A survey of Bolivian lumber drying operations

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Abstract

The Bolivian secondary forest products industry has experienced substantial growth during the last 10 years. Particularly, important investment has taken place in lumber drying capacity. Unfortunately, little information is available regarding lumber drying technology and practices used, which is essential for the formulation of improvement strategies. The Bolivian wood products industry was surveyed to determine lumber drying capacity, technology and practices. The information collected by the survey was complemented by observations made during on-site visits to six lumber drying operations in Bolivia. Thirty-one companies were surveyed and 25 completed the questionnaires. Respondent companies represented 90 percent of the total estimated lumber drying capacity of Bolivia. Results show a total drying capacity of 6.1 million board feet and 167 kilns. Drying capacity was concentrated in a small number of companies and in the eastern region of the country. Technology and practices were highly variable, and standard drying schedules for commonly dried species were not used. Many of the kilns were locally made, and commercial kilns were mostly of European origin. Three species made up 60 percent of the total volume dried, and lumber usually entered the kilns green, with 70 percent of the companies drying more than three quarters of their material green-off-the-saw. Drying control methods were equally divided between electric probes and kiln samples; electric probes prevail among commercial kilns.

Bolivia is located in the heart of South America, sharing the Amazonian rainforests with Brazil. Approximately half of its territory, 53 millions hectares, is covered with forest (CADEFOR 2002), representing the sixth largest area of tropical forest in the world.

Traditionally, three species—mahogany *(Swietenia macrophylla)*, South American oak *(Amburana cearensis)* and Spanish cedar *(Cedrela odorata)*—made up the majority of harvested timber, which accounted for 91 percent of total cut in 1992 (Barany et al. 2003). In the last 10 years, as a result of a new Bolivian forestry law approved in 1996, and efforts of several organizations with international support, Bolivia has become the leader in certification of tropical forests: More than 1.9 million hectares of its forests have become FSC-certified (Forest Stewardship Council 2006). A traditional exporter of unprocessed raw materials, Bolivia started to boost the manufacturing of value-added products, which had a 7-fold increase between 1994 and 2004 (Bolivian Forestry Chamber 2006). While logs and sawn lumber still represent a significant portion of forest products exports, they have gradually reduced their participation in the total (National Inst. of Statistics 2006). From 1993 to 2003, the percentage of primary forest products exports has decreased from 68.4 percent to 28.1 percent, whereas value-added or secondary products have increased from 31.6 percent to 71.9 percent (BOLFOR 2005). Regarding species used by the industry, there has been a shift from traditional woods—mahogany, South American oak and Spanish cedar—to lesser-used species, reducing the stress on the natural resources caused by the extremely selective harvesting of the past.

In part as a result of these changes, there has been substantial capital investment by the forest products industry in Bolivia in the past decade, particularly in lumber drying capacity, since the manufacturing of value-added wood products require dried material. However, there is a lack of knowledge concerning proper drying and information regarding newly

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used species. The increasing utilization of lesser-used species presents many challenges: There is little or no information available on the drying properties of these woods (Barany et al. 2003), mixed loads are very common, and the technology in use is not always the most appropriate (Lamb and Araman 2002, Bond 2004, Kabir 2004).

Several nongovernmental organizations (NGOs), with U.S. financial aid, are currently supporting the industry with technical assistance. This study was undertaken to assist these efforts by assembling much needed information regarding lumber drying, which could be used to develop tools for improving the performance of drying practices. The objective of the survey was to collect information about capacity, technology and practices of lumber drying in Bolivia. This information is needed in order to identify opportunities for improvement, channel international aid more efficiently, and to design training programs for kiln operators and production managers.

Table 1. — Location, capacity, and main products of Bolivian companies visited in December 2005.

Company	Department	Number of dry-kilns	Drying capacity	Main products
			(MBF)	
A	Santa Cruz	11	580	Garden furniture
B	Santa Cruz	16	370	Garden furniture, millwork
C	Santa Cruz	10	430	Millwork
D	La Paz	5	140	Interior and garden furniture, millwork
E	La Paz	4	102	Flooring and furniture parts
F	Cochabamba	3	60	Millwork

