Feed the Future Innovation Lab for Food Security Policy

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Climate-Smart Agriculture, Cropland Expansion, and Deforestation in Zambia: Linkages, Processes, and Drivers

Hambulo Ngoma, Johanne Pelletier, Brian P Mulenga, and Mitelo Subakanya

INTRODUCTION:

Expanding agriculture area into forests accounts for about 80 percent of the deforestation globally and it is the main cause of tropical deforestation (Kaimowitz and Angelsen 1998; Gibbs et al. 2010; FAO 2017). In Zambia, deforestation is estimated between 167,000 and 300,000 ha per annum (Kalinda et al. 2013; FAO 2015). While increasing production is necessary to feed a growing population and meet changing dietary preferences, basing this on expanding area at the expense of the forest is unsustainable, given the increasing land scarcity and population growth.

Deforestation contributes to climate change, which in turn disproportionately affects smallholder farmers who depend on rainfed agriculture and have the least means to adapt to and cope with climate shocks. Globally, agriculture, forestry and land use change accounted for 23 percent of anthropogenic emissions between 2007 and 2016 (IPCC 2019). Land use and land use change and forestry, and agriculture accounted for 7 percent and 87 percent, respectively of the total 364 MtC02eq emissions in Zambia in 2012 (CIAT and World Bank 2017).

While the Borlaug hypothesis postulates that increasing agricultural productivity enables intensification and potentially spares nature, increasing agricultural productivity makes agriculture profitable and might in turn might incentivize rather than reduce deforestation. The later phenomenon is called the Jevons Paradox. Climate-smart agriculture (CSA) is considered a necessary condition to increase agricultural productivity and resilience, as well as to adapt to and mitigate climate change. However, the pathways through which CSA can reduce deforestation are neither obvious, nor are they well understood. Understanding the different conditions and enabling environments for either of the opposing outcomes in different contexts remains an unresolved and important empirical regularity.

This brief aims to contribute towards a better understanding of the linkages among CSA, cropland expansion, and deforestation. Specifically, we use detailed household level data to unpack *how*, *why,* and *where* cropland expansion is occurring, and to assess drivers of cropland expansion and whether CSA reduces cropland expansion in Zambia. We supplement this analysis by using the spatially-explicit

Key Findings:

- Between 167,000 and 300,000 hectares of forest are lost every year in Zambia, and different polices are in place or have been proposed to contain forest loss.
- Agriculture land expansion is one of the major drivers of deforestation, yet increasing agricultural production is necessary to feed a growing population and meet changing diets.
- This paper assesses the extent of cropland expansion among smallholder farmers and whether or not climate smart agriculture (CSA) can help reduce expansion and deforestation.
- About 21 percent of rural farm households interviewed in RALS 2019 expanded cropland between the 2016/2017 and 2017/2018 farming seasons, clearing on average 0.18 ha, but only 13 percent of rural smallholders expanded their cropland into forests, clearing an average of 0.10 ha of forestland per household.
- Smallholder cropland expansion into forests represents about 60 percent of the average 250,000 ha of forests lost per year in Zambia.
- Most households expanded cropland because of the need to meet subsistence food needs and a few others in response to market opportunities.
- Much of the cropland expansion among smallholder farmers is concentrated in Luapula, Muchinga, Northern, North-Western, and Western provinces.
- Using CSA had no statistically significant effects on cropland expansion in our sample, indicating that CSA alone might not avert expansion-led deforestation.
- Thus, CSA-led intensification alone might not reduce deforestation unless if complemented with improved forest management policies.

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Hansen et al. (2013) data to characterize district-level forest cover changes between 2001 and 2018 and correlate these changes in forest cover with district-level changes in cropland expansion to identify processes and patterns.

More details can be found in the IAPRI working paper Number 151 by Ngoma et al. (2019) available here: http://www.iapri.org.zm/images/WorkingPapers/wp151_CSA_and_deforestation_final.pdf

DATA AND METHODS:

Data used in this paper are drawn from three main sources: the 2015 and 2019 nationally representative Rural Agricultural Livelihoods Survey (RALS), the Crop Forecast Surveys (CFS) and the Hansen data on forest cover change.

The 2019 RALS included questions on whether a household expanded cropland, the size of the new plot, and prior land use and why they expanded. Since RALS is only administered to smallholder farmers cultivating 0 – 20 ha, cropland expansion among larger farms in not captured here.

