Site Selection

I. Select fruit species/cultivars to be grown.

Based largely upon market situation; however, analysis of climate and soil of intended site may affect what species can be grown.

II. Climate.

A. Minimum winter temperature (*extreme*, not average). Killing points for some crops:

Apple, Pear: -30 to -40C (-20 to -40 F).
Peach, Plum: -20 to -25C (flower buds, wood hardier).
vinifera grapes: -20 to -25C.
Pecan: -10 to -15C.
Citrus: -2 to -7C.

B. Chilling temperatures

- Traditionally, this is measured as hours per year below 7/C (45/F).

- This information obtained from climatic atlases, extension service, web-based weather databases, or your own calculations/records.

See www.griffin.uga.edu/aemn for an example of a web service that calculates chill hours for you, and gives historical data on chilling.

* Choose a cultivar which will receive sufficient chilling each year, but will not bloom too early.

C. Frost-free days (length of growing season). Need enough time for bloom 666 maturity, and additional time after harvest for proper flower bud development for following year`s crop. Examples:

Strawberry - Only 60 days (or so) from bloom to maturity; plants often removed after 1 year and replanted in fall, can grow another crop during summer.

Cherry - 60-90 days for fruit set/development, several weeks after flower buds are sufficiently developed for next season.

Pecan, Kiwifruit - 180-220 days from bloom ----> maturity.

`Valencia' orange - over 1 year from bloom ----> maturity.

D. Frost potential. Factors influencing frequency/severity of frost at given site:

1. Latitude - Southern locations less prone with same cultivar; In Georgia, average day of last 28F occurrence is 1 month earlier in Valdosta than in Blairsville.

2. Topography - "Frost pockets" low areas in hilly terrain; can easily be 5/C (9/F) colder than hillside during calm, clear conditions. Avoid, or plant with late blooming cultivars.

3. Proximity to large bodies of water - Moderates extreme temperatures; delays bloom in spring since cool, extends season in fall since warm.

E. Heat Units. It has to be warm enough to mature a crop in a given location. Heat units , also called “degree days” or “growing degree days” integrate the effects of temperature and time:

$$\text{Growing degree days (GDDs)} = \frac{\text{daily max} + \text{daily min}}{2} - \text{base temp}$$

It’s easier to approximate with monthly temperatures:

Growing degree days (GDDs) = [monthly ave temp - base temp]* # days/month

For example, if monthly average temp is 72/F, and base temp is 50/F, then 72 - 50 = 22 x 31 days = 682 GDDs would be accumulated in that month. Sum all the GDDs that would occur over the growing season.

* Begin recording after last frost in spring, continue until first frost in autumn.

* Base temp is species dependent, but often 45 or 50/F. For citrus, 55/F.

Example - Grapes:

American species - 1800 to 2500 GDD is best, above 3000 GDD, vine vigor difficult to maintain, production and quality declines.

European species - 2500 to 3000 GDD favors high production and quality; above 3500, sugar/acid ratio is too high.

E. Precipitation and humidity.

1. Rainfall - Most fruit crops require 24 inches throughout the growing season for proper development; if less, irrigation is often used. Even with 24+ inches, rainfall may be unevenly distributed, and lacking during a critical period of fruit growth.

2. Humidity - If high, then fungal and bacterial diseases are much worse, but water use lower. If low, higher external (cosmetic) quality, due to lower disease pressure, but water use is high.

F. Sunshine, light intensity.

High light intensity required for proper color development in fruit species with anthocyanin pigments ('Red Delicious' apples, peaches, plums).

In cloudy climates, cultivars that do not require high light for color development should be used ('Golden Delicious', 'Granny Smith').

Pruning must be heavier to open canopy and sustain fruiting wood in cloudy climate, but sunscald disorders less common. Pruning slightly less severe in sunny areas, but sunscald of fruit can be a problem.