Methodology

The Bolivian wood products industry was surveyed to determine current lumber drying capacity, technology, and species being dried. The questionnaire was developed and pretested with faculty at Virginia Polytechnic Institute and State University and at one Bolivian wood products company. In order to identify the target population, a list of companies owning at least one dry kiln was developed by consulting three main sources: (1) the Bolivian Center for Promotion (CEPROBOL), a government agency for the promotion of exports and which provides a directory of exporting companies by product category; (2) the National Chamber of Industry (Cámara Nacional de Industria), which comprises all local chambers of industry and has a list of affiliated industries by product category; and (3) the Bolivian Institute of Statistics (Instituto Boliviano de Estadística), a government agency in charge of all national statistics, similar to the U.S. Census Bureau. A list of 172 companies related to either manufacturing or commercialization of wood products resulted from the initial search. This list was reduced to companies owning lumber drying capacity by conducting phone calls, asking whether they owned at least one dry kiln. In this way, the initial list was narrowed to 40 companies running lumber drying operations. Further reductions included eliminating duplicated data, mainly companies that operate under two different names, reducing the total number of companies to 31, which constituted the target population of the survey.

Once the companies of interest were identified, questionnaires were mailed, with a cover letter from CADEFOR, the Bolivian NGO partner for this project, explaining the purpose of the survey, the institutions involved, and instructions for filling out and submitting the survey. Twenty-five companies sent back completed questionnaires. Then phone calls were made to the six nonrespondents to determine only their drying capacity in BF and number of kilns. This way, the country's total lumber drying capacity was estimated. The survey was conducted from August to November of 2005. Respondent firms—the 25 companies that sent back completed questionnaires—represent 90 percent of the total estimated drying capacity.

In December of 2005 the authors visited six Bolivian companies to conduct evaluations of lumber drying practices, and gather information to complement and verify the survey results (Espinoza, 2006). **Table 1** lists capacity, location, and main products for each of the visited companies.

Results and discussion

Lumber drying capacity

According to the results of the survey, the estimated total lumber drying capacity in Bolivia is 6,104,250 BF in 167 kilns (**Table 2**). Capacity is concentrated in a small number of companies, with one-third of the companies owning 70 percent of the total capacity. Capacity is also concentrated in the eastern side of the country (departments[1] of Santa Cruz, Beni, and Pando), where 78 percent of the total drying capacity is located (**Table 2**). The majority of secondary processing plants that need kiln-dried lumber are located close to the cities of Santa Cruz, La Paz, and Cochabamba. These areas have more available labor, services and the required manufacturing infrastructure, and a great part of the timber extracted in Beni and Pando is shipped there to be dried and processed.

Species dried

Almost 60 percent of the lumber dried in year 2004 to 2005 was: South American oak (*Amburana cearensis*), mara macho[2] (*Cedreling cateneaformis*) and yesquero (*Cariniana estrellensis*) (**Fig. 1**). While no data exist on volumes dried for each species in previous years, it is thought that these results confirm the shift of production from traditional species (mahogany, South American oak and Spanish cedar), to alternative woods, since only South American oak was listed among the 10 most dried species. Specific drying schedules are needed for the currently processed species.

Lumber drying technology

Thirty-six percent of the total number of kilns is of local construction. Among commercial kilns, Italian and German brands are preferred, making up 59 percent of the total (**Fig. 2**). Since a large percentage of kilns are homemade, any educational program to improve drying methods should include information regarding the design and inspection for lumber dry kilns.

The average kiln size was relatively small, 36,600 BF (based on 2-inch thick lumber) but highly variable (**Table 2**),

[1] Department (departamento) is the main administrative division in Bolivia. The nine departments of Bolivia are: Beni, Chuquisaca, Cochabamba, La Paz, Oruro, Pando, Potosi, Santa Cruz, Tarija

[2] Common names given here are used in Bolivia.

almost half of the average kiln size in the United States (Rice et al. 1994). The smaller kiln sizes reflect the smaller size of the overall industry compared to that of the United States, but also indicate a need for greater flexibility because of the large number of species dried. Fifty-six percent of kilns were 6 to 10 years old (**Fig. 3**), suggesting that many will soon require major maintenance work. The majority of kilns can operate at maximum temperatures between 71 and 80 °C (160 to 175 °F) (**Fig. 4**). However, during visits to several companies in Bolivia (Espinoza 2006), kiln operators said that they rarely use temperatures higher than 65 °C (150 °F). Most likely these lower temperatures are used because: the majority of lumber is 2-inch thick, most of the species dried have high densities, and the lack of knowledge of safe drying rates for most common species.

