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Hiding in Plain Sight: How a Fallow Forestry Supply Chain Remains Illegitimate in the Eyes of the State

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On-farm timber production is an important subsistence and economic activity of smallholder farmers around the world. Farmer investment in wood production and the degree of formality in the sector depends on access to and conditions of the market, the nature of the regulatory frameworks that govern rights to and movement of timber, and access to financing. We evaluate the process of formalization of a thriving and adaptive existing supply chain for small-dimension lumber originating in the fallows of smallholder farmers in the Peruvian Amazon. Through field research over three years based in semi-structured interviews with diverse actors in the Amazon, we found that the supply chain for fallow timber is driven entirely by informal and some illegal transactions. A key reason for this is the lack of an appropriate regulatory mechanism by which producers can gain authorization to harvest and sell this timber. We identify conditions necessary to formalize this sector, and evaluate the degree to which these are met under several scenarios. We recommend that the state develop mechanisms that recognize property rights of long-term residents and establish a simple fallow forestry registration mechanism; and that local governments or non-governmental organizations adopt adaptive and collaborative approaches to support farmers and provide training, information and networking among actors. State recognition of and support for fallow forestry, coupled with producers organizing for collective action on processing and marketing their timber, could result in the formalization of a significant volume of timber, improvements in income security for rural people, and the development of local entrepreneurial activities.

Keywords: smallholder forestry, farm-forestry, agricultural fallow, timber supply chain, forest regulations, informality

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INTRODUCTION

On-farm timber production is an important subsistence and economic activity of smallholder farmers around the world (Pinedo-Vasquez et al., 2001; Holding Anyonge and Roshetko, 2002; Aoudji et al., 2012; Roshetko et al., 2013), providing periodic income that contributes to a diverse livelihood strategy (Porro et al., 2015). In rotational farming systems, timber is produced in several types of forest that comprise the production mosaic (Padoch and Pinedo-Vasquez, 2006): farmers selectively harvest high-value timber trees from the mature

stands they maintain on their landholdings, as is common in Amazonia (Albernaz and Ayres, 1999; Pinedo-Vasquez and Rabelo, 2002b); they plant timber species in their agroforestry systems, especially in Asia (Roshetko et al., 2013; Erbaugh et al., 2017); and they manage natural regeneration of timber species in their agricultural fallows (Pinedo-Vasquez and Padoch, 1996; Applegate et al., 2000; Robiglio et al., 2013). The latter silvicultural practice is the subject of this paper.

Fallow timber is a by-product of shifting cultivation, where the emerging secondary forest plays a regenerative role in the cyclical rotation between forest and field (Denevan and Padoch, 1987; Coomes et al., 2000). The fallow forests are managed to varying degrees by farmers to optimize ecosystem services that help to maintain soil fertility, control pests and weeds, and provide wildlife habitat and forest products (Klemick, 2011; Marquardt et al., 2013; Robiglio et al., 2013). Some of the woody biomass produced in these secondary forests (Bruun et al., 2009; Ziegler et al., 2012; Mukul et al., 2016) is harvested for on-farm construction and fuelwood, but much of it is burned or left to decompose in preparation for the next cropping cycle. In some cases, farmers commercialize their fallow timber to supplement household income.

Domestic markets for low-cost timber produced on the farm provide additional economic options for farmers, while reducing greenhouse gas emissions from burning (Montagnini and Mendelsohn, 1997; Applegate et al., 2000; Robiglio et al., 2013). Whether the woody biomass in agricultural fallows is destined for burning, on-farm use, or sale depends on a number of factors, including the size of the trees at the moment of decision, need for wood versus income, availability or access to wood harvest and processing infrastructure, presence of a buyer, and the market (Pacheco, 2012; Perdana et al., 2012). It also depends on the producer's access to legal options for selling the wood or, in the absence of this, their appetite for risks related to informal harvest and sale. This latter condition—legality—depends on the degree to which the state legitimizes these forestry activities through regulatory frameworks and authorization mechanisms that govern rights to and movement of timber, a condition which is rarely met in the global South (Byron, 2001; Pulhin and Dressler, 2009).

In many countries of the global South, state forest authorities pay little attention to smallholder timber production. As a result, few regulatory mechanisms exist that recognize, much less support, the production of timber on farms or provide secure access to timber markets (Masipiqueña et al., 2008; Román-Dañobeytia et al., 2014; Gritten et al., 2015). In Peru, state authorities fail to recognize fallow forestry as a "proper" (Pain et al., 2021), and therefore legitimate, silvicultural system. Its invisibility effectively criminalizes activities along the supply chain (Pacheco et al., 2016). This is evident by the lack of a regulatory framework that corresponds to the social and environmental characteristics of the supply chain for fallow forestry. Nevertheless, fallow forestry is a viable economic activity with a strong market demand and robust value chain, albeit one that is mostly governed by informal rules and transactions. In this paper we describe the informal supply chain for timber produced in the agricultural fallow and the viability of efforts to formalize the sector.

Informality and the Question of Formalization

Informality exists and persists in part because it works. The dynamics and structures of product supply chains are rooted in local institutional arrangements, customary rights and practices, and power positions of local actors (Menzies, 2007; Nandigama, 2013). In the Amazon, informality provides flexibility and adaptability to actors according to local ecological conditions, geographies, and social structures and relationships (Sears and Pinedo-Vasquez, 2011).

