climate change and Environmental Degradation Risk and Adaptation assessment (CEDRA Tool),
http://tilz.tearfund.org/~/media/Files/TILZ/Topics/Environmental_Sustainability/CEDRA_version_2/ExampleCEDRA_CaseStudies/AdaptationInAnUrbanEnvironment-ARocha_Uganda.pdf?la=en

2015, Contributor, Awareness raising Packs, http://www.faithsforgreenafrica.org/awareness-raising-packs.html

A book contribution: Bell, Colin Roy, ed. *Creation care and the gospel: Reconsidering the mission of the Church*. Hendrickson Publishers, 2016. A case study from Uganda, Sara Kaweesa

2012, Global call to action https://www.lausanne.org/content/statement/creation-care-call-to-action

Media

AAL_26_Alumni AudioLab with Sara Helen Kaweesa, 21. November 2019 #Podcasts#Alumni#Researcher https://oead.at/en/news/article/2019/11/aal-26-alumni-audiolab-with-sara-helen-kaweesa/

Video Narration: How to start a multi-stakeholder learning process (Video 1 of 3) https://www.youtube.com/watch?v=urCUDspH61c uploaded by Centre for Development Research, Universität für Bodenkultur Wien, December, 2017

Video Narration: What do we need to promote change in agricultural practice? https://www.youtube.com/watch?v=s9HpdKxtYmM uploaded by Centre for Development Research, Universität für Bodenkultur Wien, January, 2018

Video Narration: Elements of a multi-stakeholder learning process, https://www.youtube.com/watch?v=1VqfAShKVd8, uploaded by Centre for Development Research, Universität für Bodenkultur Wien, December, 2017

A Rocha Uganda: A healthy wetland and healthy lives, https://uganda.arocha.org/resources/a-rocha-uganda-a-healthy-wetland-and-healthy-lives/ uploaded by Mellisa Ong, A Rocha International, October 2010.

https://appear.at/en/news/article/2017/02/panel-discussion-world-food-day-2016/, Panelist, world food day 2016, event organised by Ökosoziales Forum in Vienna,

Other Responsibilities

2015- Board Member, Babishai Niwe Poetry Foundation, Uganda https://bnpoetryaward.blogspot.ug/2015/09/babishai2015-launching-poetry-on.html?m=0

2014- Member of the National Climate Smart Agriculture Task Force, Ministry of Agriculture Animal Industry and Fisheries, Uganda.

2014- 2017, Executive Committee Board Member and Chairperson, Science and Technical Committee, Nature Uganda, the Birdlife International partners in Uganda. http://www.natureuganda.org/

Trainings, workshop contributions, and certificates

Tuesday, January 31- Friday, February 3, 2017, Conceptual framing and curriculum development of the Agro-ecology course, at the Mountains of the Moon University, Fortal Portal, Uganda, **Certificate** of Participation.

March 2014, Training of Trainers workshop on Conservation Agriculture by the Ministry of Agriculture, Animal Industry and Fisheries, Mukono, Uganda

August 2014, Trainer for Islamic Farming for Muslim Leaders in Uganda

June 2014 provided technical support in curriculum development for Hope University Semuto (HUS) at the Professors'-in-Residence Forum, Makerere University Kampala. And developed a certificate level course curriculum in Agriculture. A Trustee and committee member of HUS

July 2013 –, Secretary, Uganda Faiths Network on Environmental Action, (UFNEA)

July 2013, Training of Trainers workshop on Climate Smart Agriculture- particularly Conservation Agriculture by the Ministry of Agriculture, Animal Industry and Fisheries, Jinja, Uganda

October 2012, Community based climate change innovations and responses, Presentation at the Lausanne consultation on creation care, Jamaica. And part of the writing team, https://www.lausanne.org/content/statement/creation-care-call-to-action

June 2012, Conservation of Lubigi Wetland, A Presentation at the A Rocha International Forum in Zwolle, Netherlands

January 2012, main speaker on creation care Sunday in Namirembe Cathedral, Kampala, Uganda

16th October 2011, main Speaker on creation Care Sunday, at All Saints Cathedral Nakasero, Kampala, Uganda

July-October 2011, Preparation of Policy Brief and Proposal development on climate change and water sanitation and hygiene, Climate Action Network-Uganda, (CAN-U).

February- May 2011, **Lecturer,** Environmental Studies at GTBC, a Theological college in Kampala, Uganda

January 2010, **Trainer** of Climate change and Environmental Degradation Risk and Adaptation assessment (CEDRA Tool) for agencies in Kampala, a training workshop. http://tilz.tearfund.org/~/media/Files/TILZ/Topics/Environmental_Sustainability/CEDRA_version_2/ExampleCEDRA_CaseStudies/AdaptationInAnUrbanEnvironment-ARocha_Uganda.pdf?la=en

October- November 2009, **Guest speaker** at Climate Change Impacts Tour- Restoring Eden Inc., Michigan, Ohio and Indiana, USA: https://record.goshen.edu/2009/11/8273-ugandan- environmental activist-addresses-students

October 2009, Teacher's COP 15, **Poster presentation** on teaching climate change issues in schools, launched by the Danish Ministry of Education, Denmark.

August 2009, Presentation on climate change in Uganda at the Come2gether climate change Camp, Copenhagen, Denmark. A **certificate** of participation.

July 2009, discussion **Panellist,** on climate change response in local communities, Micah Network, Limuru, Kenya.

May 2009, Climate Change Adaptation Training of Trainers Workshop course by IIED & Africa Centre for Technology, Nairobi, Kenya. A **certificate** of participation.

March 2008**,** UNEP training in waste management for Africa, Mauritius. A **certificate** of participation.

September 2008, Water quality testing techniques, Centre for Affordable Water and Sanitation Technology, Uganda

Awards

BOKU Sustainability Award November 4, 2020

March 2016- APPEAR Scholarship, Austrian Development Agency

September 2003-0ctober 2005, The one world scholarship awarded by the Afro-Asia Institute, Vienna, Austria.

September 2002, a two-week forest camp on forest biology; Earth watch Institute Fellowship, supported by Rio Tinton Plc, Tanzania, **Alumna** Earth Watch Institute, UK

August 2001, a one-month course on Tropical Biology, Darwin Initiative, University of Cambridge, UK., **Alumna,** Tropical Biology Association. Spinescence in Kibale Forest, an abstract in plant and forest ecology, http://www.tropical-biology.org/wp-content/uploads/2016/03/Uganda-Plant-and- ForestEcology.pdf

References

1. **Willibald Loiskandl,** Univ.-Prof.i.R.-Ing.Dr.nat.techn, Institute for Development Research, University of Natural Resources and Life Sciences (BOKU), Peter-Jordan-Strasse 76, 1190 Vienna, Austria. Email: Willibald.loiskandl@boku.ac.at

2. **Dipl.-Ing. Dr. Erwin Szlezak,** Head of Unit, Department of Rural Development, Soil Protection & Landscape Planning, Authority of Land Reform, Lower Austria, Landhausplatz 1, Haus 12/219, 3100 St. Pölten. Email: erwin.szlezak@noel.gv.at

3. **Anthony Mugeere,** PhD Lecturer/Coordinator, Graduate Programmes Department of Sociology and Anthropology Makerere University, Kampala (MUK) P.O. Box 7062, Kampala-Uganda. E-mail: amugeere@chuss.mak.ac.ug