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Farm-forestry in the Peruvian Amazon and the feasibility of its regulation through forest policy reform

Robin R. Sears*[,1], Peter Cronkleton, Fredy Polo Villanueva[2], Medardo Miranda Ruiz, Matías Pérez-Ojeda del Arco[3]

Center for International Forestry Research (CIFOR), c/o Centro Internacional de la Papa (CIP), Av La Molina 1895, Lima, Peru

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ABSTRACT

In 2015 the Peruvian government launched a new set of regulations associated with the forest law aimed to increase competiveness of the timber sector, ensure the conservation and sustainable production of timber on public and private forestlands, and improve rural livelihoods. Small-scale timber producers have been marginalized in the sector in the past, and the new regulations claim to provide pathways to formalization for these actors. We draw on policy analysis and field research in the central Amazon region of Peru using mixed methods to characterize smallholder on-farm timber production and evaluate the feasibility of the new regulatory mechanisms for formalizing small-scale timber producers. Through examining a case study on the production and sale of the fast-growing pioneer timber species *Guazuma crinita*, locally known as *bolaina*, we found a diversity of management practices, with the strongest reliance on natural regeneration in agricultural fallows, an informal supply chain, and no case of formal documentation at time of sale. We assessed that none of the new regulatory mechanisms will accommodate the sale of timber produced in agricultural fallow stands. We recommend the inclusion of fallow timber in the new forest plantation registry, which could result in the formalization of the supply chain and create an incentive to increase production by small-scale producers.

1. Introduction

The government of Peru has staked out ambitious environmental goals to halt deforestation by 2021 and reduce greenhouse gas emissions from land use change (MINAM, 2011). As a signatory of the 20 × 20 Initiative, Peru has also committed to reforesting 3.2 million hectares of degraded land. Achieving these goals requires major changes in the agriculture, forest and mining sectors (Finer and Novoa, 2017).

One group of actors that operates at the intersection of agriculture and forestry is the non-indigenous smallholder farmer. Smallholder farmers in the Amazon are important forest stakeholders, benefiting directly from forest ecosystem services while also shaping the forested landscape (Brondízio and Siqueira, 1997; Coomes et al., 2000; Cronkleton et al., 2013; Padoch and Pinedo-Vasquez, 2010). Many integrate agriculture, livestock, agroforestry, and forestry in complex landscape mosaics, producing food, fuel, medicine, timber and other products for subsistence and local and national markets (de Jong, 2001; Padoch and Pinedo-Vasquez, 2006; Pokorny et al., 2011; Sears and Pinedo-Vasquez, 2014).

The diverse roles played by this heterogeneous population, specifically in the forest sector, are poorly understood by government agencies and even development organizations and are thus unrecognized or underappreciated. Their productive activities in both agriculture and forestry are not accounted for in official statistics. Because they are informal, they are easy to blame as a driver of deforestation (Ravikumar et al., 2016). Policy options that are based firmly on the segregation of forestry and agricultural are largely unworkable for these landholders (ICRAF, 2001; Pokorny and de Jong, 2015), a problem even recognized by the national forest authority (SERFOR, 2015). As a result, smallholders have been either unable to participate formally in the forest sector or felt little incentive to do so. Initiating steps to include smallholders in national environmental strategies requires that policy-makers better understand their land use practices and decision-making processes.

An opportunity to highlight and support the role of these actors in

* Corresponding author.
E-mail address: robin.sears@aya.yale.edu (R.R. Sears).
[1] Present address: Hampshire College, 893 West St, Amherst, MA 01002, USA.
[2] Present address: Centro de Innovación Científica Amazónica (CINCIA), Jr Cajamarca Cuadra 1, Puerto Maldonado, Madre de Dios, Peru.
[3] Present address: Sociology of Development and Change Group, Wagenigen University, UR, Droevendaalsesteeg 4, 6708 PB Wagenigen, The Netherlands.

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the forest sector presently exists in Peru, where the government is instituting a forest sector reform. The reform goal is to alter forest use behavior through the recognition of diverse forest stakeholders and the varied motivations driving their behavior. This has opened a debate on potential mechanisms for the formal participation by small-scale timber producers.

This paper is a result of our collaboration with the Peruvian National Forest and Wildlife Service (SERFOR) to analyze policy reform proposals and our subsequent realization that decision-makers lacked sufficient information on the characteristics of smallholder timber production to define viable policy options. We set out to provide such information through the synthesis of new and previous research and current policy analysis. Our specific research objectives were to characterize smallholder on-farm timber production systems and evaluate the feasibility of new regulatory mechanisms for addressing the needs of producers in the farm-forestry sector. We asked what mechanisms do the new forest regulations present for formalizing the engagement of these timber producers in the forest sector. Our ultimate goal was to provide recommendations for promoting and formalizing farm-forestry systems in Peru, and for this invisible group to gain recognition for their contribution to forest conservation and restoration.

In the next section, we briefly introduce the concept of farm-forestry and highlight trends in Peru's current forest policy reform. Subsequently, we present field research results, including a case study on production and value chain dynamics of a fast-growing pioneer commercial timber species produced in agricultural fallows, *Guazuma crinita* Mart. (Malvaceae), known as *bolaina* in Peru. We then analyze the current situation, assessing the feasibility of formalizing this value chain.

2. Farm-forestry in the Amazon

Smallholder farmers around the world manage diverse, complex and dynamic production landscapes, and, in many cases, integrate timber production in their agricultural systems (Alcorn, 1984; de Jong, 2001; Hoch et al., 2009; Holding Anyonge and Roshetko, 2003; Pokorny et al., 2011; Summers et al., 2004). In these endogenous systems of forest production and conservation, small-scale farmers produce timber employing a diverse spectrum of interlinked practices, including forestry, agroforestry, agro-pastoral, and agro-silvo-pastoral systems. These "domestic forestry" systems (Michon et al., 2007), or farm-forestry, are distinguished from conventional forestry in that they integrate timber into a diverse production landscape. This type of production is also distinct from the extraction of timber from natural forest or forest remnants.

