# CHAPTER 11

# GREENHOUSE SITE SELECTION

## INTRODUCTION

*Selecting a "good" site for the location of a greenhouse is crucial.

*But what constitutes a "good" site?

*There are several things that should and must be considered in order to increase the chances of a successful operation and business.

## 12 THINGS TO CONSIDER WHEN SELECTING A GREENHOUSE SITE:

**1. Solar Radiation** – Plants require sunlight in order to perform photosynthesis. When plants experience cloudy days their photosynthetic rates, and therefore their ability to grow and yield a product, such as tomatoes, cucumbers, peppers, etc., will be reduced.

*Therefore, a region and location with high light intensity year-round is desired.

*****See "Solar radiation data for selected cities" at the end of this chapter. Note that the southwestern United States has some of the highest light levels in the country.  This is, therefore, an optimal region for crop production.

*See "Microclimate" below for natural/manmade factors that reduce light.

**2. Water** – Water quantity and quality is crucial.

*Water will be needed for irrigation (maximum of 1 gal/plant/day for tomatoes).

*Water will be needed for the evaporative cooling system and can equal or exceed the irrigation water amounts (10,000 – 15,000 gal/acre/day).

*In the past, excess irrigation and bleed-off water from the evaporative cooling system was allowed to "run off" onto the ground adjacent to the greenhouse (with a rec. minimum percolation rate into the soil of 1"/hr.)

HOWEVER, due to more strict regulations and a desire to avoid ground water contamination with high concentrations of salts, large greenhouses are now recirculating the nutrient solution.

Recirculating the nutrient solution also saves water, nutrients & money.

THEREFORE, excess nutrient solution should be recycled and/or mixed with the cooler bleed-off water and redirected onto designated areas, such as grass, shrubs, trees/windbreaks, etc.

*No matter what the source of the water, a water analysis should be done.

*Note: Sea water = 32,000 ppm (mg/l)  VS  Tucson water = 200-400 ppm.

Note: 640 ppm TDS (total dissolved solids)  = 1 mmhos/cm or 1 mS/cm.

See Chapter 10 for a discussion of EC or electrical conductivity.

*Desired maximum salt levels in the source water in ppm (parts per million):

| | | | | | |
|---|---|---|---|---|---|
| SO4 | < 240 | Cl | < 140 | Non-Fertilizer Salts | |
| Ca | < 120 | Fe | < 5 | Na | <50 |
| Mg | < 24 | Zn | < 5 | Al | < 5 |
| K | < 10 | Mn | < 2 | F | < 1 |
| P | < 5 | B | < 0.8 | Bicarb ($HCO_3$) < 122 | |
| NO3 | < 2-5 | Cu | < 0.2 | Alkalinity ($CaCO_3$) < 100 | |
| $NH_4$-N | < 8 | Mo | < 0.02 | | |

**3. Elevation** – will effect the Summer maximum and the Winter minimum temperatures.

*Choosing an appropriate elevation will minimize heating costs in the Winter and cooling costs in the Summer.

*Example: In Arizona tomato production is most economical between 4000 and 5000 feet (1220m-1520m). Below 4000 feet cooling costs in Summer will be more whereas above 5000 feet heating costs in the Winter will be more. Lower elevations might be suitable for peppers or cucumbers.

**4. Microclimate –**

*Latitude – Unless the global climate changes drastically, sea level at the poles will be colder than sea level in the tropics… latitude makes a difference!

*Large bodies of water – will tend to moderate the temperature (e.g., coastal areas tend to have smaller day/night temperature differences than inland areas).

*Trees, mountains or other obstructions – may cast shadows on the greenhouse, especially in the morning or afternoon hours.
Mountains can also effect wind and/or storm patterns.

*Clouds and fog – Note that certain areas (e.g., on the lee side of certain mountain ranges, or near coastal regions) may develop clouds or fog during certain times of the day or year that will reduce potential sunlight.