The study also used the CFS data for about 122,000 smallholder households over a nine-year period, 2010-2018. The CFS are detailed annual data collected from cross sectional samples of nearly 13,600 households. CFS data is statistically representative at the national, province, and district levels and collects detailed agricultural production data.

The household survey data was complemented with the spatially-explicit Hansen et al. (2013) forest cover change data, which were processed by Pelletier et al. (forthcoming). The Hansen data provides a 30 m resolution annual global Landsat-based forest cover loss, gain, and percentage tree cover.

Empirical Strategy

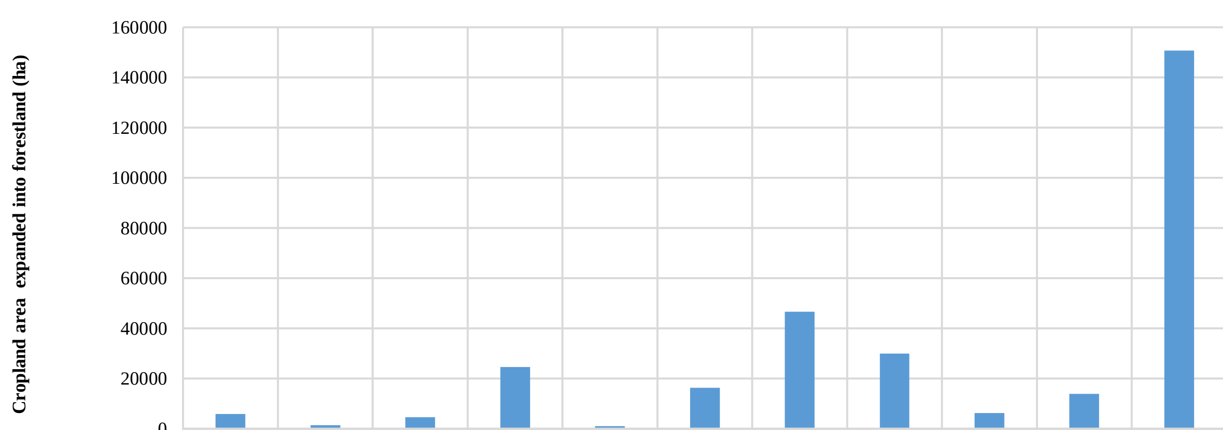
The main aim of this paper is to assess the effects of CSA use on cropland expansion-led deforestation. We faced and addressed three main empirical challenges. First, we used an instrumental variable approach to account for the fact that CSA adoption is non-random and might, therefore, be co-determined with cropland expansion decisions at the household level. Second, we used the Tobit regression model that takes into account that not all households expanded cropland and therefore, that the outcome is censored. And lastly, we took advantage of the fact that the same households interviewed in RALS 2015 were re-interviewed in 2019 and used some of the RALS 2015 covariates as base characteristics to help explain cropland expansion decisions at time *t*.

KEY RESULTS:

Extent and Intensity of Cropland Expansion and their Spatial Location in Zambia

- About 21 percent of all farm households surveyed in the RALS 2019 expanded cropland between the 2016/2017 and 2017/2018 farming seasons, clearing on average 0.18 ha.
- If deforestation is defined as expansion into virgin forests and fallow lands older than 15 years, the proportion of households who expanded cropland into forests reduces to about 13 percent, clearing an average of 0.09 ha of forest per household.
- At national level, cropland expansion into forests accounts for about 4.6 percent of cultivated land by smallholders and about 60 percent (or 150,000 ha) of the estimated 250,000 ha of forests lost per year.
- Cropland expansion overall and into forests is higher in Luapula, Muchinga, Northern, North-Western, and Western provinces (Figures 1 and 2).

