Dwarf peach trees planted 1000 to 1500 trees per acre yielded 15 to 22 tons per acre in the third growing season. Standard peach varieties planted at a density of 108 trees per acre yield about three tons of fruit at the same age.

The commercial potential of dwarf fruit trees

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Genetically-dwarfed tree fruit and nut varieties offer numerous cultural advantages to commercial producers and home gardeners alike. However, commercial producers have shown no interest in dwarfs because, among other things, the fruit of the varieties available is soft, bruises easily, and sometimes has unacceptable flavor.

Such defects could be remedied through varietal improvement, but breeding dwarf varieties that produce high quality fruit would be futile unless the dwarf trees were also productive. Therefore, this study was initiated to determine whether or not genetically dwarfed fruit trees would be as productive as standard varieties.

Production study

We established a yield trial at the Kearney Field Station (near Fresno), using as a model a dwarf peach selection supplied by Fred Anderson of Merced. This peach is derived from the Florey Dwarf, which is homozygous for the recessive *dw* gene that induces brachytic dwarfism. Mature trees of this genotype, *dw/dw,* are only about 6 feet tall because of drastically shortened internodes.

Test trees were high-budded (18 inches above the ground) onto Nemaguard rootstocks. This placed the dwarf tops at a level convenient for hand harvest (unlike trees budded 2 to 4 inches above the ground). Trees were planted in February, 1976, at densities of about 500, 1000, 1500, 2000, and 3000 per acre. About 90 trees were planted in hexagonal configurations at each density. Each of the 90-tree-density treatments was divided into three plots comprising about 30 trees each. The three plots were then randomly distributed within each of three blocks to ensure that possible differences in soil conditions would not bias comparisons of yields at different densities. Guard rows were planted around each plot.

Dwarfs versus standard

Table 1 shows dwarf tree yields in their second and third growing seasons after planting in 1976. These results, coupled with our observations of the space these 3-year-old trees occupy, suggest that optimum planting density for the dwarf peaches is somewhere between 1000 and 1500 trees per acre. In the third growing season this gave a yield of 15 to 22 tons per acre. In comparison, standard peach varieties planted at 108 trees per acre yield only about 3 tons per acre at the same age. This shows that genetically-dwarfed peach trees produce significant yields 2 to 3 years sooner than do standard peach varieties grown in the usual fashion.

Standard peach trees can produce significant yields when less than 4 years old, but they generally do not because of the considerable (and costly) pruning required while being established. (Dwarf peach trees require little pruning during this time.)

A comparison of the second and third leaf yields shown in table 1 with the average productivity of mature standard peach trees of varieties ripening in August (projected at 15 tons per acre 6 years after planting - see table 2) suggests that mature dwarf peach trees, planted at densities between 1000 and 1500 trees per acre, may well be twice as productive as are standard

TABLE 1. Dwarf Peach Yield Trial, Kearney Field Station, Parlier.

No. of Trees Per Acre	Yield Tons/Acre 1977	1978
503	4.05	5.05
1002	7.62	15.47
1521	13.42	22.30
2012	17.52	24.95
3016	21.28	21.26

The massive quantity of fruit set by a genetically dwarfed tree is seen here. The dwarf trees produce normal size fruit if the set is thinned.

peach varieties planted at 108 trees per acre and grown under the usual conditions.

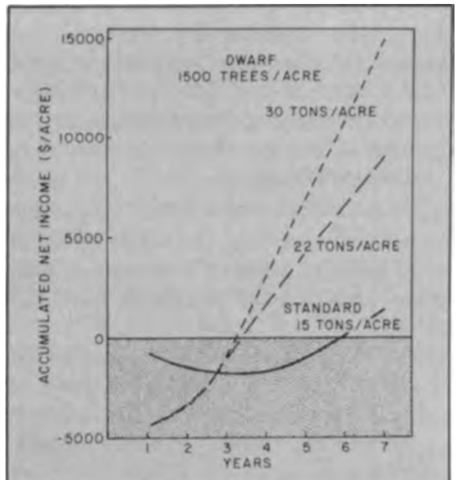
The dwarf can produce and size peaches at a greater fruit density within its canopy than can standard peach trees. Average diameter of fruit from the yield trials in this study was between 2 3/4 and 3 inches. Clearly, the gene that dwarfs tree stature does not adversely affect fruit size.

Economics of standard and dwarf

Normally, it takes between 5 and 7 years for standard variety peach orchards to pay off the costs of establishment. We have estimated the economics of establishing genetically-dwarfed peach orchards of 1500 trees per acre over a 7-year period — in order to compare required investments and returns with those associated with standard peach varieties. To make this comparison yields in the fourth through seventh years were estimated, because the Kearney trial is just now entering its fourth year. The comparison is based on two different estimates of future yield of the dwarfs. The first is based on a "worst case" assumption; namely, that the productivity of the dwarfs would not increase beyond the yield observed in the third leaf: 22 tons per acre for 1500 trees per acre. The second is our "best" estimate of what average productivity will be from the fourth through the seventh leaf yields, namely 30 tons per acre for 1500 trees per acre.

Our estimates of the accumulated net income obtainable from standard trees (108 per acre) and from genetically-dwarfed trees (1500 per acre) are plotted in figure 1 for the 7 years generally required to recapture accumulated costs of establishing standard peach orchards. Tables 2 and 3 give estimates of specific investments and returns that contributed to the net incomes depicted.