G. Diurnal temperature fluctuation.

- Warm to hot days, cool nights are best for color, sugar, flavor development, particularly important during final fruit maturation period. Humid climates have a lower diurnal temperature fluctuation than arid ones.

Mediterranean vs. Humid climates:

Mediterranean: High sunlight, low (no) rainfall and humidity, large diurnal temp fluctuation, cool nights in summer. In winter, cool, consistent weather; the majority of annual precipitation occurs in winter. Cosmetic quality of fruit excellent, internal quality also good in many species.

Humid: Lower sunlight, high rainfall and humidity, smaller diurnal temp fluctuation, night temps high in summer. In winter, weather tends to fluctuate, as in eastern United States, making bloom date less predictable. Cosmetic quality of fruit not as good, internal quality can be as good or better, although high night temps reduce color and sugar content in some cases.

III. Soil Considerations.

- Deep, well drained, sandy loam soils are best. Tight clay soils = slow growth, reduced productivity.
- Low (or no) water table; All fruit tree species very sensitive to flooding stress, reduces productivity and may kill trees. Also, encourages soil-borne fungal and bacterial diseases.
- pH 5.5 to 6.5 for most species. Slightly acid soils help keep micronutrients (Fe, Cu, Mn, Zn) available. Blueberry is the exception; pH should be 4.5.
- Adequate calcium is essential for fruit growth and quality (add lime) !

IV. Miscellaneous site factors.

A. Air drainage.

- Important for frost prevention and for air circulation to remove moisture from leaves and fruits. Remove tall trees and vegetation from around the orchard, particularly at the bottom of slopes.

B. Slope/aspect.

Slope - Some slope is good for air drainage, but when >10%, erosion, machinery movement become problems. Terracing recommended if >10%.

Aspect (direction the slope faces)

- North- and east-facing: Cooler, later blooming.
- South- and west--facing: Warmer, earlier blooming.

C. Wind, windbreaks.

Protection necessary for some crops (kiwifruit, citrus, cacao) or fruit regions (along oceans, large lakes, lee of mountains where winds are strong).

Locate windbreak 4-6 mature heights upwind of area to be protected; may need to have several throughout planting. Drawbacks of windbreaks include:

* competition for light, water, nutrients.
* sometimes alternate hosts or safe haven for pests and disease organisms.
* reduces % land area in production.
* windbreak species may require irrigation, fertilization, pest management.

D. Irrigation water availability, quality.

Source - river, pond, aquifer ?
Quality - sediments, salts, pH ?
Cost - one must buy water in arid regions; $5 to $100 per acre-foot (325,000 gal)
Government restrictions ? Indian River of Florida, Yakima Valley of Washington, San Joaquin Valley of California, etc., restrictions on how much water can be pumped on/off of your property per year.

E. Fruit growing district/ proximity to market.

Benefits of being in a large fruit region (like central Georgia for peaches):

1. Many growers, extension specialists = new ideas, help with problems.
2. Material and equipment sales and service nearby.
3. Skilled/migrant labor available.
4. Cooperative marketing agreements, marketing channels well established; + reputation to stand on; packinghouses nearby so reduced transportation fees.
5. Contract out certain operations such as site preparation, spraying, thinning, harvesting.

Disadvantages:

1. High competition.
2. Taxes or fees per box to support advertising, lobbying, research. Note that the benefit from these activities is great!
3. Outbreaks of disease, pest invasion may devastate or cause shipment quarantines.
4. Government regulations:

- Irrigation water
- Smoke from heating devices for frost protection
- Disposal of agricultural pesticides
- Minimum labor wages, benefits

F. Site history/replant problems. Previous crops sometimes leave site unsuitable for fruit production.

Tomato and bean - high levels of *Verticillium* wilt fungus, attacks some tree species (almond). Problem in western US.

Nematodes - long residence time, many hosts.

Oak root rot - broad host range in fruit crops; spores viable for up to 30 years after an orchard is removed!

