A COST ANALYSIS OF TWO ENERGY CONSERVATION METHODS, PART II — POLY OVER GLASS*

James P. Stefanis, L.D. Albright, G.B. White, and R.W. Langhans

A second method of conserving energy (see CGNL #102, 11/80) is in covering a glass greenhouse with polyethylene which may reduce fuel consumption by up to 50 percent (3, 4). This has been an important contribution to energy conservation in greenhouses and has been widely accepted by growers. As energy costs continue to rise, potential economic savings will make this practice attractive to even more growers.

Fuel savings from covering glass with a single layer of poly result primarily from reducing air exchange through the glass laps. Covering the glass with an air-inflated double layer of poly further reduces fuel use by acting as an insulator.

While poly over glass saves energy, light levels are decreased. A 53 percent reduction in solar radiation in a greenhouse covered with double-poly was reported (3), and we have measured greater reductions. Condensation and plastic which has deteriorated will both reduce light transmittance further.

Research (4) has indicated that even new poly over glass may result in production delays. Our analysis shows that production delays, as a result of decreased light levels, will reduce or nullify the fuel savings.

Research reports have stressed the percentage of fuel savings. However, these figures do not necessarily correlate with increases in profits. When analyzing any investment, *all* costs including labor, equipment, and other reoccuring expenses, must be considered. In determining the annual costs of using polyethylene, the permanent extrusions needed to hold the plastic are depreciated over a number of years. However, the labor and poly expense must be computed as often as the plastic is replaced. While annual insulation costs are less if plastic is not replaced each year, light quality is reduced in subsequent years as the plastic deteriorates and there may be proportionally greater crop delays and loss of quality. Because light intensity is critically important in the northeast, this example considers only a single layer of polyethylene over glass and the poly is replaced each year.

If fuel costs are $1.00/sq. ft./yr. and we assume that a single layer of poly saves only 30 percent in fuel, fuel savings are $.30/sq. ft./yr. and the annual fuel cost is $.70 sq. ft. Purchase and installation costs of the poly (assume $.10/sq. ft./yr.) must be subtracted from the fuel savings, so the real annual savings are $.20/sq. ft./yr. In this example fuel and insulation costs are determined by adding the cost of insulation ($.10) to the fuel costs ($.70) which equals $.80/sq. ft./yr. The actual winter fuel cost/sq. ft./week is then $.03/sq. ft./week.

Potential fuel and dollar savings for a pot mum crop grown in a glass greenhouse covered with single poly are presented in Table 4. If flowering is delayed only one week, total production costs increase by $.02. For example, a 12-week mum crop grown under glass has a net fuel cost of $.45 per plant and a total cost of $1.91 per plant. If the greenhouse is covered with poly and the crop still flowers in 12 weeks, then the net fuel cost is $.36 and the cost per plant is reduced $.09.

If the crop is delayed two weeks, thereby extending the production period to 14 weeks, the net fuel costs are $.42 and the plant costs $.13 more to produce, the next crop scheduled is two weeks late before being planted.

When crop production is delayed, costs per plant are increased, but potential earnings from plants which could have been grown in the same space are lost and this may be even more costly. The following example considers the overall effect on profits during a 36-week heating season when production is delayed because of reduced light levels in glass houses covered with poly.

Table 5 indicates total production expenses and the average cost per plant in two glass houses: one covered with poly and one not covered. The example assumes crops are delayed a total of three weeks throughout a 36-week heating period; research using chrysanthemums has shown this is possible (4).

The plants are 5½" potted chrysanthemums grown one per square foot as in the previous example. While total production costs in the poly-covered house are less ($5.06 compared to $5.38), fewer crops are grown (2.75 compared to 3) so the cost per plant in the poly-covered house is $1.82 compared to $1.79 in the glass house not covered with poly.

*A paper presented at the workshop on "Marketing and Economics of Floricultural Crops" sponsored by the Floriculture Working Group of the American Society for Horticultural Science at Colo. State Univ., July 29, 1980.

Reprinted from Connecticut Greenhouse Newsletter #103, January 1981.

Table 4. Winter production costs for a 12 week crop of 5½" potted chrysanthemums when grown in a glass greenhouse covered with single-layer polyethylene.

Greenhouse covering	Production period delay (weeks)	Net fuel & insulation costs	Percent fuel savings (per plant[w])	Net overhead[y]	Direct costs	Total costs	Cost change
Glass	none	$.45	—	$ .96	$.50	$1.91	$—
Poly over glass	none	.36	30	.96	.50	1.82	−.09
Poly over glass	1	.39	24	1.04	.50	1.93	+.02
Poly over glass	2	.42	18	1.12	.50	2.04	+.13
Poly over glass	3	.45	12	1.20	.50	2.15	+.24

[z]The assumption is that a single layer of plastic saves 30 percent; however, the savings reported include the cost of instulation and are only 20 percent.

