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Commercial Greenhouse Vegetable Production

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Commercial greenhouse vegetable production in Oregon is very limited, the total being less than 15 acres at present. Interest in both conventional and hydroponic greenhouse vegetable production has been increasing. This circular is designed to acquaint you with the problems and potentials involved.

There is a considerable difference between vegetable production in a small greenhouse for hobby purposes and commercial production. Expert management and a clear understanding of greenhouse production technology are necessary for success in a commercial operation. Growers should be thoroughly familiar with the cultural practices necessary and the marketing potential for planned crops before investing funds or attempting greenhouse vegetable production. High yields through an efficient operation, a quality product, and a good market are necessary for success in order to pay back the capital investment and operating costs associated with this type of production.

Location

Western Oregon's climate imposes some serious limitations on greenhouse vegetable production. Although temperatures are generally mild, low light intensities and high humidities make profitable winter production of tomatoes and cucumbers difficult. Supplemental lighting is not economically feasible. East of the Cascades, where sunlight is not as limiting, distance from market and colder temperatures make greenhouse production and marketing more costly.

There is increasing interest in geothermal heat resources available in several locations in Eastern Oregon. This energy source would reduce heating costs but technical problems, developmental costs, and environmental implications of tapping these resources have yet to be completely resolved. Some geothermal wells may be unsuitable for greenhouse heating due to toxic or corrosive substances in the water or water temperatures not hot enough to be economically useful.

Ideal greenhouse locations should have high winter light intensity, moderate winter temperatures, low humidities, and proximity or easy accessibility to markets.

Costs of various fuels such as coal, natural gas, and oil and their uninterrupted availability for winter heating are primary considerations.

Construction sites must be level and have deep, well-drained soil. Sandy loam soils are best. Where soil is not suitable, you may need to bring in different soil, or use a soilless production system. A soilless system considerably increases the cost of production and the initial investment without compensating increases in yield or quality. The production of greenhouse vegetables in ground beds of native soil over which a greenhouse is constructed is still the most common and preferred system.

Construction

Conventional houses are constructed of wood or metal, or may be inflatable frameless houses. Coverings are of many types, such as clear polyethylene, Mylar, glass, or fiberglass. Many grades of fiberglass are available, some of which are unsuitable for greenhouse use because they deteriorate in sunlight. Some fiberglass materials may last 25 years or longer. Polyethylene also deteriorates rapidly and usually is replaced each year. Various other plastic coverings, such as polyvinyl chloride, last longer.

Commonly grown commercial

Plastic films have gained popularity as greenhouse coverings. They can be applied in double layers with 1½ to 2 inches of air space between them to reduce heating cost and condensation. However, tests show double coverings reduce light intensity about 5 to 14 percent, a serious problem where available light is limited. Each acre of greenhouse requires about 60,000 square feet of covering; 12,000 clay tiles for subsoil drainage and soil steam sterilization; 30,000 board feet of lumber or the equivalent in a metal framework; a 100-horsepower-capacity boiler; plus several thousand feet of pipe to provide heat and water. You'll also need concrete, brick, doors, wiring, fans, ventilators, motors, and an assortment of other items. Total costs will be $125,000 to $200,000 per acre at today's prices, varying considerably with the type of construction used. Where unit heaters are used instead of a boiler, a different means for sterilizing soil and equipment is necessary. Chemical sterilants are available.

Crops to Grow

Tomatoes

Tomatoes are the most commonly produced crop. A two-crop system would generally be used under Oregon conditions, a fall and a spring crop. You can grow about 8 pounds of fruit per plant from a fall crop with a 2- to three-month harvest period. Approximately 15 pounds of fruit per plant can be grown in a spring crop with a 4- to 5-month harvest period. Plant the fall crop in mid June, to begin producing after local tomatoes are no longer available. Harvest about October aiming for a peak around Thanksgiving, terminating after Christmas or when heating costs and lighting conditions become limiting in December.

Plant the spring crop in early December, so harvest will begin in mid May. Plan production to continue beyond the July 4th holiday. Vines are usually removed by the end of July or when outdoor tomatoes become available locally. It takes

greenhouse vegetables include tomatoes, cucumbers, and lettuce

Lettuce harvest leaves growing room for tomatoes --

from 4 to 4½ months from seeding until first pick for a fall crop and 5 to 5½ months for a spring crop.

