Incentive-Based Conservation for Sustainable Agriculture in Mkushi District, Zambia.

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ABSTRACT

The interlinked tensions between agricultural intensification, deforestation and rural livelihoods have emerged as a central challenge in many parts of sub-Saharan Africa. Our study examines the potential of incentive-based conservation as a strategy to address these interconnected challenges in Zambia's agro-industrial Mkushi district. Focusing on the North Swaka Trust (NST) as a case study, we use a quantitative approach based on household survey data (n = 294) to compare farming practices, land use patterns, and economic outcomes between NST members and non-participating farmers. The findings reveal that NST participation is attributed with significantly lower input costs, greater adoption of sustainable practices such as no-tillage and crop diversification, and higher net farm incomes. While NST members place less pressure on forest resources, particularly through less charcoal production, they also tend to expand their cultivated land more frequently. This indicates a trade-off between environmental conservation and agricultural growth. The study contributes to ongoing debates on sustainable agriculture in sub-Saharan Africa by demonstrating how market-driven, community-inclusive models can generate both environmental and economic benefits. At the same time, it highlights the need for policy frameworks that address land use dynamics and promote equitable participation.

Keywords: Forest conservation, agricultural intensification, deforestation, conservation farming, livelihoods.

1. INTRODUCTION

The interlinked tensions between agricultural intensification, deforestation and rural livelihoods have emerged as a central challenge in many parts of sub-Saharan Africa. In Zambia´s agro-industrial Mkushi cluster this tension is particularly present due to the additional competition of small and large-scale farmers competition over labour, resources and especially land. As both groups seek to expand agricultural production, agricultural intensification is seen as main driver of rapid deforestation in Mkushi. Deforestation is particularly rapid in the region's most critical water catchment areas, where farmers continue to expand into protected forests despite their formal conservation status (Ritchie, 2021). Unsustainable agricultural practices, including charcoal production, further exacerbate encroachment into forest ecosystems (Richardson et al., 2021). Deforestation in Zambia is occurring at an estimated annual rate of between 250,000 and 300,000 hectares (Ngoma et al., 2021), leading to landscape degradation and threatening ecosystem services, which in turn jeopardize the livelihoods of local communities not only in Mkushi. While several interventions have been proposed to combat deforestation (Richardson et al., 2021), many fail to address the underlying concerns of rural livelihoods, which are essential for the well-being of communities in sub-Saharan Africa.

One approach incorporating both ecological and social aspects of this conflict is conservation agriculture. Conservation agriculture has gained significant attention in Zambia, with various stakeholders considering it as a potential solution for achieving both sustainable livelihoods and ecological goals. Private sector-driven, incentive-based conservation initiatives, such as the Community Markets for Conservation (COMACO) and the North Swaka Trust (NST), aim to boost on-farm productivity while curbing cropland expansion into forested areas by small-scale farmers. This study focused on the North Swaka Trust (NST) as a key case study for understanding the potential of such initiatives. Unlike exclusionary conservation models, NST diverges in its conservation objectives, stakeholder engagement, and funding mechanisms. The core aim of the NST is to protect forests that serve as an important water source, while actively involving local communities and local practices in forest and land conservation efforts, recognizing their integral role in ecosystem-dependent livelihoods. Yet, despite the growing interest in such models, there is limited empirical evidence on their effects and scalability?

This study addresses this gap by examining the impact of an incentive-based conservation programme (NST) on farming systems, land use effects (especially deforestation dynamics), and economic livelihood effects in Mkushi. Using quantitative household-level data (n = 294) from both conservation agriculture members (149) and conventional non-member farmers, we explore whether such initiatives can offer a viable pathway towards a more sustainable and inclusive agricultural future. The central research question in this study therefore is how the participation in the incentive-based conservation programme NST affect farming practices, land use and economic livelihoods compared to conventional farming. To answer these questions, we compare the two groups in terms of their farming systems, land use and economic livelihoods. In doing so, the study contributes to ongoing debates on integrated sustainability strategies in African agriculture by examining how locally adapted, incentive-based conservation practices may simultaneously address environmental, economic, and social development goals. Insights from this case may offer valuable considerations for future policy and practice at the intersection of agricultural transformation, natural resource governance, and rural livelihoods particularly with regard to their potential for broader adaptation across comparable rural settings.

2. LITERATURE REVIEW

2.1 Deforestation and Agricultural Expansion in the Global South, in Zambia and Mkushi

District

Deforestation is a pressing environmental issue in rural Africa, with significant implications for both local livelihoods and global ecological systems (Doggart, 2020). Globally, nearly all deforestation occurs in tropical and subtropical regions, with agriculture responsible for approximately 75% of forest loss (FAO, 2020; Curtis et al., 2018). Annually, about 5 million hectares of forest are lost, driven primarily by expansion of agricultural land, logging, infrastructure development, and fuelwood extraction (FAO, 2020; Global Forest Watch, 2023).

