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An orchard system is the integration of all the horticultural factors involved in establishing and maintaining a planting of fruit trees. These factors include tree density and arrangement, cultivar, rootstock and interstock, tree size and form, pruning and training techniques needed to maintain the desired configuration, mechanical training and harvesting, and support systems. An orchard system is a blueprint for the orchardist to follow throughout the life of a planting.

Orchard systems research has been the subject of international symposia in 1976, 1980, and 1984, and the proceedings document worldwide trends toward small, supported trees on dwarfing rootstocks at high tree densities (8–10).

Many regions of the world have developed unique systems for growing fruit trees, and these new orchard systems were developed to meet specific objectives. A major objective in developing the Tatura trellis in Australia was the mechanization of pruning and harvesting (1). Similarly, in New Zealand, the Lincoln canopy was developed to facilitate mechanical harvesting (2). Heavy posts are required to support the many wires which, in turn, support the tree and allow for positioning limbs with these two systems and with the Murrumbidgee Irrigation Areas (MIA) system. Current developments with these trellis systems are reported by the originators of these systems in this workshop (3, 7, 16).

Free-standing central leader systems on semi-dwarf rootstocks (semi-vigorous rootstocks for spur-type ‘Red Delicious’) have been popular in the Pacific Northwest region of North America (6) and in the Hawkes Bay region of New Zealand (14). The major objective of these systems was to provide adequate light penetration to all parts of the canopy, ensuring high production of large, highly colored fruit. The medium density French vertical-axis system was developed to minimize the skill required and time needed to prune and train trees and to ensure adequate light penetration and high fruit quality (12, 13). The Dutch slender spindle system, with supported dwarf trees on M.9 rootstocks, was developed to provide early production beginning in the second year and full production in the fourth or fifth year (17–19). Additional objectives were to reduce the costs of management and harvest and to produce high-quality fruit.

There are many published reports, including those listed previously, that describe individual orchard systems, but there are few studies that have compared systems in replicated trials. Several of those trials will be briefly described here. In a 6-year-old ‘Golden Delicious’ trial, the slender spindle on M.9, four-wire trellis on M.9, free-standing interstem on M.9/MM.106, and pyramid hedgerow systems on MM.106 were compared at 2151, 1121, 795, and 425 trees/ha, respectively (4). Cumulative yield per hectare for a 6-year period was highest for the high-density, supported slender spindle and lowest for the low-density, free-standing pyramid hedgerow. However, the trellis trees were particularly efficient, with the highest number of fruit/100 cm² of leaf area and the highest yield/trunk cross-sectional area.

An orchard systems trial planted in 1976 in Quebec with ‘Spartan’ compared the free-standing pyramid, the Van Roehoudt palmette, vertical axis, and oblique palmette, each on M.9. Ottawa 3, M.26, and M.7 rootstocks at tree densities of 740 to 2960 trees/ha (5). The most profitable system in terms of early cropping and initial yield was the vertical axis system at medium and high densities on Ottawa 3 and M.26 rootstocks.

In England, yield per hectare was related to tree density during the first 10 years of a ‘Cox’s Orange Pippin’ trial comparing continuous hedgerows and dwarf bush trees on M.26 at densities of 299 to 1922 trees/ha (15). The dwarf bushes had higher yield/trunk cross-sectional area than hedgerows. Fruit size was reduced as yield per hectare increased at the highest tree densities. In the Netherlands, ‘Red Boskoop’ and ‘Jonagold’ trees were trained to the slen-
nder spindle and North-Holland spindle tree forms, each in single, three- and six-row beds and in a full field system at densities of 2667 to 4566 trees/ha (20). Yield per hectare in the sixth growing season increased with tree density. Slender spindle trees had higher yield per hectare, larger tree volume, better light distribution, and higher leaf area index than North-Holland spindles. Neither tree density nor tree form influenced fruit size or color.

An international systems trial with 'Golden Delicious' and 'Gloser'- was planted in 1980-81 at seven sites in Europe. Preliminary data from this trial are presented as part of this workshop (11). The trial compares single- and double-row slender spindles on M.9, a three-row North-Holland spindle on M.9, and mini-bush and slender spindle trees on M.27 at densities of 2051 to 8889 trees/ha. Planting materials, experimental design, management techniques, and types of data collected were standardized. Early yields have been highest for the highest tree densities.

As promising orchard systems are developed that meet many of the objectives of local fruit industries, it is imperative that they be compared with currently popular orchard systems. However, it is not surprising that few direct comparisons of systems have been made. It is expensive and time-consuming to establish and maintain replicated orchard systems trials for the minimum of 10 years required to gather meaningful data. A substantial commitment of resources—the Lincoln canopy and the Tatura trellis—and two others compare orchard systems, one a study with apple in Europe and a case countries) are involved. Each study advances our knowledge of orchard systems and of the techniques needed to evaluate and compare systems.

The worldwide need for improved orchard efficiency will increase. Production and fruit quality data and estimates of profitability from orchard systems trials will be the key to the orderly transition to new, more efficient orchard systems. It is the goal of this workshop to provide current information on orchard systems research and to stimulate interest in this vital area of tree fruit production.

**Literature Cited**