While informality allows for certain freedoms and efficiencies in transactions for some actors, unhindered by bureaucratic and administrative requirements, for others it may represent the perpetuation of inequities and injustices embedded in informal structures that govern *de facto* rights and access to timber and markets (Bedoya Garland and Bedoya Silva-Santisteban, 2005; Pulhin and Dressler, 2009). Inequities rooted in disparities in political power and decision making among actors on the value chain can result in imbalances among actors in access to information, financial capital, technology, and market options. Lack of formality may also prevent some small-scale producers from capturing the fair value of their product (Aoudji et al., 2012; Perdana et al., 2012) and the state to capture timber-based revenue in the form of taxes and fees. It also allows for the flow of extra-legal income from supply chain actors to corrupt forest authorities and third-party enablers (Masipiqueña et al., 2008). Informality prevents full accountability and control by state agencies to govern the nation's forests and has had serious consequences to the environment, forest-dependent communities, workers, and government coffers (Dourojeanni, 2020).

Where policymakers attempt to formalize the forest sector—that is, attempt to control the modes of production and account for outputs—the resulting regulations and administrative mechanisms are too often inadequate, inaccessible, or irrelevant to certain timber production systems or actors, especially for small-scale operations (Pokorny et al., 2010; Pacheco, 2012; Perdana et al., 2012; Román-Dañobeytia et al., 2014; Sears et al., 2018). Where implemented, formalization can also have negative outcomes, among them elite capture of benefits from access to resources, exclusion of economically vulnerable and marginalized populations, reconfiguration of existing work arrangements, criminalization of customary land use practices, and economic loss (Putzel et al., 2015). In the mining sector, attempts to formalize small-scale actors have resulted in documented increase in unauthorized deforestation (Álvarez-Berríos et al., 2021).

Technically, formalization can work if appropriate governance, finance and administrative structures are in place that can support the equitable involvement and engagement of all actors in the sector. Nevertheless, where there is little congruence between the formal structures and the realities on the ground—which reflect the embedded histories of the

actors, local institutions and arrangements—or where relatively well-functioning supply chains already exist, there may be little incentive for actors to participate, and if coerced, tensions and conflict can arise.

Since 2013, we followed the development and implementation of the new forest regulations in Peru associated with the Forest and Wildlife Law (No. 29763, enacted in 2015) to evaluate their relevance and impact on actors along the supply chain for fallow timber. In previous publications, we made policy recommendations to legitimize farm-forestry systems (Sears et al., 2014a) and identified the regulatory obstacles to formal engagement in the forestry sector (Sears et al., 2018). We concluded that the only regulatory mechanism in the 2015 forest regulations that could potentially formalize the fallow-forestry production system was the National Forest Plantation Registry (RDE 165-2015-SERFOR-DE), but even that was imperfect. We concluded that the new forestry regulations overall fall short of enabling the participation of small-scale producers in the formal processes of on-farm forest management planning, much less stimulating widespread adoption of timber plantations.

The plantation registry was designed to stimulate investment in plantation forestry by providing a straightforward pathway for landholders to secure rights to produce, harvest and transport planted timber on private landholdings. Although inclusion of fallow forestry as a silvicultural system—timber production on the basis of assisted natural regeneration—was contemplated in early prototypes of the registry, this option was excluded at the national level in the final regulation. Forestry officials cited concerns about potential mis-use of this category given the degree of long-standing practices of corruption and collusion in the sector. Even though some sub-national forestry offices chose to include this category in their registry, in the end, we determined that the bureaucratic process for registration carries financial, technical and access burdens that few smallholders are able to bear (Sears et al., 2018).

In this paper, the third in a series evaluating the relevance of the recent forest policy reform to smallholder farmers, we illustrate how the informal yet highly functional timber supply chain originating in agricultural fallows persists, even while the state attempts to regulate and formalize it. As a result of this evaluation, we eventually reconceptualize the formalization process, from the state imposing regulations that reflect little of the local reality to an adaptive process of building on the existing informal arrangements and practices to bring production and trade into compliance at least with principles of equity and sustainability, if not with strict standards (Nandigama, 2013; Khadka et al., 2014; Pulhin and Ramirez, 2016). Such a process would entail reflecting on the purpose of formalization and the interests of state actors and others involved in the supply chain.

In the remainder of the paper, we present our research methodology and analytical framework then describe the key nodes of the supply chain for timber originating from agricultural fallows—the production, transformation and wholesaling. In the discussion, we evaluate how conditions for engagement in the formalization process are being met, ultimately addressing the question of whether formalization on this particular supply chain is worthwhile to any of the stakeholders, including the state. Finally, we explore two possible formalization pathways that might enable a transition from informal to legal and that would serve to strengthen smallholders' position in the supply chain, improve livelihoods, and increase sustainability in the sector.

MATERIALS AND METHODS

This paper draws on ethnographic field research conducted during three separate multi-week field excursions, dozens of short-term visits and continued contact with key informants between 2013 and 2017. Data were collected through semi-structured interviews, community meetings with the field team, and participant observation. We focused on the fallow timber supply chains originating on the farms of non-indigenous smallholders (farms from 5 to 50 ha) in fifteen villages in the lowland rainforest region of the central Peruvian Amazon, primarily in the department of Ucayali and including adjacent parts of Huánuco and Loreto departments. The villages and farmers were well-established, having at least 30 years in existence.

In interviews with 87 farmers, we gathered information about the opportunities and barriers to commercializing fallow timber. We interviewed ten small-scale mobile mill owners and eight wholesalers who specialized in trading small-dimension lumber from smallholder plots, focusing on their role in the supply chain, the market dynamics, and their perspectives and strategies vis-a-vis the state's approach to regulating activities in this space. In regional urban centers, we interviewed five financiers who support the forestry operations, and three administrative intermediaries, or fixers, who arrange paperwork to legalize the transport of the wood. These last two actors are key brokers on this informal supply chain. To understand the local interpretation and implementation of forest regulations relevant to smallholders, we interviewed five forest authorities in regional and district government offices, who were responsible for overseeing the permits and movements of timber.