Comparable studies from Africa—particularly in Tanzania—show that crop cultivation alone contributed to 89% of deforested land between 2010 and 2017, highlighting the dominant role of subsistence and commercial agriculture in forest degradation (Lyimo et al., 2020). This underscores the urgent need for cross-sectoral coordination among the agriculture, forestry, land, and energy sectors to develop sustainable land-use strategies and mitigate deforestation.

In Zambia, similar dynamics are observed, particularly in Mkushi district, where rapid deforestation can be observed primarily caused by agricultural expansion and intensification. Additionally, to deforestation, Zambia faces numerous agricultural challenges, including soil degradation, water scarcity, and biodiversity loss. These issues are largely attributed to unsustainable farming practices such as excessive tillage and the use of chemical inputs (Chirwa et al., 2019). These ecological, social and agricultural stressors form a broader systemic issue that can not only be observed in Mkushi but also in other sub-Saharan contexts and beyond, that incentive-based conservation strategies try to address. However, regarding the case of Mkushi these dynamics will be explained in more detail in the description of the case study (see below, chapter 3).

2.2 Review on incentive-based Conservation and Sustainable Agriculture

Conservation agriculture is a farming method that focuses on preserving and enhancing environmental resources like soil fertility and water quality, while ensuring that agricultural productivity remains stable or improves (Williams & Martin 2024). This conservation agriculture can be promoted through different structures, like for example through incentives. Incentive-based conservation has become a key policy tool to align environmental objectives and socioeconomic benefits for rural communities while promoting sustainable agriculture while at the same time reducing environmental pressures like deforestation. In their recent systematic review El Bakali et al. (2023) identified four main types of incentives. These main types (see also Targetti et al. 2021; Khonje et al. 2022; Zhu and Chen 2022) are:

- Agri-Environment Schemes (AES) / Payment for Ecosystem Services (PES) programmes (like conventional vouchers and agglomeration payments (for cooperative actions),

- input incentives (e.g. subsidies for improved seeds, fertilizers or input transport subsidies)

- market-based incentives (e.g. sale guarantees, or price premium)

- direct subsidies (direct payment).

Empirical case studies have illustrated the impact of conservation incentives on rural livelihoods, for instance, a study in Malawi found that incentive-driven conservation agriculture led to improved soil fertility and increased household incomes through sustainable farming techniques (Kassie et al., 2015). Similarly, in Brazil's Amazon region, PES programs successfully reduced deforestation while enhancing farmers' economic resilience (Alix-Garcia et al., 2019). However, gaps remain in the literature, particularly regarding the long-term sustainability of incentive-

based approaches and their scalability in low-income settings. Additionally, research on the intersection between conservation agriculture and indigenous land tenure systems is limited, necessitating further exploration into how localized policies can enhance conservation outcomes (Jayachandran et al., 2017). Addressing these gaps is critical in designing more effective, equity-driven conservation incentives.

Also in Zambia incentive-based conservation strategies, including payments for ecosystem services (PES) and agri-environmental subsidies, have been introduced to promote sustainable agriculture while addressing environmental concerns (Ng'ong'ola-Manani & Prokopy, 2020). In the Zambian case first studies have demonstrated positive impacts of incentive-based conservation. Mumbi et al. (2018) found that financial incentives for conservation agriculture improved soil fertility and crop yields in Eastern Province.

Stakeholder engagement is also seen as a critical factor for the success of conservation initiatives, as farmers' perceptions, knowledge, and socio-economic conditions significantly influence their participation (Muleya et al., 2021). A 2019 collaborative study by the University of Bonn, University of Cologne, and the University of Zambia explored the complexities of rural development, emphasizing the importance of historical and current land use trends in shaping conservation strategies (Kolem et al., 2022).

Despite the potential of incentive-based conservation, challenges persist, including financial constraints, inadequate extension services, and limited capacity building for farmers and policymakers (Dossou-Yovo et al., 2022; Tufa et al., 2023). Addressing these barriers requires enhanced institutional support, improved financial access, and multi-stakeholder partnerships.

Theoretical frameworks on incentive-based conservation agriculture largely stem from environmental economics and sustainable development theories. The Payments for Ecosystem Services (PES) framework frames that financial incentives can encourage farmers to adopt conservation practices by compensating them for ecosystem services such as carbon sequestration and soil preservation. The Sustainable Livelihoods Framework (Scoones, **2015)** further explains how conservation incentives contribute to asset accumulation and economic stability in rural households. These frameworks collectively highlight the role of external motivation in promoting sustainable land use and mitigating deforestation.