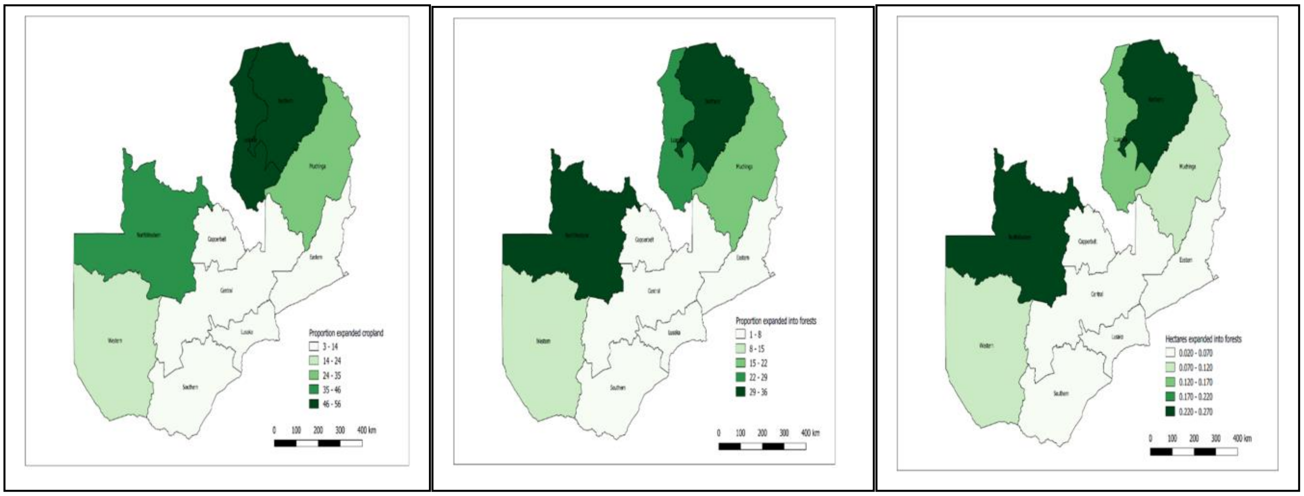
Figure 1: Area Expanded into Forests at National Level and by Province



	Central	Copperbelt	Eastern	Luapula	Lusaka	Muchinga	Northern	Northwestern	Southern	Western	National
Area expanded (ha)	5862	1442	4576	24636	1079	16318	46688	29980	6239	13924	150745

Source: CSO/MAL/IAPRI (RALS) (2019).

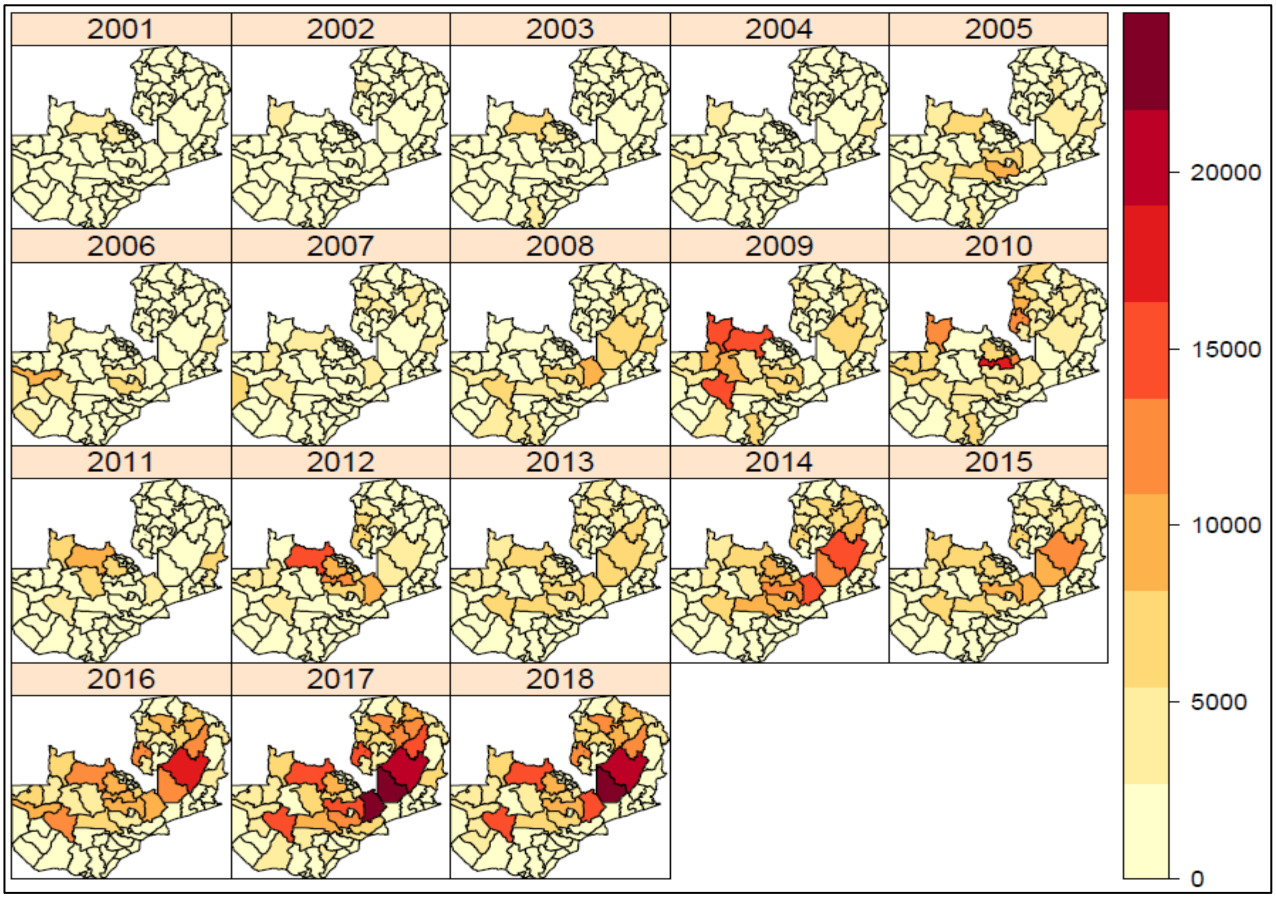
Figure 2: Province Level Spatial Distribution of Cropland Expansion (left panel), Cropland Expansion into Forests (middle panel), and Area Expanded into Forests (right panel)