We used a non-systematic purposeful sampling method to initially identify known contacts within the supply chain. From this initial group, we then used a snowball sampling technique to identify other informants in the key actor groups. Interviewees in all actor categories comprised a mix of women and men. Among farmers, 80% were men; all the millers were men; five of the wholesalers, three financiers, and all the fixers were women. Interviews took place in Pucallpa, the capital of Ucayali, and in small towns surrounding the provincial seats of Nueva Requena and Contamana, and in Lima. We had extensive engagement with policy makers and technicians in multiple agencies at different levels of government. We also have drawn on our own participation in multiple policy forums and workshops with diverse stakeholders in the sector.

Analytical Framework

As we have observed, even in informal systems based on customary rules, practices and relations, it is possible to find conditions that allow resilient systems in which smallholders are able to engage with supply chains. However, with formalization,

the nature of these conditions can shift as does the interpretation of current practice. Prior to attempting such change, it is important to reflect on expected outcomes and interests of the stakeholders involved. Drawing on Byron's (2001) key conditions for smallholder forestry, we evaluate four dimensions that circumscribe smallholder farmers' engagement in the supply chain for small-dimension lumber in Peru. These are that farmers have (1) secure rights to harvest and sell the trees, (2) secure access to land for timber production, (3) access to the market, (4) access to a functional state apparatus prepared to oversee the process of formalization with an accountability system free of corruption and coercion. We then evaluate how these conditions are met under three scenarios: the current arrangements that drive the informal supply chain, the current relevant regulatory framework (the national forest plantation registry), and a hypothetical adaptive framework for formalization. In this latter scenario, by "formalization," we mean a process of creating a regulatory framework from the ground up, based in the actual realities and conditions of local geographies and local institutional arrangements, and the capacities of actors. Required underlying conditions that are already met are the farmers' knowledge and capacity to produce timber on the farm (Sears et al., 2018) and market demand for the timber product (Padoch et al., 2008). A critical factor that is difficult to gauge, and one that depends on the outcomes of reform, is the willingness by the stakeholders and actors along the supply chain, including producers, millers, traders, intermediaries, and state functionaries, to carry out and participate in formalization.

RESULTS: THE FALLOW TIMBER SUPPLY CHAIN

The product of interest in this study is small-dimension lumber, in Peru called *tablillas*, originating in the agricultural fallow. The *tablilla* sector in Peru has been booming for decades, with ports, mills and buyers dedicated exclusively to its transformation and marketing, as it is used in both rural and urban settings for house construction, fencing, crates, and pallets. Two tree species that naturally occur in fallows in the central and northern Peruvian Amazon are of particular interest: *capirona* (*Calycophyllum spruceanum*, Rubiaceae) and *bolaina blanca* (*Guazuma crinita,* Malvaceae). These fast-growing pioneer species occur in both *tierra firme* and seasonally flooded landscapes, with *bolaina* dominating the former and *capirona* the latter, but they rarely occur together in the same stand. Both species are used as poles for construction and sawnwood to produce *tablillas*, and *capirona* is also highly valued locally, nationally, and internationally for its dense wood ideal for furniture and flooring (Mejia et al., 2015; Orrego Medina and Bustamante Guillén, 2017).

Bolaina has emerged as an important domestic timber. Sears and Pinedo-Vasquez (2014b) reported that records of volume of *bolaina* lumber passing forestry control checkpoints between the Amazon port city of Pucallpa and the national capital of Lima in 2007 were second only to *lupuna* (*Ceiba* spp., Bombacaceae, used for plywood). That intensity has been sustained, as Rodríguez Zunino (2015) reported that the volume of *bolaina* occupied second place after *shihuahuaco* (*Dypterix odorata*, Fabaceae) for sawn timber reported on transport permits from Pucallpa to Lima from 2011 to 2014. As such, smallholder forestry plays an important role in the domestic timber market.

The *tablilla* supply chain can be characterized as highly dynamic, geographically wide-spread, and composed of a diverse set of stakeholders. In the following subsections, we define the three main nodes of the supply chain: production, primary transformation, and wholesaling (**Table 1**). For each node, we describe the actors, the operations, and their articulation with the various institutions—both formal and informal—that govern it.

Production

Actors report that before the boom in *tablilla* production began in 2007, *bolaina* trees were abundant and large, sourced either from old fallow stands (> 20 years of age) or natural stands at the river's edge. Anecdotal evidence suggests that high quality *bolaina* timber is now scarce, as old fallows and natural stands have been depleted, and as smallholder farms are converted or swept away by land grabs for large-scale monocultures of rice, maize and oil palm. As one miller recounted: "In 2007, the maize farmers arrived in the zone. *Bolaina* is disappearing, finding it is more difficult each year; it is very far." Fallow forestry is threatened as farmers convert their dynamic swidden systems to agroforestry with commodity crops such as cacao and coffee, or to oil palm plantations.

Millers report that all of the *bolaina* they process today is sourced from agricultural fallows of smallholder farmers in dispersed homesteads and villages across the Amazon. Some capitalized landowners are experimenting with planting *bolaina*, but the plantation sector in the Peruvian Amazon is underdeveloped. Farming families usually operate individually, and, whether they have formal tenure rights or not, customary rights have local legitimacy for securing access to land and the trees they produce (Cronkleton and Larson, 2015). Farmers combine shifting cultivation with agroforestry and forest management in a production mosaic; timber production in the fallow is a co-benefit of shifting cultivation. Technically, fallow forestry is a result of the farmer's own private investment to prepare the agricultural field. The cost outlay for establishing the production unit—the fallow—is minimal and generally covered by family labor, sometimes supplemented by paid day labor. The relatively low investment, coupled with the fact that this is often not the primary production activity, allows producers to forgo sales if the price or terms of sale are not favorable.

