Feasibility of Smallholder Conservation:

Agriculture for IPLCs within the Bugoma Landscape

Contents

Executive summary

The study on "the Feasibility of Smallholder Conservation Agriculture for IPLCs within the Bugoma Landscape" was conducted to address an information and knowledge gap that emerged from one of the core recommendations from the study on "Economies of scale – benefits versus losses to indigenous peoples and local communities (IPLCs) in the oil and gas and agro-commodities sectors with reference to the Bugoma landscape. It emerged from the economies of scale study that the proliferation of subsistence farming has led to wide scale ecosystem degradation in the Bugoma landscape although there is a wide food supply deficit for many major crops. Conservation agriculture was recommended as a means to achieve both increased farm productivity and ecosystem restoration.

The four research questions addressed by this paper where: (i) whether conservation agriculture is likely to espouse the willingness of smallholder farmers to participate; (ii) the potential of conservation agriculture to contribute to improved soil fertility and reduced land and soil degradation within the Bugoma Landscape; (iii) the potential of conservation agriculture to contribute to increased food production, food security, income security, and social inclusiveness within Bugoma; and the potential of conservation agriculture to contribute to the ecosystem restoration and management within the Albertine Graben. The study was conducted as a desk review with stakeholder engagement through the District Agricultural Production Officers, the District Natural Resources Officers, and the consultations conducted by the Ecotrends field office. Extensive literature review was conducted at the national statistical office (Uganda Bureau of Statistics), the National Environment Management Authority, the Environmental Conservation Trust (ECOTRUST).

The findings of the study show that conservation agriculture is moderately feasible for smallholder farmers who are willing to adopt agroforestry farming practices and where the crops grown are compatible with use of cover crops, retention of crop residues, and use of crop rotations. The wetter farming systems with perennial tree crops and other perennials such as bananas can maintain minimum tillage, crop cover and residues and moderate use of rotations. Where annual crops are grown considerable tillage is practiced therefore the three basic principles of zero or minimum tillage, crop harvest retention and crop rotation cannot be achieved.

The current practice of conservation agriculture for farmers supported by ECOTRUST is accompanied by incentives linked to carbon credit payments, which seem to be the primary reason for their participation. However, there is indication that evidence of economic benefits from conservation agriculture, integration into the extension service and training, as well as an institutional support system for capital investments to implement conservation agriculture are also likely to lead to strong feasibility of conservation agriculture. Despite all this information, conservation agriculture is only likely to be one of the options for ecosystem restoration in agroecosystem given the large scale of adoption required.

The recommendations proposed for enhancing prospects for conservation agriculture include research to provide more evidence on the economic benefits and the potential for incentive mechanisms to be created, scaling up the current interventions under the Trees for Global Benefits Program of ECOTRUST, ensure that conservation agriculture is integrated in the extension services provides to farmers and institutional arrangements in place to support the required capital investments, and prioritise farmers for whom farm plans show strong compatibility to implement the three basic principles of conservation agriculture.

Introduction

1.1 Background

Smallholder Conservation Agriculture emerged as an outcome of the study on the "Economies of scale – benefits versus losses to IPLCs in the oil and gas and agro-commodities sectors with reference to the Bugoma landscape." The economic trajectories study was one of the benchmarking studies conducted as part of the Green Livelihoods Alliance (GLA 2), 2021-2025 as implemented in the Bugoma Landscape of the Albertine Graben in Uganda. The Bugoma Landscape comprises Hoima, Kikuube, Masindi and Buliisa Districts. The overall goal of the GLA 2 in Uganda is "Uganda's Albertine Rift Landscapes are protected from oil and gas challenges and sustainably and inclusively governed". The livelihoods and local economy in the Albertine Graben are driven by agriculture, which is dominated by crops with livestock and fisheries coming in second and third.

Commercial forestry activities particularly for eucalyptus and pines are also an important land use activity with Hoima City serving as a key trading centre for timber from the trees grown within the landscape (Kiyingi, 2023). Smallholder subsistence agriculture is practiced by about 80% of the households in the Bugoma Landscape. Subsistence farms of maize and rice, while beans, groundnuts and peas are observed throughout the landscape. Commercial farms of sugarcane, maize, tea, tobacco, coffee, cocoa, and cotton are increasing (NEMA, 2021).

The Economies of scale study indicated a local food supply deficit for vegetables, fruits and milk based on the responses from main food markets in Hoima City and Masindi Municipality (PAU 2021 and Masiga 2023). The supply deficit is associated with low production among indigenous peoples and local communities (IPLCs), and increased demand from the growing population in the landscape. In contrast, the subsistence production within the Bugoma landscape has continued to decrease, largely due to loss of soil fertility (UBOS 2018; NEMA 2021).

Moreover, the natural ecosystems, forests, and wetlands, face the additional strain of commercial sugarcane and paddy rice production. Meanwhile IPLCs are also losing out as large tracts of land that remain unused because the owners who do not live in the landscape prevent others from accessing their land to prevent them from becoming squatters (Masiga, 2022).

Given the low and declining soil fertility, limited use of inorganic fertilisers particularly in food crop production, the low crop and livestock productivity, and the need to boost agricultural production, conservation agriculture was recommended for the smallholder farms. The premise behind recommendation of conservation agriculture is that it can be used to support subsistence farmers to boost their production without making capital-intensive investments in fertilisers, mechanization and other. Moreover, conservation agriculture would also ensure that the aggressive land conversion for agriculture can be mitigated.

1.2 Context: Conservation Agriculture.

Conservation Agriculture is a farming system that promotes minimum soil disturbance, maintenance of a permanent soil cover, and diversification of plant species. It enhances biodiversity and natural biological processes that contribute to increased water and nutrient use efficiency and to improved crop production (FAO, 2023). Conservation agriculture is based on three principles: (i) minimum soil disturbance (zero tillage is ideal or minimum tillage where no more than 20 to 25% of the soil surface is disturbed); (ii) retention of crop residues or other soil surface cover; and (iii) Use of crop rotations help reduce build-up of weeds, pests, and diseases. Where farmers do not have enough land to rotate crops, intercropping can be used. Legumes are recommended as rotational crops for their nitrogen-fixing functions (Kaweesi *et al.,* 2018).

