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ESTIMATED COSTS FOR PRODUCING GREENHOUSE TOMATOES IN CALIFORNIA

by

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GREENHOUSE TOMATO PRODUCTION IN CALIFORNIA
A COST ANALYSIS MODEL FOR A ONE-ACRE ENTERPRISE - 1972

This cost analysis was prepared so that interested growers can better evaluate the economic feasibility of greenhouse tomato production in California. Cost estimates are based on a greenhouse approximately one acre in size, consisting of nine connected 40' x 120' (43,200 square feet) fiberglass-covered units of steel construction. The type of structure and environmental controls assumed in this study were selected to provide year-round environmental control and protection for the crop, and to be suitable for any growing method.

The basic data was obtained from a limited number of California greenhouse operators, cost studies conducted in other states, and from work standards and costs of comparable operations.

The basic requirements for greenhouse vegetable production are: (1) a structure; (2) environmental control equipment; and (3) a means of feeding the plants. Many alternatives exist from which the growers must make a choice on the basis of costs, personal preference, or conditions peculiar to the greenhouse site. Types of structures range from wood frame and polyethylene structures, which require annual re-covering, to more permanent metal structures with glass or fiberglass covering. The growing methods fall into two general categories: (1) ground bed -- utilizing the native soil over which the greenhouse was constructed, and (2) trough culture. Trough culture has a number of variations (including hydroponics), but is essentially composed of some type of rooting medium which is confined in troughs constructed from wood, concrete, or plastic. Additional details on trough culture will be found in Appendix I.

Since the majority of vegetable greenhouse operations in the United States use ground-bed culture, the cost analysis in Tables 1 through 3 relates to that method. A grower interested in costs of various trough culture methods can combine the trough culture cost information given in Table 4 with the basic cost data for ground-bed operations.

Capital Requirements and Fixed Costs

An estimate of capital requirements and fixed overhead costs for a one-acre ground-bed greenhouse operation is given in Table 1. Under the assumed conditions, a total capital outlay of $109,810 is required for growing, packing, and office structures and equipment. Annual fixed costs consisting of depreciation and interest charges, county property taxes, and general overhead amount to $21,433.

Cultural, Harvesting, and Packing Costs

Estimated cash cultural, harvesting, and packing costs for one crop of tomatoes grown by the ground-bed greenhouse method is shown in Table 2. The fairly standard cultural practices which are used by growers are outlined. Pollination by daily flower vibration is a major cost which could be reduced considerably if pollination by power blower proves to be feasible. Pruning and training, and annual heating and power costs are also significant.

These cultural, harvesting and packing costs are based on one crop containing a total plant population of 10,512, assuming a marketable yield of 15 pounds per plant. Total cash cultural preharvest costs amounted to $9,740 per acre and required 2,506 hours of labor. Picking, grading, and packing added $10,220 per acre for a total cash cultural harvesting and packing cost of $19,960. A charge for management is not included in this study.

A summary of estimated total cultural costs for one crop of tomatoes grown by the ground-bed greenhouse method is shown in Table 3. For the assumed one-acre operation, total cultural, harvesting and packing costs amounted to $39,582. The cost per pound of merchantable fruit was 26.44 cents.

Marketing

Limited records of prices received by growers for greenhouse tomatoes indicate a premium over prices received for the field-grown product. The amount of premium varies, depending on the season and the market outlet. Because of the limited price data available for greenhouse tomatoes grown in California, prospective growers should evaluate current and future market potential for their production prior to the construction of facilities.

Yield and Utilization

Since most greenhouse tomato varieties are indeterminate in their growth and fruit-producing habit, the harvest period for any one crop is somewhat flexible. Tomatoes are actually perennial plants and will produce continuously if space, nutrition, or diseases do not become limiting. In practice, the limitation in harvest period is dictated by a reduction in fruit size or market quality which usually confines the useful harvest period to four to six months, although it may vary from two to as long as eight months. The period from transplanting to first fruit production is fairly predictable: transplant to first fruit set is about three weeks, and fruit set to first harvest is about 60 days. Some variation is expected due to variety, nutrition, and environmental control.

From the foregoing it can be seen that annual utilization of greenhouse space solely for tomatoes can vary according to the length of harvest period allowed

for each crop. Some growers may choose to grow one long-harvest spring crop. Others may grow a short-harvest fall crop, replant in early January, and harvest again from March through June or July. This two-crop system is aimed at maximizing size, quality, and yield through the winter and spring months when the United States-produced field tomatoes are in lowest production. For continuous year-round fruit production in a greenhouse composed of several units, it is possible to average one and one-half crops per unit per year over a several-year period. All of these systems are capable of about the same annual marketable yield per plant space. A single long-harvest crop in the spring can produce 20 to 25 pounds per plant; a fall crop of 2 to 2 1/2 months' harvest produces 6 to 10 pounds per plant; and over 4 or 5 months' harvest the expected yield per plant would be 14 to 16 pounds. An assumed yield of 15 pounds per plant was used in Tables 2 and 3, although it should be understood that lesser yield or greater yield within limits could be obtained with variations in management, greenhouse utilization or the application of technology.

