Modern Apple Training Systems

Terence L. Robinson
Dept. of Horticultural Sciences, Cornell University
Geneva, NY 14456
The Problem: What System to Plant?

• There is great disparity of opinion on the optimum planting density.

• Some growers plant 200-300 trees/acre on semi-dwarfing rootstocks with Central Leader.

• Most growers plant 500-1000 trees/acre on dwarfing rootstocks with some version of Vertical Axis.

• A few growers plant 2000 trees/acre on dwarfing rootstocks with Super Spindle.
## Viable Orchard Systems in NY

<table>
<thead>
<tr>
<th>System</th>
<th>Tree Density (trees/acre)</th>
<th>Tree Density (trees/ha)</th>
<th>Spacing (ft.)</th>
<th>Rootstocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slender Pyramid</td>
<td>340</td>
<td>840</td>
<td>8' x 16'</td>
<td>M.26, G.30,G.935</td>
</tr>
<tr>
<td>Vertical Axis</td>
<td>622</td>
<td>1538</td>
<td>5' x 14'</td>
<td>M.9, G.41,G.11</td>
</tr>
<tr>
<td>Slender Axis</td>
<td>908</td>
<td>2244</td>
<td>4' x 12'</td>
<td>M.9, G.41,G.11</td>
</tr>
<tr>
<td>Tall Spindle</td>
<td>1320</td>
<td>3262</td>
<td>3' x 11'</td>
<td>M.9, G.41,G.11</td>
</tr>
<tr>
<td>Super Spindle</td>
<td>2178</td>
<td>5382</td>
<td>2' x 10'</td>
<td>M.9, G.41,G.11</td>
</tr>
</tbody>
</table>
Slender Spindle/M.9
Triple Row Slender Spindle/M.9
Geneva Y-trellis/M.26
V-Slender Spindle/M.9
Tall Spindle/M.9
(Note high branches that do not need to be tied up.)
Braeburn Tall Spindle/M.9 (Third Leaf)
Tall Spindle/M.9
# The Geneva Planting Systems Trial

(Planted 1997)

<table>
<thead>
<tr>
<th>System</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slender Pyramid/M.7</td>
<td>10' X 18'</td>
</tr>
<tr>
<td>Slender Pyramid/M.26</td>
<td>8' X 16'</td>
</tr>
<tr>
<td>Vertical Axis/M.9</td>
<td>7' X 15'</td>
</tr>
<tr>
<td>Vertical Axis/M.9</td>
<td>6' X 14'</td>
</tr>
<tr>
<td>Slender Axis/M.9</td>
<td>5' X 13'</td>
</tr>
<tr>
<td>Slender Axis/M.9</td>
<td>4' X 12'</td>
</tr>
<tr>
<td>Tall Spindle/M.9</td>
<td>3' X 11'</td>
</tr>
<tr>
<td>Super Spindle</td>
<td>2' X 10'</td>
</tr>
</tbody>
</table>
Super Spindle
0.6 x 3.1m
3m tall

Tall Spindle
0.9 x 3.3m
3.2m tall
• Tree density and variety had a highly significant effect on final trunk cross-sectional area.
• Among M.9 treatments the highest planting density produced trees about 1/3 the size of the lowest planting density.
Tree density had a highly significant effect on yield per ha. The highest density system achieved 50 Mt/ha on the 4th year while the lowest density system did not surpass 25 Mt/ha.
Tree density had a highly significant negative effect on cumulative yield per tree but a highly significant positive effect on yield per ha. The cumulative yield per ha of the highest tree density was 3X greater than the lowest density.
There was no significant effect of tree shape on yield but there was a significant interaction with tree density. At high tree densities the V shape was inferior to the conic shape while at lower tree densities the V shape was superior to the conic shape.
Increasing tree density had a strong negative influence on yield efficiency of M.9. The highest tree density had a similar yield efficiency as M.7.
Conclusions

- Tree density had a strong influence on tree size, yield per hectare and light interception.
- The very high tree densities achieved a high yield of 50 Mt/ha by the fourth year and had a cumulative yield 3X the lowest densities.
- Tree shape had no effect on tree size or yield.
# Orchard System Performance in Northern NY - 2005

<table>
<thead>
<tr>
<th>Variety</th>
<th>System</th>
<th>Den.</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>Cum</th>
</tr>
</thead>
<tbody>
<tr>
<td>McIntosh</td>
<td>Central Leader</td>
<td>218</td>
<td>0</td>
<td>1</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Slender Pyramid</td>
<td>444</td>
<td>0</td>
<td>37</td>
<td>113</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Vertical Axis</td>
<td>726</td>
<td>2</td>
<td>239</td>
<td>327</td>
<td>566</td>
</tr>
<tr>
<td></td>
<td>Tall Spindle</td>
<td>1307</td>
<td>13</td>
<td>351</td>
<td>771</td>
<td>1135</td>
</tr>
<tr>
<td>Honeycrisp</td>
<td>Central Leader</td>
<td>218</td>
<td>0</td>
<td>1</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Slender Pyramid</td>
<td>444</td>
<td>0</td>
<td>33</td>
<td>117</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Vertical Axis</td>
<td>726</td>
<td>0.1</td>
<td>111</td>
<td>277</td>
<td>388</td>
</tr>
<tr>
<td></td>
<td>Tall Spindle</td>
<td>1307</td>
<td>3</td>
<td>132</td>
<td>578</td>
<td>713</td>
</tr>
</tbody>
</table>
With traditional fruit prices, profitability over 20 years increases with increasing tree density up to a density of 1,000-1,100 trees/acre.
Can you afford to replant and what density should you choose?