Throughout the Amazon, farm-forestry relies on multiple silvicultural approaches. Farmers typically manage the natural regeneration of timber species in cyclical successional systems in clearings periodically opened for crop fields or pasture. The secondary forests developing on fallowed land are dominated by fast-growing pioneer tree species (Portocarrero Silva, 1999) and can be considered managed secondary forest of anthropogenic origins. Another common component of the farm-forestry system is enrichment planting, where farmers plant or transplant both fast-growing pioneer species and high-value, overexploited species on their landholdings. Both the fallow forests and mixed stands with enrichment plantings serve multiple ecological and productive functions, including soil conservation and rejuvenation, weed and pest control (Marquardt et al., 2013), creation of animal habitat, and production of wood and non-wood forest products (Klemick, 2011; Padoch and Pinedo-Vasquez, 2010).

In some cases, farmers may establish monoculture plantation systems, planted with orderly rows and spacing based on project-defined technical specifications. Such a technical approach entails high labor and capital input, as well as specialization, and often depends on external incentives for farmers to justify the investment. Thus, it is rarely adopted or successful (see, for example, contributions in Scoones and Thompson, 1994). On their own, farmers typically opt for more diverse agroforestry and successional silvicultural systems that are more resilient and have lower risk and establishment costs. These systems comprise part of the integrated farming systems typical of long-time resident farmers in Amazonia.

3. Forest sector reform

Peru has launched a comprehensive forest policy reform, with new legislation to better accommodate the country's administrative decentralization and to respond to a call for social inclusion in forest governance processes. In 2013, Peru approved the National Forest and Wildlife Policy to serve as a guideline for forest and wildlife management at all levels of government (D.S. No 09-2013-MINAGRI). The central pillar of the policy was the 2011 forest law (Law No. 29763), whose development was guided by principles of social inclusion and equity regarding access to forest resources. The forest policy established that the State should support forestry and productive agroforestry systems among diverse actor groups at different levels of governance, including small-scale producers. This was the first law in Peru to be developed in accordance with the new requirement for "prior consultation" with indigenous groups (Law No. 29785), and additional measures were taken to open the participation to a wider range of stakeholders. The forest law entered into force in 2015 when the forest regulations associated with it were passed.

Our forest policy analysis was initiated in 2014 and 2015, prior to the field research reported here, and is based on prior knowledge of the smallholder forestry systems. We reviewed drafts of the forest regulations, evaluating their suitability for facilitating the formal engagement of smallholder farmers in the timber sector. We limit our analysis to the few components of the regulations that are relevant to rural farming landscapes in non-indigenous villages in the Amazon. We contributed to the ongoing discussions of these draft regulations with national and regional forest authorities. Our final analysis, presented in the discussion section of this paper, was refined based on fieldwork results from mid-2015 reported in this paper.

There are three mechanisms defined in the regulations that could potentially apply to smallholder forestry systems: Management Plan, Management Declaration, and Plantation Registry. Which mechanism is relevant to who depends on a combination of the type of property right (title or usufruct rights contract) held by the farmer, and the kind of silvicultural system (agroforestry, plantation, natural forest management) employed (Table 1).

An important point underlying these options is that Article 4 the forest law stipulates that trees in forest plantations on private and communal property are considered private property, and thus do not require state authorization to harvest. Whilst trees and forests established naturally, either on public or private land, is national forest patrimony and do require a management plan and authorization prior to utilization. Its timber is subject to taxation.

To be able to understand the policy options in the context of farm-forestry, we introduce the relevant mechanisms under natural forest management and plantations, and later assess their feasibility for smallholder farmers against the actual production practices we have found in the field.

3.1. Natural forest management

There are two types of authorization to extract timber from natural forests, according to the level of harvest intensity. Holders of a concession to natural forest on public lands who wish to harvest at medium- to high-intensity (i.e., mechanized) can access this timber only under an approved forest Management Plan (Article 88, DS 018-2015-MINAGRI). Developing such a plan requires advanced technical knowledge and skills and the signature of a professional forester. The forest authority must review and approve all plans and operations

Table 1
Categories of timber access in Forest Law No. 29763 relevant to smallholder timber producers.

Ownership	Land classification	Forest type	Land use rights type	Modality for access to timber
Private	Agriculture, pasture land (A/P/C)	Planted	Title	Plantation registry
		Natural, primary	Title	Management plan
		Natural, secondary	Title	DEMA
Public	National forest land under protection (X)	Any	Protection only	None
	National forest land (F)	Natural, primary	Concession for medium or high intensity harvest	Management plan
	National forest land (F) adjacent to titled land or otherwise under possession	Natural, primary, degraded	Usufruct contract for low-intensity harvest in residual and remanent forest	DEMA
	National forest land (F) under agroforestry system	Planted	Usufruct contract for agroforestry	Plantation registry
		Natural, primary		DEMA
		Natural, secondary (i.e., fallow)		
		Natural, secondary		DEMA

reports, and forestry operations must be supervised by a professional forester. This is the most onerous and costly mechanism available to access timber from natural forests, even on private landholdings, and it is unlikely to be used by smallholders.

The second mechanism available is the Management Declaration (DEMA for its Spanish acronym) to harvest timber at a low intensity (by volume or non-mechanized) in a variety of forest types or silvicultural systems: remnant natural forest, secondary forest, and agroforestry systems with a natural forest component. Some regulatory norms for these systems have been published, but they are being modified according to feedback from the regions.

The DEMA is an affidavit, or sworn statement, from the authorized user and does not require supervision by a professional forester. Filing a DEMA does carry a processing fee and the timber harvested is subject to a tax according to the species and volume extracted. Some smallholders may need to contract a professional forester, at least the first time they file a DEMA, to help with orientation to fill out the form and in determining the area position coordinates, the scientific names of tree species, and timber volume.