Michigan-Ohio hybrid is a verticillium and fusarium resistant variety especially adapted to low light conditions. Veegan, Vendor, Tropic, and Floradel, are varieties having resistance to one or more additional diseases.

Cucumbers

These grow more rapidly than tomatoes and produce earlier. Seedless (parthenocarpic), or all female (gynoecious) varieties are recommended. They produce higher yields and require no bees for pollination. Because they are distinctly different from the conventional slicing cucumbers you should determine a suitable market before production. With good management, these types will produce from 20 to 30 pounds of fruit per plant over a 4-month harvest period. The varieties Fertila, Factum, Femspot, Femfrance, LaReine, and several others are available. Toska 70 is a high-yielding, high-quality seedless cucumber cultivar which is not all-female in character but still does not require bees. Conventional cucumber varieties require bees for pollinatiion. Bees pose management problems in winter greenhouse production. Cucumbers require higher temperatures than tomatoes so they are generally grown as a spring or early summer crop. Because the seedless ("European") cucumber is so different from the conventional slicing cucumber, some market can be found almost all the year round.

Lettuce

Leaf and Bibb lettuce types are used for most commercial greenhouse production. Lettuce is most often grown when light intensities are poorest and the temperatures coldest. A crop is often scheduled between the fall and spring tomato crop. Grand Rapids variety leaf lettuce is suited for greenhouse production at low light intensities. Since field-grown head lettuce and some leaf lettuce is continuously available from the various western states, competition makes marketing of the greenhouse lettuce crop more difficult.

Environmental Control

Accurate temperature, humidity, and carbon dioxide control are important. If a greenhouse is to be kept completely closed to conserve heat during long periods (several days at a time) you should provide suitable carbon-dioxide-generating equipment to keep 1,000 to 1,500 ppm in the greenhouse atmosphere. Management of irrigation to control increased humidity and control of increased disease problems also become critical in closed houses.

Temperature Requirements

Temperature requirements for major greenhouse vegetables differ. In general, the cooler temperatures are used when light intensities are low.

Tomatoes

Day, 70° to 75°F.; night, minimum 60°F. Where day temperatures might exceed 85° to 90°F., cooling equipment is needed to prevent fruit set-failure and to allow proper red color developing in the maturing fruit.

Cucumbers

Day, 80° to 85°F.; night, 65° to 75°F. Lower temperatures will delay plant growth and fruit development. Soil temperatures above 65°F. are extremely important.

Lettuce

Day, 60° to 65°F.; night, 50° to 55°F. Lettuce is best grown during the coldest months of the winter. High greenhouse temperatures will induce spindly growth and seed-stalk development in some varieties which makes the product unmarketable.

Culture

Tailor fertilizer programs for specific crops and soil fertility situations. Proper fertility is necessary for success. Plants have different fertilizer requirements during different stages of their growing cycle. Whether you use soil or a soilless system, no single set of recommendations will apply, so use soil tests to determine initial applications, and monitor fertility levels by leaf analysis throughout the growing season. Both soil tests and leaf analyses are available through Oregon State University Extension offices.

A routine fertilizer program would be the addition of 0-20-20 fertilizer at 1,000 to 2,000 pounds per acre before the fall crop, and 650 to 1,000 pounds before the spring crop or, you can supply phosphorous by applying 46 percent triple super phosphate at 300 to 500 pounds per acre and potassium by using potassium sulfate at 300 to 400 pounds.

Add nitrogen as ammonium nitrate, calcium nitrate, or potassium nitrate before planting and throughout the season, depending on the amount of organic matter in the soil. Feed weekly with solutions of balanced fertilizers.

Tomatoes

Three to four square feet of space per plant is required. Train plants to a single stem and support by strings hanging from overhead wires.

Proper feeding of tomatoes with nitrogen is critical. Too much nitrogen when the plants are small will result in soft growth, small flower clusters, and poor set. Apply nitrogen in limited quantities before planting, about 50 pounds per acre, and apply weekly as necessary to maintain adequate nitrogen levels in the leaves.

