A deforestation-free path to scaling silvopastoral production systems

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Abstract

The global community recognizes that silvopastoral systems (SPS), which are considered a form of sustainable land use, could reduce forest loss. Studies indicate that SPS can improve livelihoods, provide ecosystem services and act as carbon sinks. What has been missing from the literature, however, is how scaling SPS influences forest cover. Our research results from the Colombian Amazon point to possible unintended deforestation due to aggregated effects of farm-level changes in herd composition from broader SPS adoption with the absence of safeguards, appropriate incentives and government agencies devoted to implementing traceability of dairy and beef products to their deforestation-free origins. Our conclusions are drawn from surveying 144 livestock producers with traditional or SPS farms in Caquetá, one of the departments with the highest deforestation rates in Colombia. Land grabbing, in tandem with cattle pasture, is one of the major deforestation and conflict drivers in Colombia. We surveyed the farmers twice, both in 2016 and 2020, to determine the impact of SPS on herd composition. Our results show that surveyed SPS farmers reduced the number of male cattle and increased the number of lactating cows and calves in the herd. This suggests that these farmers specialize in producing milk, a move that constitutes a process of intensification that with the proper safeguards and incentives would unlikely broaden deforestation at the local scale. The availability of more calves and male cattle from SPS adoption, though, may exacerbate the drivers of deforestation because there is a risk that these extra calves and males would be moved to new pastures at the forest border, where they can be fattened as a source of beef. Our findings, as such, warrant a further investigation into the risk of unintended deforestation from scaling SPS and on how to mitigate that risk to make the process deforestation-free.

Introduction

The 19th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) reaffirms the importance of addressing the drivers of deforestation and forest degradation, and recognizes that addressing such drivers may have implications for livelihoods (UNFCCC, 2014). In such contexts, the widespread adoption of sustainable land use systems (SLUS), such as agroforestry and silvopastoral systems (SPS), is seen as critical to reducing deforestation for both biodiversity conservation and climate change mitigation. Research has demonstrated the immense potential of SLUS to serve as important carbon sinks and deliver both livelihood improvements and ecosystem services in tropical forest environments. Yet, the possible unintended effects on forest cover from scaling SLUS warrant further examination.

We posit the need for a careful assessment of the potential unintended effects of SLUS on forest cover, from the perspective of the deforestation drivers that each specific SLUS aims to address, before concluding that scaling SLUS by itself provides solutions toward reducing deforestation and forest degradation. To illustrate our argument, we present the findings of a study aimed at informing strategies to scale out SPS among smallholder livestock producers in the Colombian Amazon. SPS integrate trees, forage and livestock within the same area of land (Calle et al., 2013). Here we argue that although SPS produce comparatively more on less land and in a more sustainable way than traditional livestock systems, the risk of unintended effects on forest cover from current investments for scaling SPS in the Colombian Amazon is high – particularly considering observed farm-level changes in the composition of the herd and how the aggregated effect of these changes may exacerbate the prevailing drivers of deforestation.

Even though SPS have proven to be economically, socially and environmentally beneficial at the farm level, adoption remains low in Colombia and elsewhere (Tapasco et al., 2019). SPS have received growing attention in both environmental and non-environmental circles, and donor countries and multilateral agencies expect that scaling SPS would reduce pressures on forests, thereby reducing deforestation and contributing toward climate change mitigation and ecosystem conservation (Lerner et al., 2017; World Bank, 2019). The declaration of intent signed by the governments

of Colombia, Germany, Norway and the United Kingdom at the COP25 climate summit in Madrid, in which the three European countries committed result-based payments to Colombia to reduce deforestation, reflects this expectation (BMU, 2019). Despite the importance of this collaboration, potential unintended effects on forest cover from efforts for scaling SPS in the Colombian Amazon remain empirically unexplored.