Table 1. Estimated capital requirements and fixed costs for a one-acre ground-bed greenhouse tomato production [1] -- California, 1972

Item	Original Cost	Useful Life	Depreciation	Interest [2]
	$	yrs.	$	$
Growing structure & equipment				
Land - variable cost	$ 1,500	--	$ --	$ 105
Site preparation	400	10	40	14
Greenhouse, contract price erected	84,240	10	8,240	2,948
Utility connection	1,000	10	100	35
Nutrient tanks, 350-gal. (2)	700	10	70	25
Fertilizer proportioner, 3/4" (1)	430	10	43	15
Overhead support wires	180	10	18	6
Irrigation system, trickle	860	2	430	30
Other equipment				
Tractor (1 + standard equipment)	4,000	10	400	140
Pickup truck (1)	4,000	5	800	140
Vibrators for pollination (2)	50	2	25	2
Mist blower (1)	250	5	50	9
Carts (4)	200	5	40	7
Picking containers	100	5	20	4
Thermographs (2)	600	5	120	21
Small tools	100	5	20	3
Subtotal	$ 98,610		$10,416	$3,504
Grading, packing & office structure				
Structure, 800 square feet	8,000	10	800	280
Grading table	1,700	10	170	60
Office equipment	1,500	10	150	53
Subtotal	$ 11,200		$ 1,120	$ 393
Grand Total	$109,810		$11,536	$3,897

Annual Fixed Costs	
Depreciation and interest	$15,433
County taxes - variable	2,500
General overhead - office, insurance, security, etc.	3,500
Total Annual Fixed Costs	$21,433

1/ The greenhouse consists of nine connected 40' x 120' (43,200 sq. ft.) fiberglass-covered units of steel construction.

2/ Interest based on 7% of one-half original cost except land.

Table 2. Estimated cash cultural, harvesting and packing costs for a one-acre ground-bed greenhouse tomato production [1] -- California, 1972

Operation	Labor [2] Hours	Labor [2] $	Equipment $	Material Item	Material $	Total $ per acre per crop
Cultural						
Tillage - chisel & rototill	8	16	8			24
Soil fumigation - every second crop, prorated	16	32	16	Fumigant	125	173
Fertilizer - preplant	8	16	8		50	74
Planting - plow furrow & hand plant	60	120	8	Plants @ 5¢	526	654
Apply support strings	200	400	-	String	117	517
Prune & train - 40 hrs/wk x 18 wks	720	1,440	-		-	1,440
Pollination - 40 hrs/wk x 18 wks	720	1,440	-	Batteries	25	1,465
Clean up old leaves -- 10 hrs/wk x 18 wks	180	360			-	360
Irrigation:						
Install & remove trickle hose	72	144	-		-	144
Water application -- 8 hrs/wk x 28 wks	224	448	-	Water @ $40/A. ft.	80	528
Fertilizer: Prepare nutrient solution -- 1 hr/wk x 28 wks	28	56	-	Fertilizer	75	131
Pest control -- 4 hrs/applic. x 5	20	40	-	Material	40	80
Post-harvest plant removal	250	500	25		-	525
Natural gas to heat	-	-	-	Gas	3,000	3,000
Power for heaters & coolers	-	-	-	Electric	625	625
Total hours labor	2,506					
Total cash cultural cost		$5,012	$65		$4,663	$9,740
Harvesting and Packing						
Picking [3]	1,168	$2,336	-		-	$2,336
Grading, packing & selling at greenhouse estimated cost $1/carton						$7,884
Total cash harvesting & packing cost						$10,220
Total Cash Cultural, Harvesting & Packing Cost [4]						$19,960

1/ One crop of 4 months' harvest on one acre. Beds contain two plant rows and are 30" wide by 110' long. Rows are 18" apart with plants spaced 18" in the row. Aisleways are 30" wide. This arrangement provides space for 72 beds of 146 plants each or a total plant population of 10,512 (3.75 sq. ft. per plant).

2/ Labor cost based on $2 per hour including fringe benefits.

3/ Assumed yield of 15 lbs/plant merchantable fruit x 10,512 plants/acre = 157,680 lbs. fruit per acre per crop (175,200 lbs. fruit harvested, 90% packed). Picking rate/man = 150 lbs. fruit per hour. Packed in 20-lb. cartons.

4/ Charge for management not included.

Table 3. Summary of estimated cultural and fixed costs for a one-acre ground-bed greenhouse tomato production - California, 1972

	Cost	One Crop Annually
1.	Annual fixed costs 1/	$21,433
2.	Cash cultural costs 2/	9,740
3.	Total cultural costs (preharvest)	31,173
4.	Total harvesting & packing cost	10,220
5.	Total cultural, harvesting & packing costs	$41,393
6.	Total production - pounds 3/ -- 175,200	
7.	Total merchantable product @ 90% -- 157,680	
8.	Annual fixed cost per merchantable lb.	13.59¢
9.	Cash cultural cost per merchantable lb.	6.18¢
10.	Cultural cost per merchantable lb.	19.77¢
11.	Harvesting & packing cost per merchantable lb.	6.67¢
12.	Cultural, harvesting & packing cost per merchantable pound	26.44¢

1/ From Table 1

2/ From Table 2

3/ Based on a yield of 15 pounds merchantable fruit per plant. See paragraph on Yield and Utilization, page 2.