3.2. Plantation forestry

A hallmark of the current forest policy reform in Peru is a national program for the promotion of forest plantations. This program centers on the third relevant mechanism – the Forest Plantation Registry, which virtually deregulates planted timber. Forest plantations must be established on deforested and degraded lands to qualify for registration, thus advancing the national reforestation objectives. The goals of the program are to attract direct investment in the sector, increase forest production and forest ecosystem services, and expand employment opportunities in the forestry sector. The registry attempts to minimize bureaucratic and financial burdens for operators who plant trees for sale, allowing for the registration of areas up to 40,000 ha. The operator can establish a plantation on titled land, in a concession on public land, or on public land under usufruct contract (Robiglio and Reyes, 2016). Operators are not allowed to clear natural forest to establish timber plantations, and they are encouraged to use the plantation to restore degraded soils.

In theory, the bureaucratic burden of the registry is relatively low, requiring the owner to report the area planted, species, and volume, with verification by forest authorities only at the request of the state office. This process requires no payment for registry, harvest, or movement of plantation timber (Table 2), although in the Ucayali region, it does require payment for an obligatory field visit and visual inspection of the system. The current norm (RDE 165-2015-SERFOR-DE) applies to trees that are planted in the following systems: monoculture plantation; boundary markers, live fences, and wind breaks; agroforestry systems of *taungya*, shade trees, alley cropping, and trees dispersed in pasture; and "other types of plantation". As we will explain below, the national plantation registry has been implicitly interpreted to exclude trees established by natural regeneration.

The regulatory norms associated with the national program for the promotion of forest plantations have been evolving since before the new forestry law entered into force in September 2015. The first guidelines were approved by supreme decree in late 2014 (DS 017-2014-MINAGRI), which was relevant for plantations on private land only. Those guidelines allowed for the registration of timber in a diversity of silvicultural systems, including "managed natural regeneration in agroforestry systems", which neatly describes agricultural fallows, or young secondary forest (de Jong et al., 2001; Padoch et al., 1985).

The window of opportunity for the inclusion of fallow forestry in the plantation registry was short-lived, however. In late 2015, the regulations for the forestry law were passed, and these modified the norm associated with the plantation program (RDE-165-2015-SERFOR-DE), annulling the 2014 guidelines. On one hand, the new norm authorized the establishment of plantations on public lands, not just on private property. On the other, it narrowed the concept of plantation by changing the categories of silvicultural systems, specifically removing reference to "managed natural regeneration". When questioned why the fallows were excluded, forestry officials indicated that they feared that the option to register timber produced through natural regeneration left open the possibility that the registry could be used to launder illegally harvested timber. We note, however, that in 2016, the regional forest authority of Ucayali requested and was granted an exception, and its registry does include managed fallow forest.

Peru's forest policy reform has attempted to address the diversity of stakeholders, forest types and management systems present in the country's Amazon regions. However, it is not clear that the emerging mechanisms adequately reflect conditions faced by smallholders or provide viable options for them. To address this knowledge gap, and to characterize observed systems and to discuss current interaction smallholders have with existing regulatory institutions, our team conducted fieldwork in the central Amazon region, which is a known center of smallholder forest use and timber production. In the following section we present our observations and assess the feasibility of the new regulatory mechanisms as options for formalizing smallholder forest production.

4. Methods

We used mixed methods to document the characteristics of smallholder forestry systems and farmer engagement in the timber sector among selected households in the Ucayali Region of the Peruvian lowlands. We combined key informant interviews with farmers and other key stakeholders with discussion groups and semi-structured interviews.

Our team conducted fieldwork from July through September 2015

Table 2
Procedures for the management, harvest, and transport of timber from plantations versus natural forests under low intensity management.

Plantation registry	Management declaration (DEMA)
(RDE 165-2015-SERFOR-DE) 1. Submit the form to register the plantation i. UTM coordinates of plantation perimeter ii. Indicate silvicultural system iii. Volume estimate per species 2. Submit an updated form prior to harvest with precise volume to be transported, which then generates a Transport Permit	(RDE 163-2015-SERFOR-DE) 1. Pay for the right to use the DEMA form 2. Submit DEMA form, with attachments i. UTM coordinates of the management unit ii. Volume estimate per species iii. Map with internal zones iv. List the silvicultural activities to be used and define a chronogram of these v. Define ecosystem protection measures vi. Identify potential environmental impacts 3. Pay for the visual inspection by a forestry official 3. Keep an Operations Log 4. Apply for Transport Permit 5. Pay a tax on wood harvested (VEN) 6. Submit an annual operating report and a final operating report

in the northern Ucayali and eastern Huánuco regions of Peru. The area is characterized by tropical lowland rainforest, flat terrain with minor undulations, and high rainfall. The residents depend on subsistence and small-scale commercial agriculture, cattle ranching, timber extraction, coca leaf production, off-farm labor, and commerce. Ucayali's capital, Pucallpa, is the regional economic pole for the study area and is connected by road to the national capital, Lima.

In consultation with forest authorities in national and regional government agencies, the research team identified four areas known for high levels on-farm timber production along the Aguaytia, Pachitea, Utuquinia, and Ucayali rivers. The team selected fifteen non-indigenous villages (Fig. 1). Village sizes ranged from 10 to 100 households. The landholdings of participating farmers included both floodplain and upland areas.