The feasibility of conservation agriculture is generally based on demonstrating that three principles indicated can be achieved, and that when they are achieved, a set of economic (and socioeconomic), agronomic and environmental benefits can be demonstrated. In this study, the feasibility will be demonstrated through a descriptive analysis using both quantitative and qualitative analysis.

1.3 Problem statement

The Bugoma Landscape lies within the Bulindi Zonal Agricultural Research and Development Institute (zone). Whereas the whole area covers 1,757,900 ha, only 960,807 (54.7%) is farmed area and 828,427 ha (47.1%) is cropped (NEMA 2021). The rest of the land is under protected areas and other land uses, including the areas under settlements and development of oil and gas infrastructure among others. Like the rest of the country, the farmlands of the Bugoma Landscape are severely degraded. The topsoil in the landscape has been losing 70.69 kg of Nitrogen-related nutrients (N), 22.18 kg of Phosphorous related nutrients (P) and 61.20 kg of Potassium-related nutrients (K) per hectare per year since at least 2001 (NEMA 2021). Moreover, Uganda has a very low soil fertilizer usage at 1-1.15 kg/ha per year. It is, therefore, very unlikely for the soil productivity of the country to be enhanced without deliberate efforts to address the soil degradation in the landscape. Conservation agriculture (CA) is a low-input technology based 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 and 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 (FAO 2015). Conservation agriculture has many potential benefits for small-scale farmers; however, adoption remains low. Adoption of conservation agriculture could enable the IPLC smallholder farmers increase their participation in the local food value chains, while also strengthening their food security and their livelihoods, among others.

1.4 Study Objectives

(i) Explore the potential of implementing conservation agriculture in the Bugoma landscape based on community perception and willingness to participate in different techniques of conservation agriculture

(ii) Explore the potential of conservation agriculture contributing to improved soil fertility and reduced land and soil degradation within the Bugoma Landscape.

(iii) Evaluate the potential of conservation agriculture to contribute to increased food production, food security, income security, and social inclusiveness within Bugoma.

(iv) Explore the potential of conservation agriculture to contribute to the ecosystem restoration and management within the Albertine Graben.

Assessment Approach

2.1 Assessment design

The study was conceived as a desk review with limited field engagement with the production department in the four target districts of Buliisa, Hoima, Kikuube, and Masindi that make up the Bugoma landscape. The study is a descriptive evaluation that aims to generate physical information on the technical feasibility of conservation agriculture in the Bugoma landscape. As a desk study the study relies on extensive data on the farming system based on Uganda's Annual Agricultural Surveys (AAS) that collate data on the performance of farming systems by sub-region and/or Zonal Agricultural Research and Development Institute (ZARDI).

The Bugoma Landscape lies in the Bunyoro sub-region and the Bulindi ZARDI area of the country. The study also relies on the primary data collected as part of the "Economies of scale – benefits versus losses to IPLCs in the oil and gas and agro-commodities sectors with reference to the Bugoma landscape" study and the other studies in the series.

The other studies whose information was accessed include the Forest-Based Enterprises Study, and the Land Cover Assessment Report (Kiyingi, 2024 and Nangendo, 2024). The study also used secondary data and information from the Ecosystem Accounts for Land and Soil Improvement in Uganda (NEMA 2021) and the National Land Physical Accounts for Uganda (UBOS 2019), among others.

2.2 Data type and collection and analysis

The success of conservation agriculture is based on the availability of conditions for implementation of; (a) minimum or zero tillage in the farm system, (b) retention of crop residues or other soil surface cover as an important approach to support water retention, improve soil organic matter and fertility, and ensure minimum tillage, and (c) use of crop rotation within the farming system to support the soil nutrient cycle by rotating deep rooting and short rooting crops, and also improve on the biodiversity of the farm and crop diversity, among others.

The technical data was collated from the sources mentioned in sub-section 2.1; the annual agriculture surveys 2018, 2019 and 2020 (UBOS 2020; 2021; and 2022), the Land and Soil Improvement Ecosystem Accounts for Uganda (NEMA, 2021), the National Land Physical Accounts for Uganda (UBOS, 2019), the GLA 2 Series Reports on Economies of Scale, Forest-Based Enterprises and Land Cover Assessment.

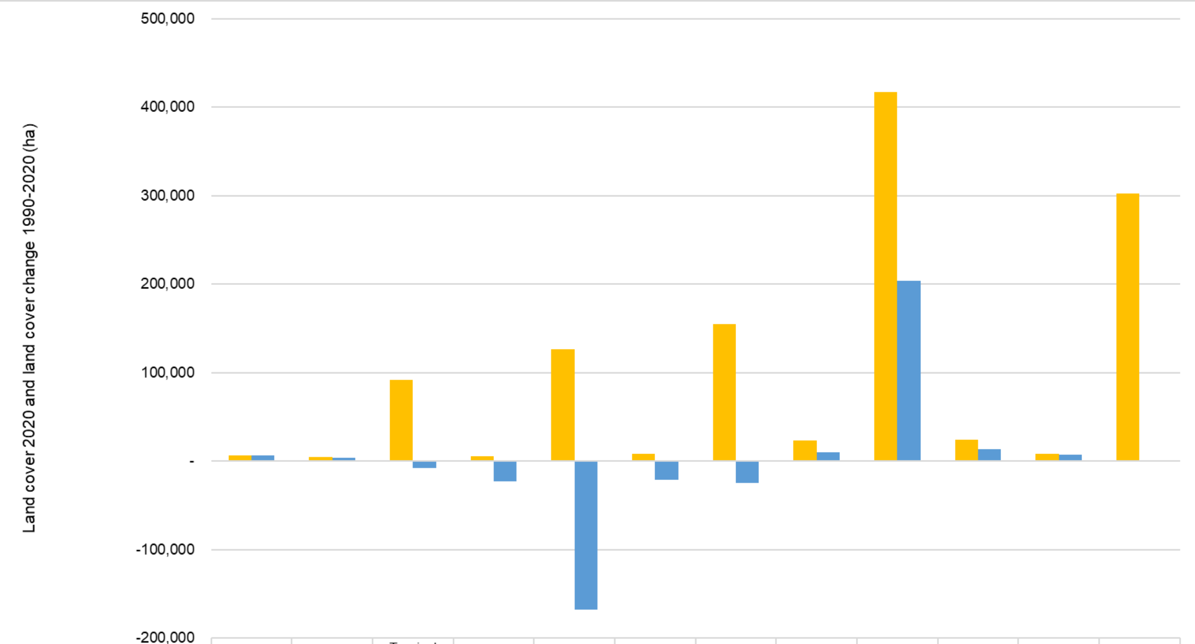
Stakeholder engagement through email exchange and phone conversations were held with the District Production Offices for Hoima, Kikuube, Buliisa and Masindo to collaborate some of the information used in this study. The Ecotrends Field Office made follow up field visits as requested to assess the condition of the subsistence and commercial farming systems in the four target districts with support of the District Production Offices.

