ECONOMIC BENEFITS OF AN AGGRESSIVE BREEDING PROGRAM

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Abstract: Before any new methods are used to speed up the breeding cycle in a tree improvement program, the economic benefits of the techniques need to be evaluated. New technologies must yield a suitable rate of return for the money invested, if they are to be utilized in applied programs. Many new methods are available which will speed up the breeding cycle: out-of-phase dormancy, indoor potted breeding facilities, gibberellin applications, containerized planting stock for genetic tests, etc. Some of the methods require substantial investments and may not be economical. Other methods require very little additional time and money and may result in high returns on investment.

A present value analysis was done to determine the economic benefits of shortening the breeding cycle of loblolly pine (*Pinus taeda* L.) by 1 to 6 years in the southeastern United States. Depending upon various conditions such as stumpage values, desired rate of return, and the number of acres regenerated with the improved planting stock, the investment in aggressive breeding programs will be very profitable in most tree improvement programs.

INTRODUCTION

Many new methods to accelerate the breeding cycle for loblolly pine (*Pinus taeda* L.) have been developed in recent years. Out-of-phase dormancy (Greenwood 1978), indoor potted breeding facilities (Greenwood et al. 1979), water stress and gibberellin applications (Greenwood 1981), outdoor potted breeding facilities (Anonymous 1983), and proper site selection, irrigation, and fertilization regimes for conventional field established orchards (Jett 1983) have all shown positive results in speeding the reproduction cycle in loblolly pine.

Before any of these new methods are used in a tree improvement program, the economic benefits of the techniques need to be evaluated. If new technologies do not yield a suitable rate of return for the money invested, then there is no justification for utilizing them. This paper will outline the biological and economic benefits which can be gained from accelerated breeding schedules for loblolly pine.

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The cycle from the beginning to end of a tree improvement generation is long and complex. The steps involve selection, breeding, testing, production of commercial quantities of seed, and, finally, the crop production through rotation. This complete cycle normally requires 50-60 years to complete for loblolly pine. If any portion of it can be shortened without adversely affecting the quality and yield of the crop at rotation age, much more economic gain will be realized. We will limit the discussion to shortening only the breeding phase of the tree improvement cycle. The only effect that a shorter breeding cycle has is to get the genetic gain into production at an earlier date. The amount of gain is not affected.

In the North Carolina State University-Industry Cooperative Tree Improvement Program, the goal has been established to complete the second generation interval of breeding, testing, and selection in 20 years. The breeding phase is expected to require 12 years to complete and selection will occur in 8 year-old genetic tests (Anonymous 1982). With intensive accelerated breeding methods such as out-of-phase dormancy and an indoor potted breeding facility, the breeding phase might be shortened to 6 years rather than 12 years (Greenwood et al. 1979). The effect of this on the amount of genetic gain per year is illustrated in Figure 1. If 15% genetic gain is achieved in 20 years, 0.75% gain per year results. If the interval is reduced by 6, 1.07% gain per year or 43% more benefit is realized. To achieve this extra benefit, additional costs will be involved. Therefore, the objective of our tree improvement activities is to optimize the amount of genetic gain per unit time so as to maximize the rate of return for the investment in tree breeding.

METHODS

A present value analysis was done to show the value of saving time in a tree improvement cycle. Two successive cycles of improvement were evaluated with the biological assumptions being:

- Genetic gain equal to 15% of value per generation.

- Base growth rate for land is 1.5 cords/acre/year.

- Twelve years after grafting are required to complete breeding without using flower stimulation methods.

- Selections from progeny tests will be made at age 8.

- Seed orchards begin full production at age 12.

- Rotation length equals 25 years.

The biological benefits of speeding up the breeding activities are shown in Figure 2. If two consecutive breeding cycles are shortened by six years, an extra 15% value per acre, measured as 5.6 and 6.5 cords per acre, respectively, will be harvested for 6 and 12 years sooner from the first and second generations of improvement, respectively.