While many studies focus separately on conservation or agricultural productivity, few examine how incentives balance both. To close this gap based on this literature review we decide to empirically analyse the impact of an incentive-based conservation programme (NST) on farming systems, land use effects (deforestation dynamics), and economic livelihood effects in Mkushi. This research approach provides actionable insights for policymakers on designing effective incentive structures that promote conservation without undermining rural livelihoods. By assessing the long-term sustainability and scalability of these approaches, it offers a roadmap for similar models in regions facing deforestation and land degradation challenges. While existing literature attributes deforestation to agricultural expansion, this study extends the discourse by analyzing how conservation incentives influence farmer behaviour. It critiques the lack of clear implementation strategies and advocates for localized, market-driven conservation models like NST to reduce donor dependency and promote sustainable agriculture.

3. THE CASE OF MKUSHI AND THE NORTH SWAKA TRUST

This study was conducted in Mkushi District, located Zambia´s Central Province, focusing on villages surrounding the North Swaka and Mkushi headwater forests. In these areas the North Swaka Trust (NST) is actively engaged (Figure 1). Covering an area of approximately 17,726 km² (6,844 sq. miles), Mkushi District is home to a population of 208,635 people (Ministry of Local Government, 2022). Mkushi is strategically positioned along the Great North Road and the Tazara railway line, linking it to the neighbouring districts of Kapiri Mposhi and Serenje. The district is known for its natural attractions, such as Changwena Falls, Lunsemfwa Wonder Gorge, and the historic Fort Elwes, situated within the North Swaka Protected Forest Area. The district

supports numerous commercial agricultural operations, with a notable presence of expatriate white farmers (Ministry of Local Government, 2022).
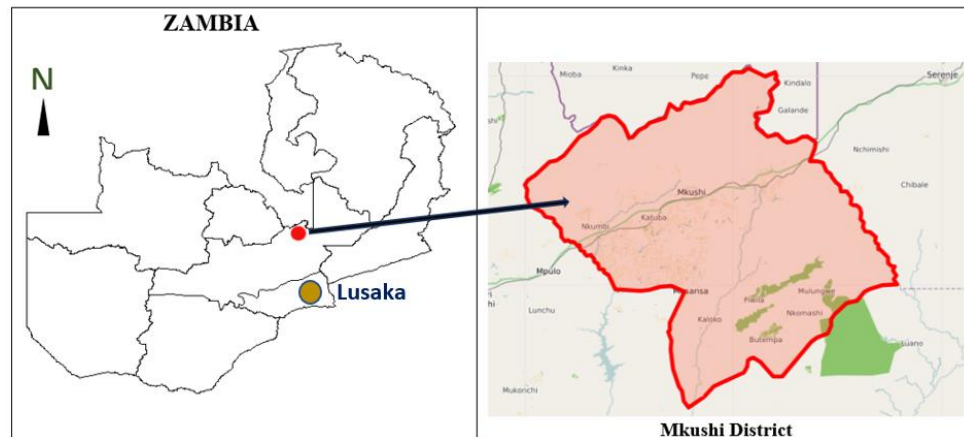

Figure 1: Location of Mkushi District

In recent years, agricultural intensification, defined as the increased input of labour or capital to boost output per hectare (van Lauwe & Dobermann, 2020), has been identified as a key driver of land-use change in the region. As smallholder and commercial large-scale farmers compete for land, labour and natural resources the pressure on the protected forest has intensified. Despite their conservation status, these forests are increasingly encroached upon, exacerbated by unsustainable practices such as charcoal production (Richardson et al., 2021).

These developments reflect broader dynamics in Zambia's agro-industrial sector, where the interplay between agricultural intensification, deforestation, and rural livelihoods has become particularly pronounced. Across rural Africa, the livelihoods of millions of people are heavily dependent on forest resources. Zambia, like many sub-Saharan African countries, faces alarming rates of deforestation and other forms of land degradation. Numerous studies have identified the drivers of deforestation and its detrimental impacts on ecosystems (Ikeafor, 2023; Shapiro, et al., 2023). The escalation of land degradation is primarily attributed to population growth and the increasing demand for food and biomass energy in rapidly urbanizing regions. These challenges underscore the potential role of incentive-based conservation strategies in promoting a sustainable agricultural future.
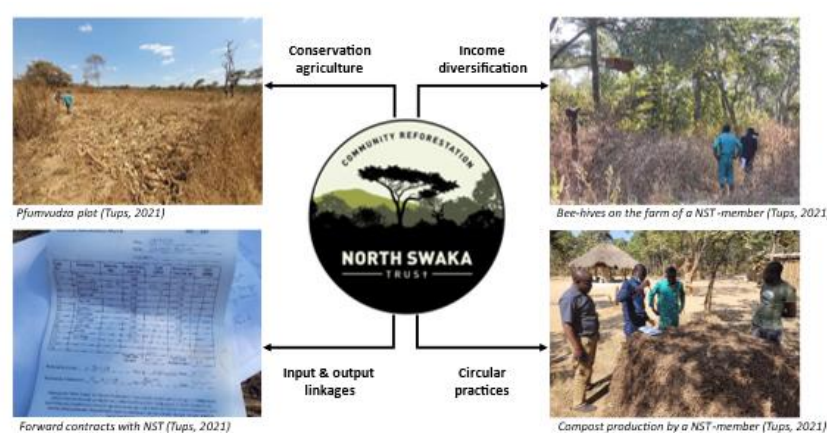