The production of commercial tree stock on these farms starts in the agricultural field, where pioneer species take advantage of the high light conditions to establish. The farmer weeds them out in the first round of cropping, but when they are ready to fallow the land, the natural regeneration is released at the end of the final cropping cycle. The young trees are minimally managed through tree selection, clearing weeds at the base of seedlings and saplings, stand thinning, and cutting vines from established trees. Some farmers passively manage their stands, investing minimal labor, although informants suggested that even minimal management significantly affects the timber yield. As one mobile miller from Huanuco put it:

TABLE 1 | Fallow timber supply chain nodes, the actors, operations and other parameters.

Supply chain node	Production	Transformation	Wholesaling
Actor	• Farmer	• Mobile miller	• Buyer
Operation	• Produces trees, minimal forest management	• Sources timber • Primary transformation • Dispatch lumber from farm to buyer port	• Finances the miller • Arrange legal papers • Dispatch product to the market
Costs	• Labor to clear land and stand management	• Machinery and maintenance • Labor and board for crew Commission on loan from creditor • Transport	• Administrative paperwork • Credit to miller
Gains	• Price for raw material minus management costs	• Price for lumber minus commission on loan minus operational costs	• Market price minus operational and administrative costs
Decision	• When, how much, how to sell • Terms of the deal*	• Quality of timber to buy • Terms of the deal*	• Terms of the loan to miller • Purchase price
Vulnerabilities and risks	• Positioned as price-taker • Unauthorized to harvest and thus vulnerable to sanctions if inspectors find out • No legal recourse if the miller cheats them	• Weather setbacks • Beholden to creditor for terms • Decommission of lumber if paperwork is not in order • Accidents • No legal recourse if the producer or the buyer cheat them	• Ability to operate depends on relationships with willing corrupt officials • No legal recourse if the miller cheats them
Protections	• Ultimately decides whether to sell	• Banked social capital with the creditor	• Can blackmail corrupt officials

**The producer and miller will negotiate the terms of purchase. The miller is bound by the terms they have made with their creditor, and the producer is often bound by the urgency of their need and the distance to market.*

> *The best wood comes from* purma [the local colloquial term for agricultural fallow], *not from plantations. The boles are longer and with nearly no knots, and the trees grow faster. It is important to thin these natural stands and to clear climbing vines, but it is advisable to allow the other vegetation to grow (*"dejar empurmar*") to avoid branching, and, thus, knots, in the bolaina. One hectare of managed fallow can yield 7,500 tablillas, while yield from an unmanaged fallow is between 4,000 and 5,000 tablillas.*

Timber harvest occurs ideally after the trees reach a minimum diameter of 20 cm, and when the farmer either has a financial need or wishes to clear the stand to start the agricultural cycle again. Typically, the producer commercializes their trees by engaging the services of a mobile miller, who processes the timber on site, either paying a flat price for the entire stand or a price set per tree. In fact, an incentive for the farmer to contract a miller to buy the standing volume of timber in the fallow is to get the land cleared.

There is very little risk to producers at this node, since it is not a crime to grow trees, but harvest without a permit could bring heavy fines, although in remote areas they are unlikely to get caught. The producer does risk theft of standing timber, especially for absentee owners, and, due to the informal nature of their production system, they have no legal recourse or insurance against those eventualities. The opportunistic nature of the timber sale, in the presence of urgency and absence of market information or capacity to calculate standing volume, and the informality of the sale negotiation, does leave the producer vulnerable to unfavorable terms with the miller or buyer.

Transformation

At this second stage in the fallow timber supply chain, the standing trees are felled, bucked and transported to a processing site, usually on the farm, where logs are transformed into *tablillas*. The harvest, processing and transport of the lumber requires an investment of approximately S./10,000[1] that covers labor, food and fuel, but few producers have access to financing, which leaves the node open to the engagement of the mobile miller. Prior to 2011, and the current forestry regulations, *tablillas* were largely produced in the fixed urban mills, fed by logs floated down river by the producer. These mills still operate, but a growing market for the *tablilla* and local adaptations to converting fixed mills to mobile mills stimulated the emergence of a new class of actor: the mobile miller, or *tablillero*. The mobile miller scours the region for standing timber to buy, mainly targeting small farms, each working a defined area.

Because the state considers all trees established by natural means as national patrimony and subject to regulation, felling trees in naturally regenerated secondary forests, including in fallows, without a permit is illegal, even on private landholdings. Transformation and transport of lumber from the site could alert forest authorities to this activity, introducing risk at this node of being caught for unauthorized deforestation and/or harvest of timber. Until the introduction of remote sensing technologies for remote monitoring of forest activities by state agencies and conservation organizations, the absence of the state in remote rural communities kept that risk low. Even so, low budgets for forestry offices keeps enforcement activity low.

It is usually a mobile miller who processes the standing timber into *tablillas*, but sometimes the producer will fell and buck the trees. Millers are local entrepreneurs who may have grown up farming but now have connections to an urban center and to people working in the provincial forest office, lumber wholesalers, and creditors. They necessarily have some knowledge about forestry, regulations, and the market. Millers

[1]Monetary amounts are presented here in the Peruvian Nuevo Sol (S) to make local interpretation easier. During the study period the average exchange rate was S/3.10 to United States $1.00.

maintain a communication network to obtain information about who has fallow timber of a commercial size, and who might be in urgent need for cash. This latter information they use to their advantage when negotiating terms of their service with the producer, especially if there are no other millers operating in that region.