Results from previous studies, usually performed at a small or pilot scale, indicate that SPS present positive results at the farm level in economic and environmental terms (Chará et al., 2017; Mancera et al., 2018). Meanwhile, Lerner et al. (2017) highlight the capacity of SPS's role as a driver of deforestation or as a driver of forest regrowth depending on what land cover the SPS replaces (traditional livestock systems vs forests) and proposes both on-farm and larger-scale conservation strategies to avoid undesired land cover transitions and to achieve forest and biodiversity conservation goals. Consistently, project developers are integrating conservation agreements, in which farmers commit with the conservation of forest remnants, as a pre-requisite to receive technical and financial assistance for implementing SPS. The expectation is that such agreements will support the transition from traditional livestock systems to more efficient and productive ones and avoid on-farm deforestation due to increases in livestock herds. However, conservation strategies to mitigate the risk of unintended deforestation at larger geographical scales have not yet been integrated into these agreements. In part, this is because understanding such land use transitions requires longer-term studies and greater adoption of the systems. Therefore, in this study, we first assess farm-level changes in the herd from SPS adoption. Taking the Colombian Amazon as a reference, we then examine how the aggregated effects of such changes link the drivers of deforestation in the context in which they will be promoted. Finally, we discuss the risks of unintended deforestation from scaling SPS in the Colombian Amazon and how to mitigate that risk to make the process deforestation-free.

Methodology

Our findings are based on results from surveys we undertook with smallholder livestock producers from four municipalities of the Amazonian department of Caquetá, namely Albania, Morelia, Belén de los Andaquies and San José del Fragua. Caquetá was chosen as it is one of the departments with the highest deforestation rates in the country. According to IDEAM (2019), the department concentrated the highest percentage of deforestation in the country (26.29%). In 2019, Caquetá lost 29,800 ha of natural forest, equivalent to 14.1 Mt of CO₂ emissions (Global Forest Watch, 2020). Of the 16 municipalities in the department, three are part of the 'deforestation arc', the term used for the 13 municipalities with the highest rates of deforestation in the country. Historic data on forest cover, from Global Forest Watch (2020), and on livestock herd composition at the municipality level, from Colombian Agricultural and Livestock Institute–ICA (2019), confirm the relationship between deforestation and livestock at both Colombian Amazon and Caquetá levels (Figure 1). These data sets also indicate that municipalities of the department of Caquetá inside the deforestation arc have higher percentages of fattening animals (composed of male cattle aged between 1 and 3 years) than cows (heifers and cows aged above 3 years), while municipalities outside the deforestation arc have higher percentages of cows compared to fattening animals (Figure 2 and Figure S1).

We surveyed a total of 144 smallholder livestock producers to gather baseline data on their production systems in 2016. We then surveyed them again in 2020 to assess the effects of SPS on herd composition. At baseline, we classified the cattle farms into three groups: traditional farms; SPS farms; and advanced SPS farms. Traditional farms feature traditional extensive cattle grazing techniques with either natural or improved pastures. SPS farms integrate, at a minimum, assisted or natural regeneration of trees, combined with either natural or improved pastures. Advanced SPS

farms refers to SPS farms that, in addition to regenerating trees, integrate other practices in the production system, such as fodder banks, trees in line, rotational grazing and livestock aqueducts.

Results And Discussions

Study results indicated that within the four-year study period, surveyed farmers in the SPS farms group decreased the number of male cattle (1-3 years of age) in the herd (from 1 to 0.7; $p=0.06$) and increased the number of lactating cows (from 0.7 to 2.5; $p=0.08$), suggesting that this farming group over time may specialize in milk production (Table 1). Additionally, results indicate that surveyed farmers in the SPS farms group ($n = 45$) increased the size of the cattle herd (from 3 to 7 heads; $p=0.26$) and increased the number of calves (from 0.2 to 1.5; $p=0.26$) compared with farms with 'traditional' grazing SPS techniques ($n = 99$). This is consistent with previous studies reporting that integrating trees and grasses produces shade and reduces heat stress, thus reducing animal anxiety and providing higher quality, varied diets, which in turn have positive effects on cow fertility and milk production levels (Broom et al., 2013; Chará et al., 2017).

Table 1. Change over time (2016–2020) in average number of animals in the herd by adoption group.