- If you receive a farm gate fruit price of at least $5.50/bu., have land or can buy land for up to $5,000/acre, can purchase trees for a price of $5.32, and have access to capital at 5% then you can afford to replant.

- The greatest profitability will be with the Slender Axis system (4' in-row spacing=908 trees/acre) or the Tall Spindle system (3' in-row spacing=1320 trees/acre)

- A 4 wire trellis and feathered trees are essential components of the system.
The Tall Spindle and Slender Axis Systems

- 3-4' in-row spacing
- 10-12' between rows
- 10' tall
- no permanent branches
- highly feathered trees
- minimal pruning at planting
- feathers tied below horizontal at planting.
Rootstock Selection

• M.9 T337 on vigorous soils or with vigorous scions, Nic29 or Pajam 2 on replant soil or with weak scions)

• B.9 or O.3 are alternatives.

• G.41 or G.11 may be better.
Recommended Tree Type for the Tall Spindle and Slender Axis Systems

- Plant large caliper highly feathered trees (8-15 feathers).
  - Feathers should be high enough (<24") to eliminate the need to tie up feathers.
Tree Spacing of the Tall Spindle

• In-row spacing of 3' for weak growing varieties (Honeycrisp, Delicious, Empire, Macoun, Gala).

• In-row spacing of 4' for vigorous varieties and tip bearing varieties. (McIntosh, Fuji, Cortland, Jonagold, Gingergold).

• Between row spacing should be 12-13' on slopes and 10-11' on level ground.
Pruning after Planting of Tall Spindle

Large caliper highly feathered trees (8-15 feathers).
- Do not head the leader.
- Remove all feathers below 24".
- Remove feathers that are larger than 2/3 diameter of leader.
- Do not tip the feathers.

Medium Caliper poorly feathered trees or whips.
- Head the leader at 60".
- Remove feathers larger than 2/3 diameter of leader.
- If there are less than 3 good feathers remove them using a bevel cut.
- Score above every other bud along leader from 24"-42" high.
Tree Training During the First Summer

- Pinch side shoots in upper 1/4 of leader when shoots are 4-5" long.
- Re-pincho side shoots in upper 1/4 of leader when regrowth is 4-5" long.
- Tie leader to support system.
- Tie down 4-5 lower branches below horizontal at planting or in July to induce flowering.
Pruning Year 2

• Do not head leader.
• Do not head feathers
• Remove side branches that compete with leader using a bevel cut.
  • Remove narrow angled branches.
  • Remove scaffolds that are larger than 2/3 diameter of leader.
  • Remove side branches that are longer than 2'.
• Remember "large branches create large trees"
Early Cropping

• "The best way of restricting vegetative growth is to produce apples." (Kurt Werth)

• Cropping must begin:
  – In the second year with the Tall Spindle system.

• Cropping targets for the Tall Spindle
  – Year 1  1-5 fruits
  – Year 2  20 fruits
  – Year 3  40 fruits
  – Year 4  70 fruits
  – Year 5  90 fruits
Pruning Year 3- 5

• Allow crop to bend the top.
• Limit height of tree only after top has bent by cutting leader to a weak fruitful side branch.
• Remove branches larger than 3/4 inch diameter.
• Remember "large branches create large trees"
• Shorten older, pendant branches to a weak side branch or spur.
• With Gala begin stubbing back pruning.
Pruning Years 6-20

• Limit height of tree by cutting to a fruitful side branch.

• Annually remove 2 branches per year (limb renewal pruning).
  – Focus on the middle tiers of branches first then on upper branches.

• Remove low hanging branches.

• Shorten pendant branches to point of bend.

• Do not overprune.
Young Tall Spindle Orchard
Older Tall Spindle Orchard
Conclusions

1) The tall spindle or Slender Axis systems appear to be the most profitable systems.

2) **High tree density** gives high early yield.

3) **Highly feathered trees** are the key to the systems.

4) **Minimal pruning at planting** (No heading the leader or tipping the feathers at planting)

5) **Branch angle management.** Bending feathers below horizontal at planting induces early cropping and limits branch size.

6) **Branch caliper management.** Ruthless removal of large branches keeps trees manageable. "Large branches create large trees"

7) "The best way of restricting vegetative growth is to produce apples."