In each village, the team explained the research project and its goals and requested the participation of residents. The group discussions allowed the team to rapidly appraise the local panorama and to identify how residents engage locally in the sector. The field team used these meetings as the starting point for a purposeful snowball sample of households actively producing timber on their landholdings. Because we were looking to quantify and qualify the production of timber on farms, our village and household samples are biased towards areas

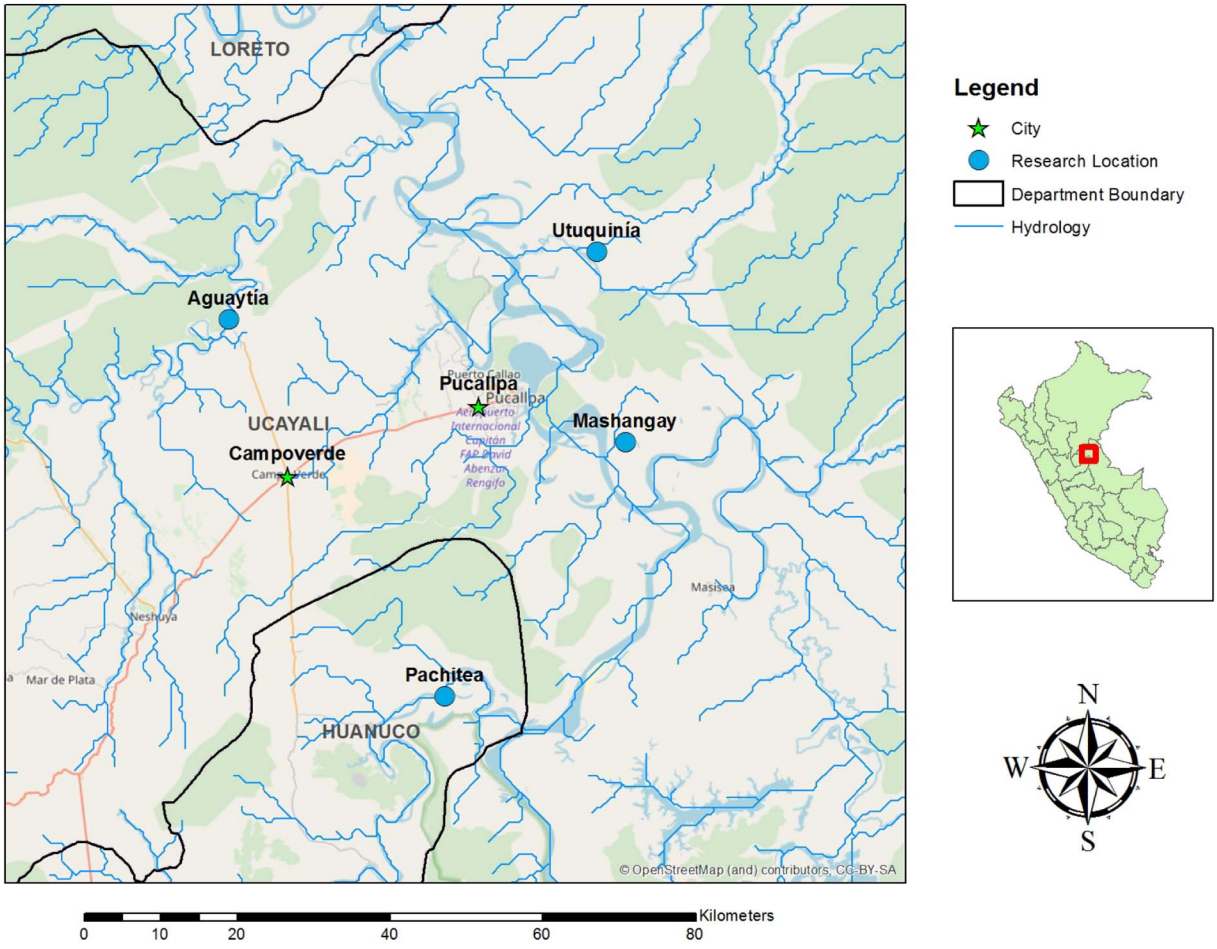

Fig. 1. Location of study sites in the regions of Ucayali and Huánuco.

where farm-forestry is active.

Sampling resulted in the selection of 79 households from the 15 villages to participate in semi-structured interviews. Thirteen of the interviews were with female household heads, and the rest were with men or with both female and male household heads together. Questions focused on livelihoods, production strategies, and market engagement. Informants were asked specifically about land tenure, forest management practices, recent timber sales, knowledge of forestry regulations, and participation in forestry extension projects. In discussion after the interviews, we shared information about the new forest policy with the families and asked for their opinion about reforms. In September 2015 the team returned to seven of the villages to share results and discuss options for engaging in formal mechanisms to sell timber from their farms.

5. Results

The following section uses survey results to characterize of sampled households and their strategies and practices for timber management and sale. We then organize the information as a case study illustrating how farmers produce and sell *bolaina* (local name for *Guazuma crinita* Mart., Malvaceae), an abundant pioneer species found in regional farm-forestry systems. The summary data and case study provide a basis for evaluating policy options for supporting and formalizing these producers.

5.1. Farm-forestry households

Most of the families in our sample were farmers, but their livelihood strategies were based on diverse production systems, often combined with off-farm labor. Of the 79 families interviewed, 63 or almost 80%, reported agriculture as their primary livelihood. Another 10% identified logging as their primary income source, i.e. timber extraction from mature forest. Other primary livelihood activities reported in small numbers were *bolaina* sales, shop keeping, health worker, and wage labor.

As is typical among rural Amazonian households, most informants had mixed farming systems, where the household maintained a diverse production landscape with multiple products and ecosystem services. Households met subsistence needs with annual crops, selling surplus production, but some also invested in commercial crops. Thirty percent had cacao agroforestry systems, and one household had a small area of coffee. Due to our sampling criteria, all households maintained patches of *bolaina* on their land and 62% of these had sold *bolaina* within the 12 months prior to the interview. Respondents mentioned that diversified production provided a safety net in the event of crop failure.

The size of landholdings in our sample varied between two and 200 ha, with the average size of 32 ha. Half of the landholdings were less than 20 ha and 65% were less than 50 ha. Only four properties were over 100 ha. All farmers reported maintaining multiple land uses on their plots, among them fields, pasture, fallow forest (*purma*), plantation, and mature forest (Table 3). Over half of the farms (58%) claimed some area of mature forest to their landholding (average forest area 24 ha).

Table 3
Frequency of land use types reported and average size per farm.