[y]Overhead costs = $.08/sq. ft./week.

[x]Total costs = net fuel cost + net overhead + direct costs.

[w]Percent fuel savings were determined by the following equation:
1 - (1/.45) {(.0378) (.7) (production period weeks) {.
1 - 2.2 x .0378 x .7 x number of production weeks.

When these plants are sold at $2.50 each, the effect on net profit becomes clearer. Table 6 shows that revenues per square foot in the uncovered glass house are $7.50 (3 x $2.50) compared to $6.88 (2.75 x $2.50) for the poly-covered glass house. Net profit for the 36-week period is reduced from $2.12 for the uncovered house to $1.82 for the poly-covered house or $.30/sq. ft. This difference could be greater if the plants grown in the poly-covered house were of a lower quality and sold for less or if the crops were of equal quality but sold for $2.75 or $3.00. In both cases considerable potential profits are lost because of reduced production.

Several conclusions can be drawn from these examples. One should perform a thorough analysis before installing energy conserving systems. Assess *all* costs and determine the effect, if any, on the crop timing and quality.

If the production periods are extended by growing at lower temperatures or under less light, compare the value of the fuel savings per plant with the increased overhead per plant and reduced profits. Although total expenses per year may be less because of a lower fuel bill, if fewer crops per year are grown and plant quality is lowered, this will result in a higher cost per plant and a lower return on investment.

Not all areas in the country experience production delays with poly-covered glass houses and growers may achieve fuel savings greater than the 30 percent we used. Our example is a conservative estimate of fuel savings and considers a wide range of possible production delays. But where winter light intensities are low and where double poly over glass is used, crop production can be delayed and plant quality may be reduced (4). The longer poly remains on a house, the greater the light reductions; this may also cause production delays in areas where light intensities are usually adequate.

Table 5. A comparison of production costs for 36 weeks for 5½" potted chrysanthemums grown in glass houses with and without a poly covering.

	Uncovered glass house	Poly-covered glass house
Number of crops grown	3	2.75[z]
Fuel costs (per sq. ft.)	$1.00	$ .70
Poly costs (per sq. ft.)	—	.10
Direct costs ($.50 per plant)	1.50	1.38
Overhead (per sq. ft.)	2.88	2.88
Total production expense	$5.38	$5.06
Cost per plant	$1.79	$1.82

[z]Production was delayed three weeks during the 36 week heating period, a one week delay per crop.

Table 6. Profit analysis of 5½" potted chrysanthemums grown in glass houses with and without a poly covering.

	Uncovered glass house	Poly-covered glass house
Number of crops grown	3	2.75[z]
Revenues (per sq. ft.)	$7.50	$6.88
Expenses (per sq. ft.)	5.38	5.06
New profit	$2.12	$1.82
Profit per plant	$ .71	$ .66

[z]Production was delayed three weeks during the 36 week heating period.

Both lowering the greenhouse temperature and covering a glass greenhouse with polyethylene reduce fuel consumption. However, both methods have their disadvantages as discussed in these papers (CGNL #102 and 103). Fuel is a large expense and a valuable resource; it should not be wasted. An investment in greenhouses and equipment is substantial. Overhead costs per square foot are more than twice the fuel costs during the winter, more than five times the cost of fuel during the fall and spring.

The grower who lowers the thermostat to 40° saves a lot of fuel but is also out of business. Using poly over glass is an excellent way to reduce fuel cost; but the economic savings may be lost.

Literature Cited

1. Albright, L.D., R.G. Reines, S.E. Anderson, P. Chandra, D.R. Price, R.W. Langhans and R.V. Cerilli. 1978. Experimental results of solar heating a Brace Institute style greenhouse. Proceedings, Third annual Conference on Solar Energy for Heating of Greenhouses and Greenhouse-Residence Combinations. April 2-5, 1978. Fort Collins, Colorado.
2. Ball, V. 1978. The business end of growing. Grower Talks 41(12):1-39.
3. Bauerle, W.T. and T.H. Short. 1977. Conserving heat in glass greenhouses with surface-mounted air-inflated plastic. Circular 101, Ohio Agricultural Research and Development Center, Wooster, Ohio.
4. Cerilli, R.V. 1979. The effect of energy conservation and alternate energy techniques on the production of two commercial floriculture crops. M.S. Thesis, Cornell University, Ithaca, NY.
5. Stefanis, J.P., L.D. Albright, G.B. White and R.W. Langhans. 1980. A cost analysis of two energy conservation methods, Part I. Conn. Greenhouse Newsletter 102:4-9.

Published by
Colorado Greenhouse Growers Association, Inc.
Dick Kingman, Executive Vice President
2785 N. Speer Blvd., Suite 230
Denver, Colorado 80211

Bulletin 373

Direct inquires to:
Office of the Editor
Horticulture Department
Colorado State University
Fort Collins, Colorado 80523