SOUTHERN TREE IMPROVEMENT'S IMPACT ON FOREST PRODUCTS - THOUGHTS ON THE FUTURE

Richard L. Porterfield

Abstract.--Past findings with respect to the economic value of tree improvement work are reviewed. These previous findings indicate that tree improvement activities have been economically worthwhile. Recent trends in product prices and the value of quality characteristics, however, promise to move profitability even higher. Because the forest products industry faces unprecedented demand, the tree improvement specialist has never been in a better position to contribute to southern forestry.

Nearly all economic evaluations of southern pine tree improvement programs have shown them to be economically worthwhile investments (Dutrow, 1974). In fact, most studies (for example early work by Davis (1967)) have demonstrated that volume gains of less than five percent justify tree improvement work. So why have this discussion of the economic value of tree improvement? It is simply because the economic setting within which the tree improvement specialist works is not static, but rather ever-changing. There have been and are some very significant changes taking place which should impact tree improvement efforts. Following a short review of past findings, this discussion will focus on the influence that economic trends may (should) have on the economic merits of tree improvement work.

PREVIOUS FINDINGS

I wish I could report that there have been several recent economic studies evaluating tree improvement activities, but to my knowledge there has not been. Such studies are needed to improve upon available results.

In 1973, I did a detailed study of first generation clonal seed orchards and cited the following major findings (Porterfield, 1973):

1. The economic return from tree improvement activities is high. Internal rates of return of 10 to 14 percent are common for most programs. Accounting for a real price rise in stumpage value raises the rate of return to above 16 percent. These results are considered conservative.

2. Total volume gain from first generation clonal seed orchards ranges from 12 to 14 percent over unimproved plantations. In addition, a 5 percent improvement in specific gravity is predicted if this trait is being selected. Straightness and crown improvements for existing programs are in excess of 5 percent for each organization studied and a 10 percent reduction in volume lost to fusiform, in areas of medium infection, is easily attainable.

3. The expensive progeny testing phase and subsequent roguing of the orchard is an economic practice. In fact, the model indicated that roguing intensity should be increased toward the biological limit if maximum economic return is the principle objective. Volume gain could be doubled or tripled with a strategy of putting more clones in the orchard at a close spacing and then utilizing a higher roguing intensity.

1/ Manager, Technical Development, Champion Timberlands, Stamford, CT 06921.

4. Results clearly demonstrated the merits of speciality orchards with a limited number of clones. Candidate traits might be disease resistance, high specific gravity or others. Given likely heritability, selection for fusiform resistance is quite profitable in medium to high fusiform rust incidence areas.

5. Costs associated with the selection of superior individuals in wild-stands or, currently, in plantations seem high, but actually more should be spent. For first generation orchards, wild-stand selection expenditure should have been tripled in order to realize maximum economic worth from tree improvement. These selections effectively determine initial genetic gain.

6. Similarly, while actual orchard seed production is more than sufficient to guarantee high profitability, there is a direct and proportional relationship between seed production and profitability in an existing orchard. Within the orchard, genetic gain is largely fixed. This means the insect and disease control in the orchard and overall orchard maintenance are of the utmost importance. Allowing a 20 percent loss in seed yield means a 20 percent decline in that year's net present value from tree improvement.

7 It is imperative that organizational goals for tree improvement be established early. There are opportunities to tailor tree improvement programs to an individual organization's goals during the selection process, but only if goals are known. Conversely, without firm initial goals significant errors can be made and the tree improvement program not meet its potential.

8 Given two traits, A and B, with a positive genetic correlation, it can be most cost effective to select for gain in A through its correlation with trait B. For example, bole straightness and desired crown characteristics had a genetic correlation of 0.65 in the study (Porterfield, 1973) and greater gain in straightness per dollar spent on wild-stand selection was often obtained by selecting for improved crown characteristics. Thus, if trait A were phenotypically apparent, it could be selected for in order to achieve gain in a highly positively related trait, B, (which might not be phenotypically apparent) with little loss in genetic efficiency and a gain in economic efficiency.

AN UPDATE

What events have occurred since 1973 that have significant impact on the above findings? First, the value of wood raw material has gone up appreciably. An increase in stumpage value is a mixed blessing for forest industry since it makes controlled wood more valuable, but also raises the price of outside wood. This increase in value, at least for sawtimber sized material, has included an increase above the general inflation rate (a real price rise) and this typically signifies a tightening supply situation.