Land use unit	Frequency (% of farms)	Average and standard deviation area per farm (ha)
Field[a]	73	5 ± 6
Fallow	81	13 ± 16
Plantation	31	4 ± 5
Forest	58	25 ± 28
Pasture	10	9 ± 2
Total farm area		32 ± 38

[a] Includes areas for annual crops and agroforestry systems.

Table 4
Kinds of land tenure held by smallholder farmers in this study (n = 79).

Land claim document type	Percent of occurrence
Title	70
Certificate	18
None/no response	14
Manner of land acquisition	
Purchase	30
Community	24
Occupation	24
Inheritance	19
Donation	3

Among the sampled households, 54 (68%) had received title to their land, or at least a portion of their land claim. Another 14 households had received a type of semi-official or 'imperfect' title that recognized them as legitimate occupants (known as *constancia de posesión* or *certificado de posesión*). Such documentation is granted by local authorities and is usually a precursor for initiating land titling. The remainder of the sample had no documentation for their land holding or provided no response (Table 4). Despite norms against titling forestlands, 38 farms claimed forest area in their title or land certificate. Holding clear property rights is necessary for demonstrating the legitimacy of resource access claims, and the type of rights held determines how citizens gain legal resource rights.

5.2. Timber management practices

Farmers sampled in this study demonstrated a diversity of silvicultural strategies and practices. They established timber trees on their farms by managing natural regeneration, transplanting volunteer seedlings, broadcasting seeds, direct seeding, and by planting seedlings from nurseries. Farmers reported experimenting with different production strategies through trials in their fields, and modifying their practices in response to the results. Here we discuss the most common management practices we observed.

Most farmers agreed that the natural regeneration of timber species in their agricultural fallows is a valuable resource for their livelihoods. Some reported actively managing fallow stands, especially in the establishment phase, by selecting seedlings, determining spacing, and filling gaps with transplanted seedlings (Fig. 2). Others managed passively, allowing competition among plants to drive the development of the stand, and intervening only occasionally, for example to cut vines

Fig. 2. Bolaina saplings transplanted from a nearby field to enrich a maturing field of cassava.

from the stems. In one village, several farmers reported clearing young fallows (and selling the timber), then transplanting *bolaina* seedlings one day, and planting maize seeds the next. In four months, they report to harvest the maize and let the *bolaina* take over the field. This is one strategy that could be considered timber plantation under the concept of *taungya*.

Some farmers also reported enrichment planting to introduce or increase timber and other tree species into their fields and fallows. Twenty-three percent of the farmers had retained areas planted with high-value timber species such as *Dipteryx* spp. (Fabaceae, *shihuahuaco*), *Swietenia macrophylla* King (Meliaceae, *caoba*), *Amburana cearensis* (Allemão) A.C. Sm. (Fabaceae, *ishpingo*) sp., and *Cedrela odorata* L. (Meliaceae, *cedro*). Some were planted on the farmer's own initiative, and others were introduced in government reforestation programs from the 1990s. However, our field observations of these planted stands revealed that most were in poor condition, likely from lack of management or inappropriate siting. The Meliaceae species (*Swietenia* and *Cedrela*) had suffered early attacks from the insect *Hypsiphyla*, as evidenced by trunk division low on the bole, and others had small diameter stems or malformed boles from excessive competition. These enrichment plantings should be considered under the Forest Plantation Registry.

Thirty-one (39%) farmers reported having timber plantation ("*madera en plantación*") on their farm, although producers did not appear to distinguish between conventional timber plantations (monoculture, systematic arrangement of trees) and their enrichment plantings. Only ten (13%) of these reported participating in plantation development projects sponsored by the Ucayali government. "*Gateando yo sembraba mis bolainas*" ("Crawling, I planted *bolaina*"), exclaimed one villager as she recounted the collective enthusiasm she and her neighbors had about the plantation project. Of these, six farmers received technical training, and only eight saw their trees mature enough to sell the timber. The development projects did not provide them with information on how to legally sell timber, so they ended up selling the timber through informal channels. Many of their plantings failed, farmers reported, due to improper siting and lack of management due to the lack of technical follow-up by the project.

When asked why they did not devote more land to conventional timber plantation, respondents linked the question to constraints on crop production. They depend on household or hired labor to clear forest for crop land, which is later allowed to revert to fallow or could be planted with trees. Farmers would only fell forest if they could first earn income from cropping for several years prior to dedicating that field to forestry. Expanding or intensifying such a system requires cash for additional day labor to cultivate more land or to cover time invested in management activities to enhance tree growth and development. Only capitalized actors are able to do this.

When pressed about establishing tree plantations, respondents highlighted the need for planting material (64% of the sample), financial assistance to clear additional forest and prepare the land (41%), and technical information specifically on planting (e.g., suitable site conditions, plant spacing) and pest management (33%). Two informants mentioned the need for help to deal with the permit system.

In either case, whether the timber is produced in the fallow system or in a formal plantation, respondents indicated a need for short-term loans specifically for the harvest, transformation, and transport of the timber.

5.3. Case study on bolaina

Bolaina is an early succession, fast-growing timber species in lowland Amazon and is one of the main species in the market for small-dimension lumber (*tablilla*). Another pioneer species, *Capirona*, (local name for *Calycophyllum spruceanum* (Benth.) Hook. F. ex K. Schum., Rubiaceae), dominates in other areas of the lowlands, particularly in agricultural landscapes on the floodplain (de Jong, 2001; Nebel et al., 2001; Sears and Pinedo-Vasquez, 2004). Other naturally-occurring pioneer commercial species in the agricultural landscape are *Ochroma pyramidale* (Cav. ex Lam.) Urb. (Malvaceae, *topa*) and *Jacaranda* sp. (Bignoniaceae, *humanasamana*). Seventy of the sampled households in this study (85%) had natural regeneration of *bolaina* on their landholding.

