PRODUCTION FORESTRY INTO THE 21 ST CENTURY
A WORLD VIEW

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Abstract. Until about 1960, industrial forestry and wood manufacturing was primarily in the northern hemisphere, notably in Scandinavia and North America where huge quantities of natural forests existed. Since then there has been a movement to the lower latitudes where exotic pine plantations supplied the resource. In more recent years, the emphasis has turned to establishment and use of plantation hardwoods. Among the reasons for this shift is the rapid growth rate of hardwoods, the timber of which can be harvested at about 6 years, and the great emphasis on use of printing and writing grades of paper, especially computer and copy paper. The US has been caught up in this trend, to the extent that hardwoods are being advocated on some lands that are better suited for pine plantations. Except for localized conditions, the message is to suppress this urge. For a given level of management, the softwoods will produce more wood per unit area and time, and their long fibers (tracheids) connotes strength properties to pulp, paper, paperboard and solid wood products that are lacking with hardwoods. Recycling will provide a brief respite to the timber supply dilemma, both in the US and worldwide, but an increased supply of primary (virgin) fibers will still be needed to satisfy the growing population and the increased per-capita consumption of that population.

INTRODUCTION

Until about 1960, the northern hemisphere had almost completely dominated the wood-based pulp and paper industry. That activity was particularly strong, as it continues to be, in Scandinavia and North America. Since that time, however, new activity has shifted to the lower latitudes, first to Australia, New Zealand and southern Africa, and then to Latin America, especially to Brazil. That activity continued its shift in Latin America, to Argentina, Venezuela, Columbia and, more recently, to Chile. But in these commodity traded wood products, no one claims dominance for long. The shift is now to the Far East, especially Indonesia and Southern China, but other countries in the region are being swept into the momentum.

The concentration of wood-based pulp and paper mills was once determined by the available resource. Huge quantities of natural timber existed in Scandinavia and North America. As the timber was harvested, reasonably good attempts were made to replace the forests, largely by plantations. Thus, the timber industry has continued to thrive in those regions. More recently, however, the emphasis has been to locate the manufacturing plants in areas where plantation forests exist; thus, the movement to Australia, New Zealand, southern Africa, Latin America and, now, Southeast Asia.

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My purpose is to show where the world's greatest forest and wood-product manufacturing activity is located, and how that scenario will change in the early part of the 21st century.

THE US SITUATION

The per capita consumption of wood in the United States, for all purposes, is about 80 ft^3. That value has stayed relatively constant over the last decade whereas that of the paper and paperboard subset has declined during that time, from 699 lb. in 1988 to 680 lb. in 1995. During that period, however, the population increased from 245 to 263 million people[2]. Thus, more wood is being consumed each year from a forest land base that continues to decline in area and in quantity of available timber harvested. For example, the commercial forest land base in the South is about 180 million acres today, compared to about 200 million acres 25 years ago. In the Pacific Northwest, erosion of the land base has been less of a concern than is the amount of timber being harvested on public lands which represents nearly one-half of the productive forest land base in that region. Because of environmental concerns, public perception and governmental decree only about one-fourth of the timber is being harvested on the region's National Forests as was harvested in 1988. So, what is the future?

The US has, for decades, been a net importer of wood and wood products, ranging from 10% to 15% of total needs. The majority of those imports have come from Canada from where as much as 60% of our newsprint consumption has been received. In addition, about 33% of the structural lumber, from a total of 48 billion bd ft, comes from north of the border. Indications are, however, that the wood flow from Canada will steadily decline due to high manufacturing costs, distance to markets of both raw materials and products, US-imposed restrictions on imports and self-imposed forestry practices.

The short-term solution has been to shift more production to the US South where private ownership (only about 10% is publicly owned), climatic conditions, topography, infrastructure, labor supply and tolerance of forest farming is superior to other regions of the US and Canada. About one-third of the lumber consumed in the US is produced in the South, compared to about 21% in 1988. In addition, about 65% of the pulp produced in the US is of southern origin, and facilities for manufacturing engineered wood products, consisting of laminated veneer lumber (LVL) and oriented strand board (OSB), are continually locating to the area.

The question is "can the South sustain the harvest?" Starting about 1930 and continuing to this day, timber growth has exceeded drain in every region of the US, especially in the South. About 10 years ago, however, some analysts concluded that the softwood supply would be inadequate if all mills of solid wood products and pulp were operating to capacity. At about 53% of the total wood standing inventory, the further conclusion was that the hardwood supply would be inadequate, not because of the absolute lack of the

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[2] The population increase is about 1.5 million annually, with about 1.1 million being immigrants of which 800,000 are legal.

resource but because of non-availability. As opposed to the softwood resource where about 50% of the potential supply is in 28 million acres of plantations, the hardwood resource is almost all in natural stands which are increasingly found in habitats where harvesting is limited by wet conditions or by steep and rocky terrain.