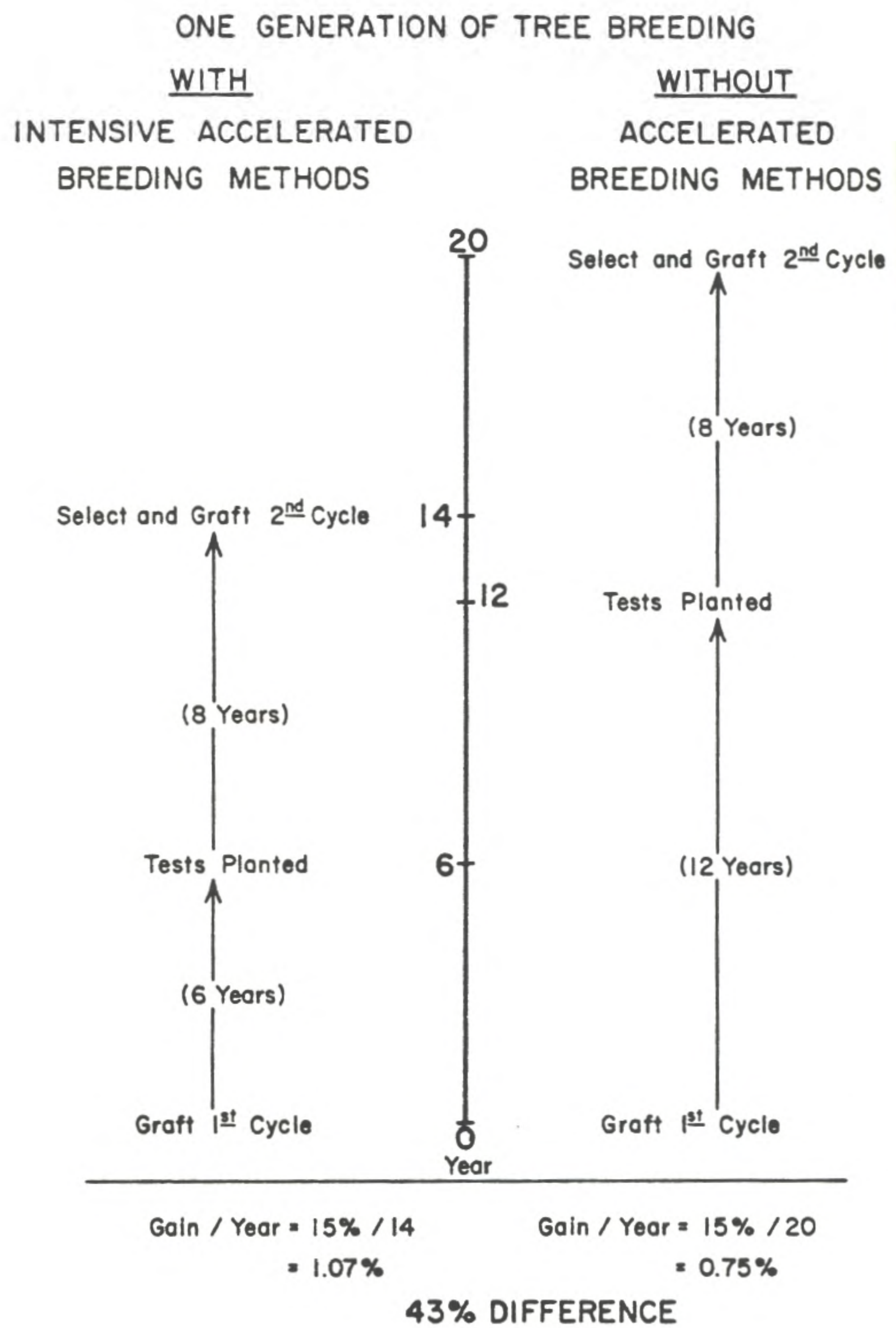

Figure 1.--One Generation of Tree Breeding With and Without Intensive Accelerated Breeding Methods.