The major impact of this rapid escalation of stumpage value is to make tree improvement work more profitable. Costs associated with first generation orchards are sunk, i.e. can not change, but the revenues are increasing. The 1973 conclusion that first generation orchards had internal rates of return from 10 to 14 percent was based on some $12 per cord for pulpwood and only $40 per MBF for sawtimber. Recent stumpage prices should increase the rate of return from tree improvement to between 15 and 20 percent.

A second economic trend that influences the economics of tree improvement work is the change in relative prices of finished southern pine products. Representative prices for random length 2 x 10 #2 (top) and 2 x 4 #2 (middle) southern pine lumber (per MBF) and for a thousand square feet of standard 1/2 in. exterior southern pine plywood are shown in Figure 1.

Considering only the lumber price lines, it is obvious that the premium for wide boards is growing. The differential, 10 in. vs. 4 in. deminsional lumber increased from $8 per thousand in 1971 to $35 per thousand in 1978. The compound rates of growth are provided on the figure. The point is that the quality aspects of the resource are of growing importance. The likelihood of obtaining 10 in. lumber from future plantations is dependent on growth rate certainly, but bole straightness will be of increasing value for the size of material likely to be harvested.

Previous estimates of the value of tree improvement work have been based on volume growth only. Characteristics such as crown form and straightness were valued only through their genetic correlations with volume growth in the results cited above. The economic value of quality improvement may well be rising at a faster rate than that for volume improvement.

The bottom line in Figure 1, plywood, has the most rapid rate of growth. This fact goes a long way in explaining the tremendous past and present growth of the southern pine plywood industry. Observation of veneer yield as plywood blocks are peeled is convincing with respect to the importance of traits such as limb size and straightness. Since the south's principle plywood product is sheathing, these quality characteristics combined with growth rate will determine whether a proper ratio, C vs. D face veneer, is maintained.

Concurrent with increases in recent product prices, costs, particularly those associated with heavy equipment, have risen rapidly. From 1967 until 1976 the wholesale price index (now producers price index) increased 70 percent while the wholesale price index for southern pine lumber increased some 110 percent. Cost of mechanical site preparation however increased well over 200 percent (Moak, 1977). The importance of planting seedlings with a 15 percent or so volume gain capability is obvious. Returns must be increased to maintain acceptable profitability.

Cost of mechanized thinning is also up dramatically. The greater uniformity associated with improved plantations should be of great aid in this instance (Davis, 1971). Mechanized thinning is a "slave" to extremes today. With greater uniformity in stand diameter, equipment can be designed to better fit specific site/stand conditions. This uniformity, particularly in specific gravity, should also improve processing (especially cooking time) in the pulp and paper industry.

Overall, recent trends have significantly increased the profitability of tree improvement work both because of rising raw material values and the growing importance of quality characteristics. Remember, too, that many of the costs associated with tree improvement have occurred in the past and that any actions to add to genetic gain or seed yield are probably good marginal investments. For this reason, the importance of maximizing improved seed yield has never been greater and those with sufficient improved seed may consider means of increasing genetic gain. Could more roguing be done in the