	Average Number of animals				
	Traditional Farms	SPS Farms	T-test	Advanced SPS Farms	T-test
	<i>N=99</i>	<i>N=45</i>	(p-value)	<i>N=27</i>	(p-value)
	(1)	(2)	(1)-(2)	(3)	(1)-(3)
Cattle Total	2.99 (23.8)	7.33 (20.0)	0.258	10.2 (16.2)	0.070*
Dry Cows (>3 year)	-0.19 (5.96)	1.02 (7.36)	0.335	1.89 (7.65)	0.199
Lactating Cows (>3 year)	0.67 (7.33)	2.47 (4.67)	0.078*	2.59 (4.29)	0.086*
Heifers (1-3 year)	1.14 (7.19)	2.73 (11.9)	0.408	3.41 (11.2)	0.325
Calves (0-1 year)	0.23 (7.72)	1.53 (5.73)	0.262	2.37 (3.48)	0.040**
Males (1-3 year)	1.04 (7.02)	-0.71 (3.88)	0.057*	-0.44 (3.42)	0.128
Males (>3 year)	0.10 (0.75)	0.29 (0.87)	0.214	0.41 (0.75)	0.066*
Cattle Total/Total Farm Ha	0.16 (0.72)	0.16 (0.69)	0.984	0.26 (0.53)	0.445

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$;

Results also showed that such differences are greater between traditional farms and those with advanced SPS ($n = 27$) and that the last ones produce more on less land (Table 1; Figure S2). On the one hand, moving toward milk production is essentially a process of intensification, which generally means higher output per hectare, higher labour inputs, a more limited market, and, with the proper safeguards and incentives, is therefore unlikely to drive further deforestation at local scale. On the other hand, although the dairy and beef (cattle) supply chains in the Colombian Amazon are geographically dispersed, they are linked through the provision of inputs (fattening animals) from one to the other (González-Quintero et al., 2020). Therefore, big changes to one could affect the other and possibly the entire livestock sector and their value chains. This raises the question on how the extra calves and males between 1 and 3 years that resulted from investments for scaling SPS would influence land use changes.

The interlinkages between milk and beef production systems (i.e., provision of fattening animals) and between deforestation and livestock rearing (Figure 1), as well as the current geographical distribution of fattening animals in the Caquetá (Figure S1), suggest that there is a risk that these extra calves and males resulting from scaling of SPS would be moved, as fattening animals, to new pastures at the forest frontier. Relationships between the cattle sector and deforestation worldwide have already been widely documented (Seymour & Harris, 2019) such relationships between deforestation and livestock also exist at both Colombian Amazon and Caquetá levels (Figure 1).

Accordingly, actions to reduce deforestation defined in the above-mentioned declaration of intent include transforming 147,000 hectares of “traditional” cattle pastures into SPS by 2022. Investments for scaling of SPS in the Colombian Amazon will not likely target beef producers, who are mostly associated with deforestation. Instead they will likely target farmers that produce milk and sell calves and males, or fattening animals, for beef production (Nelson & Durschinger, 2015). The conditions of the livestock farmers surveyed for this study reflect these aspects because their municipalities are not in the deforestation arc and their main source of livelihood comes from milk and the sale of fattening animals. Milk- and calf-producing farms are common in municipalities outside Colombia’s deforestation arc, which usually are areas with lower deforestation rates, good market access and good governance conditions (Nelson & Durschinger, 2015). Furthermore, municipalities in Caquetá, outside the deforestation arc, have significantly more cows or heifers and cows aged above 3 years, than their counterparts located inside the arc. In contrast, further afield at the Amazon’s receding forest frontier, in the deforestation arc where deforestation and armed conflict overlap (Castro-Nunez et al., 2017) producers focus almost exclusively on beef production as suggested by the greater number of fattening animals, or male cattle aged between 1 and 3 years, in municipalities inside the “deforestation arc” (Figure 1). These production systems thrive, in part, because of limited market access, decreased governance and the higher-quality pastures that are available on recently deforested land.

Although the increased supply of calves and male heads does not necessarily directly equate to more deforestation, it is better to be safe than deforested. Thus, all investments for scaling SPS would need to implement environmental safeguards to ensure environmental and economic benefits to make an eventual widespread adoption of SPS indeed deforestation-free. Given that governance is weaker in forest frontier areas (Baptiste et al., 2017), the risk of an unintended leakage (or displacement of deforestation and related emissions from one region to another) effect is high. Recent findings indicate that economic factors or market demands do not influence beef production in deforestation frontiers; land acquisition and land-grabbing do (Castro-Nunez et al., 2017; Dávalos et al., 2014). Furthermore, studies indicate that cattle pastures form a considerable part of deforestation and land-grabbing strategies (Armenteras et al., 2019). In order to be truly deforestation-free, SPS scaling interventions in the Colombian Amazon need to be designed based on an understanding of the interlinkages between food and land systems. They must target both milk and beef producers, strengthen the beef and dairy value chains, and create mechanisms to avoid the steady supply of calves and males from neighbouring milk-producing municipalities located outside the deforestation arc to limit the expansion of cattle pastures and the associated deforestation within this arc.