Findings

3.1 Ecosystem type and change for the Bugoma Landscape

The four districts of the Bugoma Landscape cover an area of 1.17 million ha, which is 4.86% of the total land area of the country (24.16 million ha). Subsistence farmlands are the single largest land use (35.5%) while commercial farmlands (2.1%) are the other component of the farmland ecosystem. The subsistence farmlands doubled from 213,054 ha to 417,155 ha between 1990 and 2020. Forest ecosystems are composed of forest plantations, tropical high forests, and woodlands. Woodlands declined by 57% from 293,986 ha to 126,395 ha while the tropical high forest (THF) declined by 24% from 128,090 ha to 97,245 ha between 1990 and 2020. The open waters cover 25.8% of the landscape, including parts of Lake Albert. Forest plantations increased by 1,093% from 868 ha in 1990 to 11,226 ha in 2020 (Figure 1). The grasslands declined by 14%, built up areas increased six-fold while the commercial farmlands doubled. Meanwhile wetlands increased by 70% from 13,820 ha in 1990 to 23,506 ha in 2020.

Figure 1: Land cover 2020 and land use change 1990-2020 for the Bugoma Landscape

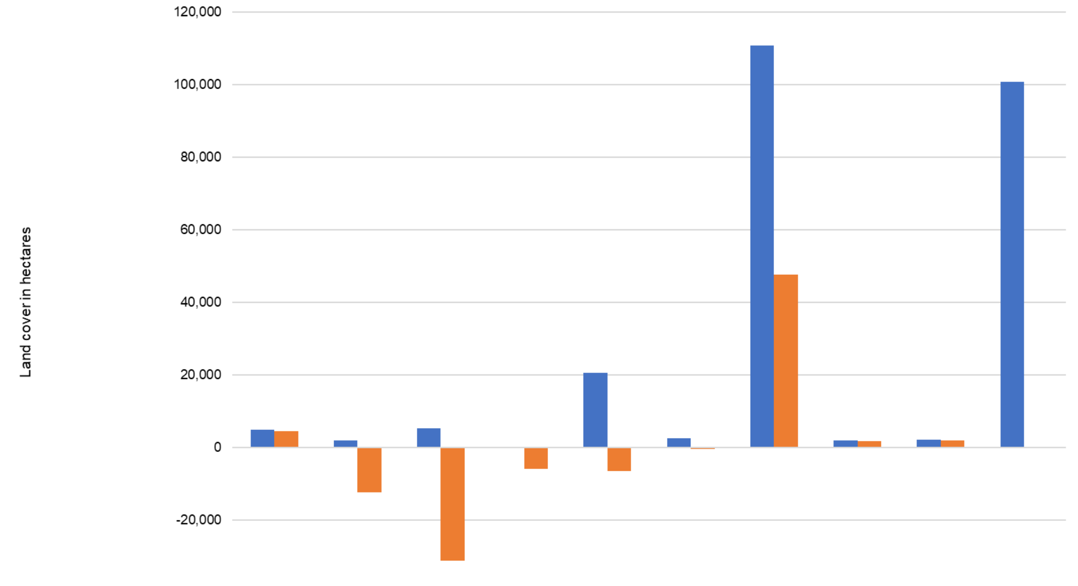


	Deciduous plantation or woodlot	Coniferous plantation or woodlot	Tropical High Forest, fully stocked	Tropical High Forest, depleted	Woodland	Bushland	Grassland	Wetland	Subsistence farmland	Uniform farmland	Urban or built-up area	Open water
Total 2020 (ha)	6,851	4,375	91,858	5,387	126,395	8,548	154,855	23,506	417,155	24,391	8,253	302,966
Net increase (ha) 1990-2020	6,527	3,831	-7,548	-23,297	-167,591	-21,165	-24,895	9,686	204,101	13,162	7,075	-128

Source: adapted from UBOS 2020 and Nangendo 2024

For Hoima district, the degradation of woodland and tropical high forests was clearly linked to expansion of small-scale farmlands (85%, 47,720 ha). The expansion of plantations commercial farmlands and built-up areas was 14% (8,110 ha) of the converted and degraded tropical high forest, woodlands, grasslands, wetlands, and bushlands (Figure 2).