The *bolaina* value chain supports a number of actors – including smallholder farmer producers, mobile millers and transporters in the rural zone, and buyers, millers and bureaucratic intermediaries in the urban zone in the Peruvian Amazon (Putzel et al., 2013). It feeds an urban housing industry that serves the low-resource populations in the larger cities of Peru (Padoch et al., 2008).

The history of bolaina dynamics in the region was described by one long-time resident in the Aguaytia watershed:

> *When I need money, I harvest* bolaina. *[This village] was a* bolainal *[an area dominated by bolaina trees], and we used to fell it [and burn it] because it was like a weed. It had no value, and, furthermore, there was no sawmill. Since 1994 or '95 we started to sell bolaina trees with a diameter greater than five inches, which had some value. More buyers started to appear in 1998, and we harvested from the* purmas *[fallows]; there was no "reforestation". I started selling bolaina in 1997, when its price was S/0.30*[4] *per hundred tablillas. Once you burn the* chacra *[agricultural field] to plant corn, the bolaina seedlings appear after 20 days. Once we harvest the corn, we leave the bolaina.*

Seventy percent of the respondents in our study suggested that the market for *bolaina tablillas* has grown in the past five years, and over half reported that they have "increased their participation in the sector" in the last five years in either production or sale from their farms.

Farmers reported selling *bolaina* wood in three ways, consistent with practices found elsewhere in the Amazon (Mejia et al., 2015; Sears and Pinedo-Vasquez, 2014): by stand or tree, *tucos* (log sections of 2.5 m length), or *tablillas*. The nature of the sale of timber from these farms varies and depends on multiple factors, including distance to the market, equipment used and financial capital available, as well as social networks and relationships. We assessed 73 sale events within the past three years reported by 54 farmers (Table 5).

Nine of the transactions were for the sale of standing *bolaina* trees. In such cases, a miller and crew do the work in the farmer's fallow with a mobile mill. The miller assumes the costs of harvest, transformation; they transport of the rough lumber and arrange for its sale. The farmer may request payment for their trees in the form of cash or lumber. Farmers can capture more income by selling *tucos* (16 cases) at the farm-gate, or transport to a nearby river port. The majority of the transactions reported in our sample where for the sale of *tablillas* (47 cases). When selling *tablillas*, the farmer assumes the cost of harvest, transformation and transport of the lumber. These producers usually contracted the services of either a mobile miller or a fixed mill. The producer then sells the *tablillas* to a buyer (who might be the miller).

For the sale of *tablillas* and *tucos*, farmers usually rely on some form of credit. Of the 73 sale events reported in our sample, 58% were financed by the farmers, 32% by a moneylender or buyer, and 11% by a combination of both. No farmer financed the sale with funds from a bank, a cooperative, or a village fund.

While farmer informants did know that permits were required to extract high-value timber from natural forests, three-quarters were unaware of precise regulatory requirements for pioneer timber species from their farming system. None of the *bolaina* sales reported by these respondents occurred with a timber harvest or transport permit. Only one individual had actually acquired a permit for a future sale.

Together, these characteristics suggest that *bolaina* production and

[4] Monetary amounts are presented here in the Peruvian Nuevo Sol to make local interpretation easier. At the time of data collection, the exchange rate was S/3.00 to US $1.00.

Table 5
Terms of reported individual sales of bolaina in the past five years (n = 73).

Parameter	Trees	*Tucos*	*Tablillas*
No. of sale events	9	16	47
Price/earnings			
Price (S/.) offered per unit, range	2.0–10.0	1.2–3.5	0.80–1.95
Earnings (S/.) reported per sale, range	40–2000	100–1650	200–60,000
Number of units sold			
Average (st. dev)	148 (± 102)	457 (± 382)	9302 (± 14,162)
Min./max.	30/200	200/1100	500/60,000

access to the market, at least for smallholder farmers, is informal. Producers and millers alike indicated a desire to engage formally in the sector to avoid risk of fines or confiscation of product by state authorities. After the interview, we informed participants about the new plantation registry proposed by the government. Respondents reported that transporting timber was usually the riskiest part of the transaction because the police or forest authorities could seize the undocumented wood, assess fines, or ask for bribes to avoid both of those things. They thought the formal documentation in the plantation registry could improve security for their on-farm timber resources through avoiding risk of confiscation or alleviating the need to pay bribes in transit. Several informants suggested that since there were no authorities between their farm and the buyer, they ran little risk in moving undocumented timber. Thus, they said, they saw little need to register their timber or seek a permit.

Given this information about the *bolaina* sector, what mechanisms do the new forest regulations present for formalizing the engagement of these timber producers in the forest sector? The two available mechanisms, the plantation registry and the DEMA, have limitations. Possibly the best scenario for smallholder farmers who hold a title to their land would be to register their stands in the plantation registry, accommodating their particular silvicultural system to the sanctioned categories. While the national plantation norm does not include timber produced through natural regeneration, and thus excludes the majority of on-farm bolaina production, the special dispensation in the Ucayali region at least opens this option up to many families. The harvest of timber in fallows elsewhere requires a DEMA, except that to date the norm for harvest in secondary forest has not yet been published. Furthermore, even if a DEMA allowing $6.5 m1 m^3\ ha^{-1} y^{-1}$ is allowed, this will not work since in a shifting agricultural cycle fallows are clear cut for later planting to annual crops, and a typical hectare of fallow of six years can easily have $38 m^3$ of *bolaina* timber (Sears and Pinedo-Vasquez, 2014). Furthermore, the technical and financial requirements are beyond the capacities of most smallholder producers, putting the DEMA option out of reach for low-income farmers, as the DEMA entails significant administrative costs, whereas in theory the Plantation Registry is free (see Table 2).

In the end, there is currently no feasible national regulatory mechanism for low-income smallholder farmers to harvest timber produced by natural regeneration as part of the agricultural cycle in diversified farming systems.

6. Discussion

The results presented above illustrate the general characteristics of the farm forestry sector and the limitations of existing policy options for formalizing these production systems. Here, we present recommendations to strengthen and secure the formal participation of smallholder farmers in the forest sector.

