Tree-Planting Machine-- Can You Afford One?

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An effective tree-planting machine must not only plant trees successfully, it must be affordable. To be affordable, a tree-planting machine must plant seedlings at, or less than, the cost of handplanting. Handplanting cost data are readily available. Machine planting costs are not as readily available, so San Dimas engineers devised a method to predict an affordable price for a tree-planting machine.

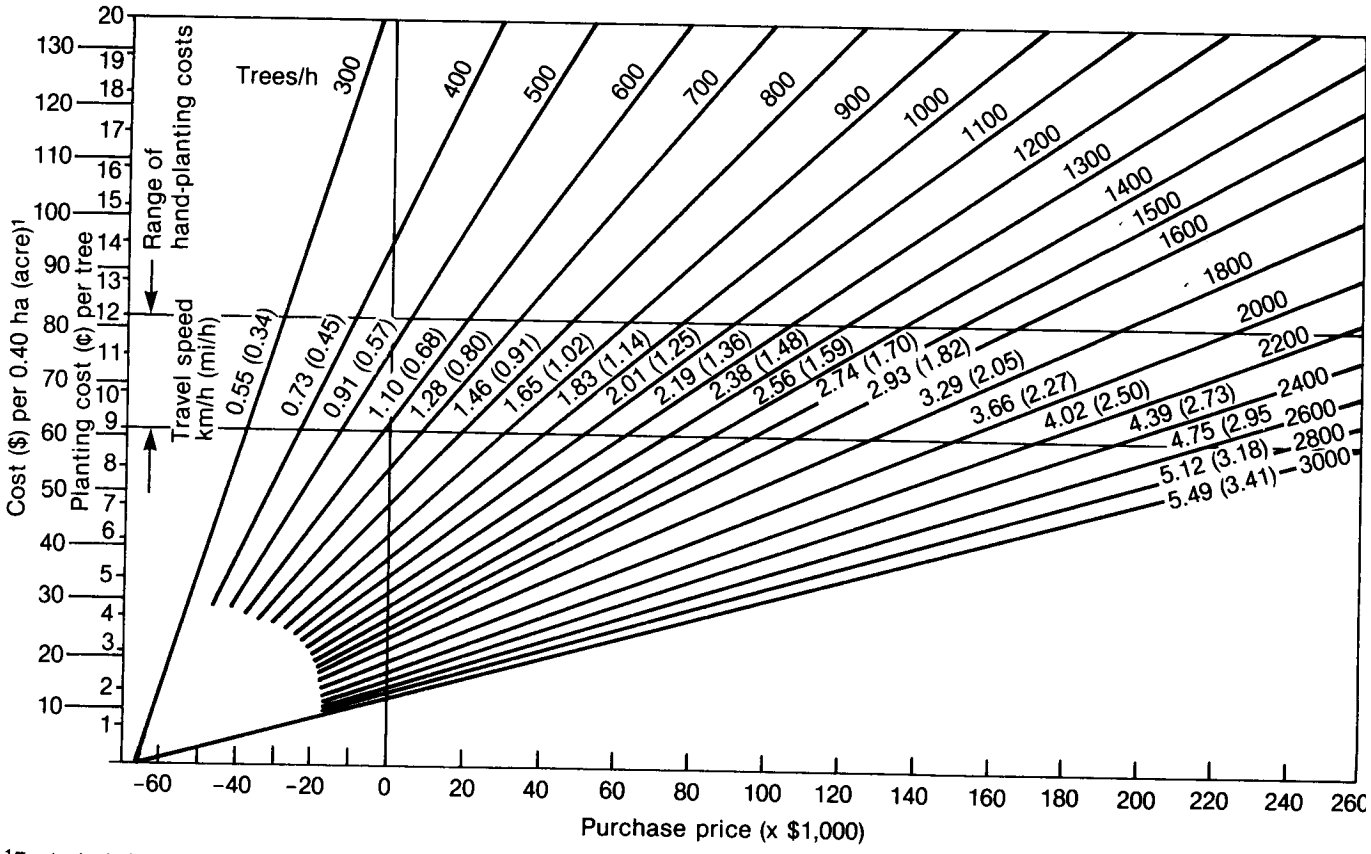
The San Dimas Equipment Development Center was assigned a project for the development of an intermittent tree-planting machine. The first task was to establish performance criteria for a tree-planting machine-one that would meet minimum requirements for quality, dependability, safety, and reliability. Second, the machine would have to be cost-effective; that is, compete economically with handplanting. This would require machine planting costs to be equal to or less than handplanting costs.