Forest industry, which owns about 22% of the commercial forest land in the region, has heard the call about the potential wood shortage. Whereas today with only about 30% of the consumed wood coming from fee and controlled land, a segment of the industry, including Champion International Corporation, has concluded that it needs to double that amount from fee and leased land and from contractual arrangements with non-industrial private forest owners. To accomplish that goal, on a land base that is being consolidated to those parcels of potential highest productivity and nearest the mills, wood productivity will have to be greatly increased. For example, Champion has a goal of increasing productivity by three times in plantations established in 2015 compared to those established in 1994. Other industrial organizations have similar goals.

The increased productivity will be obtained while adhering to sound sustainable forestry practices. To be good stewards of the land, and responsible to society, Champion has categorized its land base into four segments: **preservation, restricted, general** and **intensive.** The **preservation** category represents lands that are 'set asides' as special places. The will be protected from timber harvesting and other man-caused disturbances. The **restricted** areas constitute places such as streamside zones where selective harvesting of the timber may be practiced, but without the entrance of logging or site preparation equipment. The **general** areas are those where natural regeneration of the forest will be practiced; they will have special application to hardwood forests and to situations where it is appropriate to establish conifers by this method. It is the last category, **intensive,** where we expect to make the greatest impact in increasing wood production. We will farm those lands for timber, using every silvicultural practice that is economically and sustainably viable.

EFFECT OF RECYCLED FIBERS ON TIMBER SUPPLY

Recycling in the US had been a minor component of the total fiber supply until about 10 years ago. About 25% of the paper and paperboard produced had historically been collected for reprocessing, but 5% to 7% of that was regularly exported. The environmental concern about landfills being inundated with paper, paperboard and wood refuse created a political reaction that resulted in decrees to recycle a greater proportion of the 90 million tons of paper and paperboard produced annually in the US. The decree resulted in new de-ink mills being built, and for many existing primary-fiber mills to either begin using recycled (secondary) fibers or to expand its use. As a result, collection of the pulp and paper refuse now exceeds 45% of that produced, and the goal is to achieve a 50% recovery level soon after the turn of the century. A recovery rate beyond 50% becomes problematic because of even-flow and economics.

The use of secondary fibers does not mean that there will be a reduced, or even a static, use of primary fibers. Among the reasons are that, with each use, the fibers are fractionated, making them shorter and stiffer. Thus, each use relegates them to a lower-grade paper or paperboard until they eventually find their way into the effluent. For the highest-grade papers, secondary fibers can only go through the process about twice before grade specifications are violated. Even for the lowest grade of paper or paperboard, a repeat of the process for 6 or 7 times is the limit.

However, the task has not been achieved without its limitations. Because of fluctuations in market price of the finished product, from both primary and secondary fibers, the waste-paper flow has been erratic. During times of poor finished-paper prices, warehouses are filled with wastepaper, awaiting processing. At other times, when the price for the finished product is high, the waste-paper supply becomes exhausted, causing prices to escalate so that primary fibers are cheaper to process. It will still be a number of years before the combination of primary and secondary fibers finds an economically workable medium.

ALTERNATIVES TO INTERNALLY PRODUCED WOOD

The trend in recent years to produce greater quantities of printing and writing grades of paper has caused an increased use of. the broadleaved species, commonly known to us as hardwoods. The fibers of those species are one-third to one-fourth the length of the tracheids (fibers) of conifers, and the cell wall thickness of the fibers are proportional to their length. These wood properties translate to excellent paper-sheet formation and opacity[3]. They are also very well suited for the manufacture of boxboard (food cartons and ovenables, for example), and for the top layer (white top) on cartonboard which is commonly used for set-up advertising displays and advertising on shipping cartons.

As a result of the quality characteristics of the fibers, most pulp mills in the southern US have increased their use of hardwoods in the furnish. The concerns about long-term availability of the resource from natural forests have caused some organizations to invest in hardwood plantations in the Tropics and Subtropics. Among those organizations are Stone Container Corporation and Simpson Paper Company with *Gmelina arborea* plantations in Costa Rica and Guatemala, respectively, and Champion International with plantations of *Eucalyptus grandis, E. urophylla* and their hybrid in Brazil. The wood produced will either be sold on the world market, shipped to resident mills in the southern US, or processed directly into pulp and/or paper at the offshore location.

[3] Opacity translates to light diffusion; printing on the opposite side of the page is largely restricted on paper with high opacity.

THE RUSH TO HARDWOOD PLANTATIONS

Within the last two decades, the worldwide trend in the construction of new pulp mills or modernization and expansion of existing facilities has been similar to that of the US South in using increased amounts of hardwoods in the furnish. In addition to the huge demand for printing and writing papers, especially in countries with developing economies, hardwoods are favored for their high mean annual increments which allow them to reach financial maturity in 6 to 8 years. The trend to plant additional areas of hardwoods to fulfill these objectives is nowhere better exemplified than in Brazil where some pine plantations are being replaced with hardwoods, primarily eucalypts, in areas north of about latitude 25°S. The phenomenon is also common to southern Africa, and to a lesser extent in Chile, New Zealand and Australia.