6.1. Farm-forestry

The first objective of this research was to characterize the systems used by smallholders for timber production in Ucayali and lowland Huánuco of the Peruvian Amazon. Our results indicate that timber is still an integral part of a diverse production landscape and agricultural cycle for many farmers, a finding that is consistent with past studies (Coomes et al., 2000; de Jong, 2001; Denevan and Padoch, 1987; Padoch and Pinedo-Vasquez, 1996; Pinedo-Vasquez et al., 2001). Farmers maintain a patchwork of fields, fallows and forests where each year some portion is dedicated to annual crops while other fields are left fallow to recuperate soil fertility. In these fallows, commercial timber species spontaneously regenerate creating a timber production system subsidized by nature. While technically a secondary forest, the fallow stand is an anthropogenic production space in which farmers apply distinct forestry practices to improve the density, quality and yield of commercial and other tree species. Since the fallow is a single-aged stand, the farmers will want to clear-cut when they need the area for a new cropping cycle.

We also found that very few farmers have dedicated their land to monoculture plantation forestry, as there are reasons farmers do not convert their dynamic, diverse, resilient production systems. First, fallow forestry is a low-input, low-capital production system based in the management of natural regeneration and enrichment plantings. In comparison, conventional plantation forestry requires considerable labor, material, financial and technological inputs, and these investments coupled with the lower diversity, add up to greater risk. It is fundamentally based in the management of natural capital using local ecological knowledge, making farm-forestry imminently more accessible to low-income smallholder farmers than conventional plantation forestry.

Second, the production cycle in the fallow reflects the farmer's agricultural decisions and cash needs. Maintaining a timber-rich fallow forest provides a financial safety-net, like having a savings account that accrues interest annually, and from which withdrawals can be made on an as-need basis. As one farmer put it, “Bolaina is a reserve and savings for the future.” This is helpful to farmers who have no access to banks or equitable loans. Third, timber is but one of several components of an integrated production landscape, with the rotation of fields of annual crops and fallows complemented by permanent orchards, pasture and mature forest. The system provides multiple goods and ecosystem services, and multiple sources of income.

Finally, the timber from farm forestry feeds a market chain that is familiar and accessible to rural farmers. The transactions are straightforward and similar to their other agricultural transactions. Furthermore, fallow forestry is forestry by the poor for the poor: the timber from the fast-growing pioneer fallow species is destined for the domestic market, serving low-income residents of urban and peri-urban areas (Padoch et al., 2008).

Surely there is benefit in promoting technical forestry systems in the form of timber plantations, and we have seen how capitalized landowners have established productive plantations; however the cost of installing and maintaining a timber plantation is beyond the means of most farming families. Thus, conventional forest plantations are unlikely to catch on in this group without a subsidy or secure long-term loan program. Nor do we promote the conversion of the diverse, resilient and adaptive production systems – farming systems that have sustained rural smallholder farmers through countless product booms and busts over the decades (Pinedo-Vasquez et al., 2002; Pinedo-Vasquez et al., 2001) – to monoculture tree plantations. Simplification dangerously reduces resilience in uncertain market, climate and regulatory environments, as are found in Peru. Rather, we recommend that the state recognizes these diverse systems for their value in livelihood security, forest conservation, and timber production, and accommodates the realities of the value chain into the regulatory mechanisms, even perhaps deregulating the fast-growing pioneer species of timber

produced on these farms.

6.2. Conditions for smallholder engagement

The second objective of this project was to evaluate the viability of mechanisms defined in the new forest regulations for engaging smallholder timber producers, and to assess the likelihood that these producers will formalize the production and sale of timber produced on their farm.

We found that timber from the farms of smallholder producers is almost without exception established and managed informally and sold without proper legal documentation. Why is this case? Formalization depends on three factors: the existence of relevant regulatory mechanisms and administrative channels; right conditions to engage, including proper land tenure, secure access to the market, and capital; and that the benefits of formalization outweigh the costs of the status quo. Each of these points is examined below.

In the first place, are the current regulations sufficient? Formalizing timber production through registering timber in the plantation registry or developing the DEMA for secondary forest (advanced-age fallow) could help smallholder producers reduce risk and improve income. However, neither of these modalities quite captures the realities of the lowland Amazon farm-forestry system. We do not believe that the new norms go far enough to open the channel for smallholder farmers to follow the rules and thus will not result in widespread formalization of farm forestry, for two reasons.

Second, the distinction the State makes between planted trees and natural regeneration is difficult to apply in farm forestry systems, since on-farm silvicultural systems are varied and complex (Chokkalingam and de Jong, 2001), and thus defy the simple categories defined in the law. If a farmer enriches her field with seedlings of fast-growing species found nearby to fill gaps among seedlings originating by natural regenerating, could this whole field now be considered a plantation? Will the forest technician recognize it as such? So, again, we suggest that the state accommodate these diverse production systems by including their categories appropriately in the norms, such as enrichment plantings and managed natural regeneration.

No viable national mechanism is available at this point that would allow for the sale of timber produced through the cyclical nature of shifting cultivation. The full forest management plan and the DEMA have harvest limits, and the national plantation registry does not consider trees established by natural regeneration. Few producers have the capital – technical, financial, time, and knowledge – to fulfill the bureaucratic and technical requirements to comply with either the DEMA or the full management plan requirements.

The inclusion of managed natural regeneration in fallows in the Plantation Registry by Ucayali's regional government is a laudable effort to adapt mechanisms to include these endogenous silvicultural systems. This effort is exactly the type of adaptive experimentation likely to develop appropriate policy options that fit smallholder needs while also satisfying regulatory requirements of the state. Peru's national authorities should closely monitor such efforts to evaluate outcomes and identify viable options and to revise norms in response. We see this as a viable approach for defining options for the formalization of farm timber short of complete deregulation.