Figure 2: Incentive-based Conservation

This study explores such an incentive-based conservation strategy (see figure 2) by examining the case of the North Swaka Trust (NST) as a key case study for understanding the potential of such initiatives. The NST represents an innovative model that diverges in its conservation objectives, stakeholder engagement, and funding mechanisms. It operates as a river catchment-based initiative, engaging both small-scale farmers upstream and large-scale farmers to address

livelihood challenges and facilitate ecosystem restoration. The core aim of the NST is to protect forests that serve as the source of the Lunsemfwa and Mkushi Rivers, which are critical for the sustainability of the Mkushi farming block. Leveraging Zambia's new Forest Policy, which allows private sector involvement in managing local forest reserves, the NST, supported by commercial farmers, oversees the management of the North Swaka Forest and Mkushi headwaters.

Unlike exclusionary conservation models, the NST actively involves local communities in forest and land conservation efforts, recognizing their integral role in ecosystem-dependent livelihoods. Financial support for the NST comes from philanthropic sources and the commercial farmers, who indirectly benefit from the improved ecosystem services resulting from sustainable activities. A distinctive feature of the NST's approach is the promotion of locally adaptable conservation farming practices, which aim to improve both livelihood outcomes and ecosystem restoration. This study evaluated the sustainability of these practices, exploring their potential for scaling up across rural Africa. Specific objectives of the study include assessing the livelihood outcomes of the NST conservation farming model, evaluating the impact of conservation farming on local livelihoods, and analysing the effect of these interventions on deforestation.

To improve crop productivity within limited cultivated areas, the NST has adopted the [1]Pfumvudza model originating from Zimbabwe (Foundations Zambia, 2022). Research has shown that a Pfumvudza plot can produce substantial quantities of staple crops, such as maize, sufficient to sustain an average household of six people throughout the year. Central to this model is the use of cover crops, which are also favoured by commercial farmers practicing regenerative agriculture in the region. These cover crops enhance soil fertility and can be harvested for seeds, which are sold to commercial farmers through the NST.

Key cover crops integrated into the model include red and black Sun hemp (Crotalaria juncea L.), cowpea (Vigna unguiculata), and pigeon pea (Cajanus cajan). Additionally, the conservation farming model emphasizes the use of organic fertilizers, training farmers in compost production. Proficiency in compost-making is a prerequisite for NST membership, with the organization providing practical training on establishing conservation farming plots using the Pfumvudza model. The NST also supports crop rotation and teaches composting techniques, while supplying small-scale farmers with cover crop seeds and ensuring a market for the seeds they produce. This study explored community perceptions of these incentive-driven conservation measures and evaluated their effectiveness in promoting sustainable agricultural practices. A key strength of the NST model is its market-driven approach, creating a financial incentive structure that reduces reliance on donor funding by ensuring a market for cover crop seeds produced by smallholder farmers.

The North Swaka Trust was selected as a case study because it offers a particularly relevant setting shaped by emerging land-use conflicts between smallholders and commercial large-scale farmers in ecologically sensitive catchment areas. The NSTs model stands out for its governance structure, the combination of conservation agriculture with market access and the focus on both upstream and downstream stakeholders. Moreover, the strategy is embedded in Zambia's evolving forest policy landscape, making an informative example for the potentials and limitations of incentive-based conservation strategies.

4. METHODOLOGY

To address the research question on how far incentive-based conservation can promote a sustainable agricultural future, this study employed a quantitative approach informed by an in-depth literature review.

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[1] A Pfumvudza plot consists of a small crop field with a specific arrangement of 52 lines and 28 planting stations per line.