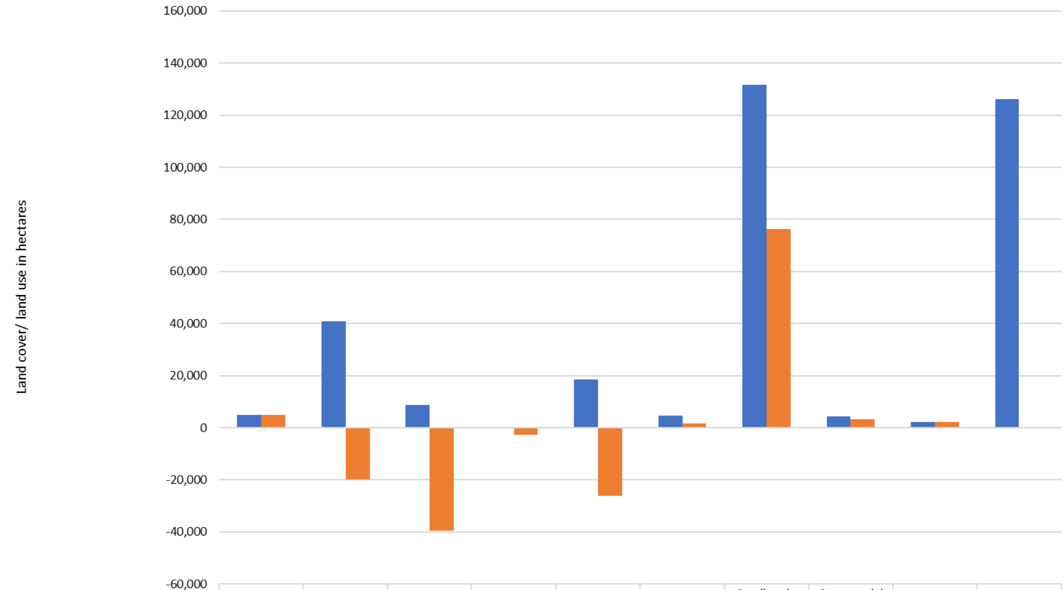
Figure 2: Hoima district land cover 2020 and land use change 1990-2020



	Plantations	THF	Woodland	Bushland	Grassland	Wetland	Small scale farmland	Commercial farmland	Built up area	Open water
Hoima Land cover (2020)	4,912	1,987	5,370	28	20,551	2,515	110,706	1,975	2,166	100,861
Hoima Net increase 1990 - 2020	4,471	-12,307	-31,138	-5,910	-6,377	-295	47,720	1,710	1,929	116

Just like Hoima district, in Kikuube district the pressure for land use change was largely on woodlands, grasslands and tropical high forests. The tropical high forests and woodlands are both natural forest cover, and grasslands too are natural ecosystems with very minimal external conversions (Figure 3). An even larger 76,245 ha was ceded to subsistence farmlands and 3,307 to commercial farmlands.

Figure 3: Kikuube district land cover 2020 and land use change 1990-2020

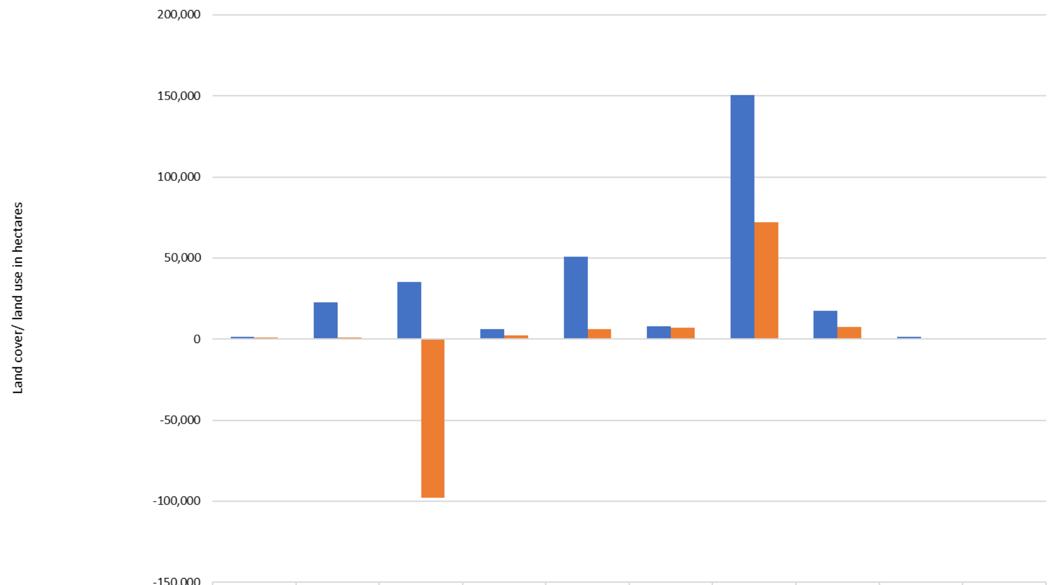


	Plantations	THF	Woodland	Bushland	Grassland	Wetland	Small scale farmland	Commercial farmland	Built up area	Open water
Kikuube Land cover (2020)	4,944	40,951	8,806	25	18,401	4,726	131,584	4,332	2190	126,108
Kikuube Net increase 1990 - 2020	4,906	-19,899	-39,576	-2,595	-26,236	1,718	76,245	3,307	2,082	-19

Land cover/ land use type

In Masindi district, unlike Kikuube and Hoima, all the forest degradation occurred in woodlands, while all other land cover types expanded including tropical high forests, wetlands, forest plantations. Like the other districts, subsistence farmlands expanded the most by 72,183 ha (Figure 4).