Table 4. Estimated installation costs of trough and sand culture for a greenhouse vegetable operation [1/]

Item	Amount Required	Cost per Acre [2/] Gravel Hydroponics	Sand Culture Trough	Sand Culture Complete Fill [3/]	Peat-Lite [4/]
1" x 12" redwood @ $0.19/lineal foot	16,236 ft	$ 3,085	$ 3,085		$ 3,085
1" x 2" redwood cross and corner braces @ $0.10/lineal foot	5,306 ft	531	531		531
Labor to construct & fill troughs (8 man-hrs/bed)		1,152	1,152		1,152
Labor to spread and level sand				$ 200	
A. Using Recirculated Nutrient Solution:					
8 mil poly bed liner (48" width) @ $0.058/lineal foot	8,200 ft	476			
Pea gravel (6" depth) @ $3.13/yd³	372 yd³	1,165			
Nutrient solution supply tank (2 gals/plant)	25,000 gals	12,500			
Pipe, valves, pumps, motors, and time clocks		4,000			
B. Using Expendable Nutrient Solution:					
6 mil poly floor or trough liner (double layer plus overlaps) @ $9.27/M ft²	113,400 ft²			1,051	
	65,600 ft²		738		738
Coarse sand @ $2.65/yd³	1,560 yd³			4,134	
	370 yd³		980		
Drain line and fittings for sand beds			1,219	1,219	
Peat-lite [4/] (6" depth) @ $15.00/yd³					5,550
Irrigation system			2,000	2,000	2,000
Nutrient solution proportioner (sand 1 1/2"; peat-lite 3/4")			720	720	430
Nutrient solution concentrate tanks (2 x 350 gals)	700 gals		700	700	700
Total Costs		$22,909	$11,125	$10,024	$14,186

1/ To estimate complete costs for sand or trough culture, the costs for items shown in this table should be added to those in Table 1 while eliminating items in Tables 1 and 2 which are not appropriate. Example: for gravel hydroponics, subtract in Table 1 the costs for the nutrient supply tanks, fertilizer proportioner, and the irrigation system. Add the items totaling $22,909 for hydroponics and recalculate depreciation and interest. From Table 2, subtract tillage and fertilizer costs.

2/ Based on a one-acre operation containing 72 beds 110' x 2.5' x 1.0' or 7,920 lineal feet.

3/ Sand 12 inches deep over entire floor of house.

4/ Mixture of 1/2 sphagnum peat, 1/2 vermiculite, and required fertilizer materials.

Appendix I.

CULTURAL ALTERNATIVES FOR GREENHOUSE VEGETABLES

Greenhouse vegetables are most often grown in ground beds in the native soil over which the greenhouse is erected. This is the least expensive system of growing and should be utilized except in cases where the greenhouse cannot be located on a site which takes advantage of good soil, or when the greenhouse is already constructed over soil which is unsatisfactory due to structural, textural, or disease problems. In these cases, the greenhouse operator is justified in utilizing some form of "trough" culture, although at a greater capital cost.

Trough culture involves the construction of growing beds (usually wood, but sometimes concrete) which contain a selected growing medium. This could be gravel, sand, or an artificial soil prepared from various combinations of sand, sphagnum peat, vermiculite, redwood shavings, perlite, etc. The choice of the growing medium must take into consideration the plants' needs in terms of nutrient and water supply, and an aerated, pathogen-free root environment.

Sand and gravel have little or no nutrient- and water-holding capacity, but provide excellent aeration for the root system and are easy to sterilize. When used alone as the rooting medium, they must be bathed regularly with water containing a full complement of required nutrients. Of the two, sand has the greater water-holding capacity and will need irrigation only every day or two as compared with every few hours in gravel. This is known as hydroponic or solution culture and requires the installation of nutrient solution supply tanks, pipe lines, and pumps.

Artificial soil mixes include sphagnum peat and/or vermiculite for the purpose of improving water- and nutrient-holding capacity. The ingredients are assumed to be pathogen-free by their nature, and when necessary can be easily sterilized. In preparation, a full complement of nutrients is added to the soil mix in dry form in sufficient quantity to supply the plants' requirements through the cropping period. Nitrogen (and possibly some potassium and phosphorus) is supplied in the irrigation water during plant growth. This method requires a nutrient solution supply system of simpler construction and components than for hydroponics.

After installation, gravel or sand beds have a longevity equal to the life of the greenhouse structure. Leaching or sterilization operations can be accomplished without disturbing the beds. Artificial soil mixes can also be leached and sterilized in place; but settling of the beds during the crop requires an annual renewal or addition of approximately 10 percent of the bedding material and some replacement of the major nutrients.

Regardless of the type of rooting medium used (soil, hydroponics, or artificial soil) no difference in yield and quality of fruit produced should be expected, assuming that proper management is applied in each case. The choice of rooting medium used, therefore, is dependent on the cost of installation, availability of materials, local soil conditions, or personal preference.