***** Generally, not good to plant same fruit species as previous orchard; root exudates and soil-borne pests build up in orchards. Soil fumigation can be used to overcome replant problems in many cases, but it is expensive.

G. Size of Operation.

1. Type of production: Monoculture for shipping or multiple fruit species for pick your own or local marketing?

2. Other agricultural interests: pasture, livestock, vegetables, agronomic crops.

Sometimes good to diversify, and also to create cash flow until orchard reaches full bearing potential (could be as long as 10 yr).

3. Land cost and taxes.

4. Amount of clearing, site preparation necessary.

5. Amount of irrigation water available.

6. Fixed costs of machinery.

i.e., X acres necessary before cost of a large air-blast sprayer ($20,000+) or mechanical harvester can be justified.

"Economic unit" = minimal land area which produces reasonable return. varies greatly among sites, crops.

In pecan, considered . 500 acres! Less for other crops.

* Much more economical to grow same quantity of fruit on smaller acreage than larger acreage, despite higher establishment costs and variable costs per acre for smaller, more intensive operations. High yields are important!

Site Preparation

I. Soil preparation. Prepare well ahead of planting (at least 1 yr).

- Soil test for pH, P, K, Ca, Mg levels.
- Identify problem areas with poor drainage, poor soil type, frost-prone areas, hard pan depth.
- Cover crop such as alfalfa or clover (fix N) builds soil tilth, organic matter, N.

A. Leveling. May be necessary for equipment operation, eliminate low spots, poorly drained areas.

Problem- removes top soil from high areas, exposes subsoil; poor growth on former high spots if top soil shallow, result is uneven growth of trees.

Raised beds: Necessary with poor drainage or high water table; increases rooting volume. Grader forms single or double row beds, trees planted at crowns or shoulders, resp.

B. Sub-soiling, chiseling. May be necessary to break up hard pans/clay layers which restrict rooting.

Subsoil at least 2 feet.

Add limestone when mixing soil (if pH low) since calcium movement in soil is very slow; add gypsum if no pH adjustment is necessary.

Alternative = backhoe or auger individual holes for trees.

C. Choose row orientation, planting design, density.

1. Row orientation. North-south is best since slightly more light is intercepted, and fruit set and quality on north (shaded) side of E-W rows is inferior.

Air drainage facilitated by planting rows parallel to slope; or, "skirt" trees sufficiently to allow air at ground level to move.

2. Planting density. Considerations:

a. Vigor of rootstock/variety, ultimate tree (plant) size.

b. Need for pollinizers.

c. Use of “filler” or temporary trees for subsequent removal with standard sized trees.

d. Placement and type of existing irrigation system.

e. Mechanical vs. hand harvest.

- Design so harvester moves freely; for example, blueberries

traditionally spaced at 4.5 x 9 ft, but between row spacing increased to 10 ft recently to facilitate mechanical harvester.

f. Size of equipment.

* Ideally, we should determine equipment size by optimal tree spacing, not vice-versa. HOWEVER, row width must accomodate a tractor (4-5 ft) in most farms.

g. Row length - as long as possible, less turning and down time at end of rows for equipment; particularly important for trellised crops.

3. Planting design.

a. Square. Old days; wastes space between trees in rows. However, allows access to trees equally from all sides.

b. Rectangular. Better than square, utilizes within row space more effectively, giving earlier and sustained yields/acre. Most popular.

c. Quincunx. Square with a tree in the center - pollinizer or filler tree. Equipment runs diagonal to square.

d. Hexagonal or triangular. All trees equidistant from each other; equipment runs at diagonals to block border. Permits about 15% more trees/acre than square and utilizes available light more efficiently.

e. Hedgerow. Fruiting wall; individual trees loose integrity. High density orchards, requires size controlling rootstock in most cases.

f. Contour planting. Start at steepest point, stake out minimum width of drive middles; then rows laid out at equal elevation, regardless of distance between adjacent rows. Eliminate/add rows as necessary when slope steepens/flattens.