The miller assembles a work crew of five to eight individuals, including chainsaw operators, sawyers and sawyer assistants, and a cook. They set up a temporary camp at a convenient location on the farm and install processing equipment consisting of a circular saw and carriage rails to produce blocks from the logs, and a table saw to produce *tablillas* from the blocks. The operation can last two to three weeks, and the sawn wood is air dried until the operation is complete. The wood is taken off site using a small tractor, and then loaded on a boat or truck for transport to the port.

Although forest regulations require that all forestry operations are reported and that equipment is registered, no miller we spoke with had complied with either of these. The millers were accustomed to operating under the radar or to paying necessary bribes to move their equipment around and to transport lumber from the farm gate to the dispatch point. One stated, "*As a* tablillero *(mobile miller), I purchase illegal permits to transport the wood. A transport permit for a truckload of bolaina tablillas* [approximately 14,000 tablillas, or 50 m^3] *costs S/1200.*" They relied on their network to produce the paperwork necessary for the safe transport of the lumber to the market port. Millers were aware that their informal status is becoming riskier with more state surveillance in the forestry sector.

Risks to the miller are high. Their unregistered machinery can be confiscated and the unregistered lumber in transit can be decommissioned, leaving them with no product and a hefty loan to repay. If law enforcement intervenes before the product is dispatched from the farm, the miller may be able to deflect sanction to the producer, the presumed owner of the unauthorized harvest, where evidence can be found in the form of fresh stumps. Once the lumber is dispatched from the village port, however, the miller assumes the risk of intervention by law enforcement. For this reason, the miller mitigates risk by maintaining "good relationships" (i.e., payoffs) with provincial forest authorities and police in the districts where they operate, and by arranging payment to their workers only once the lumber is successfully delivered to the buyer.

Dependency appears to define this actor class. All the mobile millers we interviewed operated using a loan advance from a creditor, who is often the wholesaler. The millers interviewed reported receiving advances of S/2,000 to S/10,000 for each field operation, depending on their own capital. Attached to the loan is an obligation to sell an agreed amount of product to the patron, which is the hook that ties them to the lender. They may opt to sell any excess on the open market. As one miller stated, "*A buyer lends me money so that I give her my production, and this way I secure a buyer. She sets the price.*" One tablillero reported that the patron always pays "*dos rayos*" (two-tenths of a Sol) less than the market price for the *tablillas*, which the creditor justifies as their commission on the loan.

One miller was in their sixth year working with the same patron. They explained the convenience of the arrangement, and that they were not able to invest in their own business because their earnings go to supporting their younger siblings through school and mother in the city. Furthermore, they said, the relationship goes beyond credit for timber operations, as the patron has supported some of their unrelated requests for loans or support.

While there may be inequities in this informal finance arrangement, it does present some advantages in its flexibility, availability and other soft benefits. Borrowers we spoke with recounted how the lender might help to take care of someone's family in the case of an accident or would lend them money for needs unrelated to the logging operation. A female miller interviewed in this study emphatically said that she chooses to sell all of her *tablillas* to the financier rather than only the portion she owed him, even at a lower price. She explained that the good relationship with the financier was more important than the cash if they would then be willing to help her out in times of need or to lend money for other endeavors.

Wholesaling

At this node, rough-hewn *tablillas* are delivered to a market port, aggregated by a wholesaler, and dispatched to the national market to supply home builders in Peru's cities in the highlands and on the coast. The center for wholesaling *tablillas* is the city of Pucallpa, Ucayali, but there are outlying hubs that have direct connection to the national highway system, including Atalaya in Ucayali and Tingo Maria in San Martin. There were six main wholesalers in and around Pucallpa in 2017. For some of them, the *tablilla* trade is one activity in a diverse portfolio, and for others it is their main livelihood. One wholesaler describes how they got into the *bolaina* business.

> *Eight years ago, I was a driver for a logging boss from Lima. For five years, I drove bolaina from Pucallpa to Lima. I asked around about acquiring my own timber and found ten hectares near town. Half of the property was fallow with bolaina, and the other was natural forest on the floodplain. I started by clearing five hectares of bolaina, which yielded 30,000 tablillas, or approximately 100 m^3 of sawn wood. The price in the port town at that time was S/110 per hundred tablillas, but I sold it directly to my logging boss in Lima for S/150 per hundred. Seeing the profits I could make, I decided to dedicate my time to producing and buying bolaina locally. I now buy from known local producers coming from different villages at S/135 per hundred and sell in Lima at S/185 per hundred.*

The wholesaler at the port aggregates *tablillas* purchased from known millers (often those to whom they provide loans) to fill outbound cargo trucks in loads of approximately 50 cubic meters of lumber. The truck and driver may be contracted or wholly owned by the wholesaler. The aggregation process requires coordination with millers and intermediaries to avoid long delays at the port where the lumber is susceptible to rot, theft, or decommissioning by forest authorities.

Lumber cannot be dispatched from the port without a transit permit, and a transit permit cannot be issued without a harvest permit. Because the producer cannot obtain the harvest

permit, the wholesaler must arrange to acquire the appropriate paperwork through a network of traders in information and services. Once issued, the transport permit is held by the truck driver and is presented at various checkpoints in route. Given this dynamic, the wholesaler's success depends on the collusion of the forest authorities, who are paid to look the other way.

The wholesaler's operation depends on their ability to acquire wood, which necessitates access to information from rural areas and is facilitated by trusted associates, especially millers. Those relationships are often based on the finance the wholesaler provides to the miller, as discussed earlier, which hooks the miller to the wholesaler in a dependency relationship rooted in the debt-peonage system that has characterized labor relations in Amazonia for more than a century (Bedoya Garland and Bedoya Silva-Santisteban, 2005; Sears and Pinedo-Vasquez, 2011; Mathews and Schmink, 2015).