Figure 4: Masindi district land cover 2020 and land use change 1990-2020

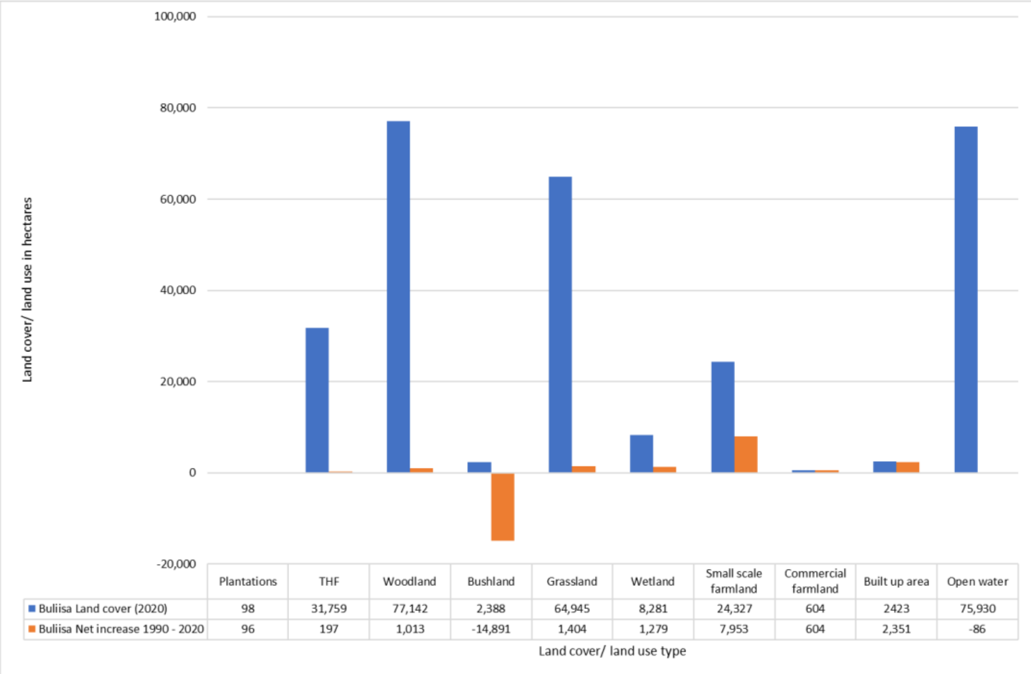


	Plantations	THF	Woodland	Bushland	Grassland	Wetland	Small scale farmland	Commercial farmland	Built up area	Open water
Masindi Land cover (2020)	1,272	22,548	35,077	6,107	50,958	7,984	150,538	17,480	1,474	67
Masindi Net increase 1990 - 2020	885	1,164	-97,890	2,231	6,314	6,984	72,183	7,541	713	-139

Land cover/ land use type

For Buliisa district, all the other land cover/ use types increased at the expense of bushlands. The small-scale farm land expansion was 53% of the loss of bushland area (Figure 5).

Figure 5: Buliisa district land cover 2020 and land use change 1990-2020



	Plantations	THF	Woodland	Bushland	Grassland	Wetland	Small scale farmland	Commercial farmland	Built up area	Open water
Buliisa Land cover (2020)	98	31,759	77,142	2,388	64,945	8,281	24,327	604	2423	75,930
Buliisa Net increase 1990 - 2020	96	197	1,013	-14,891	1,404	1,279	7,953	604	2,351	-86

Subsistence agriculture is the major primary driver for farmland conversion in the Bugoma Landscape (Nangendo, 2024). Forest plantations and commercial farmlands, while significant, did not emerge as a limiting primary factor. Instead, oil and gas infrastructure development, commercial farmlands, increased plantation forest, and increased refugee population seem to combine as secondary drivers leading to increased land conversion for subsistence farming. The secondary factors linked to subsistence farming as part of the farming system are explored further below.

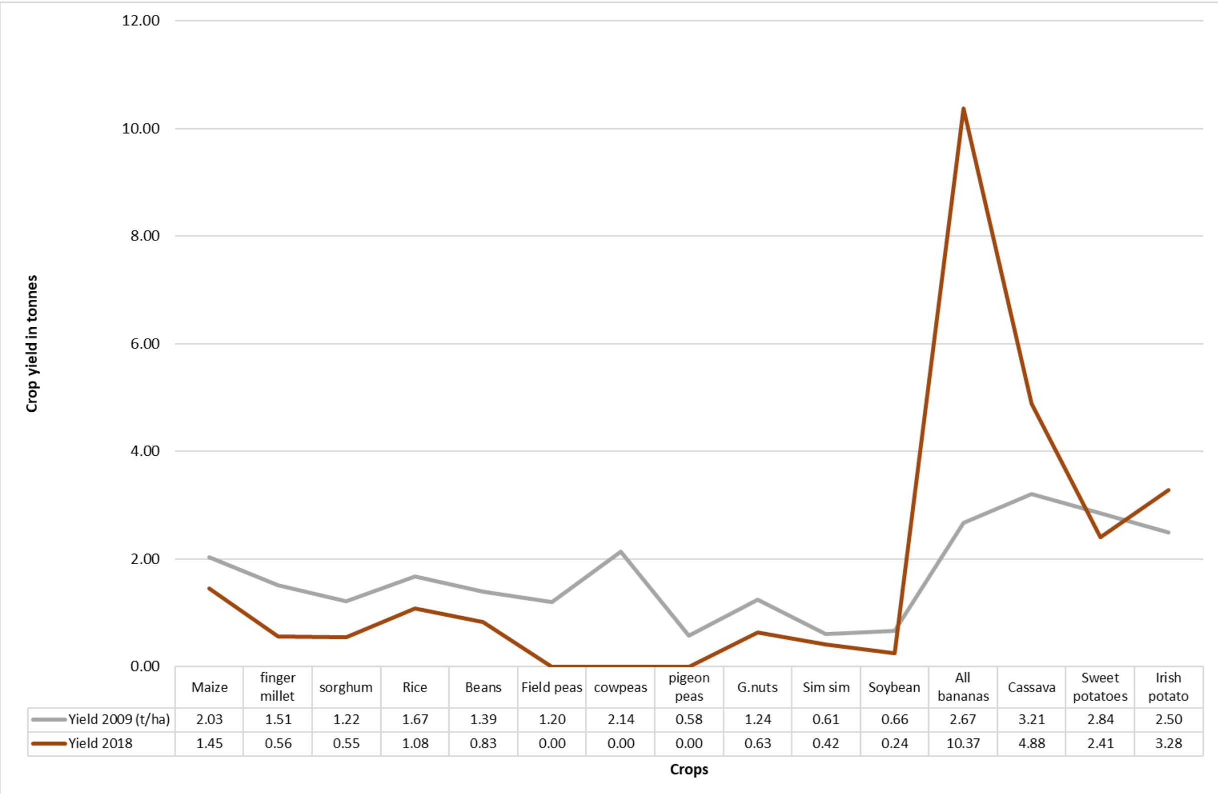
The secondary factors linked to subsistence farming as part of the farming system are explored further below.