Figure 1. Price Trends for Various Southern Pine Products

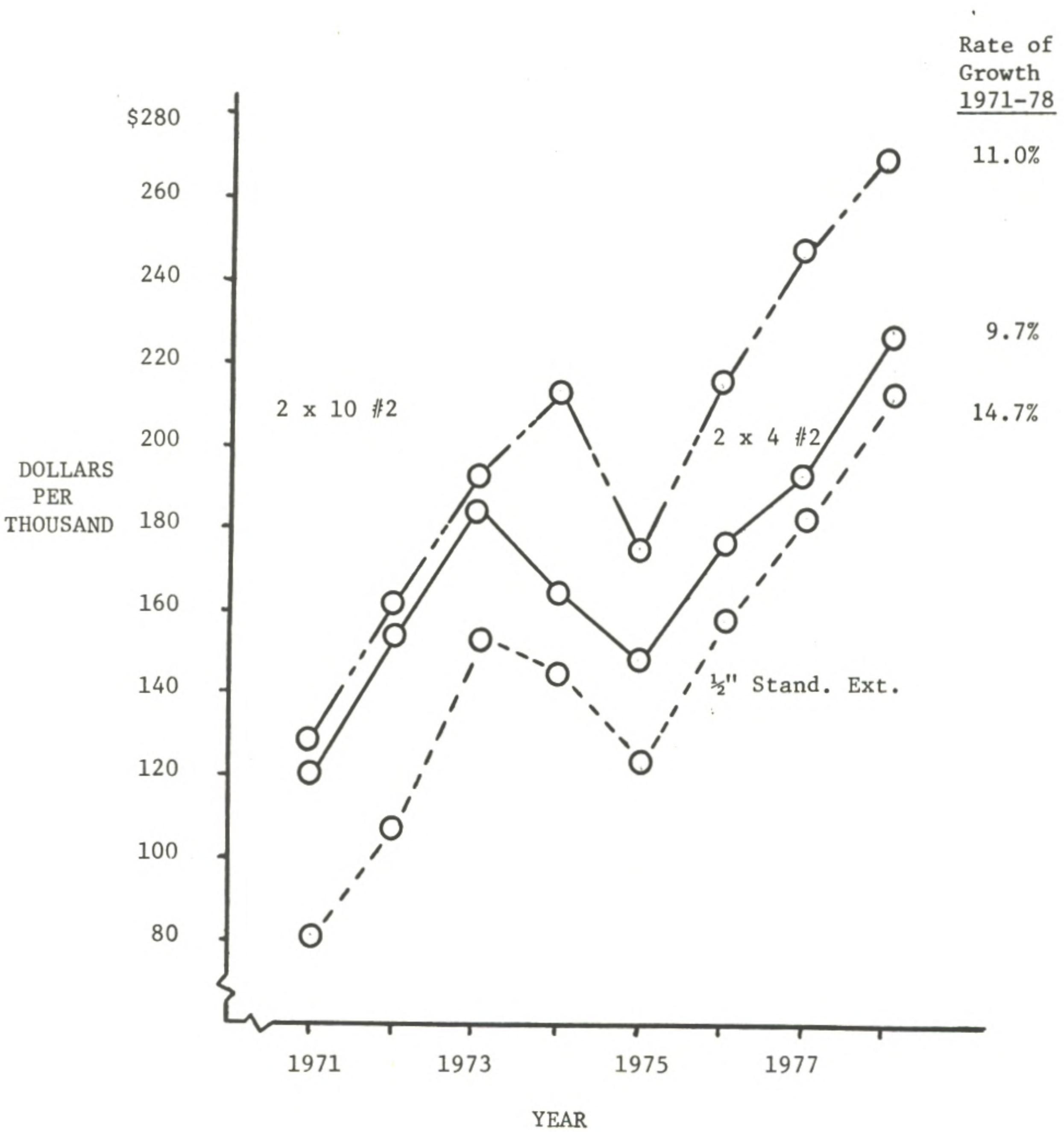
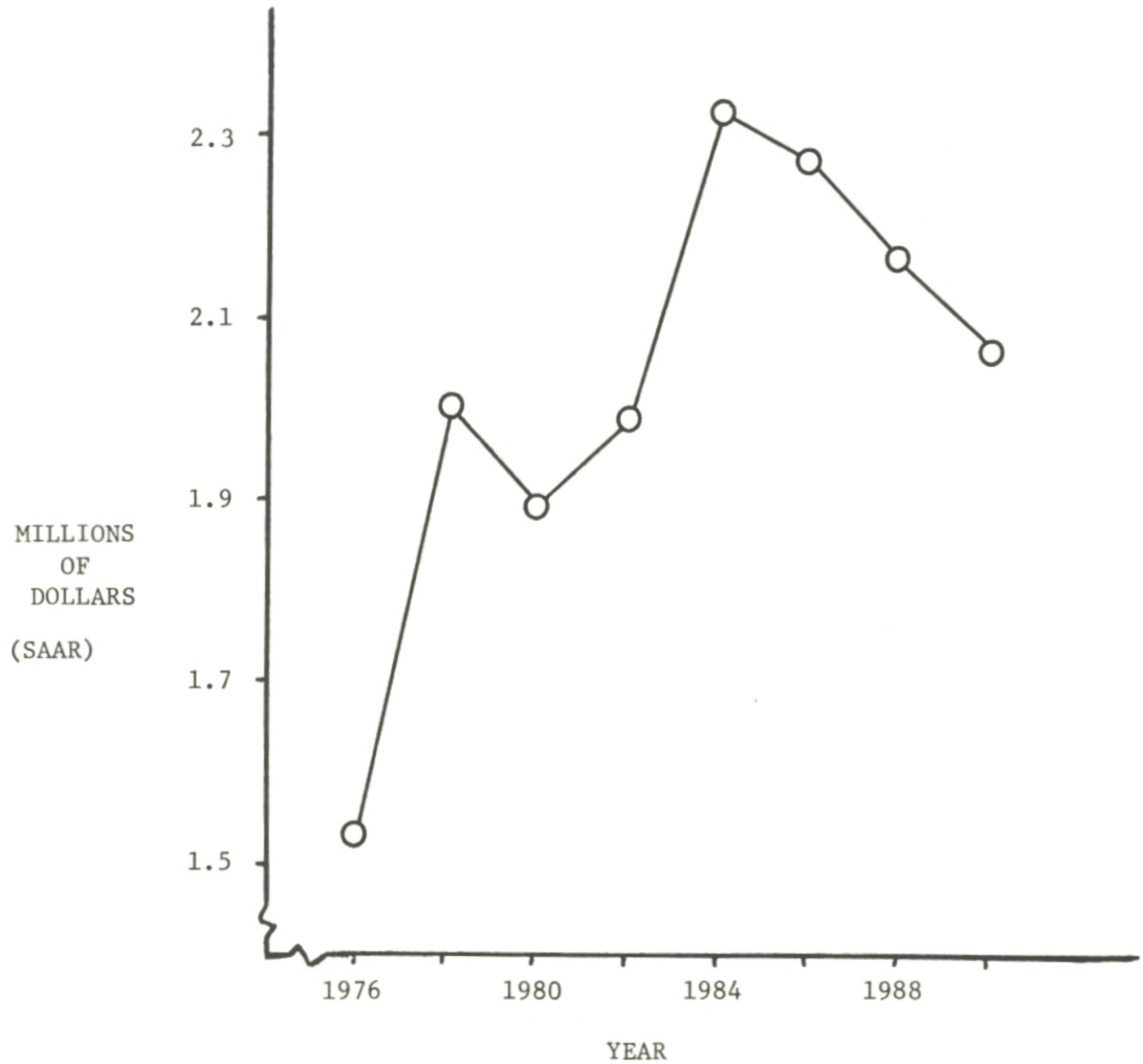