Supporting Roles

Other actors on the supply chain provide critical services at and between nodes. Boat captains and truck drivers provide transport services between transformation and wholesaling, charging for weight or volume. Some of them also serve as intermediate traders, buying from producers to sell to wholesalers. Another critical actor is the person who trades in information and administrative services to generate the paperwork that can formalize the undocumented lumber. Locally known as a *tramitador/a,* this individual acts on behalf of the miller in district hubs or for the wholesaler in the regional hub to secure the necessary paperwork to allow the lumber to move. This actor charges based on the volume of timber to be legalized, which covers both official paperwork fees and unofficial tips to other actors who facilitate access to information.

Other actors include functionaries in the district and regional forestry offices, whose mandate it is to implement the formal state rules and regulations. The timber sector is policed by entities authorized to conduct forest-related monitoring and enforcement activities, including the regional environmental agencies, the police, and even the Navy. The culture of corruption is historically deeply embedded in the ranks of some of these entities (Crabtree and Durand, 2017), and state functionaries practice rent-seeking behavior, such as demanding bribes, generating and selling falsified documents, and selling information. Despite a surge of attention to illegal logging in Peru, our interviews in 2017 suggest that rent-seeking behavior among authorities and intermediaries was very much alive.

DISCUSSION

We have described the structure and dynamic of the timber supply chain originating in the agricultural fallows of small-scale farmers in the Peruvian Amazon. We report that *tablilla* production through fallow forestry is conducted entirely outside the gaze of state authorities, with no registered management plans, no annual cutting plan, and no local transport permit. Only when the lumber arrived at a main port and was purchased by a wholesaler was the timber "legalized," through the acquisition of falsified documents (Sears et al., 2018).

Fallow forestry has long enjoyed the privilege of governance under customary rights embedded in the "lived norms" (Hirons et al., 2018). The absence of a feasible mechanism to register their timber precludes fallow forest producers from engaging in the formal system, and, as long as it remains illegitimate to the state, and therefore illegal, actors on the *tablilla* supply chain remain vulnerable to inequitable transactions and state intervention. In the next section, we explore what it would take to legitimize fallow forestry by asking how formalization could contribute to creating the conditions necessary for secure engagement by small-scale producers on this supply chain. We explore the impacts of its hypothetical formalization at all nodes of the supply chain and suggest ways forward that could meet the needs of both the state and the actors on the fallow forestry supply chain.

Necessary Conditions

Under the state-driven implementation of the forest sector reform through the current regulatory framework, formalization appears to be a process of coercion of actors to follow state-imposed rules. While the forest authority conducted a widespread public engagement process to develop of the new regulations, they still fell short of capturing the local realities of at least some rural sectors. A more inclusive—and, we argue, effective formalization would involve a process of creating a regulatory framework from the ground up, based in the actual realities and conditions of local geographies and local institutional arrangements, and the capacities of actors.

We return to our analytical framework of four key conditions that must be in place for smallholders to engage in the timber supply chain with timber produced in the fallow forestry system (**Table 2**). We compare how these conditions are met under three scenarios: the current informal supply chain, the current regulatory framework defining formalization, and two hypothetical options for an adaptive formalization framework. Conditions are obviously met under the first scenario, given the steady flow of *tablillas* to the local markets. If the state were to enforce the current regulations, and where they actually have begun to do so, the supply of *tablillas* may decrease dramatically. The third scenario—both options—is designed as a ground-up adaptive process to formalization, which would serve to primarily meet the needs of both producers and state actors. An assumption is that other actors on the supply chain will accept and adapt accordingly.

Here and in **Table 2**, we reflect on the strengths and weaknesses of the first two scenarios in terms of meeting the necessary conditions for smallholder engagement in the supply chain. We address the hypothetical scenario in the following section.

Within Peru's forestry regulations, possession of a land title or accepted equivalent (condition 1) is a necessary initial requirement for gaining legal authorization to harvest and sell timber (condition 2), whether the trees are planted or natural. While only a portion of smallholders in the villages we visited had valid land titles, in the current system customary property rights provide sufficient security for farmers to access informal

TABLE 2 | Conditions for smallholders to commercialize trees from their agricultural fallows, evaluation related to three scenarios: the current informal supply chain, under current regulatory framework, and under an adaptive formalization process.

Key necessary conditions	Status under informal supply chain	Status if formal rules are followed	Adaptive formalization
1. Secure access to land	• Producer need only have customary rights recognized by neighbors.	• Producer must prove legal rights with a title or other certificate.	• Require a demonstration of at least customary rights: validation by community authorities demonstrating long term residency of producer.
2. Secure rights to harvest and sell trees	• *De facto* rights are locally recognized. • Wholesaler arranges illegal paperwork to legitimize the lumber in collusion with corrupt officials.	• Natural regeneration is state property and thus requires formal authorization to harvest and sell. • Formal authorization is impossible due to absence of a viable regulatory mechanism.	• State must recognize assisted natural regeneration as legible silviculture. • Registration mechanism that reflects local conditions and realities, including a possibility of total deregulation for fast-growing pioneer species. • Collective action to register community level producers as groups. • Communal monitoring of compliance.
3. Market access	• Direct access by producer is limited and risky due to absence of legality, high costs. • Market access through informal agreements with supply chain actors, relegates producers to position as price-takers.	• With legal harvest and transport permits, market access is clear. • Legal authorization could pave the way for equitable finance enabling producer direct access to the market.	• Provide a pathway to formality for producers to create conditions for better price. • Producer associations to provide better access to markets and finance.
4. Adequate state apparatus	• Actors benefit from a weak and disorganized state, including forestry officials' willingness to participate in corruption.	• Inadequate due to corruption, myopic perspective on farm forestry, and low budget for monitoring and enforcement.	• State could use remote sensing to monitor status of registered fallow patches. • State could provide information materials to supply chain actors on rights and responsibilities. • State could direct resources to reducing high-impact illegal logging rather than controlling farm-based forestry.

value chains. Their sale of fallow timber is viewed by neighbors as a legitimate transaction. Shifting producers into formal markets will require innovative efforts by the state to develop mechanisms to recognize property rights of long-established farm foresters, either through expedited land titling programs or usufruct contracts (CU-SAFs) (Robiglio and Reyes, 2016). That would allow them to gain legal authorization to harvest and sell small dimension timber.