3.1.1.2 The farming system of the Bugoma Landscape: agricultural productivity and soil fertility

Bugoma Landscape lies within a section of Uganda's agroecological system that is zoned under the Bulindi Zonal Agricultural Research and Development Institute (Bulindi ZARDI) (NARO 2023). The zone receives bimodal rainfall ranging from 800 – 1500 mm per annum. Temperatures are moderate ranging from 18 – 300 ^{0}C. The soils are ferralitic and generally acidic. The zone is rich in water resources and the main economic activities are linked to agriculture. They include crop farming, livestock, forestry, mining, and fisheries. The region also has tourism and oil and gas exploration.

Whereas the farmland has continued to increase crop yield has continued to decrease except for bananas and Irish potato. The latter two crops have benefited from considerable research and improved planting materials and seed (Figure 6). The over 95% reliance on local seed over improved seed for the other crops means that seed technology improvements need to be considered alongside any other interventions including conservation agriculture.

Figure 6: Comparison of crop yield from 2009 to 2018 for the Bugoma Landscape



	Maize	finger millet	sorghum	Rice	Beans	Field peas	cowpeas	pigeon peas	G.nuts	Sim sim	Soybean	All bananas	Cassava	Sweet potatoes	Irish potato
Yield 2009 (t/ha)	2.03	1.51	1.22	1.67	1.39	1.20	2.14	0.58	1.24	0.61	0.66	2.67	3.21	2.84	2.50
Yield 2018	1.45	0.56	0.55	1.08	0.83	0.00	0.00	0.00	0.63	0.42	0.24	10.37	4.88	2.41	3.28

Source: adapted from UBOS 2021; 2020; 2008

3.2 Community willingness to participate in conservation agriculture

There is no institutional arrangement for implementation of conservation agriculture in the Bugoma Landscape. The system of farming where conservation agriculture is implemented in the landscape is under the smallholder carbon projects, the Trees for Global Benefits (TGB) implemented by the Environmental Conservation Trust (ECOTRUST) under the Plan Vivo Standard. Smallholder farmers are encouraged to practice agroforestry dispersed in the farm or boundary planting, mixed crop and livestock farming, intercropping, minimum tillage and use of intercrops. The farmers earn an incentive from carbon sequestered in the agroforestry system, which accounts for both above ground and below ground carbon stored on the farms (ECOTRUST, 2022).

The ecosystem and ecosystem service benefits achieved are like those considered under conservation agriculture, increased organic matter, improved water infiltration and storage, increased biodiversity including soil microorganisms and improved soil fertility.

Under ECOTRUST, about 58 ha of land are under conservation agriculture in Kikuube and Hoima districts. The main incentive for the farmers is the payments from the carbon sequestered mostly from the biomass accumulated in the dispersed trees planted in the agroforestry system and the below ground carbon accumulated. Where farmers grow tree crops such as cocoa, coffee and fruit trees, the system works efficiently as the carbon is accumulated directly in the tree crops. In the predominant annual crop system, most of the carbon accumulation is in the planted tree species and not the crops.

Table 1: Farmers implementing Conservation Agriculture related farming system under the Trees for Global Benefits Scheme in Hoima and Kikuube districts

District	Sub-county	Number of farmers	Smallholder area under conservation agriculture	Total tons of carbon sequestered tCO2	Saleable sequestered tCO2
Hoima	Buseruka	4	4		
	Kabwoya	1	1		
	Kigorobya	23	25.2		
	Kitoba	8	7		
	Total	36	37.2	787.6	708.9
Kikuube	Bugambe	9	7.5		
	Kabwoya	2	1.5		
	Kiziranfumbi	1	1.0		
	Kyangwali	8	10.5		
	Total	20	20.5	4,036.7	3,633.0

Source: ECOTRUST 2022

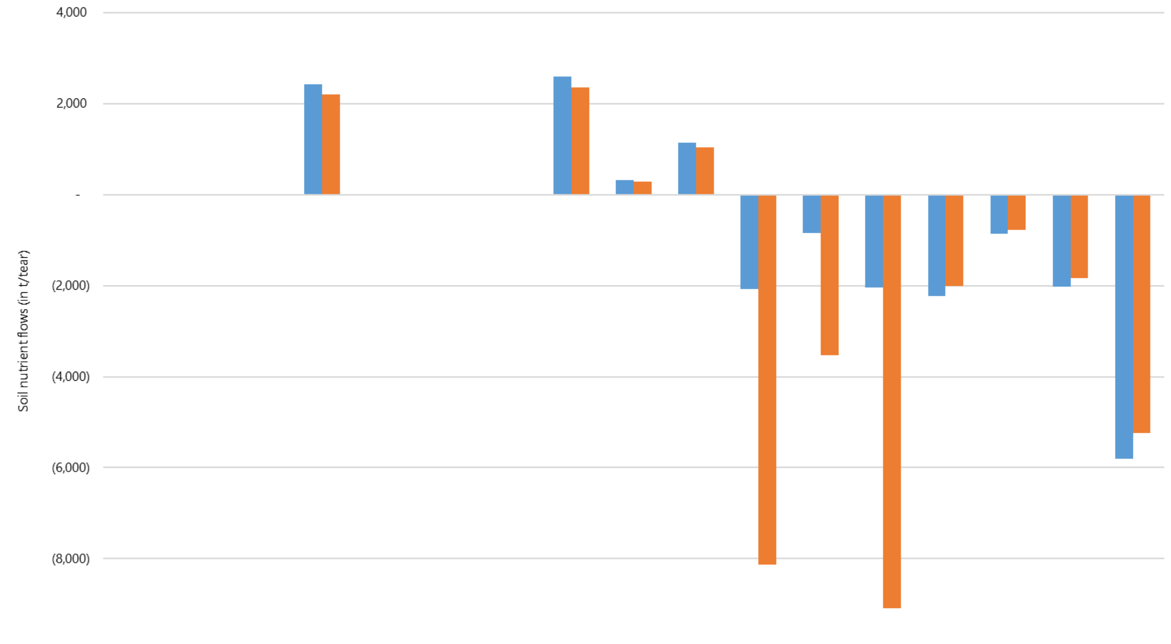
The annual reports from ECOTRUST indicated a willingness for farmers to participate in this type of farming because of the added incentive. However, few farmers are interested in the institutionalised conservation agriculture in the absence of such an incentive. Improvements in crop yields have been reported in several areas where similar farming systems have occurred in parts of the Mt. Elgon landscape, and the Abertine Rift in Uganda (Shames et al. 2013). However, no specific research on the yield improvements registered has been observed.

