Maximum Use of Minimum Acres

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There was a time, not long ago, in the geologic time scale, when not one acre of the 56,790,000 square miles making up the seven continents was claimed by a human being. Less than 400 years ago, our country was shared by a few hundred thousand Indians. Today, the 2-1/3 billion acres in the United States are shared by about 198 million people, an average of less than 12 acres per person. And this average is shrinking fast.

How is this area allocated? Some of the major uses are urban developments, crop farming and livestock raising, highways, railroads, power line rights-of-way, water impoundments, parks, wildlife preserves, wilderness areas, and productive forests. This does not leave much of the 12 acres available for any single use.

Our concern here is the productive forest, which I define as the segment economically providing the raw materials for wood-using industries, ranging from pulpwood production to face veneer of fine hardwoods.

Is our timbered area holding its own against the demands from other uses? On strictly an area basis, the situation is not bad; the area has decreased only 8 percent since 1900. But area does not tell the whole story. Many acres not timbered then are now forested, whereas even more land then forested has since been cleared.

Some examples will illustrate this shift. In Arkansas, from 1935 to 1950, there was a 19-percent reduction in the timbered area in the Delta portion. During the following 8 years the timbered area for the state as a whole increased about 7 percent, but in the Delta portion it decreased another 7 percent.

In Mississippi, the timbered area increased between 1948 and 1957 by 4 percent, whereas in the Delta region it decreased 6 percent.

In the Prairie region of Missouri, the timbered area increased 15 percent between 1947 and 1960, but in the Riverborder region it decreased 7 percent. Even more striking, for the six Bootheel counties within the Riverborder region, the decrease was 39 percent for the same period.

Thus, highly productive timber land has been cleared for agricultural use and less productive acres have replaced these good lands in the total forest land inventory. Economically it is difficult to argue against this change. However, the trend does point out the need to get maximum production from each acre, with the greatest emphasis on the better sites still available. In a sense, we must make each acre bigger.

There are many ways to increase production. The simplest and least productive, extensive silviculture, and one requiring little or no investment, relies completely on natural reproduction with little concern for species composition. At the other extreme, we can rely exclusively on planting, where we can control spacing, species composition, and the use of improved trees within a species, and can more easily apply stand improvement measures such as pruning, fertilization, irrigation, and weed control. On the better sites these intensive practices will likely become more and more commonplace.

A major step in increasing production on the diminishing acres can be made solely by exerting greater control over stand composition. For example, probably no one has ever retired comfortably on the profits from harvesting boxelder, but much has been invested to eliminate it from stands so that better trees will have more growing space. Sixty percent of the current hardwood sawtimber growth is concentrated on less desirable species, such as hickory, beech, and inferior upland oak species. Certainly the land owner whose income is solely from such timber had better look into alternative land uses.

Production can be increased also, at least for some species, by fertilization, weed control, and irrigation. But none of these benefits can be fully realized if adequate growing space is not provided, whether in plantations or natural stands.

Many trees have been wasted simply because an acre cannot support as many large trees as small ones. So, many of the trees are removed

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either by natural mortality or by noncommercial thinnings or poisoning. In addition to this direct loss there is another important one: through competition the wasted trees have reduced the growth of those that will make up the harvest.

The major reason for wasted trees is that until recent years we did not really know how much space a tree of a certain size and species could use. So we either left or planted enough per acre so that we could be sure of having enough for the harvest.

Fortunately, it is a relatively simple matter to determine how much growing space a tree can use. This was first shown for several oaks, hickory, and Norway spruce, where very high correlations were found between crown width and d.b.h. Since then the same high correlations have been found for several conifers in Canada, eucalyptus in Australia, and a number of conifers and hardwoods in this country.

One thing should be emphasized at this point. Despite the highly correlated relationships, the crown width in relation to d.b.h. can vary greatly among species (Table 1). The differences are even more striking when the widths are converted to crown area. For example, for 15-inch trees the crown width of Norway spruce is 81 percent of that for oak-hickory, but the area of the crown is only 59 percent of that for the oak-hickory. Consequently, far more trees and volume can be produced per acre with one species instead of another, assuming equal site suitability and comparable diameter growth rates.