D. Irrigation system installation. After sub-soiling, grading, row layout, unless flood irrigation is used, in which case planting is designed around irrigation delivery system, not vice-versa.

1. Choose type of irrigation system (sprinkler, drip, traveling gun).
2. Choose water source and site pump.
3. Choose application device, then design delivery system.
4. Lay pipe at sufficient depth to avoid damage by cultivation.

II. Young tree planting and care.

A. Timing.

- Trees dug from nursery when dormant, can be shipped more easily and successfully.
- Winters with adequate rainfall, moderate temperatures - Plant in autumn; some root growth will occur prior to bud break, faster start in spring.
- Winters with low rainfall, extreme temperatures - Plant in late winter, early spring

(Feb-March) to avoid drought and freezing stresses.

B. Nursery stock.

- Keep moist and cool until planted.
- Inspect for dryness/mortality upon arrival, return if poor quality.

C. Planting hole.

- Make wider than roots, mound in middle if many laterals, spread roots.
- Do not add chemical fertilizer in hole; however, compost or organic matter may improve growth.

D. Planting a young tree.

1. Planting height.

± Use a planting board to keep roots/graft union at proper height.

Bud union at ground level - if stock susceptible to trunk diseases/pests, winter injury, sunscald (etc) or tends to sucker from the trunk.

Union well above ground - if scion is susceptible to soil-borne diseases/pests, or if stock is dwarfing (avoid scion rooting).

If too deep - scion rooting will occur; also, wind-rocking will create gap around base of trunk, prevent establishment of shallow laterals and allow water to collect (foot rot).

2. Remove air pockets from around roots by mild compaction or with water ("mud trees in").

3. ± Mound soil at trunk to prevent water collecting at base of trunk (?). If planted properly, this may be unnecessary.

4. ± wrap to prevent rodent, herbicide, fertilizer, sunscald, freezing injuries.

5. Mulch (or cultivate) to remove weeds; herbicide is dangerous around young trees, especially with low or dangling limbs. Cultivation may kill tree roots in upper layers of soil, especially if soil is shallow, poorly drained.

E. Fertilizer.

Should be unnecessary during first year; base on past experience.

Follow with light applications of nitrogen as $Ca(NO_3)_2$ or 10-10-10 in subsequent years (see extension guidelines).

Keep away from trunk of young tree.

III. Pollinizer placement.

A. Selection of a pollinizer. Only for crops that are self-unfruitful.

1. Cross compatible with main cultivar.
2. No undesirable xenia or metaxenia effects (rare).
   Xenia: Direct effect of pollen on endosperm and embryo.
   Metaxenia: Direct effect of pollen on tissues outside the embryo sac (which become the flesh of the fruit in many cases).
3. Bloom period overlaps with main cultivar.
4. Large amounts of viable pollen produced.
5. ± Bears marketable crop.

   French crab or 'Winter banana' used as pollinizers for apple, but bear worthless fruit. Can plant within rows, between trees to give almost solid blocks of the main cv; prune or train to occupy least space. If bearing a marketable crop, cultural requirements should be similar.

B. Placement depends on:

1. Wind vs. insect pollination.

   Wind - plant on upwind side of the rows of main cv.
   Insect - *Within* row at selected spacings is best, since insects tend to travel shortest distances, i.e., within rows rather than across, especially if windy.

2. Means of harvesting.

   If mechanically harvested in hedgerows, and pollinizer within rows, then must separate cvs after harvest (difficult) or hand pick pollinizer fruit prior to harvesting. Can plant pollinizer in alternate, solid rows if ratio is 1:1 or 1:2.

C. Ratio of pollinizer to main crop.

1:1 or 1:2 if pollinizer is of equal value to main cv.
1:8 male:female for kiwifruit, pistachio (dioecious).
1:8, 1:12 - sweet cherry, apple, pear, other major fruits when pollinizer is lower value.