Cornell Recommendations for Replanting

• Conduct a continual replanting program to remain competitive over the long term.
• Replant 4-5% of the farm annually
  - This maintains the non-bearing to bearing ratio <15%
  - This allows the entire farm to be replanted over 20-25 years
• We recommend that fresh fruit blocks be planted at 900-1300 trees/acre in the tall spindle system
• We recommend that processing fruit blocks be planted at 500-700 trees/acre in the vertical axis system
• We recommend that growers plant highly feathered trees
Choosing the Variety

- The variety planted has a large impact on profitability of the new orchard.
- To minimize risk, plant the best of the wholesale varieties on 50% of new orchard acreage.
- To generate high returns, plant new varieties that have high fruit prices on 40% of new orchard acreage.
- Gamble for very high returns with an emerging variety on a small acreage (10%)
On a Fresh Fruit Farm in NY State the Replanting Strategy would look like:

- **To minimize risk, plant the best of the wholesale varieties on 50% of new orchards.**
  - Gala - red stains (Brookfield etc.)
  - McIntosh -red strains Linda/RubyMac / Snappy / Acey Mac
  - Empire - Royal (with MCP)
  - Royal Cortland (with MCP)
  - Delicious (Best red strain with G.935 or G.202 at 1,000 trees/acre
  - Golden Delicious (Smoother or Reinders from Europe)

- **To generate high returns, plant new varieties that have high fruit prices on 40% of new orchards.**
  - Honeycrisp
  - Jonagold - Rubinstar, DeCoster, Red Prince (with MCP)
  - Golden Supreme
  - Fuji (Early strains Sept Wonder, Auvil Early, Beni Shogun)
  - Fuji Regular Strains -Aztec, Kiku Fubrax, Top Export, Suprema
  - Cameo

- **Gamble for very high returns on a small acreage (10%)**
  - New club varieties (Ambrosia, Piñata, Jazz, Envy, Pacific Rose, Sweet Tango, NY-1, NY-2 etc..)
On a Processing Fruit Farm the Replanting Strategy would look like:

• To minimize risk, plant the best of the wholesale varieties on 50% of new orchards.
  – Idared
  – Jonagold
  – McIntosh
  – Cortland
  – Mutsu/Crispin
  – Rome

• To generate high returns, plant new varieties that have high fruit prices on 40% of new orchards.
  – Autumn Crisp
  – Granny Smith
  – Fresh Fruit Varieties

• Gamble for very high returns on a small acreage (10%)
  – New club varieties for the fresh market (NY-1, NY-2 etc.)
Choosing the Right Rootstock and Spacing

• The choice of rootstock and spacing depends on:
  • Economics
  • Rootstock Livability
  • Rootstock Vigor and Efficiency
  • Scion Vigor
  • Climate
  • Soil type and fertility
  • Irrigation/Fertigation
  • Replant Disease
  • Spacing
  • Training System
1. Economics: Profitability of Fresh Fruit Apple Orchards in NY over 20 Years

- We suggest that fresh fruit growers plant the tall spindle system at the optimum density 900-1300 trees/acre (3-4’ in row X 10-12’ between row)
• We suggest that processing apple growers plant the vertical axis system at the optimum density
  600-700 trees/acre (5-6’ in row X 13-14’ between row)
2. Rootstock livability: Fire blight infection of rootstocks is a major problem in the USA

- Infection of susceptible rootstocks results in the death of the tree
- Infection of resistant rootstocks does not result in the death of the tree. The tree survives and the infected branches can be quickly re-grown.
2a. Fire blight susceptibility of Geneva and Other Rootstocks after Infection (RN 18 Plot)

**Gala**

- B.9USA
- G.41
- JM.7
- P.14
- B.9Europe
- P1Au 56-83
- JM.2
- M.9Burg756
- Supporter4
- M.9Nic29
- M.26NAKB
- M.26EMLA
- M.9T337

**Honeycrisp**

- B.9Europe
- G.16
- G.41
- B.9USA
- G.65
- G.11
- G.935
- P22
- M.27
- Supporter4
- M.9EMLA
- Ottawa 3
- M.26EMLA

Tree Mortality (%)
2b. Rootstock Livability: Survival of Honeycrisp and McIntosh on Different Rootstocks After the Severe Winter of 2004