Cucumbers

Six to seven square feet of space per plant is required. Train cucumbers to a single stem. In general, they are heavy feeders. Large quantities of manure, up to 70 tons per acre on poor soil, are often used. Phosphorous is added at 800 to 1,000 pounds of superphosphate per acre is a preplant

-- or cucumbers

treatment. Cucumbers need a weekly feeding with balanced solutions of such fertilizers as 10-52-17, 15-30-15 or 20-20-20.

Lettuce

Lettuce usually takes about a month from seeding to transplanting. During mid-winter it may take as long as 12 to 15 weeks from seeding to harvest, but during early spring it matures in 8 to 10 weeks. Plant lettuce at a 9- by 9-inch spacing when light intensities are poor, and as close as 6 by 6 during the more suitable spring period.

Lettuce is a poor feeder. Maintain high levels of nutrition, even though the plant takes up only a small part of what is available. Work a balanced fertilizer high in phosphorus into the soil before planting. Additional applications of nitrogen fertilizer may be necessary at two to three intervals after the plants are set in the greenhouse.

Carbon Dioxide Enrichment

Addition of carbon dioxide to greenhouses has been demonstrated to improve vegetable yields. Carbon dioxide is normally present in the atmosphere at a concentration of 300 parts per million parts of air. Concentrations of 1,000 to 1,500 ppm in greenhouse atmospheres have given the best results. Increases of 20 to 40 percent in yield have been reported for various vegetables. Lettuce is by far the most responsive to added carbon dioxide of the crops discussed here. Generating and monitoring equipment is readily available. Many different types are in use. Investigate the various models and types before purchasing.

Mulching

If mulches are used, apply to the soil when tomatoes and cucumbers are about two feet high. Straw mulch is most common, used at about 200 bales per acre. The mulch reduces evaporation of water from the soil and prevents compaction of the surface.

Watering

Maintain an adequate supply of water to plant roots. Excess water reduces soil aeration. Young plants put in the greenhouse in mid-winter may need to be watered only once every 10 to 14 days. The same plants in mid-summer may need water every two or three days, requiring an estimated ¼ to ¾ gallon per plant per day, depending on size. A fall crop would need a total of about 15 to 18 inches; a spring crop may need 20 to 25 inches of water.

Mulch is desirable

Hydroponics

Hydroponic culture is the growing of plants in gravel, sand, or artificial soilless mixes in troughs, tubes, or tanks suitably built to allow circulation of the nutrient media. Soilless culture is more demanding and less forgiving of mistakes than conventional soil culture. Good nutrient media composition and balance are important.

Hydroponic methods allow production of vegetables in areas where suitable soil is not available or where disease or other conditions make ground bed production unfeasible. Although you can automate this system to minimize irrigation and fertilization labor input, continuous monitoring of all

aspects of plant growth and culture media, nutrient balance and a thorough understanding of the crop and its physiology is critical. Costs of the automatic devices and special nutrient media are substantial. All other aspects of production remain the same as with conventional culture. There are no yield or quality advantages over conventional production if the quality of management is equal. Hydroponic greenhouse promoters have often failed to present their product fairly and have created unrealistic expectations. None of the package offers of equipment and technical services guarantees success. Investigate thoroughly before making substantial investments.

Disease and Insect Control

Proper control of plant disease is critical in greenhouse environments, where high temperatures and humidity are ideal for diseases to develop. Insect and nematode infestations, too, can become rampant under the confined greenhouse conditions.

You can control most fungus and virus diseases with fungicides and proper sanitation and sterilization of soils, growth media, and equipment. The most serious fungus disease on tomatoes are leaf mold (*Cladosporium*), early blight (*Alternaria*), leaf spot (*Septoria*), gray mold (*Botrytis*), and the wilt diseases (*Fusarium* and *Verticillium*).

Tobacco mosaic virus can be serious and several other virus diseases may occur. Proper sanitation to reduce spread by workers, soil sterilization, and control of insect vectors are some of the methods of control.

Powdery mildew (*Erysiphe*) is a common fungus disease on cucumbers: chemical controls are available. Several virus diseases also affect cucumbers.