*High Wind Areas – High winds can “suck” heat away from the greenhouse and therefore increase the heating energy needed to maintain the temperature inside ($$). High winds can also cause structural damage to greenhouses.

*Blowing dust/sand – High winds can “kick up dust or sand”, especially in desert regions, which can damage some greenhouse glazings.

*Snow – The weight of heavy, wet snow on a greenhouse could crush it.
However, high winds in snow areas can also blow snow up against the greenhouse structure (snow drifts) and cause damage to it. This danger can be reduced by using windbreaks (trees, snow fences, etc.).

**5. Pest Pressure** – Choose a site away from existing agriculture production areas which could harbor insect pests in the fields. Insect pests of concern include white flies, aphids, spider mites and thrips (see Chapter 4 for pests and control methods).

**6. Level and Stable Ground** – The ground upon which the greenhouse will sit must be:

*Graded for routing surface water to a drainage system or a holding pond.
(Typical grade = ½ % or a 6 inch drop over a distance of 100 feet.)

*Compacted so there will be no settling after the greenhouse has been constructed.

**7. Utilities** – Availability of utilities should include telephone service, three-phase electricity and fuel for heating and carbon dioxide generation.

*Note that, when compared to propane, electricity or fuel oil, **natural gas** is a fairly economical heating energy source. However, as fossil fuel costs increase, alternative energies may become more cost effective.

**8. Roads** – Need access to good roads to transport the "product". Good roads close to a large population center, or to a brokerage center aids wholesale and retail marketing.

**9. North-South Orientation** – The greenhouse should be oriented north-south, AND the plant rows within the greenhouse should be oriented north-south.

*If oriented north-south, the greenhouse structure itself will not cast consistent shadows on any one area of the plants throughout the day.

*If oriented north-south, the plant rows will receive equal light throughout the day. If oriented east-west the south most rows (in the northern hemisphere) will shade the rows to the north.

**10. Capability of Expansion** – Purchase more land than you anticipate using in the beginning so that you have the ability to expand your operation. Locate the initial greenhouses such that future expansion will utilize the land area most efficiently.

**11. Availability of Labor** – The grower needs people who will want to work as laborers and who are "trainable" to become a retainable workforce.

*Such skills included pruning/training the plants and harvesting/packing the fruit.

*SPECIALTY LABOR will include people with additional training in such fields as plant production, plant nutrition, plant protection (insects and diseases) computers, labor management, marketing, etc. These may or may not be part of the regular workers, but may be called on as consultants as needed.

**12. Management residence** – The grower/manager residences should be close to the greenhouse so that they can get to the greenhouse quickly in case of emergencies.

**COMMUNITY PROFILE:**

*Prior to selecting a site for greenhouse construction the grower should obtain a "Community Profile" for potential locations.

*These are available at the city or area Chamber of Commerce and contain

- Community background information: location, elevation, history and weather
- Population, employment structure and labor force information
- Growth indicators, principal economic activities and property tax information
- Available properties, financing, transportation, communications and utilities
- Government, medical and educational services
- Listings of area churches, recreational facilities and lodging
- Area attractions including scenic parks, drives, etc., historic sites, annual events, etc.

**An example of solar radiation data for selected cities in MJ/m2/day (MJ = megajoules) ***

(Data is ordered according to total light from October to March)

