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Land, Labor, and Production Efficiency of Vegetables in Variable-sized Garden Areas

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Abstract. **A 2-year study involving 15 garden vegetables and 5 different-sized gardens was conducted to assess land, labor, and production efficiency. As garden size increased, total production increased, but yield per unit area decreased. Relative labor inputs varied with garden size, but were greatest for harvesting (38%) followed by planting (23%), miscellaneous (22%), and weeding (17%). The highest production in relationship to labor and land use was obtained with beets, carrots, cucumbers, onions, tomatoes, and summer squash. The poorest yielding crops were pole and bush beans, sweet corn, peas, peppers, and radishes. Total vegetable yield for the 2-year study averaged 6.2 kg/m^2.**

Research results concerning commercial production of vegetable crops are readily available and continue to supply valuable information for large-scale operations. Yet little scientific information has been collected on small-scale, multicultural vegetable production with respect to efficiency of land and labor use.

Studies have shown that home vegetable gardening can be an economically profitable venture if labor is not considered as an expense (2, 3, 4). The purpose of this research was to determine labor inputs, total production, and the labor, land, and production efficiencies of various vegetable crops for different-sized production areas.

The research was conducted at the Brigham Young Univ. Agriculture Research Station, Spanish Fork, Utah, during the summers of 1977 and 1978. One area of uniform silty clay loam soil was selected and subdivided into 5 different-sized gardens (Table 1). Each size was replicated 3 times. The statistical design was a completely randomized block, and the means within years were tested by using the Newman-Keul pairwise comparison procedure. The following 15 locally adapted vegetable cultivars recommended by the Utah State Agricultural Experiment Station were grown in both years: Beets (*Beta vulgaris* L. 'Detroit Dark Red'), bush beans (*Phaseolus vulgaris* L. 'Bush Blue Lake'), cabbage (*Brassica oleracea* L. Capitata group 'Danish Ball Head'), carrots (*Daucus carota* L. 'Danvers Half Long'), sweet corn (*Zea mays* L. 'Jubilee'), cucumber (*Cucumis sativus* L. 'SMR18'), lettuce (*Lactuca sativa* L. 'Buttercrunch'), onions (*Allium cepa* L. 'Yellow Utah Sweet Spanish,' bulb type), peas (*Pisum sativum* L. 'Laxton's Progress'), peppers (*Capsicum annuum* L. 'Yolo Wonder'), pole beans (*Phaseolus vulgaris* L. 'Pole Blue Lake'), potatoes (*Solanum tuberosum* L. Red Pontiac'), radishes (*Raphanus sativus* L. 'Cherry Belle'), tomatoes (*Lycopersicon esculentum* Mill 'Better Boy'), and summer squash (*Cucurbita pepo* L. 'Burpee Hybrid Zucchini').

Because of limited space, vegetables cultivated in garden E were limited to onions, carrots, beets, radishes, lettuce, and tomatoes. Additionally, pole beans, peppers, and cabbage were included in garden D. Gardens C and B contained all of the crops in gardens D and E plus bush beans, peas, broccoli, and summer squash. All of the vegetables listed in Table 2 were grown in garden A.

Dairy cattle manure (15 cm depth) was incorporated into the soil each fall, and ammonium nitrate (2.0 g N/m^2) was incorporated each spring. Sprinkler-irrigation water, insecticides, and fungicides were applied as needed, but no herbicides were used. Seed and plant spacing arrangement of the various vegetables was in accordance with recommendations given on the seed packets, and harvest was accomplished as close as possible to the peak of quality. All crops were graded, and cull or poor quality produce was not included in the yield data. Every activity performed on each plot was identified separately, timed, and determined during the season. Land preparation, planting, fertilization, irrigation, and spraying were accomplished with readily available hand tools normally used by homeowners.

Seed planting and transplanting of cool-season crops commenced 18 Apr. 1977, but due to inclement weather in 1978, was delayed until 11 May. Warm-season crops were planted during May and the beginning of June. The 1st killing freeze was on 20 Oct. in 1977, and on 20 Sept. in 1978.

As plot size increased, the total production per garden area increased from 25 kg to 580 kg/plot, but there was a corresponding decrease in the production per unit of land from 12.1 kg/m^2 to 2.5 kg/m^2 (Table 1). The latter is partly a result of the type of vegetables grown in small gardens. The low yields in 1978 (about 50% lower than in 1977) were due to the short growing season. Over the 2-year period of the study, an overall average production of 6.2 kg/m^2 was obtained, which is similar to that obtained in a previous study (6.85 kg/m^2) conducted in Ohio (4).

Of the 4 classifications of labor, harvesting was the largest single time consumer—averaging 38% (8.3 hr) of the total time of 21.6 hr, while planting required 23% miscellaneous (irrigation, pest control, fertilizing) 22%, and weeding 17% of the total (Table 1). Thus, the often dreaded task of weeding actually was less time consuming than either harvesting or planting. The proportion of time spent in harvesting and planting did not vary significantly with size of garden. The proportion of time spent in weeding decreased and in miscellaneous activities, increased as garden size decreased.