Figure 2. Total Housing Starts - U.S.



orchard? Could seed be collected by clone and only seed from the best general combiners used?

FUTURE

The rapid real price rise for southern pine stumpage mentioned previously is indicative of an impending softwood supply "crunch" across the South. A supply "crunch" which is not limited to specific companies or locations. The real problem however is that this tightening of supply corresponds to an unprecedented increase in demand for wood products. Figure 2 shows the projected number of housing starts through 1990.

The 1976 to 1984 increase (Figure 2) is the driving force behind current activity in the forst products industry. The 1978 level of starts, just over 2.0 million, had the industry running at capacity. The post-World War II babies will be at prime house-buying ages in the next few years. Demand for pulp and paper also cycles, but this industry is largely "mature" and growth is slower (2.5 to 4.0 percent) and less cyclic than for building products.

Also important is the fact that housing starts are projected to decline after 1985. This will heighten pressures for obtaining genetic gains faster. Right or wrong, young plantations are going to look increasingly attractive in the future, especially improved plantations.

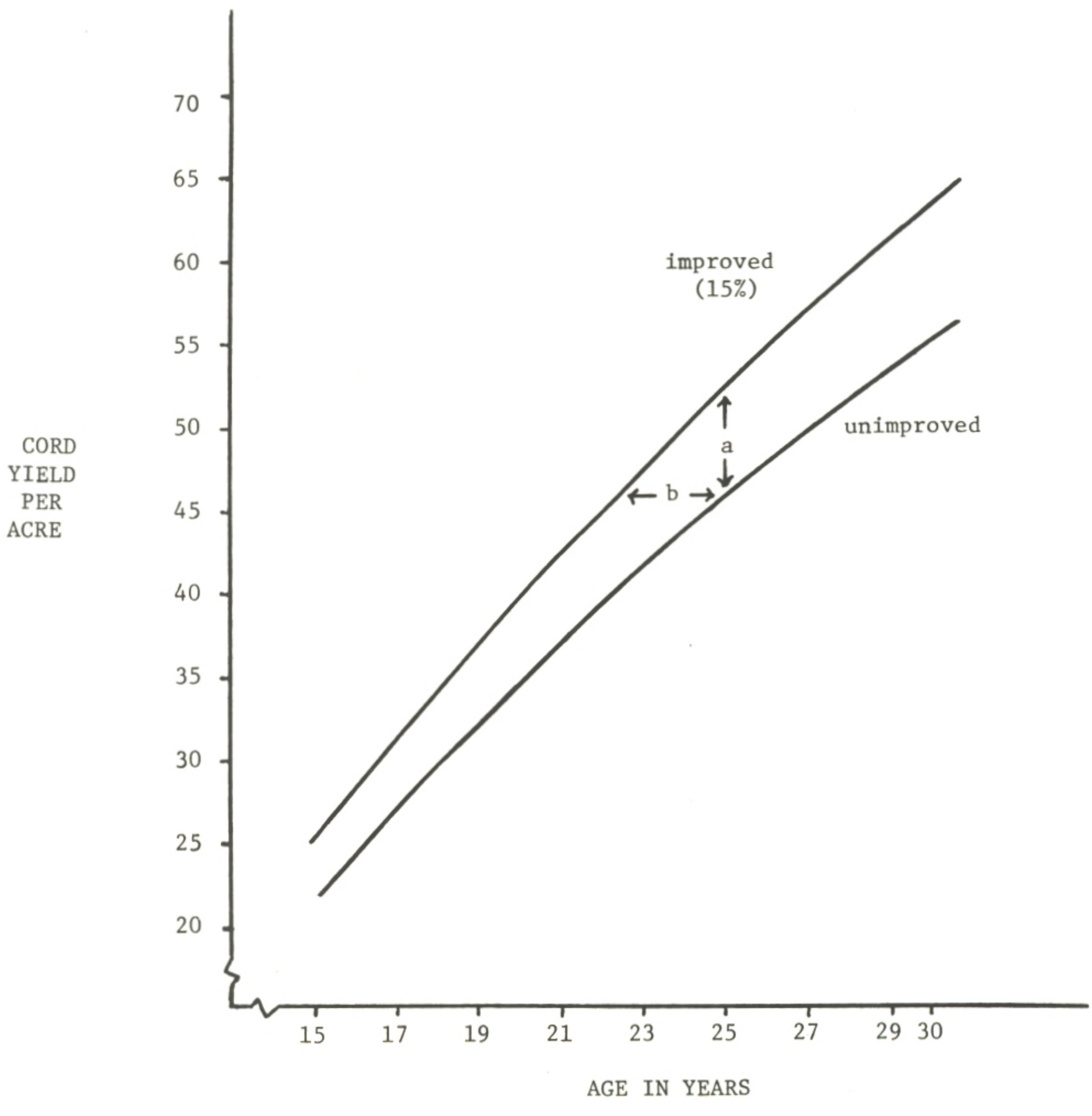
To illustrate, consider the two plantations portrayed in Figure 3. The unimproved yield is for plantations in Virginia and the data are relatively old (Dierauf and Marler, 1965). These yield data were used simply because they provided a yield estimate each year over the rotation. Other yield data would just as well demonstrate the point.

At age 25, the unimproved plantation is estimated to produce 45.8 cords or $458 at $10 per cord. The improved plantation, with a 15 percent volume gain, would yield 52.7 cords or $527 at age 25. Using 10 percent interest, the present value of the difference represented by "a" in Figure 3 is $6.37. On the other hand, a volume similar to the age 25 yield of the unimproved stand is attained by the improved stand in 22 years. The improved stand yields 45.2 cords in 22 years. The present value of 45.2 cords at 22 years is $13.24 higher than that for 45.8 cords at 25 years (difference "b" in Figure 3). In other words, it is worth twice as much to harvest the improved stand earlier than to wait for the improvement at the old rotation age. Given this fact, and the demand projected in Figure 2, improved stands will probably be harvested sooner. This point has been stressed by Lambeth (1978) also.