Table 1.-- Equations for Crown Width of Open-Grown Trees

Species	Y = crown width in feet D d.b.h. in inches	Basis: no. of trees	r2
Black walnut 1/	Y 1.993D + 4.873	36	.98
0ak-hickory 2/	Y 1.829D + 3.12	173	.97
Norway spruce 2/	Y = 1.313D + 5.057	157	.98
Lodgepole pine 3/	Y 1.424D + 3.27		
Eastern white pine 4/	Y = 1.714D + 2.54	69	.91
Austrian pine 4/	Y = 1.442D + 3.72	145	.97
Sweetgum 4/	Y = 1.975D + 2.65	46	.93
Baldcypress 4/	Y = 2.026D + 8.32	47	.89
Pin oak 4/	Y = 1.525D + 9.06	41	.91
Sycamore 4/	log Y = 0.6428 (log D) + 0.8341	64	.98
Jack pine 5/	Y = 2.036D + 1.763	83	.92
Loblolly pine 6/	Y = 1.56D + 4.78	600+	

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There is another aspect that must not be overlooked. In addition to the differences among species in the crown width -d.b.h. relationship, there are differences in how trees of various species react when crowns close and crowding begins. Though sycamore has the widest basic (open-grown) crown of any hardwoods investigated so far, stands with high basal area and volume per acre are found. On the other hand, oak-hickory stands with a narrower basic crown have basal area values per acre that do not exceed or even come close to sycamore. What is not known, however, is whether the percentage reduction from the maximum growth rate is the same for heavily-stocked oak-hickory and sycamore stands.

It is reasonable to assume that growth (total production of dry matter) will be greatest in the open-grown tree. As the trees are brought closer together, the crowns will finally touch and eventually become crowded so that there will be a reduction in actual or effective crown size. This will result in a reduced production of dry weight per tree. In the final analysis, the dry weight production per acre of living trees will be reduced also.

With the characteristics of open-grown trees known, one can predict, for any initial spacing, the size (d.b.h.) of the trees at the time the stand begins to close. For one interested in rapid growth of individual trees to a specific size, this is a crucial point, particularly when crown width varies with d.b.h. among species.

For example, we may want to have the stand start closing at d.b.h. of 5 inches for sycamore, white pine, and loblolly pine. From the equations in Table 1 we can compute the following initial spacings (rounded to the nearest half-foot): sycamore, 19 x 19; white pine, 11 x 11; and loblolly pine, 12.5 x 12.5.

In our work with black walnut, using open-grown tree data and with an objective of rapid growth until harvest, we have decided that a spacing of 18 x 18 feet is needed to produce sawlogs, and a spacing of 26 x 26 feet to produce veneer logs. We recognize that some pruning will be necessary. And possibly a pulpwood crop of another species can be produced among the walnuts during the first half of the rotation without detriment to the walnut. We believe this will give us maximum use of minimum acres.

It is not difficult to collect the basic data needed to apply this approach to spacing. The standards we have used in selecting our sample trees are:

1. Crown free of competition on all sides.
2. Limbs extending to the ground on small trees and nearly so on larger trees.
3. Lowest branches the longest, or at least as long as those above. (This eliminates trees that had been released from competition in the past and on which the lower portion of the present crown originated from epicormic branches.)
4. For small trees (less than 16 feet tall), no forking in the entire length; for larger trees, no forking of the bole below 16 feet. (This limits the sample to trees that are of the type that would be favored in the forest stand, except for limbiness and excessive taper.)
5. No evidence of pruning, shearing, browsing, decadence, storm damage, or serious insect damage.
6. Tree apparently not of sprout origin.

Tree diameters are measured to the nearest tenth-inch and crown widths (the average of two measurements) to the nearest half-foot. With careful adherence to the standards of sample tree selection, relatively few sample trees (50 or less) may be adequate.

The characteristics of open-grown trees can also be used to decide on the initial spacing where one or more intermediate cuts are planned. In fact, the characteristics provide an excellent guide to prevent overthinning. Understocking is just as much a factor in production loss as overstocking.

This approach, using initial wide spacing, is contrary to what many foresters accept. However, we feel that, where the product objective is sawtimber, this procedure will provide the most of the desired product in the shortest time. Intensive culture, such as pruning and weed control, will be necessary. This is not the easiest way to practice forestry, but we believe it is the quickest way to get increased production of desired products.