The ranking of vegetables (in descending order) in relationship to land utilized (kg/m^2) was: carrots, summer squash, onions, tomatoes, cucumbers, beets, lettuce, cabbage, pole beans, peppers, potatoes, bush beans, radishes, sweet corn, and peas (Table 2). Tomatoes might have ranked higher, but yield in 1978 was greatly reduced due to inclement weather and the short growing season. Ranking in relationship to total time required (kg/hr) was: cucumbers, summer squash, cabbage, carrots, potatoes, tomatoes, beets, onions, sweet corn, peppers, lettuce, bush beans, pole beans, peas, and radishes. The most efficient crops with respect to total labor time (minutes/m^2) were sweet corn, potatoes, cucumbers, cabbage, summer squash, peas, and peppers. The least efficient crops were pole beans, radishes, onions, carrots, bush beans, and lettuce. When harvest time per unit area was considered (minutes/m^2), the most efficient crops were sweet corn, cabbage, onions, potatoes, peppers, and cucumbers. The least efficient crops were pole beans, bush beans, radishes, carrots, lettuce, and beets. The reason that some vegetables required much more labor than others is related to the amount of time required for harvesting and the size of the individual harvested portion. The most efficient crops (sweet corn, cabbage, and potatoes) are all harvested over a very short period of time and the harvested portions are relatively large. In contrast, the least efficient crops tend to be harvested over a relatively long period of time and/or the individual harvested portions are relatively small.

Small to medium gardens have the benefit of reduced weeding time, increased yield per area, decreasing the possibility of gardeners becoming discouraged and quitting (1). As garden size decreases, selection of efficient crops is essential to maximizing time and land use. The data suggest that beets, cabbage, carrots, onions, tomatoes, and summer

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Table 1. Size of garden plots and yield and labor time associated with various sized multicultural garden areas.

Garden	Dimensions (m)	Area (m^2)	Total yield-avg. of 1977 & 1978 kg/plot	Yield kg/m^2 1977	1978	Mean	Time required for activities Mean of 1977 & 1978 totals (hr) Planting	Weeding	Harvest	Misc.	Total
A	15.2 × 15.2	231.0	580 d[z]	3.4 a	1.6 a	2.5	14.2	11.3	22.9	7.9	56.2
B	6.1 × 6.1	37.2	175 c	5.7 b	3.5 b	4.6	4.5	4.0	8.6	6.7	23.8
C	4.6 × 7.6	34.9	160 c	6.2 b	3.5 b	4.8	3.5	2.0	6.4	3.9	15.8
D	3.1 × 3.1	9.6	65 b	8.8 c	5.5 c	7.1	2.2	0.9	2.6	3.3	9.0
E	1.5 × 1.5	2.3	25 a	18.1 d	6.0 c	12.1	0.6	0.1	0.9	1.4	3.1
Mean	--- ---	---	---	---	---	6.2	5.0	3.7	8.3	4.6	21.6

[z]Yields in columns followed by the same letter are not significantly different at the 0.05 level.

Table 2. Yield, land use, and time efficiencies of 15 common garden vegetables

Vegetable	Yield kg/m^2 1977	1978	Mean	Yield kg/hr 1977	1978	Mean	Total labor time-area efficiency minutes/m^2 1977	1978	Mean	Harvest time-area efficiency (min/m^2) 1977	1978	Mean
Beets	8.1 cd[z]	7.7 ef	7.9	11.3 de	14.0 de	12.7	43.8 hi	35.2 hij	39.5	16.1 ghi	10.1 de	13.1
Bush beans	2.5 abc	1.5 abc	2.0	2.4 ab	2.6 a	2.5	64.0 j	32.1 hi	48.1	45.1 k	21.8 g	33.5
Cabbage	5.0 abcd	3.7 bcd	4.4	16.4 fg	15.3 ef	15.9	19.8 abcde	13.5 bcd	16.7	2.1 abc	1.4 a	1.8
Carrots	17.4 f	8.7 f	13.1	13.0 def	16.6 f	14.8	64.1 j	41.8 j	53.0	21.9 ij	15.0 f	18.5
Sweet corn	1.5 ab	0.8 ab	1.2	11.3 de	7.4 bc	9.4	7.7 a	6.4 ab	7.1	1.7 abc	1.0 a	1.4
Cucumbers	10.0 e	6.0 e	8.0	56.2 j	42.2 h	49.2	10.6	8.6 abc	9.6	6.8 abcdef	4.3 abc	5.6
Lettuce	6.0 bcde	4.7 de	5.4	6.4 abc	7.4 bc	6.9	54.7 ij	39.6 ij	47.2	21.5 hij	10.9 e	16.2
Onions	10.4 e	8.9 f	9.7	13.6 def	11.8 cd	12.7	62.4 j	51.6 k	57.0	4.3 abcde	2.0 a	3.2
Peas	0.7 a	0.4 a	0.6	1.5 ab	1.3 a	1.4	31.3 efg	18.9 def	25.1	12.3 efg	9.7 cde	11.0
Peppers	3.3 abc	2.2 abcd	2.8	7.3 bc	6.6 b	7.0	30.7 efg	19.6 def	25.2	7.5 abcdef	3.2 ab	5.4
Pole beans	3.5 abc	2.4 abcd	3.0	1.7 ab	1.4 a	1.6	126.0 m	105.3 n	115.7	49.7 h	21.3 g	35.5
Potatos	3.2 abc	1.4 abc	2.3	18.1 g	10.1 bcd	14.1	10.5 ab	8.0 abc	9.3	3.4 abcd	3.4 ab	3.4
Radishes	1.7 ab	1.6 abc	1.7	1.4 a	1.1 a	1.3	88.9 k	83.9 m	86.4	20.4 hij	32.5 h	26.5
Tomatoes	16.2 f	0.4 a	8.3	25.2 h	2.2 a	13.7	47.2 hi	15.5 cde	31.4	19.9 hij	0.5 a	10.2
Summer squash	20.2 g	5.4 e	12.8	48.1 i	23.5 fg	35.8	25.0 cde	12.6 bcd	18.8	13.7 fgh	5.2 abcd	9.5

[z]Numbers in the same column followed by the same letter are not significantly different at the 0.05 level.

squash should be recommended for most efficient garden production. It should also be noted that beets and tomatoes have been reported to yield particularly high dollar returns per unit of land area (4). The data also suggest that peas, beans, radishes, and sweet corn are the least efficient producers.

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