Genetic gains above 15 percent, that is to the left of the improved yield in Figure 3, simply mean that stands may be cut even earlier. Actual financial maturity on the stump occurs earlier than age 25, but harvesting costs, as a function of stem size, dictate a later harvest. However, harvesting efficiency would be very similar with yields at age 25, unimproved, and age 22, improved.

Of concern is the matter of juvenile vs. mature wood if improved stands are to be harvested earlier. Bendtsen (1979) concludes that, relative to mature wood, juvenile wood has shorter fibers, larger fibril angle, lower

Figure 3. Yield of Virginia Plantations With and Without Genetic Gain



specific gravity and percent of latewood, has irratic and typically greater longitudinal shrinkage, greater amounts of spiral grain and compression wood, and is lower in strength. These factors have a particularly adverse effect on the use of greater amounts of juvenile wood for solid wood products. Pearson and Gilmore (1979) also conclude that young, fast growing trees are of lower density and strength and Bendtsen (1979) suggests that design codes may have to be altered for material from fast growing plantations. Breeding trees with high density juvenile wood or that have a more rapid transition from juvenile to mature wood should be increased in priority.

Another means of meeting rising future demand for timber products is for an organization to acquire more forest land. Purchase of forest land increases the proportion of controlled timber during periods of peak demand. But, in the next 5 to 10 years, there will be substantial acreage of improved plantations available and these plantations will be of great benefit since they will reduce additional land needs.

For example, consider the simplified case of a firm that currently harvests 300,000 cords of wood annually from its land to meet minimum backup standards. With an average unimproved yield of 2 cords/acre/year over a 25 year rotation and under ideal regulation conditions the firm would require a land base of 150,000 acres. Now suppose that in the mid to late 1980's, mill size increases by 50 percent in the face of increased demand. The firm now needs an annual harvest of 450,000 cords and consequently a larger controlled land base. In fact, using 50 cords per acre at age 25, the firm needs 75,000 additional acres to maintain a fixed fee timber backup.

If, however, the firm is in a position to take advantage of higher yields from improved stands in the future, its additional land requirements are greatly reduced. A 15 percent volume gain at age 25 (same rotation age assumed for simplicity) from improved plantations would increase yield to 57.5 cords. Only 45,652 additional acres are needed with improved plantations.