The second condition for smallholders to formalize their timber production is that they have the capacity to engage in the formal procedures. The two sub-conditions for this are that they have proper rights to the land on which they produce timber, and that they have the capital to engage.

Securing land tenure is elemental for gaining timber rights and conducting forestry operations (Cronkleton and Larson, 2015), since timber is a long-term investment. One-third of the farmers in our study did not possess a land title. Thus, prior to pursuing any option to formalize their timber production, they would have to apply either for land title or a contract for usufruct rights. Until the land titling program has been extended to all corners of the country, which unlikely in the near future, and until the usufruct contract mechanism is activated (Robiglio and Reyes, 2016), the new law becomes a yet another policy innovation that misses the urgent needs of a significant portion of rural Amazonians.

Few rural farmers have the capital to invest in plantation forestry or to finance the harvest of timer. They do not keep savings from which to draw capital or have access to secure loans. Rather, they rely on informal loans or the services of intermediaries to harvest, process and transport their timber. Some producers reported supportive relationships with moneylenders who facilitated access to the market, while many expressed frustration with dishonest moneylenders cum buyers who renege on the terms of loans and purchase price. Further insecurity comes from dishonest forest authorities, who demand bribes for safe passage along transportation routes.

Whether farmers manage natural regeneration or plant trees, respondents in this study expressed interest in receiving information and training in several areas, namely management practices to improve stand productivity, estimation of the volume of standing timber stock and calculation of volume of sawn wood, market requirements of wood quality, and market prices and dynamics.

Armed with this technical capacity, farmers could benefit from a simple, short-term loan mechanism that would allow them to harvest and transport their farm timber independently to mills and other points of sale. Small-scale loan programs targeted to the forest sector through the independent bank Agrobanco may eventually work for these actors, but a high interest rate and rigid requirements common to the banking industry will likely be unattractive to low-income farmers. Our recommendation is for communities to consider ways to generate a local community fund, with favorable terms, from which residents could draw very short-term loans (up to one month) for enough to cover the operational costs of harvest and transport of their timber (on the order of S/0.6000).

6.3. What we stand to gain from formalization

In our view, it is worthwhile for the Peruvian government to recognize the diverse timber production systems of smallholder farmers. In our study area, we estimate that in each village 550 ha of farmland was dedicated to some type of *bolaina* production, either active or passive. (This estimate assumes that 78% of the families in the village produce *bolaina*, each with an area of 13 ha.) Scaling that up to the Ucayali region, based on numbers of farming families with similar landholdings (MINAG and INEI, 2013), we estimate that in the entire region smallholder farmers dedicate 90,000 ha to production of this species, producing 950,000 m^3 of *bolaina* sawn wood annually.

Almost all of the *bolaina* timber currently produced in Ucayali is moved from the farm to mills through informal channels, without documentation of its origin, rendering it “illegal”. Should these small-scale timber producers have a simple manner of registering their production, the government could count this towards meeting the goals of area reforested and amount of timber produced legally. This would go a long way in generating confidence in Peru's ability to reform the timber sector and to meet their objectives in sustainable forest management.

7. Conclusions

We conclude that the new regulatory mechanisms do not go far enough to capture the diversity of systems—and especially the most productive component of the farm-forestry system: the agricultural fallow. In the absence of viable regulatory mechanisms to harvest and sell the timber from fallow forests that are cyclically cleared for agricultural use, the woody biomass of these highly productive secondary forests will either end up being sold illegally at increasingly serious risk to the producer, or it will be burned (Fig. 3), resulting in greenhouse gas emissions.

Fig. 3. Capirona trees in a fallow that will not be utilized.

While difficulties presented by a culture of corruption in the forestry sector and the incomplete land titling process give us pause, we do believe that with some adaptive management of the regulations and raising awareness among forest authorities of the farm-forestry systems, over time we may see some degree of formalization among smallholder farmers who produce timber on their landholdings.

At the same time, we recognize that formalization is not a panacea to solving the complex problems of rural livelihood and sustainable natural resource management, especially for the most marginalized actors (Putzel et al., 2015). In the case of *bolaina*, we feel that the new policy still over-regulates a product—timber of pioneer species produced in young agricultural fallows—that by all intents and purposes could be considered an agricultural product (Masipiqueña et al., 2008; Sears et al., 2014). We also see little point in prioritizing oversight of the movement of pioneer species over much more valuable and vulnerable species and forest ecosystems.

Many of the farmers in this study expressed a desire to operate legally, and the state has a strong incentive to legalize timber that is currently harvested outside of the gaze of forest authorities. However, unless the benefits of formalization outweigh the costs, including the opportunity costs of forgoing the status quo arrangements, there will be little incentive to formalize. The forest plantation registry is the only mechanism in the new forest policy that has potential to legalize a significant volume of timber from fast-growing pioneer species produced by smallholder farmers. For the registry to work, however, we recommend that the sustainable on-farm forestry systems employed by these actors should be reflected in the legal categories of silvicultural systems in the regulations, whether those trees are planted in straight lines, transplanted into fields and fallows, or originate as natural regeneration in the agricultural field or pasture. Policy-makers should monitor the pioneer efforts of the Ucayali forest authority in doing just this. Alternatively, we recommend that the state actually deregulates the movement of a specific list of fast-growing pioneer timber species. In either case, the national forestry office should work with regional forestry offices to organize campaigns in rural zones to provide information and services to villagers about the new forestry regulations and mechanisms to legalize timber produced on the farm as well as to provide technical extension services and training in the value chain dynamics, as driven by producers' needs.

These innovative changes would free state forest authorities from regulating, monitoring, and enforcing what is, on the whole, a sustainable, productive, and profitable system for producing timber at the small scale. The result will contribute to alleviate poverty, reduce emissions from agricultural systems, and eliminate informality in the production of fallow timber, thereby legalizing a significant volume of timber produced in Amazonia. Furthermore, formally recognizing farm-forestry and instituting only minimal regulations on it could increase domestic timber production, improving Peru's competitive position in at least its domestic forest product market.

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