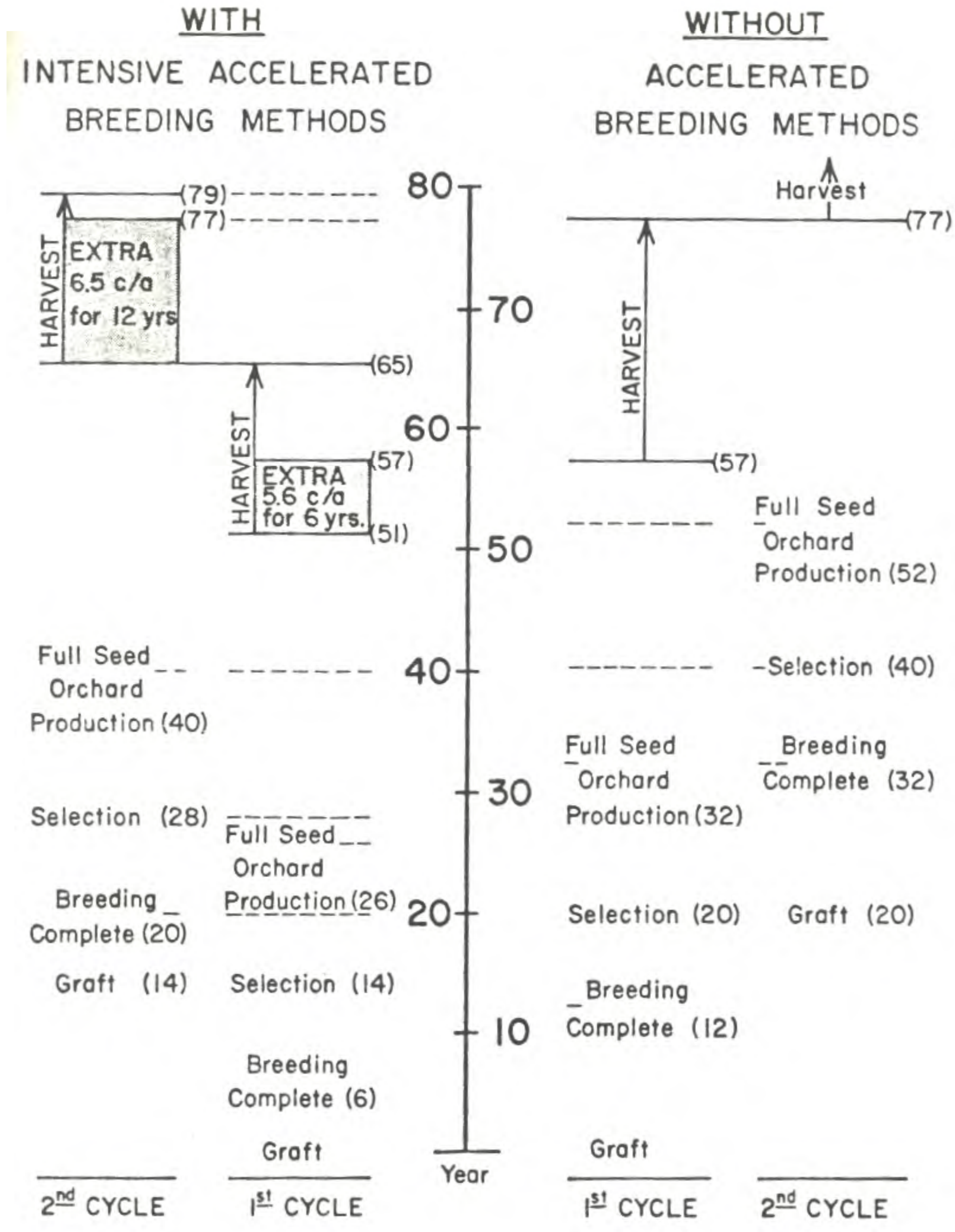

Figure 2.--Result of Reducing the Breeding Cycle from 12 to 6 years for 2 generations of improvement.

The economic benefits of the time savings were determined by discounting the future value of the increased harvest to today's dollars. Stumpage prices were increased at a rate of 2% per year above inflation. This has been a trend in the South for several years and is expected to continue as demand for southern pine fiber increases (Anonymous 1982b, Clephane 1982).

The analyses were done for stumpage values of $15 and $25 per cord, with rates of return of 6%, 8%, 10%, and 12%. The number of years which could be saved varied from one to six years. The present values were calculated for a 10,000 acre per year regeneration program.

No attempt was made to include cost figures in the economic analysis for the various treatments used in accelerated breeding programs. Most of the methods are relatively new and little information regarding the costs of treatments is available.

RESULTS AND DISCUSSION

The values presented in Table 1 indicate that investing in accelerated breeding methods will be very profitable in most cases. Saving as little as one year in the breeding cycle is worth a great deal of money. At an 8% discount rate and $15 per cord stumpage price, the present value of the time savings would be over $60,000 for a 10,000 acre per year regeneration program. For a larger program of 30,000 acres per year regeneration and $15 per cord stumpage, if 6 years could be eliminated from the breeding cycle, the present value would be $2,251,500 (i.e. 3 times the Table 1 value for 10,000 acre program) at an 8% discount rate. A variety of time savings, stumpage prices, and discount rates can be evaluated from Table 1. The analysis is quite sensitive to the discount rate used, because of the long time period for the investment.

Many low cost methods such as gibberellin applications for female stimulation, wire girdling for pollen stimulation, or growing seedlings in containers in a greenhouse are all workable methods to reduce the breeding cycle from 1 to 3 years. Very little added expense would be incurred if these methods were used, but very large economic benefits would result.

There is no set answer as to whether or not certain investments are justified to accelerate a breeding program. The analyses which were presented are simplified. No consideration was given to important factors such as depreciation of equipment or structures, operating costs, or taxes. However, it should be apparent that investing in an aggressive breeding program will be profitable in most situations.

Table 1.--Present Value for Saving 1-6 Years per Tree Improvement Cycle for 2 Cycles for Regenerating 10,000 Acres per Year.

Years Saved	Today's Stumpage ($/Cord)	Desired Rate of Return 12%	10%	8%	6%
1	15	$ 6,200	$ 18,800	$ 60,300	$ 204,200
	25	10,300	31,300	100,500	340,300
2	15	13,100	39,600	125,800	420,800
	25	21,800	66,000	209,700	701,300
3	15	20,900	62,700	197,100	651,000
	25	34,800	104,500	328,500	1,085,000
	15	29,800	88,300	274,400	894,800
	25	49,700	147,200	457,300	1,491,300
5	15	39,800	116,800	358,600	1,153,600
	25	66,300	194,700	597,700	1,922,700
6	15	51,200	148,600	450,300	1,428,500
	25	85,300	247,700	750,500	2,380,800

"For different number of acres to be regenerated, multiply the table value by the appropriate factor (ie. 2 x for 20,000 acres) to obtain the proper present value.

[2/] Real interest rate, above inflation.

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