4.1 Secondary data

An extensive literature review was conducted prior to assess existing research and case studies surrounding incentive-based conservation agriculture. The review focused on case studies by Muleya et al. (2018), Mumbi et al. (2018), Ng'ong'ola-Manani & Prokopy (2020), and Richardson (2021), providing a qualitative analysis of key findings. This approach enabled the identification of recurring patterns, success factors, challenges, and lessons learned across diverse contexts. By comparing these case studies, we evaluated the effectiveness of different incentive mechanisms in promoting sustainable agricultural practices.
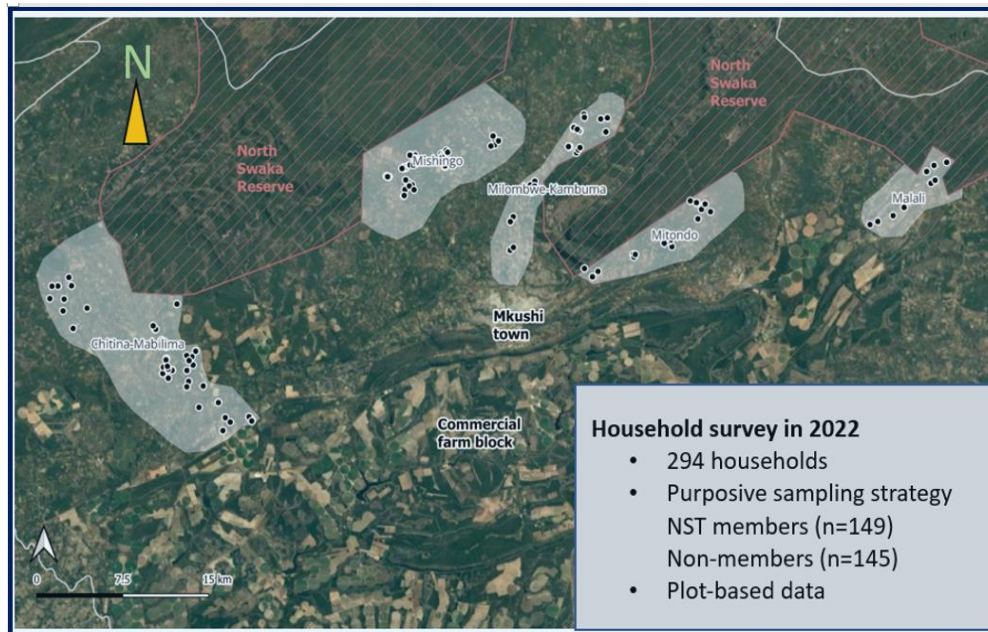
4.2 Primary data

Figure 3: Sample Sites of 2022 Household Surveys

To evaluate the effects of NTS´s we conducted quantitative data from both NTS members and non-members (conventional farmers) to compare them. Household survey data were collected from five sites located between the North Swaka Forest and the surrounding commercial farm block (see figure 3). A purposive sampling approach was employed, with local extension staff facilitating the process to ensure a representative sample of both conservation farming practitioners and conventional farmers. The survey targeted 294 households, comprising 149 NST members and 145 non-members, during the 2020/2021 agricultural season. Structured interviews were conducted using the KoBo Toolbox as the primary data collection tool. To ensure a robust comparison, interviews were conducted with both NST members and neighboring non-participating households. Research assistants were trained in effective interview techniques to ensure high data quality and integrity.

The data were analysed using a combination of descriptive statistics, Pearson's chi-square test, and paired t-tests. Descriptive statistics were used to summarize demographic data, while the chi-square test examined the relationship between NST membership and the adoption of conservation tillage practices. The paired t-test was applied to assess differences in agricultural income, crop yields, and land use, comparing conventional and conservation tillage methods between farmer participating and not participating in NST programmes.

5. EMPIRICAL RESULTS AND DISCUSSION

5.1 Farming Systems effects

The study reveals that incentive-based conservation farming through the North Swaka Trust has positive effects on the farming systems in Mkushi district.

A key benefit is the significant lower input costs, particularly for fertilizers, making agriculture more cost-effective. Fertilizer costs per hectare are on average significantly cheaper among NST members than non-members. For maize production NST members spend on average USD 463 for fertilizer per hectare when NST members only spend USD 232 (see figure 5). For soya beans, commercial farmers pay USD 1,078 for input where farmers in conservation agriculture pay USD 138 (see figure 5).

Despite this significantly lower input costs, yield stability has been maintained, with no significant differences observed between conventional and conservation farming for maize and soya beans (see figure 6).

Our results show, that NST members use more sustainable practices (no-tillage) for common crops, which are maize and soybeans compared to the non-members conventional farmers. Additionally, conservation farming promotes plot diversification, allowing farmers to cultivate a variety of crops, reducing reliance on a single crop, and improving financial stability. This diversification is seen with non-members only cultivating maize (70% of total cultivation) and soybeans (30%), while among NST members cultivating the same share of soybeans but less maize (61%) (Figure 4). The remaining 9% are diversified including more high-value crops like hemp seed, peas and sunflower (Figure 4).