As mentioned earlier, the current regulations present no viable mechanism to obtain authorization to harvest and sell timber from the agricultural fallow, which is the second necessary condition. Without a viable pathway to authorized harvest, this supply chain will remain in the shadows of informality. This oversight is rooted in the lack of recognition by the state of fallow forestry as a legitimate silviculture system. The state could develop a clear, simple and secure administrative mechanism by which farmers can register their fallow timber, giving them rights to tree ownership and harvest, which could buttress customary property rights.

We see two routes to achieve regulatory legitimacy, both based in local conditions and realities. One would be to include assisted natural regeneration in agricultural fallows as a category of silvicultural system in the national forest plantation registry. This still would require paperwork and supervision, and until the state solves the corruption problem among functionaries in forest offices, there will still be room for rent-seeking behavior.

The other route, one that is more parsimonious under the current political and social conditions of the state and especially in the Amazon, would be to deregulate the harvest and sale of fast-growing pioneer species produced in agricultural fallows. This might have to be coupled with some way to register and validate the origin of the timber, or remote monitoring of the status of these stands. We acknowledge that regulatory simplification that nearly approximates deregulation might make state forest authorities nervous that actors may use it to deforest mature stands to create more crop areas and eventual fallow. This was the case with the original proposal to include assisted natural regeneration in the National Forest Plantation Registry in its first iteration (which was later removed) (Sears et al., 2018). Some precedent for this fear might be found in the evidence of an increase in deforestation from mining after the implementation of strict regulations and zoning for artisanal, small-scale mining in Madre de Dios, where miners took advantage of regulatory loopholes, coupled with strong support from a resistance movement (Álvarez-Berríos et al., 2021). On the other hand, the implementation and enforcement of new forestry regulations between 2008 and 2010 had a clear negative effect on the income of small-scale forestry operators when they were unable to comply with the new rules (L'Roe and Naughton-Treves, 2014).

The current informal supply chain, with its network of actors and information, provides farmers with access to the market, the third condition. The informal arrangements among supply chain actors that characterize current market access are not always equitable, but to a certain extent market conditions help to regulate them. Active law enforcement of the regulations, however, can limit access. As the state implements control

measures under the formal rules, the cost of bribes required of millers and wholesalers to the few remaining rent-seeking officials at forestry checkpoints to move the lumber increases. This cost may be extracted from the purchase price from producers or passed on to consumers. Because timber production and sale is just one of several income opportunities for these producers, if the risk of state sanction of informal timber is too great, or if they cannot negotiate a suitable sale, farmers may choose not to sell.

We see that market forces can help to regulate production of fast-growing pioneer species with ample natural regeneration. As the millers indicated, increasingly, farmers had been offering younger trees of poor quality, which fetch a lower price in the market. To address this, one buyer we worked with has prepared information sheets for producers and millers detailing the standards for quality and milling dimensions. We recognize that science-based restrictions on timber extraction are essential for the survival of late successional timber species in natural forests—long-lived species, or those whose recruitment is slow—but we maintain that the unrestricted movement of fast-growing pioneer species from farmland poses little risk to species survival.

A fourth condition, which is essential for a regulated formal system, is the existence of a functional state apparatus prepared to oversee the process of formalization with an accountability system free of corruption and coercion. The state should produce materials explaining to producers what kinds of production are acceptable (i.e., natural regeneration, plantation) and explaining their rights and responsibilities under the system. Under the informal supply chain, a weak state apparatus is favorable for all actors, since it alleviates restrictions on the system and democratizes actor participation in certain ways. Volumes of timber traded and prices are limited only by supply chain infrastructure—including the raw resource itself—and the market, rather than by restrictions set by the state. A weak state apparatus obviates the need for supply chain actors to formalize. This may change, however, as anecdotal evidence indicates that the movement of *tablillas* in the port of Pucallpa had all but stopped when the state carried out periodic enforcement operations in 2016 and 2017.

To summarize, under the current informal supply chain, the four conditions are essentially irrelevant beyond the local level. Informal arrangements and agreements at the village level and among supply chain actors serve to regulate this sector. Formalization is all but impossible under the current regulatory framework, precisely because the state fails to recognize and appreciate the fallow forestry systems. This is evident by the stoppage of timber flow when the state apparatus flexes its muscles and engagement in the informal supply chain becomes more risky for all actors. It remains unclear whether the underlying political and social conditions in the Peruvian Amazon will present barriers to these conditions being met. In the next section, we explore potential pathways that could enable the continuance of this supply chain.

Formalization: A Way Forward

In the case of small-scale farm-forestry, where the practice of timber production already exists as an inextricable part of an agricultural cycle, we have shown that the problem of informality of fallow forestry is one of regulatory impossibilities (Sears et al., 2018), not inefficiencies in the supply chain or market. Rather, more positive impact on the livelihoods of forest-dependent people and on forest production could be made by removing regulatory obstacles (Masipiqueña et al., 2008; Ordoñez et al., 2011; Gritten et al., 2015; Flanagan et al., 2020), improving local forest governance (Agrawal et al., 2008), securing land and resource rights (Bruce and Fortmann, 1988; Cronkleton and Larson, 2015), and building local capacity in the normative and technical aspects of forestry, from management to business (Pacheco, 2012; Bloomfield et al., 2018).