Source: CSO/MAL/IAPRI (RALS) (2019).

The spatial distribution of cropland expansion based on RALS is qualitatively similar to district level changes in forest cover captured using satellite data and the district level changes in area cultivated based on CFS data (Figure 3).

Figure 3: District Level Spatial Distribution of Forest Cover Loss by Year from 2001 to 2018 (in ha)



Source: Author compilation using Hansen et al (2013) forest cover change data.

Why Do Households Expand Cropland in Zambia? [1]

- Nearly all households who expanded cropland (90 percent) did so in order to meet subsistence food requirements
- Six (6) and 10 percent expanded in response to availability of virgin land and improved market opportunities, respectively.
- About 2 and 3 percent, respectively expanded due to declining soil productivity and in response to improved market conditions from the Food Reserve Agency.
- Less than 1 percent of households expanded cropland to secure tenure, or in response to access to input subsidies or other farm inputs.

What Land Parcels Do Households Expand Cultivated Area into in Zambia?

- About 60 percent of households who increased cropland expanded their area cultivated into virgin forests.
- Nearly half (about 47 percent) expanded into natural fallows and about 4 percent expanded into improved fallows and 3 percent expanded into grasslands.
- Less than 1 percent of households expanded into wetlands or protected forests.

Effects of CSA Use on Cropland Expansion among Smallholders in Zambia

- After controlling for other confounding variables, our main result from the econometric models suggests that using CSA had no statistically significant effects on cropland expansion among smallholder farmers in our sample.
- Distance from the homestead to the new plot, farm size, secure plot tenure and being a male-headed household lead to increased cropland expansion.
- And, age and education level of the household head reduced cropland expansion.

CONCLUSION:

We did not find that adopting CSA had any significant effects on cropland expansion in our national sample, perhaps, indicating that CSA alone might not avert expansion-led deforestation. However, cropland expansion among smallholder accounts for 60 percent of (the often cited) 250,000 ha of forest lost per year in Zambia. We conclude and posit that CSA-led (technological) intensification alone might not reduce deforestation unless it is complemented with improved natural resources management to control conversion of forestland to other uses.

Three Main Policy Implications:

- First, relying only on technological-driven intensification to spare forests may be risky. CSA practices might be more likely to lead to win-win outcomes if accompanied by improved resource governance initiatives, such as payments for environmental services and better land use planning.
- Second, our finding suggesting that smallholder-led expansion accounts for about 60 percent of the reported annual deforestation in Zambia, and that most of this expansion occurs in the current agricultural belt signals the urgency with which policies are required to curb expansion. If left unchecked, there is a possibility that the northern region, which receives abundant rainfall in Zambia, might soon start to experience reduced rainfall due to deforestation-induced climate variability.
- And, lastly, given the strategic role CSA plays in building climate resilience in smallholder agriculture, concerted efforts are needed to identify sustainable and efficient ways to scale-up and scale-out CSA adoption in Zambia and the region.

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[1] Notes: Percentages need not add up to 100% because a household might have had more than one plot, with each plot drawn from different prior land uses.

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ABOUT AUTHORS:

Ngoma and Mulenga are Research Fellows, and Subakanya, Research Associate at the Indaba Agricultural Policy Research Institute (IAPRI); Pelletier is Postdoctoral Fellow at the Atkinson Center for a Sustainable Future and the Charles H. Dyson School of Applied Economics, Cornell University, Ithaca, NY.

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