Thus, genetically-dwarfed peach trees would offer considerable economic advantages over standard peach varieties, even if their productivity did not become greater than that attained in the third leaf of the Kearney trial.



Economics of establishing orchards of standard and dwarf peach trees.

Potential of dwarf orchards

To summarize what we know about genetically-dwarfed fruit trees:

1. Their obvious cultural advantages to commercial producers include:
   A. Elimination of the need for ladder operations
   B. Drastic reduction of pruning requirements
   C. Better utilization of soil, water and light energy in a limited area

TABLE 2. Estimated Cost and Income of Standard Peach Orchard (108 Trees Per Acre).

Annual costs	Year	Years after planting					
($/acre)	planted	1	2	3	4	5	6
Planting and trees	$ 260	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Culture	90	135	240	361	479	470	738
Interest on operating capital	35	14	24	36	48	48	74
Overhead	425	491	560	615	621	561	450
Harvest (at $25/ton)	0	0	75	150	250	325	375
Total cost	810	640	899	1,162	1,398	1,413	1,637
Yield (tons)	0	0	3.0	6.0	10.0	13.0	15.0
Income ($200/ton)	0	0	600	1,200	2,000	2,600	3,000
Annual net income	-810	-640	-299	38	602	1,187	1,363
Accumulated net income	-810	-1,450	-1,749	-1,711	-1,109	78	1,441

TABLE 3. Estimated Cost and Income of Dwarf Peach Orchards (1500 Trees/Acre).

Annual costs	Year	Years after planting					
($/acre)	planted	1	2	3	4	5	6
Planting and trees	3,375	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Culture	210	681	675	745	767	755	755
Interest on operating capital	359	68	68	75	77	76	76
Overhead	450	909	837	603	525	525	525
Harvest (at $15 ton)	0	201	335	450	450	450	450
Total cost	4,394	1,859	1,915	1,873	1,819	1,806	1,806
Yield (tons)	0	13.4	22.3	30.0*	30.0*	30.0*	30.0*
Income ($200/ton)	0	2,680	4,460	6,000	6,000	6,000	6,000
Annual net income	-4,394	821	2,545	4,127	4,181	4,194	4,194
Accumulated net income	-4,394	-3,573	-1,028	3,099	7,280	11,474	15,668

*Thus far we have measured yields only through third year. These figures are our best guess of what the yield will be.

D. Ability to facilitate far more precise applications of pesticides.

2. Trial results strongly suggest that peach and nectarine varieties dwarfed by this particular gene are more precocious and more productive (for their size) than standard varieties.
3. Commercial acceptability of these drawf varieties hinges on the development of varieties with higher fruit quality than presently available in existing varieties.
4. Full exploitation of the potential of genetic dwarfs will probably depend on some modifications of the cultural methods appropriate for trees of standard size.

Dwarf tree breeding

Fortunately, dwarfing of tree fruit breeding stocks of the University of California will induce a several-fold increase in the effectiveness of its variety improvement programs because the cost of evaluating individual dwarf seedlings is only a small fraction of the cost of evaluating large-sized standard tree fruit seedlings. That means more seedlings can be evaluated without increasing costs, and the more seedlings evaluated the greater the odds are for breeding improved varieties.

Because of the potential advantages of dwarf tree fruit varieties, we initiated in 1975 a breeding program designed to improve fruit quality of dwarf freestone and clingstone peaches and nectarines. The best available genetically-dwarfed peaches and nectarines were crossed with standard breeding stocks maintained by the University of California at Davis and at Parlier. Inasmuch as the dwarfing gene involved is recessive, the F_1 progeny are all heterozygous (*Dw/dw*) for the dwarfing gene and therefore of standard size. Intercrosses between F_1 seedlings having superior fruit quality were made this past year and one-fourth of the resulting progeny are F_2 genetic dwarfs (as genetic theory predicts). These dwarfs should have significantly improved fruit quality. Evaluation of improved genetically dwarfed F_2 selections should begin in 1981.

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Mature dwarf trees are only about 6 feet tall, less than half the height of the standard variety shown next to Staff Research Associate Jim Doyle. Dwarf trees require little pruning.

The inves[t…]
research: [...]

Criticism of the land grant college system's research and extension programs began in 1972 with Jim Hightower's book, *Hard Tomatoes, Hard Times,* and has extended to the recent lawsuit by the California Rural Legal Assistance to arrest farm mechanization research at the University of California. Numerous studies have estimated the returns to society from public monies spent for agricultural research and extension, but these studies have generally been couched in academic jargon intended only for academicians to read. Our purpose here is to explain clearly and simply the essence of these studies.

In one of the first attempts to estimate returns to research expenditures (in 1958), Agricultural Economist Zvi Griliches used the development of hybrid corn as a case study. He added up private and public research costs between 1910 and 1955 and concluded that for every dollar spent on hybrid corn research, society can expect back about seven dollars each year in perpetuity.

Subsequently, agricultural economics researchers used Griliches' model as a prototype or developed their own methodology to estimate the returns from agricultural research and extension in the U.S. and elsewhere. Serious criticisms have been launched against these studies, many with valid points, but the fact remains that the