In Uganda studies on the willingness to adopt conservation agriculture have been conducted in the Lango sub-region of Northern Uganda. The farmers peg their willingness to adopt on the existence of training, extension services, availability of equipment and machinery; and institutional support provided through appropriate partnerships to enable the purchase of capital assets (Kaweesi et al., 2018). Other requisite factors for willingness to uptake conservation agriculture are evidence; (iv) through quantification of annual yield increases; (v) evidence of reduced input/labour costs; and (v) evidence of increased financial returns. The research also needs to consider socioeconomic factors such as social networks, gender issues, land issues, machinery-sharing options, and viable markets that could absorb CA produce (Kaweesi et al., 2018). As Lorenzetti and Fiorini (2022) observed despite its potential, the transition to conservation agriculture is not easy to implement. Paying a price for CO_2 sequestration would be a welcome buffer effect on the volatility of agricultural profit, concurrently addressing the high-risk aversion in farmers relative to the taking up of new production techniques.

3.3 Potential of conservation agriculture contributing to improved soil fertility and reduced land and soil degradation

The Bugoma Landscape lies in the Bunyoro sub-region and Bulindi ZARDI where the soil nutrient flows show a large deficit of soil nutrient inflows to outflows. The nutrient outflows are very high on atmospheric deposition, crop harvest and soil erosion and leaching (Figure 7). The inflows observed were from biological nitrogen fixation (BNF). The losses crop harvest, soil erosion, and leaching can be directly addressed through conservation agriculture.

Figure 7: Comparison of soil nutrient inflows and outflows 2009 to 2018 for Bugoma Landscape



	N (t)	P (t)	K (t)	N (t)	N (t)	P (t)	K (t)	N (t)	P (t)	K (t)	N (t)	P (t)	K (t)	N (t)	P (t)	K (t)	N (t)
	Inorganic / Organic Fertilisers			BNF	Crop residues			Atmospheric deposition			Crop harvest			Soil Erosion			Leaching
Nabuin 2009				2,426	-	-	-	2,599	314	1,143	(2,067)	(845)	(2,037)	(2,224)	(854)	(2,024)	(5,799)
Nabuin 2018				2,195	-	-	-	2,351	284	1,034	(8,125)	(3,520)	(9,090)	(2,011)	(772)	(1,831)	(5,246)

Categories of nutrients for 2009 and 2018

Source: adapted from NEMA 2021

Based on the review from the Trees for Global Benefits Project under ECOTRUST, there are indications to suggest that the soil carbon decline in the Bugoma Landscape can be reversed through the organic fertilisers, biological nitrogen fixation and crop residues associated with the agroforestry and conservation agriculture practices. Whereas specific research needs to be conducted on the actual nutrient contributions made from the conservation agriculture practices under the Trees for Global Benefits Project in Kikuube and Hoima districts, it would seem reasonable to suggest that additional nutrient inflows will be realised and there will be improvement in soil fertility. Conservation agriculture is likely to be successful in systems where cover cropping, crop residues and other organic (including manure) can be realised and crop rotations. In dry areas such as Buliisa district where cover cropping, and crop residues are more or less not available conservation agriculture may be less feasible (Guto et al., 2012; and Baudron *et al.,* 2012).

3.4 Increased food production, food security, income security, and social inclusiveness within Bugoma

There is little specific evidence on conservation agriculture and how it can contribute jointly to food production, food security, income security and social inclusiveness. As separate impacts, studies indicate that growing trees especially fruit trees, was associated with improvements in both total household consumption and nutritional outcomes (proxied by weight and wasting status of children younger than 5 years old) (Miller et al., 2020). The studies were based on agroforestry on farms where trees grown as fruit trees and tree crops can play in poverty reduction and sustainable development efforts. Annual reports (EOTRUST; 2022) and work by Shames et al. (2013, 2016) show strong social inclusiveness associated with conservation agriculture particularly in developing community capacity to share training, and extension services, to share equipment and planting materials (tree seedlings, wildlings, improved seed, and nurseries for seedlings), and establishment of savings and credit associations. The social inclusiveness extends to the capacity to share knowledge on health and education services through schools, among others.

3.5 Likelihood for conservation agriculture to contribute to ecosystem restoration and management within the Albertine Graben

Conservation agriculture tends to require availability of labour for the smallholder farmers, relatively strong land tenure systems, compatibility for the farming system i.e. ability to generate crop harvests, cover crops that can lead to minimum tillage, and feasibility of crop rotations. For the Bugoma landscape, if the appropriate farmers are identified and the willingness established there is strong indication that the conservation agriculture can contribute to restoration of the agroecosystems. Critically, it seems that conservation agriculture will likely be successful where farmers are able to tap into the incentives associated with carbon sequestration such as the Trees for Global Benefits Programme of ECOTRUST. Elsewhere, there is no evidence of an organised system for farmers to practice conservation agriculture within the landscape. Under ECOTRUST in Kikuube and Hoima districts, conservation agriculture is practiced only on 58 ha, which is 0.14% of the 417,550 ha of smallholder farmland in the landscape. There may be an opportunity to scale up the conservation agriculture since it seems to be successful for some farmers.

Conclusions

4.1 Main outcomes and key lessons

Conservation agriculture is feasible within the Bugoma landscape. The feasibility is based on the growing threat of conversion of other ecosystems into agricultural land particularly for smallholder farmlands. In addition, there are large deficits in net nutrient inflow with very limited use of inorganic or organic fertilisers, crop residues and limited biological nitrogen fixation. Through conservation agriculture the nutrient inflows can be increased, and the deficit reduced. There is some limited practice of conservation agriculture in the smallholder farm lands under the Trees for Global Benefits Program of ECOTRUST. Whereas the level of practice is limited to just 58 ha compared to 417,155 ha of farmland by 2020, the positive results associated with the conservation agriculture suggest a good opportunity for scaling it up beyond the current scale.