While formalization on this supply chain could be beneficial, we feel it is important to debunk the pervasive notion in development discourse that shifting to formality is automatically necessary for bringing about change, since, as we have shown, formalization and authorizations do not necessarily translate to equity, access and sustainability (Sears et al., 2018). The environmental, social and economic stakes in formalizing farm forestry and its associated supply chain are very low in comparison to the artisanal, small-scale mining, where any activity there has nearly irreversible deleterious environmental outcomes (Álvarez-Berríos et al., 2021). Nevertheless, it is inevitable that the Peruvian state will move forward with attempts to formalize all economic sectors. Should the state insist on controlling the domestic movement of even small-dimension lumber from fast-growing species, strengthening producer rights through formalization will be essential.

We recommend that smallholder forestry should be promoted and supported through a combination of private and public initiatives that builds on the flexibility of existing arrangements among actors on the fallow timber supply chain. These include first, a recognition by the state that fallow forestry is a legitimate timber production system, and that without market access, that wood will continue to be burned, resulting in greenhouse gas emissions. Second, the state should modify the regulatory framework to allow for a very simple pathway to legality. Third, small-scale producers could be supported to engage in collective action to form producer associations at the village level, which can help to achieve an economy of scale to strengthen producer leverage on the supply chain. These can be modeled on existing agroforestry cooperatives for coffee and cacao. The association could host a simple, innovative and equitable finance mechanism to provide small loans to producers to bridge the gap between harvest and sale (Boscolo et al., 2010). This condition of local social organization has been key to the success of other cases of grassroots sustainable development initiatives in Latin America, especially where government institutions are weak or regressive (Silva, 1994; Sibelet et al., 2021).

For producers, the gains of formalization could be positive, especially since legitimacy—that is, authorization to the producer to harvest and sell timber—could provide leverage for the farmer to negotiate a more favorable arrangement for the timber sale. The transfer of legal permits down the supply chain would alleviate the need to pay bribes or buy doctored paperwork, saving those actors money and anxiety. Higher and more secure economic gain by farmers could generate interest among some

to optimize production through stand management and harvest planning, improving the sustainability of this short rotation timber resource. All of this could yield timber of higher quality and steady quantity, which also improves business for millers and wholesalers.

The state would gain by accounting for more legal timber—since the persistence of illegal timber trade is still a serious problem in Peru (Pacheco et al., 2016). A simple formal process may incentivize smallholder farmers to maintain diverse and dynamic production landscapes, where fallow forestry is a natural component, rather than converting farms to monoculture plantations, thereby promoting biodiverse farming. Formal engagement may also generate some revenue for the state through fees associated with downstream nodes of the supply chain. The losers in this scenario would be the rent-seeking intermediary actors who either receive bribes or fix the papers.

We believe that both the refusal by professional foresters and forest authorities to recognize fallow forestry as a legitimate silvicultural system and their fear of losing control over the production and the movement of timber blinds them to the overwhelming positive benefits of legitimizing an existing timber production system that remains in plain sight. The cyclical nature of fallow forestry, as an integrated component of the productive landscape mosaic of smallholder farmers in the Amazon (Pinedo-Vasquez et al., 2002a), and the conversion of trees into lumber rather than smoke and ashes, can help the state to achieve climate commitments while stabilizing production. Furthermore, given the budget shortfalls of state forestry offices at all levels in Peru, deregulation of this minor supply chain would allow forestry officials to focus their attention on improving sustainability in the supply chains for high-value timber species in Amazonia that are of serious concern (Grogan et al., 2010; Putzel et al., 2011).

CONCLUSION

Peru's 2015 forest regulations fall short of meeting the needs of smallholders and legitimizing their farm-based forestry systems. The fallow forestry system persists as an enigma to policy makers and forestry professionals in Peru. It is a system of timber production whose value, volume and sustainability remain both underappreciated and illegitimate in the eyes of state governing agencies. Despite the invisibility of farm-forestry to the state authorities in Peru, a robust supply chain exists for wood products emerging from it, operating entirely through informal (and some illegal) transactions.

Policy makers and forest authorities will serve society best if they clearly identify the behaviors they want to stop and those they want to encourage. We question the notion that the state should put energy and resources into stopping the sale of timber from small-scale agricultural fallows. We suggest introducing a very simple administrative process that nearly deregulates the timber produced in agricultural fallows. Barring this radical departure from forestry norms, at the very least we recommend that local governments or civil society organizations establish a system of support for administrative and technical assistance to those farmers who want it, to help improve their market position by producing high-quality timber. We also recommend that a short-term loan program be developed locally, which would allow producers to add some value to the product.

By legitimizing fallow forestry, the state creates an opportunity to promote smallholder forestry to meet national goals on timber production and improve rural incomes. Allowing the commercialization of woody biomass that is felled in a legitimate agriculture cycle, as an alternative to burning, can contribute to the country's climate mitigation strategy. Most importantly, supporting fallow forestry would serve to provide a measure of security to the tens of thousands of smallholder farmers in the Peruvian Amazon who produce timber.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The activities described in this paper followed protocols established by the Declaration of Helsinki with regard to informed consent, vulnerable groups and individuals, confidentiality of data, and other requirements. During fieldwork, verbal prior informed consent was received in Spanish, and individuals were informed that participation was voluntary and that they could cease participation at any time.

AUTHOR CONTRIBUTIONS

PC and RS developed the project concept and secured funding. RS, MMR, and MP-OA carried out field data collection and data analysis. RS led the manuscript development with significant input of ideas and feedback contributed by all authors. PC and MP-OA contributed to the text. All authors contributed to the article and approved the submitted version.

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