| CITY | Oct-Mar | Total | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| El Paso TX | 97 | 261 | 28 | 26 | 23 | 19 | 14 | 12 | 13 | 17 | 22 | 27 | 30 | 30 |
| Tucson AZ | 93 | 256 | 27 | 25 | 23 | 18 | 14 | 11 | 13 | 16 | 21 | 27 | 30 | 31 |
| Albuquerque NM | 89 | 249 | 28 | 26 | 22 | 18 | 13 | 11 | 12 | 15 | 20 | 25 | 29 | 30 |
| Prescott AZ | 89 | 248 | 26 | 24 | 22 | 18 | 13 | 11 | 12 | 15 | 20 | 26 | 30 | 31 |
| Miami FL | 89 | 213 | 21 | 20 | 18 | 15 | 14 | 12 | 13 | 16 | 19 | 22 | 22 | 21 |
| Las Vegas NV | 87 | 254 | 29 | 27 | 23 | 18 | 12 | 10 | 11 | 15 | 21 | 26 | 30 | 32 |
| Farmington NM | 84 | 242 | 28 | 26 | 22 | 17 | 12 | 10 | 11 | 15 | 19 | 24 | 28 | 30 |
| San Diego CA | 82 | 218 | 25 | 23 | 20 | 16 | 12 | 10 | 11 | 14 | 19 | 22 | 23 | 23 |
| Riverside CA | 79 | 216 | 25 | 23 | 20 | 15 | 12 | 10 | 10 | 14 | 18 | 20 | 23 | 26 |
| Santa Maria CA | 78 | 218 | 26 | 23 | 20 | 16 | 12 | 9 | 10 | 13 | 18 | 21 | 24 | 26 |
| Grand Junction CO | 74 | 220 | 27 | 23 | 21 | 15 | 10 | 9 | 9 | 13 | 18 | 22 | 25 | 28 |
| Denver CO | 73 | 214 | 26 | 23 | 20 | 15 | 10 | 8 | 10 | 13 | 17 | 21 | 24 | 27 |
| La Jolla CA | 65 | 170 | 19 | 17 | 15 | 12 | 10 | 8 | 9 | 11 | 15 | 17 | 19 | 18 |
| Fresno CA | 63 | 202 | 26 | 23 | 19 | 14 | 9 | 6 | 7 | 11 | 16 | 21 | 24 | 26 |
| Davis CA | 59 | 197 | 26 | 23 | 19 | 13 | 8 | 6 | 7 | 10 | 15 | 20 | 24 | 26 |
| Madison WI | 48 | 162 | 22 | 19 | 15 | 10 | 6 | 4 | 6 | 9 | 13 | 16 | 20 | 22 |
| Columbus OH | 44 | 153 | 21 | 16 | 13 | 10 | 5 | 4 | 5 | 8 | 12 | 16 | 20 | 23 |
| Buffalo NY | 37 | 141 | 20 | 17 | 13 | 9 | 5 | 3 | 4 | 6 | 10 | 15 | 18 | 21 |
| Seattle WA | 33 | 146 | 26 | 18 | 13 | 8 | 4 | 2 | 3 | 6 | 10 | 15 | 20 | 21 |
| S. England** | 30 | 131 | 19 | 17 | 12 | 7 | 4 | 2 | 3 | 5 | 9 | 14 | 19 | 20 |

*For a discussion of solar radiation data, how it is gathered, its accuracy, obtaining updated info, etc., visit The Renewable Resource Data Center (RReDC) managed by The Department of Energy's Office of Energy Efficiency and Renewable Energy at http://www.nrel.gov/rredc

**Data for The Netherlands, where there is a huge greenhouse industry, would be very similar to that for Southern England. Many growers there have switched to flowers from fruiting crops, like tomatoes (which need lots of light) because they can't compete with Mediterranean growers.

**REFERENCE MATERIAL:**


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2. **Hydroponic Food Production.** 2001. H.M. Resh. Woodbridge Press Publishing Company, P.O. Box 209, Santa Barbara, CA 93160. ISBN 0-88007-222-9
3. **Protected Agriculture: A Global Review. Part 7: Water supply, water quality and mineral nutrition**. 1995. M.H. Jensen and A.J. Malter. The World Bank (Techincal Paper #253), 1818 H. Street, N.W., Washington D.C., 20433. ISBN 0-8213-2930-8
4. **Web Pages**: http://ag.arizona.edu/ceac/