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>% Live Trees</th>
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<td>Mark</td>
<td>92 ab</td>
<td>96 a</td>
<td></td>
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<td>G.16</td>
<td>92 ab</td>
<td>92 ab</td>
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<td>M.9 T337</td>
<td>86 abcd</td>
<td>36 cd</td>
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<td>B.9</td>
<td>66 bcde</td>
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<td>26 cd</td>
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<td>M.9/MM.111</td>
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<td>MM.106</td>
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<td>17 d</td>
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</table>
3. Rootstock Vigor and Efficiency: NC140 project
4. Scion Vigor

Crist Orchards (NY) Dwarf Rootstock Plot
Planted in 2005

- G.222 yields are roughly equivalent to M.9
- G.222 is not replant tolerant.
- G.222 generates blind wood similarly.

Crist Orchards (NY) Dwarf Rootstock Plot
Planted in 2005

TCA (cm²) Cum Yield Efficiency (kg/cm² TCA)
4. Scion Vigor

- Mutsu (Crispin)
- Northern Spy
- Jonagold
- McIntosh
- Cameo
- Fuji
- Gala
- Empire
- Idared
- Greening
- Macoun
- Sweet Tango
- Jazz
- Spur Delicious
- NY1
- Honeycrisp
Scion Vigor: Grow the tree to the top wire (10 ft.) by the end of the second year

Gala/M.9

Honeycrisp/M.9
### 5. Climate

- Length of Season
- Growing Degree Days
- Soil Temperature
- Winter Temperatures

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Tree Survival</th>
<th>Trunk Cross-sectional area</th>
<th>Cumulative Yield</th>
<th>Average Fruit Size</th>
<th>Cumulative Yield Efficiency</th>
<th>Alternate Bearing Index</th>
<th>Cumulative Root Suckers</th>
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<td>58.9</td>
<td>104.9</td>
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</table>
5. Soil Type and Fertility

- High Organic Matter vs. Low Organic Matter
- Sandy soil vs. loam soil vs. clay soil

6. Irrigation and Fertigation

- Irrigation in the first 3 years improves tree growth 50-100%
- Fertigation improves tree growth 50-100%

7. Replant Disease

- Rootstocks differ in their tolerance to soil pathogens which cause replant disease.
7. Rootstock Tolerance to Replant Disease in North America
Making the *Spacing Decision* considering several inter-related factors that affect final tree vigor

Rootstock Vigor +/- Factor for Scion Vigor +/- Factor for Climate +/- Factor for Soil Vigor +/- Factor for Replant Disease

Examples

**Mutsu/M.9 virgin ground in NJ**

Base Spacing of 6’ in row +1’ for vigorous variety+1’ for vigorous climate+1’ for vigorous soil+1’ for virgin soil =10’ in row spacing

**Honeycrisp/M.9 replant ground in Northern NY**

Base Spacing of 6’ in row – 1’ for weak cultivar – 1’ for short cool growing season + 0’ for moderate vigor soil – 1’ for replant disease = 3’ in row spacing
8. Tree Spacing

Effect of Tree Density on Tree Size

- McIntosh
- Gala
- Fuji
- Empire

Tree Density (trees/ha)

Trunk X-Sect. Area (cm²)
8. Training System: The Effect of Branch Angle on Tree Development
8. Tree Training System
8. Training System: “Large Branches Create Large Trees”
Making the Rootstock Decision based on Economics: 900-1300 trees/acre (3-4’ in row X 10-12’ between row)

- Use 3’ for weak and medium vigor varieties.
- Use 4’ for vigorous varieties.

- Find the right rootstock to fit the 3 or 4’ spacing.

Examples
- Use vigorous clones of M.9 (Nic29 or RN29) for medium vigor cultivars and or replant soil.
- Use weak clones of M.9 (T337 or Flueren56) for vigorous varieties or virgin soil.
- Use M.26, interstems, or M.7 for very weak varieties.
- Use irrigation/fertigation to improve lack of vigor.
- Use limb bending and limb renewal pruning of the Tall Spindle system to keep trees slender.
Released Geneva® Apple Rootstocks
Arranged by Tree Size

M.27 Size
- G.65
- G.11
- G.41
- G.16

M.9 T337
- G.935
- G.202

M.9 PAJ 2
- G.214

M.26 Size
- G.969
- G.210
- G.890
- G.222
- G.213

M.7-MM106 Size

Seedling Size
- G.210

New Releases

Geneva Rootstock Liner Production

Liners Production (number)