Drying practices and methods

Air-drying is not a common practice in Bolivia, which places a lot of pressure on kiln-drying capacity. The majority of companies receive lumber "green-off-the-saw" and put it into the kilns as soon as possible to avoid degrade; 70 percent of the companies answered that more than three quarters of their incoming lumber is put in kilns "green-off-the-saw" (**Fig. 5**). Drying schedules were invariably based on moisture content (MC), which was expected considering that mostly hardwoods are dried. Companies predominantly develop their own schedules, but they also resort to published materials and past experience from other companies (**Fig. 6**). The most common published resources for drying schedules were the Manual of the Andean Group for Lumber Drying (López et al. 1989) and the Manual for Kiln-drying of Lumber (Viscarra 1998).

Regarding control of the drying process, locally made kilns were chiefly manually controlled, while commercial kilns generally used electric probes (electrode pins embedded in the wood to measure MC using electrical resistance). One hundred percent of locally made kilns and 29 percent of imported kilns were controlled with sample boards, and 71 percent of imported kilns were controlled with probes (**Fig. 7**). During the on-site visits, however, it was seen that even kilns capable of automatically controlled running were not operated in that manner, and changes in the drying schedule were usually made manually. Most operators acknowledged differences of up to 5 percent between readings from probes and calculations derived from sample boards. It was also observed that most kiln operators used portable meters to check MC during and after drying (Espinoza 2006).

Fuel used for kiln-drying varied by department. Natural gas was relatively affordable and available for industrial use in the main cities of La Paz, Cochabamba, and Santa Cruz. As was expected, a significant proportion of industries in these three departments used natural gas as the energy source for heating dry kilns, as can be seen in **Figure 8**. Wood residues invariably refer to dry scrap wood, as there are no wood-dust boilers currently in Bolivia.

Table 2. — Bolivian lumber drying capacity by geographic region.

Geographic region	Number of kilns	Capacity[a]	Percentage	Average kiln size
		(MBF)	(%)	(MBF)
Santa Cruz	98	3,791	62	38.7
La Paz	26	782	13	30.1
Beni	14	610	10	43.6
Cochabamba	15	508	8	33.9
Pando	9	345	6	38.3
Tarija	5	68	1	13.6
Total	167	6,104	100	36.6

[a]Capacity based on 2-in-thick lumber.

Summary and conclusions

The Bolivian wood products industry was surveyed to determine current lumber drying capacity, species dried, technology and methods used. It was determined that the total lumber drying capacity was 6.1 MMBF and there were 167 kilns in the country. Lumber drying capacity was concentrated in a small number of firms, and one-third of companies owned 70 percent of total capacity. Capacity was also

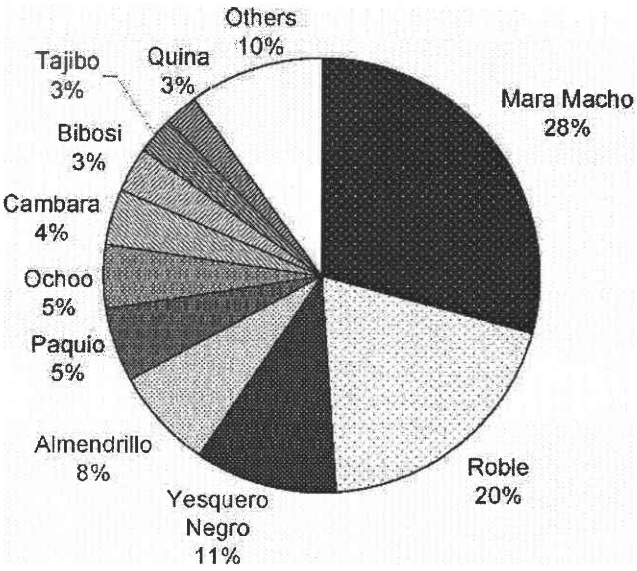

Figure 1. — Percentages of the 10 most dried species in Bolivia (2004 to 2005).