The greatest forestry phenomenon in the world, however, is taking place in Southeast Asia, inclusive of India. With economies that are expanding at 5% to 10% a year, a population approaching 3.4 billion people, and a per capita consumption of paper and paperboard of about 25 lb which is increasing about 2 lb per person per year, the demand for wood resources and manufacturing facilities is tremendous. In Indonesia alone, licenses have been issued for the construction of 14 world-class pulp and paper mills. Due to the lack of finances, it appears that only 5 of those facilities will be operational by the year 2000. These 5 mills are in addition to 4 wood-based mills, some of which are approaching one million metric tons per year of bleached hardwood pulp at a single location, with plans to double production within three years.

The wood resource for the operational pulp mills in Southeast Asia is primarily mixed tropical hardwoods, but plantations of *Acacia mangium, A. crassicarpa, Gmelina arborea,* and *Eucalyptus* spp. are starting to feed into the system. Plantation tree growth rates of 25 m^3 /ha/yr (5 cd/ac/yr) are being obtained at harvest ages of about 6 years. With genetic improvement, average growth rates of 35 m^3/ha/yr (7 cd/ac/yr) are anticipated.

The alternative to growing plantation hardwoods offshore for potential use in the southern US is to grow the resource within country, using intensive culture. The example has been set in the Pacific Northwest where plantations of hybrid cottonwood, primarily *Populus deltoides x P. trichocarpa* and in northern California where *Eucalyptus camaldulensis* are being grown. The difference between these highly successful plantations, and the marginal industrial ones of about 100,000 acres established in the southern US since about 1970 is that the trees are vegetatively propagated, grown in a weed-free environment, and receive measured amounts of nutrients and water through a drip irrigation system. Growth rates of about 7 cd/ac/yr are obtained, with harvest ages of 6 to 7 years.

Based on the experience in the PNW, trial plantings have been installed in various parts of the southern US, primarily evaluating cottonwood *(P. deltoides),* sycamore *(Platanus occidentalis)* and sweetgum *(Liquidambar styraciflua).* To accommodate the fertilization/irrigation (fertigation) regime, soils with a high sand content are desired. Thus, if the scheme proves successful and if environmental concerns, such as availability of

irrigation water, can be resolved the marginally productive Sand Hills could be supporting our next hardwood crop.

Before investing heavily in hardwood plantations in the southern US, however, we should take stock of reality. The majority of the available forest lands are suited for growing southern pines, primarily loblolly ***(Pinus taeda)*** and to a lesser extent slash *(P. elliottii)* pines, but only the very best lands (and those conducive to fertigation regimes) are suited for growing acceptable crops of plantation hardwoods. Research results have shown that 4 cd/ac/yr can be achieved by growing loblolly pine on those best sites by controlling competition and pests, and by applying nutrients at appropriate times. Even on the poorer sites, 2 cd/ac/yr can be achieved with a reasonable silvicultural regime, at a rotation age of 16 years. Now, compare that to hardwoods. On the best sites, we might be able to achieve the same production as for pines, but because of the sensitivity of hardwoods to site, the poorer sites will give progressively less yields than pines.

Plantation yields of hardwoods in the Tropics and Subtropics, with eucalypts, can exceed 10 cd/ac/yr with rotations of about 6 years; whereas, the yields of pines, in southern Brazil for example, is about 6 cd/ac/yr at a rotation of 16 years. A little arithmetic will show that growth and yield of pine plantations in the southern US is reasonably comparable to the growth and yield of pine plantations in Brazil, reaching 40% and 80% of the goal from the poorest to the best sites. For hardwoods, however, even the best sites in the US South will achieve only about 40% of the productivity of their Brazilian counterparts. The point is that the forest lands in the US South, compared to large parts of Latin America, are more suited to growing plantation pines than they are to growing plantation hardwoods. The recommendation, therefore, is to avoid heavy investment in hardwood programs in the southern US, except on alluvial soils where hardwoods prosper at the expense of pines, and where productive hardwood plantations can be established on upland sites to fulfill a local need.

Extensive plantations of fast-growing conifers (almost universally pines) are restricted to Australia, New Zealand, Chile, southern Brazil, southern Argentina and the southern US. The potential exists for southern China to be included in this elite group, but my personal observation is that plantations established there before about 1990 received so little silvicultural care that they are only marginally productive.