- G.11
- G.41
- G.935
- G.16
- G.30
- G.202
- Total CG
Stoolbeds of Geneva Rootstocks in the USA

![Graph showing the amount of stoolbeds over years for different rootstocks.](image-url)
Characteristics of G.11

- Tree size similar to M.9 T337.
- Productivity is similar to M.9.
- Large fruit size
- Resistant to Fire Blight but not immune.
- Resistant to Crown Rot
- Not tolerant to replant disease
- Susceptible to Wooly Apple Aphid
- Commercial sales in the US are picking up volume (~250,000)
- Good rooting in stoolbed (close to M.9)
Characteristics of G.41

- M.9 vigor
- Highly yield efficient
- Highly productive (most U.S. trials yields 100-125% of M.9)
- Very precocious
- Very cold hardy
- Does well in warmer climates (Mexico)
- Immune to Fire Blight and Crown Rot and Wooly Apple Aphid
- Replant tolerant
- Some issues with propagation being resolved by use of tissue culture mother plants
- In the USA production is ~100,000 plants in 2011.
Characteristics of G.935

- Vigor intermediate between M.9 Pajam 2 and M.26
- Very cold hardy
- Good graft union and propagation characteristics
- Resistant to Fire Blight and Crown Rot
- Tolerant to Replant Disease Complex
- Susceptible to Wooly Apple Aphid
- Production in US ~50,000 plants in 2011.
Characteristics of G.202

- It is similar in size to M.26
- Precocious, productive
- It is resistant to woolly apple aphid, fire blight, and crown rot
- In New Zealand it has been a top performer
- Good choice for weak growing cultivars like Honeycrisp
- Tolerant to apple replant disease
- Moderate rooting in stoolbed.
- Production in North America ~80,000 plants in 2011.
Characteristics of G.214

- Vigor similar to M.9 Pajam2
- Highly yield efficient
- Highly productive (most U.S. trials yields 100-125% of M.9 check)
- Good precocity
- Resistant to Fire Blight, Crown Rot and Wooly Apple Aphid
- Replant tolerant
- Very good stool bed propagation
- No commercial production of liners.
Characteristics of G.969, G.210 and G.890

• Vigor between M.7 and MM.106
• Replacements for G.30
• Free standing
• Precocious, productive
• Yield efficiency similar or better than M.9
• Resistance to woolly apple aphid, fire blight, and crown rot.
• Tolerance to apple replant disease.
• Good rooting in stoolbed few spines.
• Mostly for processing industry
Rootstocks for Fresh Fruit Growers

- We suggest that fresh apple growers plant the tall spindle system at the optimum density
  1,000-1,300 trees/acre (3-4’ in row X 10-12’ between row)
- G.11
  - best in virgin ground
  - best with vigorous varieties (McIntosh, Jonagold, Fuji, Mutsu)
- G.41
  - best in replant ground
  - best with weak and medium vigor varieties (Gala, Empire)
- G.935
  - best with weak varieties (Honeycrisp, SweetTango, NY1, Delicious)
Rootstocks for Processing Growers

- We suggest that processing apple growers plant the vertical axis system at the optimum density 600-700 trees/acre (5-6’ in row X 13-14’ between row)

- **G.969**
  - high yield but very manageable vigor
  - tree is free standing but the large early crops need support

- **G.890**
  - more vigor than 969 but still very productive
  - great for replant ground

- **G.935, or G.202**
  - less vigor than 969 so require higher density
  - use densities of 700-800 trees/acre

![Graph showing Net Present Value (NPV) vs. Tree Density for Trellised and Free Standing Systems](image-url)
Summary

- Plant either 3 or 4’ in row and 10-12’ between row using the tall spindle system for greatest profitability.
- Plant 5’ in row and 13-14’ between row for processing blocks.
- Pick a rootstock that is adapted to your climate and in the right vigor range for your soil and scion.
- Use fertilization, irrigation, limb bending and renewal pruning to manage vigor.
- Several new Geneva rootstocks may allow a more precise matching of scion, soil and climatic vigor with rootstock vigor to fit the optimum economic tree density.
- There will be 500,000 Geneva liners planted in the US nurseries this coming spring and 1 million in 2013.