These results suggests that conservation farming supports economic and environmental sustainability within farming systems without reducing productivity. Furthermore, farmers practicing conservation techniques have adopted sustainable methods such as reduced tillage, cover cropping, and crop rotation, which enhance soil health, improve biodiversity, and promote long-term land productivity. These practices also contribute to better water retention and reduced soil erosion. The study found that farmers who adopted conservation farming practices were more likely to diversify into high-value crops such as hemp, cowpeas, and sunflower, which can provide higher profits and improved livelihoods due to market interest for these crops (Figure 4,5 & 6).
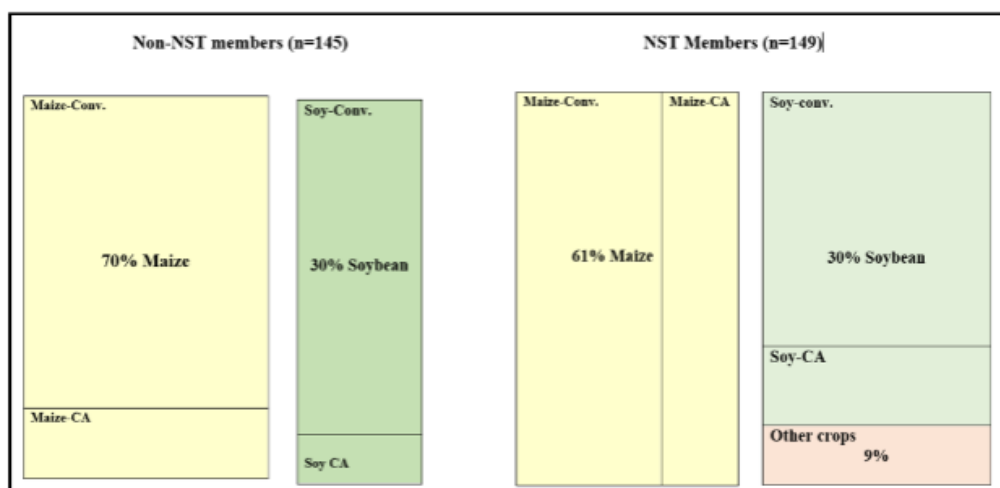

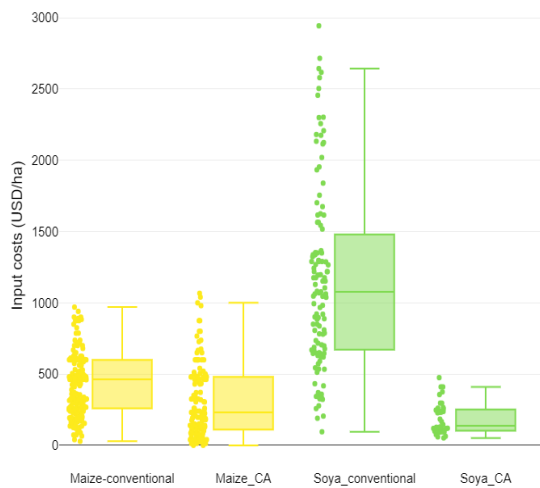**Figure 4:** Conventional and Conservational Farming Practices

Figure 5: Input Costs for Maize and Soya beans under Conventional & Conservation Agriculture
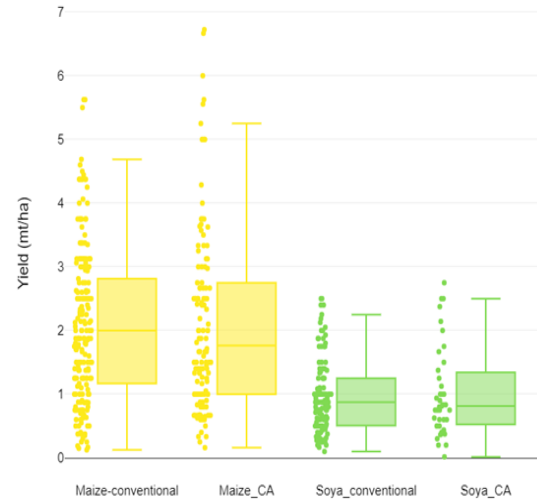
Figure 6: Yields for Maize and Soya beans under & Conventional Conservation Agriculture

5.2 Land Use Effects

Our results show that NST members cultivate significantly more land than non-members. On average, non NST members cultivate 1.49 hectares, whereas NST-members cultivate a larger area of 1.74 hectares (see figure 7). In addition, over the last 3 years (before the survey) 72.2% of the NST members expanded their land in use, compared to only 60.6% among the non NST members. Land use expansion for agricultural purposes has been identified in the literature as one of the main drivers of deforestation. In light of this, the land use effects of NST-members should be critically examined. Our findings suggest that NST members cultivate more land and also tend to expand their agriculturally used area to a greater extent than non-members.