On a world scale, long-fibered pulp that emanates from conifers, sells for a premium to short-fibered pulp. The cadillac of long-fibered pulp is spruce/fir *(Picea spp./Abies* spp), but following it closely is pulp from Monterey *(P. radiata),* loblolly, slash, Caribbean *(P. caribaea),* patula *(P. patula)* and kesiya *(P. kesiya)* pines. During times of high pulp prices, the spread between northern bleached softwood kraft (NB SK) and southern bleached hardwood kraft (SBHK) can be as much as $100/ton; during down cycles, the spread is less, but it is still commonly greater than $40/ton. As a comparison, northern bleached hardwood kraft (NBHK) sells at a comparable price to that of eucalypts pulp during both good times and bad, both of which have less market value than NBSK and southern bleached softwood kraft (SBSK).

The conclusion from this is that softwood pulps have historically sold at a premium to hardwoods pulps, and there is no reason to expect the situation to change. After all, softwood pulps are highly desired for products requiring strength, such as for linerboard and sack papers, and a portion of the furnish (10% to 15%) of even the best hardwood pulp and paper mills requires some softwood pulp, largely to hold the mat together on the high-speed forming belts.

The softwoods (conifers) also have intrinsic values for structural lumber and other solid wood products that are largely lacking in the hardwoods. Work is in progress in some countries, especially in New Zealand, Chile and Australia, and to a lesser extent in South Africa and the southern US, to manage fast growing softwood plantations for sawlogs or plywood bolts. The regime involves two or more thinnings, together with pruning to heights of 18' to 25', with an harvest age of about 28 years.

Plantation hardwoods that are managed for solid wood products, such as teak *(Tectonia grandis)*, paulownia *(Paulownia tomentosa)*, black walnut *(Juglans nigra)* and red ceiba *(Bombocopsus quinata)* are of greatest value when slow grown (more than four annual rings per radial inch); thus the management regimes are matched accordingly. In recent times, however, efforts are being made to manufacture furniture-grade lumber from fast growing species, such as from *E. grandis*. The key to success of this endeavor is to process green logs, quarter saw them as opposed to flat sawing, and pay heed to the heat, moisture and timing regimes of kiln drying.

SUMMARY AND CONCLUSIONS

Mention has been made of all the high forest-producing areas of the world, save one, and that is Russia. That country has more than half of all the long-fibered species in the world and, yet, we have chosen to ignore it. But for good reason. The political climate and the economy, along with the lack of infrastructure for forestry and forest product manufacturing is so in disarray that it will be a minimum of 20 years before Russia will become a major player in world trade of these commodities. For example, the pulp output in 1996 compared to 1995 was off about 25%, not from lack of markets but from aging mills and a disarrayed administration.

The area of greatest forest and forest product activity in the next two decades will be Southeast Asia, inclusive of India. Entrepreneurs in that part of the world are establishing fast growing forest plantations and building world-class manufacturing plants to satisfy a population of about 3.4 billion where the economies are growing from 5% to 10% annually. The entrepreneurs are committed to fulfilling the home market; they do not consider themselves being in competition with major paper and paperboard producers in other parts of the world. The effect on world markets, however, is that vendors from outside the region will have a difficult time selling into the region unless partnering relationships are formed.

Outside of Southeast Asia, the area with greatest latent potential for fast growing plantations and product manufacturing is southern Brazil, Argentina, Uruguay and Paraguay. This opportunity complements Brazil's existing pulp and paper industry that is largely concentrated in the Tropical and Subtropical zone immediately south of the Amazon Basin. The multi-country area is blessed with an excellent climate for forest growth, and it is replete with a good labor supply and infrastructure. Depending upon local conditions, both softwoods and hardwoods can be grown with high expectations. A high percentage of the land is open, having supported a marginal cattle industry; thus allowing plantation establishment with minimal cost. Much of the land, almost all of which is privately held, has already been planted to trees, assuring an initial wood supply for manufacturing plants locating to the area.

About 7 million acres of radiata pine exist in Chile, New Zealand and Australia. Much of that timber is just reaching harvest age, and a high proportion of it, as logs, chips, lumber and pulp, is destined for foreign markets, specifically Japan and China. These countries will have a significant impact on world trade in wood and wood products during the next two decades.

The southern US has great potential for maintaining its place as an international player in the manufacture and sale of wood products in the coming years. The greatest potential lies in intensively managed pine plantations, where growth of 4 cd/ac/yr can be achieved on the best upland sites in concert with intensive silviculture. Even on marginal sites, growth rates of 2 cd/ac/yr can be achieved. Almost all of the domestic hardwood resource will continue to be obtained from natural stands, largely because of the high cost associated with the relatively low yields obtained from plantations. The alternative for obtaining hardwood fiber or pulp for processing in southern US mills is to establish plantations in the Tropics or Subtropics, from which the wood or pulp would be ferried to the US. Offshore plantations of hardwoods for use in the US already exist in Guatemala, Costa Rica and Brazil.