Bottom rot (*Sclerotinia*) is a troublesome lettuce disease which can be difficult to control. Few other diseases are troublesome in greenhouse lettuce.

Early control of white fly, aphid, and spider mite infestation is important. Several chemicals are available to control these pests.

Nematodes may become a problem in either soil or hydroponic culture. Sterilization of soil or hydroponic media is used as a preventative measure. Current recommendations on pesticides are available from your county Extension agent. Always follow label instructions and safety precautions precisely.

Summary

Large commercial greenhouse vegetable production is an exacting and costly enterprise. Only expert management can prevent large-scale financial losses. Publications are available from libraries. Although several companies offer package investment opportunities, supplying equipment, materials and advice, none of these can guarantee success. In greenhouse production there is no substitute for experience.

Photos are mostly commercial greenhouses in the North Central states, taken by the author while at Michigan State University. The cucumber grower, page 3, is George Yoshihara, of Milton-Freewater, Oregon. The end-product picture, below, is in an experimental geothermal-heat greenhouse at the Oregon Institute of Technology, Klamath Falls, Oregon.

The end —

A means to the end —

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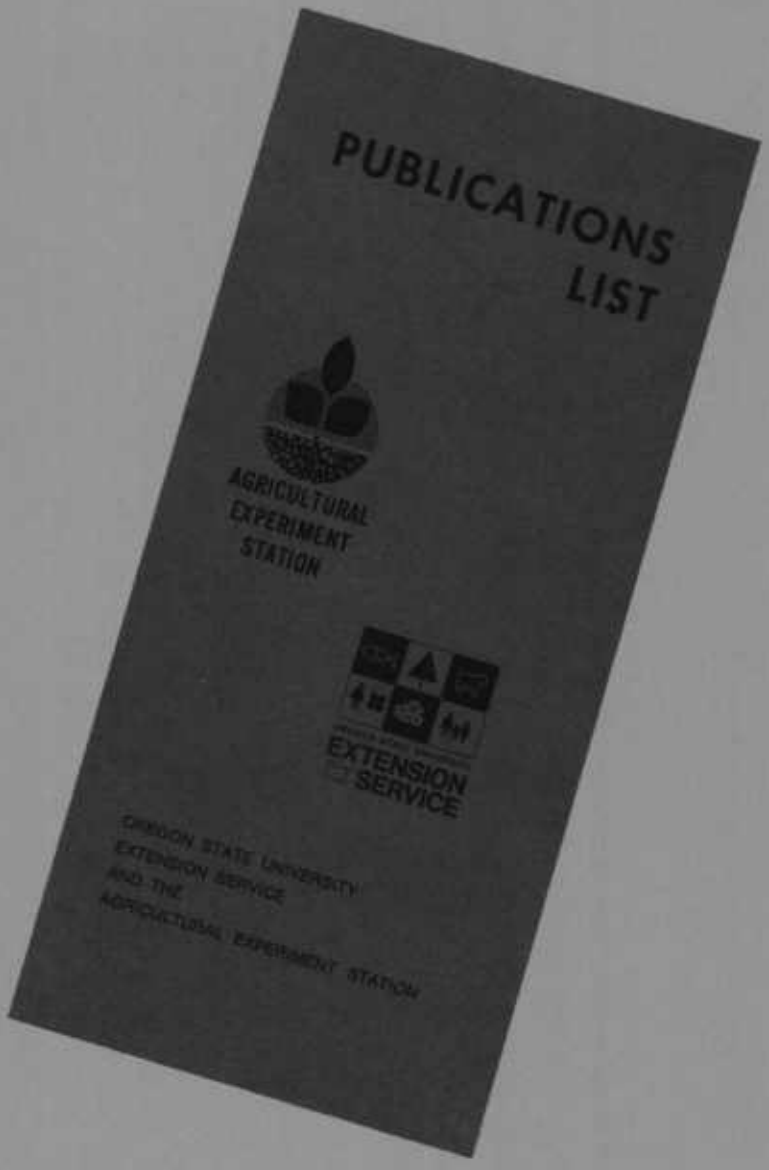

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