Table1: Land use comparison

Indicator	Non-NST-Members	NST-Members	p-Value
Sample size (n)	145	149	
Agricultural land use			
Land cultivated (ha., mean)	1.49	1.74	*
Land use expansion (3-years %)	60.6%	72.2%	**
Forest resources used			
Charcoal	33.7%	18.9%	***
Firewood	31.2%	28.4%	
Other (honey, fruits mushrooms and caterpillars)	44.4%	43.7%	

p-Values * =0.1 ** =0.05 *** = 0.01

However, future research could explore the underlying causes of these trends. As discussed in the section on farming system effects, NST members have diversified more in their crop choice. It would be valuable to investigate whether this diversification contributed to land expansion, or whether this expansion was enabled by the observed reduction in input cost compared to non-members.

Despite these negative effects of Conservation Agriculture on agricultural land use, we can see positive effects of NST membership in a lower illicit use of forest resources. This is particularly significant for charcoal burning, where we can see that among the NST member only 18.9% are burning charcoal compared to non-members with 33.7% (Table 1).

It would also be interesting for further research to examine how the positive farming effects might lead to people in Conservation Agriculture not being forced to burn charcoal anymore as an income-generating activity.

5.3 Economic Effects

Economic effects were analysed in terms of net farm income and income from forests (Figure 7 & 8). The agricultural income differs between NST non-members who have a negative income of -157 USD/ha and NST members with a lower negative of -58 USD/ha (figure 8). Conservation agriculture plots generate a positive income of 192 USD/ha which is significantly higher than the loss or negative income among conventional plots with -222 USD/ha (figure 8). There is a difference in forest incomes between members and non-members, which is however not significant (Figure 8).

In reference to economic livelihood, it is noted that NST members have a significant higher income household income when farm and forest income are combined (225 USD/hh) than non-members (45 UDS/hh) (figure 9). There is strong evidence suggesting reduced input costs for Conservation agriculture and beekeeping can overcompensate the income losses when charcoal burning is abandoned. However, it must also be considered, that this could be an income effect of NST farmers farming on more land (1.73 ha vs. 1.50 ha).
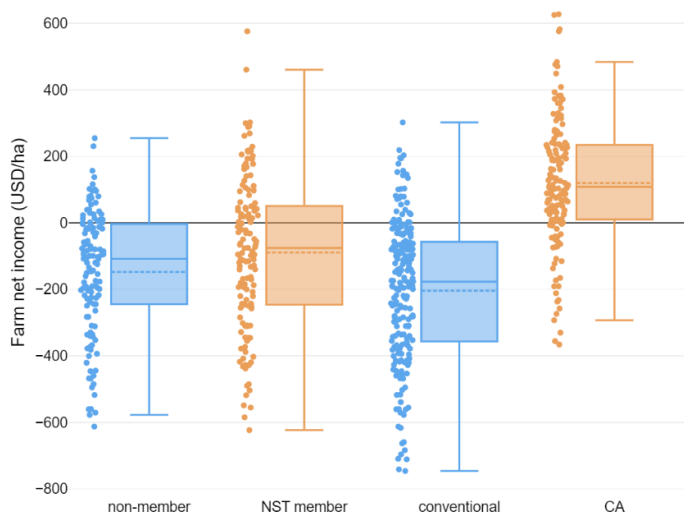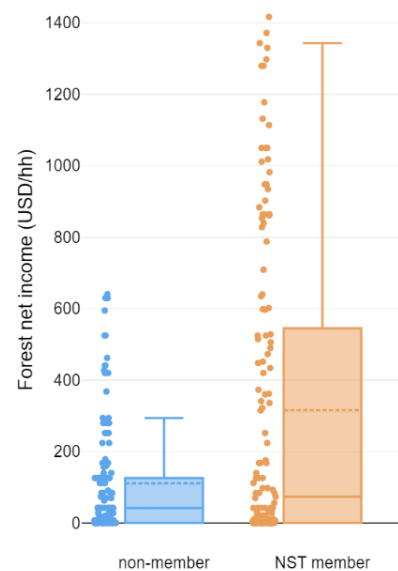