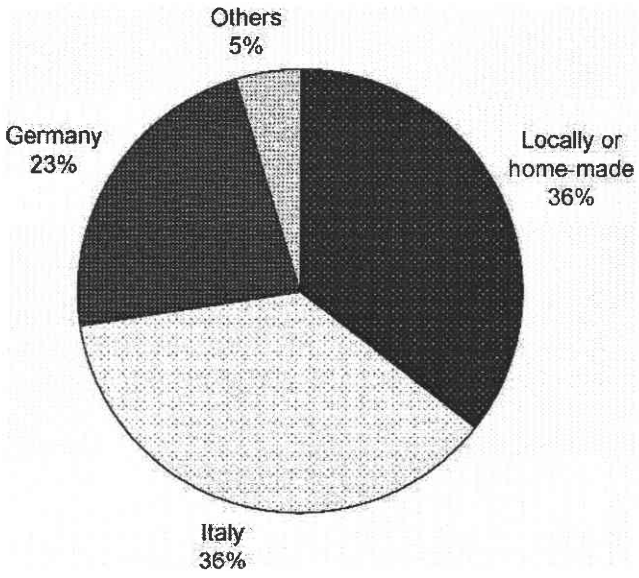

Figure 2. — Origin of lumber-drying kilns in Bolivia.

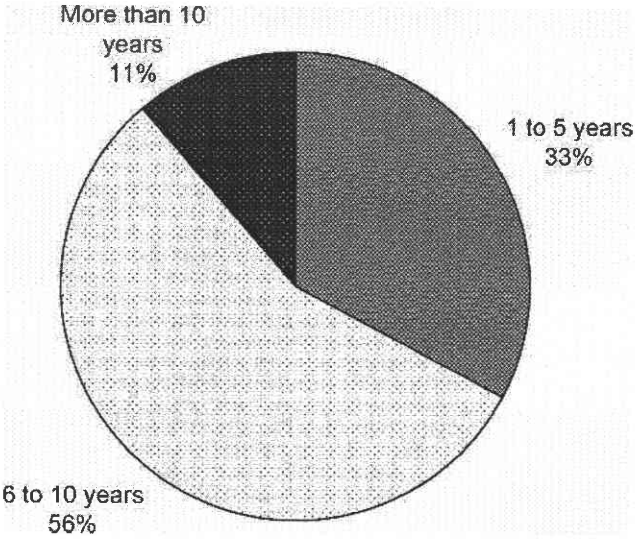

Figure 3. — Age of lumber-drying kilns in Bolivua.

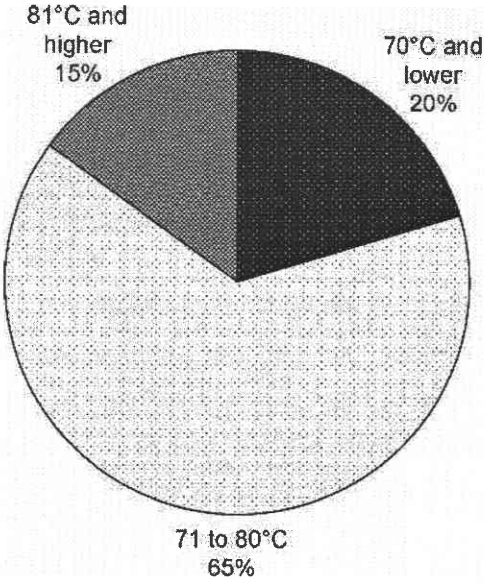

Figure 4. — Maximum operating temperature of lumber-drying kilns in Bolivia.

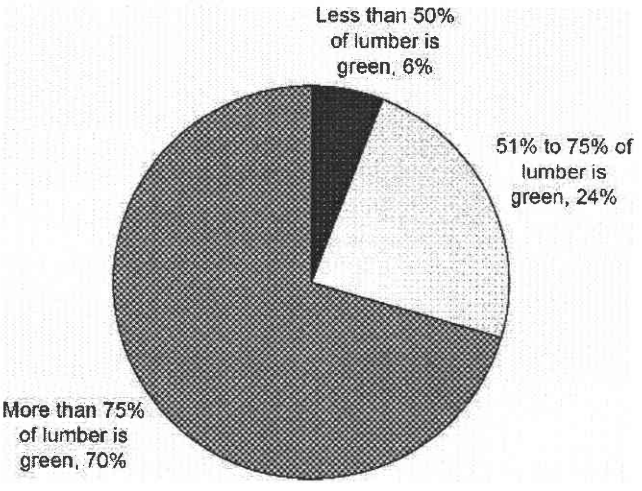

Figure 5. — Proportion of green lumber coming into the kilns.