Despite the feasibility highlighted above, there is generally limited interest to practice conservation agriculture in the absence of incentives associated with carbon credit payments under ECOTRUST's plan vivo standard credits. There is disparate practice of the aspects of conservation agriculture for example tree cropping systems with intercropping and crop covers to support water retention and soil organic carbon/ manure accumulation for fertility purposes. This more widespread in coffee, cocoa, and banana farming systems. However, regular tillage still occurs, and crop rotations may not always be implemented. Conversely many smallholder farming systems practice crop rotations but these rotations are also associated with regular tillage to prepare the field for the second season crop rotation.

Outside of an incentive mechanism such as that associated with carbon payments, there is need to provide stronger evidence of the economic benefits from increased crop production, savings in labour costs, and food security, associated with conservation agriculture. As Kaweesi et al. (2018) noted, the success of conservation is also associated with training, extension services, and institutional support to ensure the require capital investments for conservation agriculture can be acquired and shared by farmers.

4.3 Way forward

1. There is need to conduct research to provide more evidence on the benefits associated with conservation agriculture. It may be prudent in the research to consider the potential for incentives or incentive payments linked to conservation agriculture that will play a role in enhance the willingness to participate.

2. There is an opportunity to scale up the current design of the conservation agriculture as implemented under the Trees for Global Benefits Program of ECOTRUST. The current set of farmers involved, and the neighbouring communities indicate a strong willingness, which is in part linked to the carbon payments incentives.

3. The implementation of conservation agriculture needs to be mainstreamed within the agriculture extension system, and trainings and institutional arrangements for capital investment need to be put in place.

4. Conservation agriculture is unlikely to be compatible for the whole Bugoma landscape. It will be feasible for smallholder farmers who can easily integrate agroforestry within their current farming systems. The farm plans developed will need to show that the farmers can grow cover crops, maintain crop residues on the farm, and crop rotations while still achieving food security, and viable farm income.

References

Baudron, F., Tottonell, P., Corbeels, M, Letourmy, P. and Giller, K.E. 2012 ***Comparative performance of conservation agriculture and current smallholder farming practices in semi-arid Zimbabwe***, Field Crops Research Journal, 132(2012): 117-128

Ecotrust (2013) Trees for Global Benefits (TGB) 2021 Plan Vivo Annual Report, ***The Environmental Conservation Trust of Uganda (ECOTRUST),*** Lubowa Housing Estate, Entebbe Road, Kampala

Guto, S.N., Pypers, P., Vanlauwe, B, de Ridder, N. and Giller, K.E. 20 ***Socio-Ecological Niches for Minimum Tillage and Crop-Residue Retention in Continuous Maize Cropping Systems in Smallholder Farms of Central Kenya***. Soil Tillage, Conservation & Management Journal, 104 (1): 188-198

Lorenzetti, L. A. and Fiorini, A. ***2022 Conservation Agriculture Impacts on Economic Profitability and Environmental Performance of Agroecosystems***. Environmental Management https://doi.org/10.1007/s00267-023-01874-1

Kaweesa, S.; Mkomwa, S.; Loiskandl, W. ***Adoption of Conservation Agriculture in Uganda***: A Case Study of the Lango Subregion. *Sustainability* 2018, *10*, 3375. https://doi.org/10.3390/su10103375

Shames, S., Q. Bernier, and M. Masiga. 2013. ***Development of a participatory action research approach for four agricultural carbon projects in east Africa***. CAPRi Working Paper No. 113. Washington, D.C.: ***International Food Policy Research Institute***. http://dx.doi.org/10.2499/CAPRiWP113 .

UBOS 2019 ***Uganda National Land Physical Accounts 2019***, Uganda Bureau of Statistics, Kampala. http://www.ubos.org

UBOS 2020 ***Uganda Annual Agriculture Survey 2018,*** Uganda Bureau of Statistics, Kampala. http://www.ubos.org

UBOS 2021 Uganda Annual Agriculture Survey 2019, Uganda Bureau of Statistics, Kampala. http://www.ubos.org

UBOS 2022 Uganda Annual Agriculture Survey 2020, Uganda Bureau of Statistics, Kampala. http://www.ubos.org

NEMA 2021 Uganda Land and Soil Improvement Ecosystem Accounts 2021, National Environment Management Authority, Kampala. http://www.nema.go.ug

Annexes

Annex 1: **Land cover 2015 for the districts in the Bugoma Landscape**

	Broad leaved plantation	Coniferous plantation	THF well stocked	THF low stocked	Wood-land	Bush-land	Grass-land	Wet-land	Small scale farmland	Commercial farmland	Built up area	Open water
Hoima												
Land cover (2020)	2,650	2,262	1,626	361	5,370	28	20,551	2,515	110,706	1,975	2,166	100,861
Net increase 1990 - 2020	2,633	1,838	-2,613	-9,694	-31,138	- 5,910	-6,377	-295	47,720	1,710	1,929	116
Kikuube												
Land cover (2020)	3,441	1,503	39,372	1,579	8,806	25	1,8401	4,726	131,584	4,332	2190	126,108
Net increase 1990 - 2020	3,411	1,495	-4,829	-15,070	-39,576	- 2,595	- 26,236	1,718	76,245	3,307	2,082	-19
Masindi												
Land cover (2020)	697	575	19,447	3,101	35,077	6,107	50,958	7,984	150,538	17,480	1,474	67
Net increase 1990 - 2020	422	463	-74	1,238	-97,890	2,231	6,314	6,984	72,183	7,541	713	-139
Buliisa												
Land cover (2020)	63	35	31,413	346	77,142	2,388	64,945	8,281	24,327	604	2423	75,930
Net increase 1990 - 2020	61	35	-32	229	1,013	- 14,891	1,404	1,279	7,953	604	2,351	-86

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