The method developed to predict an affordable price for a tree-planting machine is illustrated on the charts in figures 1 and 2. It is based on data and assumptions from the Southeastern United States where such machines are in demand because of tree farms with large areas to be planted and a long planting season. If a different area is considered or these assumptions do not fit, they can be changed and new charts developed.

Assumptions used to develop these charts were:

1. The Southeastern United States is the prime area of concern and the charts are based on its climate, terrain, and labor and equipment rates.
2. While the affordable tree-planting machine can be either an intermittent or continuous-row machine, the intermittent planter is the one under consideration.
3. Site preparation costs are the same loran intermittent tree-planting machine and handplanting.
4. Within the rows, tree seedlings are to be planted 1.8 meters (6 ft) apart.
5. Tree-planting machines have an 85-percent availability; productive equipment time is equal to 85 percent of labor time; and, for a towed planter, the prime mover has an availability of 90 percent.
6. Equipment life is 6,000 hours of operating time over a 10-year period.
7. Overhead plus profit on labor is equal to direct labor cost.
8. Maintenance cost is equal to straight-line machine depreciation cost, without the cost of capital.
9. Machine depreciation cost is calculated by employing the capital recovery factor in conjunction with cost of capital and equipment life.
10. Overhead and profit on equipment are equal to the straight-line depreciation cost, without the cost of capital, plus the maintenance cost; or twice the direct straight-line equipment depreciation cost; or twice the maintenance cost.
11. The cost of capital is 15 percent.
12. The crawler tractor that tows a tree planter ranges in size from 4,500 to 6,300 kilograms (10,000 to 1 5,000 IN and can travel at a speed of approximately 2 kilometers per hour (1.24 mi/h) on cutover areas.
13. The pass-through equipment cost (renter's overhead and profit) equals 0.25 times the equipment cost.
14. The salvage value of equipment after 10 years of use is zero.
15. Tree survival rates for intermittent machine planting are equal to handplanting.
16. Government experiences the same direct overhead and costs as private enterprise.

Using these assumptions, the families of straight lines in figures 1 and 2 can be developed and expressed as a linear equation that



[1]For typical plantings in Southeastern United States: 1.8 x 3.3 m (6 x 10.7 ft) spacing, or 680 trees per 0.40 ha (acre).

Figure 1—*Planting cost at various production rates for a towed tree planter.*

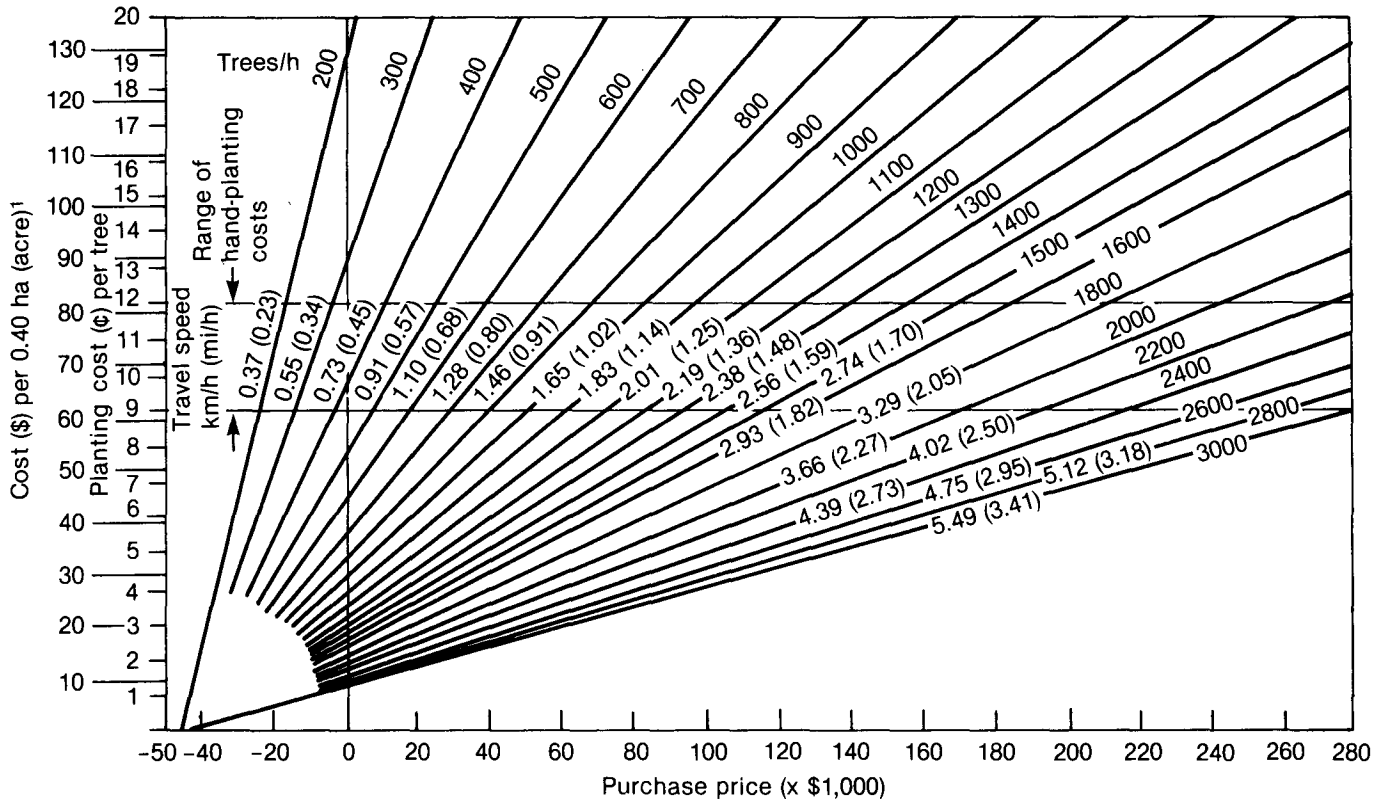
tells how much you can afford to pay for a tree planter:

$X = C_1 + C_2 (HPC) (MPR)$

X is the maximum affordable tree planter purchase price in dollars.

C_1 is a negative constant in dollars determined by extending the straight lines to their point of convergence as they intercept the X-axis. By inspecting figure 1 for tow tree planters, C_1 = -$61,500. By inspecting figure 2 for self-propelled tree planters, C_1 = -$46,700.

C_2 is a constant in hours that, when multiplied by *HPC* (handplanting cost in $/tree), gives the additional amount, in dollars, that can be paid for a mechanized tree planter with an increase of one tree per hour in the production rate.



[1]For typical plantings in Southeastern United States: 1.8 x 3.3 m (6 x 10.7 ft) spacing, or 680 trees per 0.40 ha (acre).

Figure 2—*Planting cost at various production rates for a self-propelled planter.*

HPC is the handplanting cost known to exist in the planting location being considered.

MPR is the machine production rate in trees per hour for the unit under consideration.

C_2 has been determined by "plugging in" various sets of values for X, *HPC,* and *MPR* in straight-line relationships in both figures 1 and 2. These solutions for C_2 have resulted in 1,203 hours for a towed planter and 1,202 hours for a self-propelled planter. For example, to determine the maximum economical purchase price, if handplanting in your area costs $0.12 per tree and a towed tree-planting machine being considered for purchase can plant 1,100 trees per hour, the maximum economical purchase price for that planter is $X = C_1 + C_2 (HPC) (MPR) =$ -$67,500 + 1,203 hours ($0.12/ tree) (1,100 trees/hour) = $91,300. Alternatively, you could use figure 1.

Recent (1980) contracts in the Southeastern United States indi-

cate the *HPC* range is from $0.09 to $0.12 per tree. At $0.12 per tree, the maximum that you should be willing to pay for an intermittent tree planter with an *MPR* of 1,100 trees per hour is $91,300 for a towed planter and $112,000 for a self-propelled unit. If we were to assume a two-row machine with an *MPR* of 1,500 trees per hour, the maximum affordable price for an *HPC* of $0.12 per tree is $149,000 for a towed machine and $169,000 for a self-propelled one. Also, from figures 1 and 2, a machine must have a planting rate of at least 540 trees per hour (if we assume a minimum machine cost of $10,000 for a towed unit and $27,000 for a self-propelled unit) to be affordable. At a planting rate of 540 trees per hour, this will only allow 6.7 seconds to plant each tree. At this rate, planting cannot be a stop-and-go operation and specific spot selection for seedling insertion cannot be made. At higher, more desirable (and possibly necessary to make the machine affordable) planting rates, the problems of stop-and-go operation and specific spot selection become more acute.

In conclusion, the most important factor that a designer of a tree planter has control over is the production rate of the machine. A production rate of at least 600 trees per hour must be achieved or an intermittent tree planter will not be economical (affordable). Much higher planting rates than 600 trees per hour are desirable and may be necessary for the machine to, be affordable, depending on the cost of the machine and other circumstances.

Project Record 8124 1203, June 1981, "Tree-Planting Machine-- How Much Can You Afford To Pay For One?", contains more detailed information on this subject. It is available from the San Dimas Equipment Development Center.