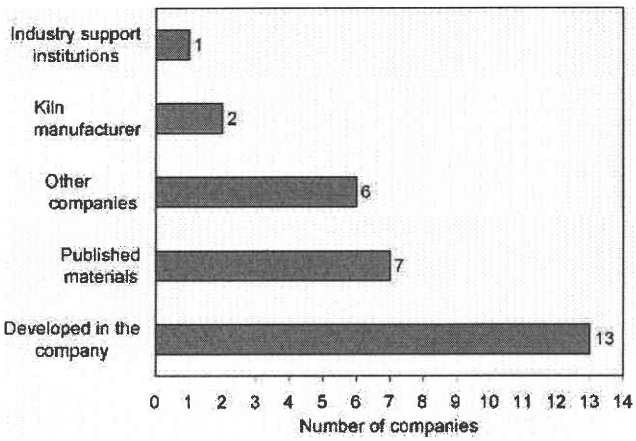

Figure 6. — Sources of lumber-drying schedules used by Bolivian kiln operators.

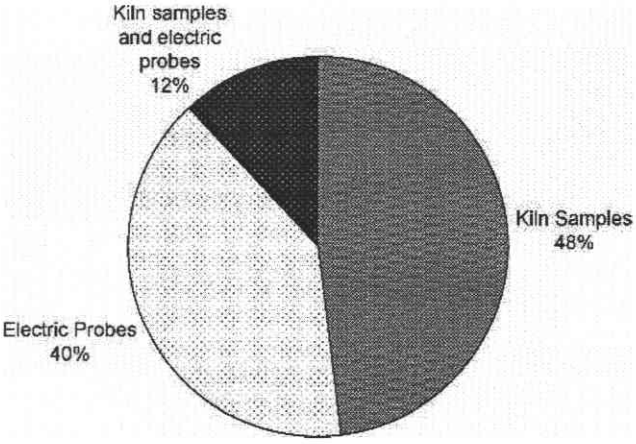

Figure 7. — Method used for lumber MC control.

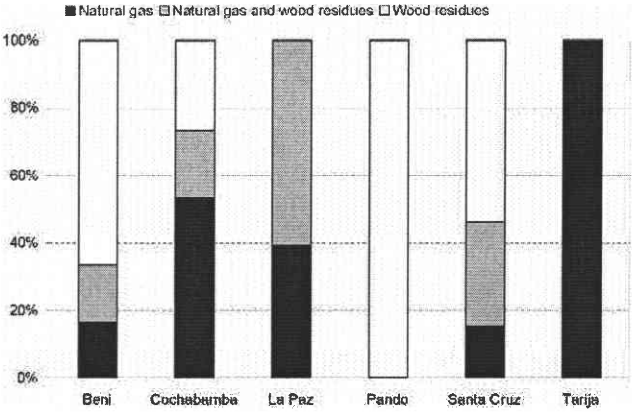

Figure 8. — Fuel used for lumber drying by geographic zone.

concentrated geographically; 78 percent of capacity is located in the eastern region of the country, with Santa Cruz being the department that may be considered the kiln-drying center of Bolivia.

The two most commonly dried species were South American oak (*Amburana cearensis*) and mara macho (*Cedreling cateneaformis*), with almost a half of total volume dried. With the exception of South American oak, all the 10 major species dried were considered alternatives woods, which shows the shift from traditional species.

Locally made kilns constitute 36 percent of all kilns. Among commercial brands, Italian- and German-made kilns are preferred, making up 59 percent of total number of kilns. The average kiln size is relatively small, 36.6 thousand BF (MBF). Some probable reasons for this are variability of the market, need to process mixed-species loads, long drying times, and the need to stagger loads to keep steady flow to the processing plants. Average kiln age is consistent with the growth in value-added products exports during the last 10 years, and numbers suggest the need for major maintenance work in the near future for many kilns.

Companies chiefly develop their own schedules, but they also resort to published materials and experience from other companies. There is a marked preference to control drying with probes when companies own commercial kilns; thus training in proper use of probes would lead to significant improvements in lumber drying in these companies. All firms include equalization and conditioning steps in their drying schedules. Most operations dry lumber green-off-the-saw; thus, education, improvement programs, and schedule development should focus on drying green lumber rather than air-dried or predried material.

The information provided by this survey can be used to assist in planning and designing improvement strategies for lumber drying operations. Based on these results, important topics to include in training programs for kiln operators should be the drying of green material, inspection and maintenance of kilns, and the correct use of moisture meters and probes. Development of drying schedules should start with the most commonly dried species (South American oak, mara macho, and yesquero). Improvement actions will have greater impact if they started in those departments with most of the drying capacity: Santa Cruz, La Paz, Beni, and Cochabamba.

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