Figure 7: Farm Net Income

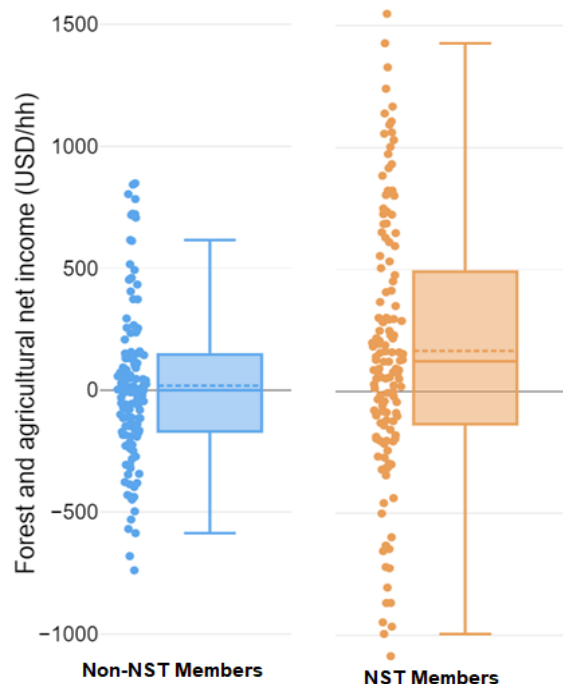**Figure 8:** Forest Income

Figure 9: Forest and Agriculture Net Incomes

5.4 Discussion and Policy Implications

Zambia is largely an agrarian economy, with agriculture contributing significantly to its GDP and employment. The agro-industrial zone of Mkushi, located in the central region of Zambia, is one of the country's key agricultural areas. It has attracted substantial investment in farming, particularly in maize, soybeans, and tobacco production. However, this agro-industrial activity has brought about considerable environmental and socio-economic challenges, notably deforestation, degradation of natural resources, and shifting rural livelihoods. However, rural communities in Mkushi, especially smallholder farmers, depend heavily on agriculture for their livelihoods. While the rise of agro-industrial farming has created new opportunities, it has also posed challenges for traditional farming systems.

Incentive-based conservation has gained increasing attention as a potential solution to the trade-offs between agricultural intensification, environmental degradation, and rural development. This study provides empirical evidence that financial and technical incentives can promote sustainable farming without compromising livelihoods through the case of NST. Unlike exclusio-nary conservation models, Zambia's North Swaka Trust (NST) approach actively involves local communities in land and forest management, ensuring broader participation and shared responsibility (Ng'ong'ola-Manani & Prokopy, 2020). Our results indicate NST members farm more sustainably and cost-effectively by reducing input costs while maintaining similar yields, and they adopt more sustainable practices like no-tillage and crop diversification. Although they engage less in illegal forest use, they tend to expand their agricultural land more, indicating a potential trade-off between environmental conservation and agricultural growth. Overall, NST participation leads to higher incomes and more sustainable agricultural practices, but the impacts on land use require critical review and further research.

The example of Mkushi indicate, that policies integrating agricultural development and conservation goals by creating regulations that balance land-use rights with environmental preservation can be able to address many pressing challenges in Zambia and beyond. An advantage in incentive-based conservation schemes could lie in them being accessible to both large-scale and smallholder farmers, like in the example of NST. Like this attention could be

given to land tenure security and ensuring smallholders are not excluded from such programmes. The targeted investments in training, extension services, and access to knowledge helped farmers transition to more sustainable farming practices in the case of NST, what can be an example for future policies. Further collaboration between government, private sector, NGOs, and local communities can be a chance to implement and scale up incentive-based conservation programmes. Public-private partnerships could play a crucial role in financing and delivering incentives.

6. CONCLUSION

The study aimed to evaluate incentive-based conservation, using the case of North Swaka Trust (NST), as a potential approach to balance agricultural intensification, environmental sustainability, and rural livelihoods in Zambia's agro-industrial region of Mkushi. Therefore, we examined how participation in the incentive-based conservation programme NST affects farming practices, land use and economic livelihoods compared to conventional farming in the Mkushi district.

The results for effects on farming practices show that NST members have significantly lower input costs, particularly for fertilizers, while maintaining similar yields for maize and soybeans. Among the group of NST members comparatively more farmers apply sustainable practices such as no-tillage and show greater crop diversification, including the cultivation of high-value crops. In terms of farming practices NST members were therefore more sustainable and cost effective without being less productive than non NST members.

The land use comparison revealed that while NST members were less involved in illicit forest use (especially charcoal burning) they cultivate more land and expanded their land use more often than non NST members. This highlights a potential trade off between environmental conservation and agricultural growth that needs further exploration (e.g. the relevance of income effects).

Regarding economic livelihood effects, NST members report higher net farm income and higher combined income from farm and forest activities than non-members. Lower income costs and other income sources like beekeeping may offset income losses from reduced charcoal burning. However, higher income could also result from their slightly larger cultivated land. Interrelations between these factors could be an interesting field for further research.

This study highlights the broader potential of locally adapted, market-driven conservation models like the North Swaka Trust (NST) to address sustainability challenges at the intersection of agriculture, environmental protection, and rural development. By embedding conservation within economic incentive structures and promoting cooperation between the private sector, local communities, and policymakers, such approaches offer a viable alternative to donor-dependent conservation schemes. The NST case also emphasizes the importance of inclusive policy frameworks that ensure smallholder farmers are actively supported and not left behind. Future research should explore how such models can be scaled to other regions and adapted to local conditions, particularly in light of ongoing challenges around land use and institutional support. This study thus contributes to the debate on how to align agricultural development with environmental goals in a way that is both practical and socially inclusive.

By integrating agricultural development with conservation goals, this study presents valuable insights for policymakers, development practitioners, and researchers in sub-Saharan Africa.

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