Complementary policies to mitigate the potential unintended effects on forest cover of scaling SPS may include conditional payments. Conditional payments have the same essence as payments for ecosystem services, that is, to provide economic incentives for landowners to carry out and maintain specific actions on their farms (Alix-Garcia et al.,

2018; Andersson et al., 2018; Piñeiro et al., 2020) In this context, the objective of the conditional payment would be that cattle farmers prescribe an adequate and efficient use to the calves and male cattle that will not be incorporated in the specialization of their cattle herd designated to dairy production. Likewise, the strengthening of value chains makes it possible to create incentives for farmers to not only maintain the adoption of sustainable technologies, but also to not increase the area of land that is subject those strategies (Bold, et al., 2017; de Janvry & Sadoulet, 2020). These strategies could be used to mitigate the risk of deforestation leakage resulting from an increase in cattle herds under the implementation of the Colombian government's commitments to transform 147,000 hectares to SPS (which according to our results will lead to approximately 10,290 additional calves^[1] after four years, of which about 5,145 would be males or fattening animals^[2].

^[1] This calculation is made based on the 0.07 increase in animals found over total hectares for the cattle farmers who adopted a high-intensity SPS. Therefore, $0.07 * 147,000 = 10,290$.

^[2] This calculation is made based on the probability that calves would be male is 0.5; hence, the number of potential male calves is $(0.5 * 0.07) * 147,000 = 5,145$.

Conclusion

The growing body of research on scaling SLUS to halt global deforestation focuses on monitoring the benefits and identifying the factors limiting their adoption (Amadu et al., 2020). Consistently, investments in scaling SLUS focus on overcoming adoption barriers, inadequate access to finance, markets, technical assistance and production inputs, but they do not necessarily create institutions and accompanying mechanisms to mitigate the possible unintended effects on forest cover derived from their widespread adoption such as safeguards, proper incentives and establishment of public agencies dedicated to conducting traceability of dairy and beef products to their deforestation-free origins. In Colombia, for instance, there is an arm within the government that can trace agricultural commodities back to their origins to verify whether they present a health hazard. However, there is no arm within the government that can verify whether indeed the production of a particular commodity does not contribute to forest loss. These institutional gaps exist, in part, because existing literature has yet to provide a deeper understanding of the topic. Determining any unintended effects of investments promoting SLUS thus warrants further investigation. This is significantly important considering that other forest-rich countries, nine of them from Latin America, are designing strategies to overcome factors that limit the adoption of SLUS. One such country is Peru, which aims to scale 119,000 SPS in the Amazon Region to meet sustainable development objectives, including food security, climate change mitigation and biodiversity conservation. In the meantime, achieving a deforestation-free path through the scaling of SLUS will only be possible with a 'push' that allows farmers to overcome adoption barriers and with incentives that allow value chain stakeholders in both dairy and beef sub-sectors to complete the additional actions required to mitigate possible unintended effects on forest cover.

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Declarations

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Figures

Figure 1

Relationship between deforestation and total livestock herd for the Colombian Amazon region and for the department of Caquetá. Source: (Global Forest Watch, 2020) and (ICA, 2019).

Figure 1

Relationship between deforestation and total livestock herd for the Colombian Amazon region and for the department of Caquetá. Source: (Global Forest Watch, 2020) and (ICA, 2019).

Figure 2

Difference in the percentage of fattening animals (males aged 1 to 3 years) and cows (1 to 3 years of age) with respect to the total livestock herd between municipalities in Caquetá inside and outside Colombia's 'deforestation arc'. Source: (ICA, 2019).

Figure 2

Difference in the percentage of fattening animals (males aged 1 to 3 years) and cows (1 to 3 years of age) with respect to the total livestock herd between municipalities in Caquetá inside and outside Colombia's 'deforestation arc'. Source: (ICA, 2019).

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