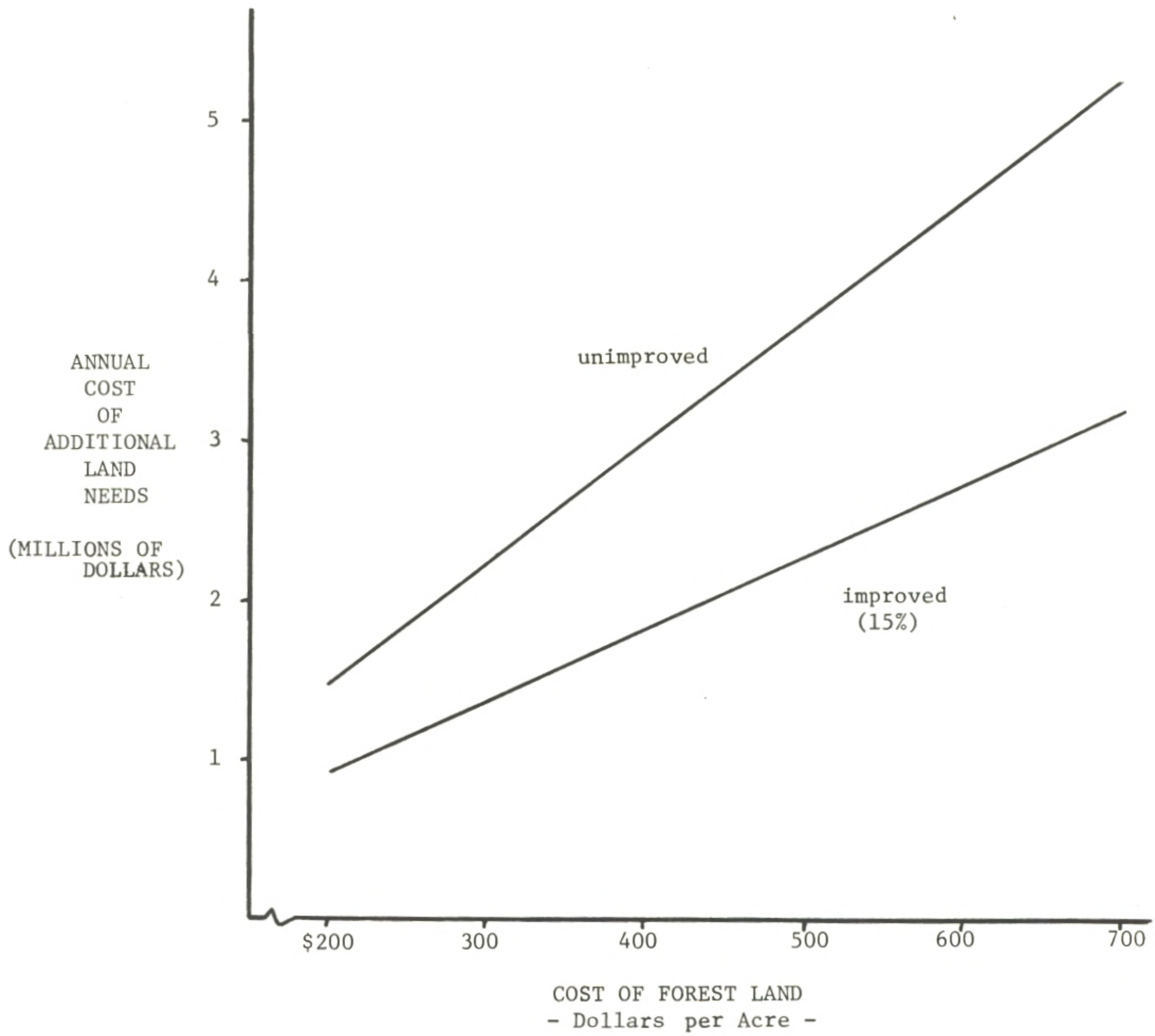
The difference in annual interest charges for the purchase of additional forest land, if unimproved vs. improved plantations are available, is depicted in Figure 4. As the cost of forest land (including standing timber) increases, the magnitude of the difference also increases. At $500 per acre, there is a savings of $1,500,000 per year directly attributable to tree improvement. Furthermore, to this savings in annual interest (or opportunity) charges must be added the savings in property taxes and management costs associated with the smaller land base requirements with improved plantations.

SUMMARY

This anlaysis of the economic value of tree improvement activities has been purposely broad. It has considered the market environment within which tree improvement work is important. This overall perspective, especially given the future wood products demand situation, shows that past economic evaluations of tree improvement have probably been very conservative. Tree improvement programs may well move from good to excellent investment status. This fact should be good news for the tree improvement specialist.

However, recent trends and recognition of the leverage that tree improvement provides almost surely mean that tree improvement activities are

Figure 4. Annual Cost Associated with Additional Lands Needed After Mill Expansion.



considered an integral part of operations - certainly no longer research. As such, tree improvement work faces the same day-to-day operational pressures as other phases of the business. Consequently, there is going to be growing impatience with the current pace of genetic improvement and probably an increasing need to clearly define both breeding and operational goals for tree improvement.

I am afraid that we have stressed tree improvement costs too much in the past. That is natural in the early part of such a long-term venture as tree improvement, but the emphasis needs to change. In the future, questions of cost are going to be secondary to questions of added return (yield) and the timing of such returns.

The past emphasis on costs has also made us somewhat conservative as to approach. Particularly given future demand levels, forest industry will be willing and indeed actually called upon to take substantial risks. I challenge the tree improvement specialist to do the same; take some risks. More research is needed relative to genetic gain sooner and/or increasing its magnitude. If this means a narrowing of the genetic base, so be it. Simply make an effort to keep such practices outside the long-term breeding scheme. The tree improvement specialist has never been in a better position to contribute to southern forestry.

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