fied in relying upon refrigeration for storage. Either system has cost involved, and I don't believe any of us will argue that refrigeration isn't practical. Refrigerated storage is controlled environment, so perhaps we can look upon the use of heat in plastic house storage in the same way. We're exercising some control over the elements.

Now, perhaps we can disregard he costs involved in erecting facilities suitable for growing and storing container stock, for there are so many variables involved. Construction standards vary from grower to grower. If poly is used as an annual protective covering, compared to standard greenhouse construction, we know the costs are substantially less.

Quonset-type construction permits an easy application of poly for winter cover, and equal ease in removing the cover in the spring. Then by putting on saran, we also find it easy to convert these facilities to conditions most favorable for summer-growing. No other type of construction permits such fast and easy exchange of fabrics.

Exclusive of electric power and routine maintenance costs, polyhouses can be covered with liners inside and out and heated with unit heaters burning LP fuel, and carried at frost-free temperatures at an annual cost of less than 12c per sq. ft. of area covered. So in conclusion whether we are storing ground cover stock or larger canned material, we believe these costs are fully justified. These costs are minor, certainly, considering the assurance we have that our production inventory is protected.

MODERATOR SHUGERT: Our final speaker this afternoon is Bill Flemer who will answer the question, "Does cultivation preserve soil moisture?"

DOES CULTIVATION PRESERVE SOIL MOISTURE?

WILLIAM FLEMER, III
Princeton Nurseries
Princeton, New Jersey

At the time of the publication of Laurie and Chadwick's *The Modern Nursery* in 1931 and for countless years before, there would have been hesitation in answering affirmatively the question which forms this title of this paper. Agricultural and horticultural experience had long endorsed the practice of cultivating the soil not only to control weeds, but to conserve soil moisture during summer dry periods.

So the matter rested until the advent of the modern herbicides which for the first time made it possible to control and virtually eliminate weeds in crop rows without even a single cultivation during the growing period. Soil scientists at many experiment stations began to question whether there was any value to cultivation at all, now that weeds could be suppressed by herbicides, and experiments seemed to show that soil mois-

ture was depleted at a greater rate from cultivated than from undisturbed soil.

The coming of the herbicides was enthusiastically received in the nursery world as well as among the row crop cotton, soy bean, and corn farmers, and in several widely read articles the cultivating tractor was said to be joining the hoe in the museum of technological obsolescence.

We at Princeton have always felt that thorough cultivation was a prerequesite for successful field production and have been doubtful about the idea that just as good or better crops could be grown in uncultivated fields. Conclusions which might be justified in crops like corn and soy beans might not also apply to nursery crops which are quite dissimilar in growth habits and requirements.

To begin with, corn lands treated with herbicides and not cultivated were not planted at the row widths and at the population density common in former times. Rows were greatly narrowed and the spacing of seeds in the rows increased so that much greater surface coverage was achieved and much less sunlight and wind could strike the soil surface to dry it out. New harvest machinery was designed to accommodate the narrower rows and the whole concept of yield per acre was upgraded. In the case of nursery production most of which is not a one year crop like corn or cotton, row width and spacing satisfactory for the first year or so in the field will not permit the develoment of a saleable finished plant in later years. Harvesting equipment presently available will not adapt to greatly reduced row widths or plant density in the row without excessive breakage or loss. Consequently it is impossible to plant nursery plants in the field closely enough to get any appreciable shading effect and conserve moisture during the first few years of a field crop cycle.

A second consideration was the quality of cultivation used in those experiments with nursery stock which seemed to indicate that the practice was unnecessary. The art of setting cultivator teeth properly to obtain an even, thorough job of cultivation is apparently rapidly dying out anyhow, and will soon join that ox shoeing if the present trend continues. Nursery experiments comparing cultivated with non-cultivated areas have been largely based on very small plots in which hand tool scratching of doubtful thoroughness was the "cultivation" practiced. In farm field experiments, often no mention was made of the depth of cultivation practiced, and it is well known that deep cultivation of corn, for example, does sever valuable brace and feeder roots and reduce yields.

With the above doubts in mind and with the whole problem of moisture control becoming more acute during the past three summers of severe drought conditions, we determined last spring to do a series of relatively large scale but simple experiments to determine whether field cultivation was worth the time and expense put into it. I regret to say that we did not install mois-

ture recording devices in the soil of these plots, but merely recorded the growth of the plants involved in comparison with check plots ,but the results were significant to us, at least.

Plots were laid out in fields of the following varieties planted in the row widths given. All plots were 200 feet long.

Number of Rows Cultivated	Not cult.	Variety	Age	Row Width	Plant spacing in the row
6	6	Juniperus horiz. plumosa	2 yrs.	4 ft.	18 in.
8	8	Acer platanoides	4 yrs.	8 ft.	2 ft.
10	10	Ligustrum ovalifolium	2 yrs.	4 ft.	8 in.
7	7	Taxus cusp, densiformis	3 yrs.	4 ft.	18 in.

The cultivated rows were sprayed in a band approximately 14 inches wide with a mixture of Kloben and Dow Pre-Merge in late March. The spray was directed at the bases of the plants.

The uncultivated rows were sprayed over the entire row width to cover the ground with herbicide.

At the end of the growing season in late September the plants in each plot were counted. The results are tabulated as follows.

Juniperus horizontalis plumasa

	12 to 15 in.	15 to 18 in	18 to 24 in	2 to 2½ ft.
Uncultivated Plot	280	310	180	3
Cultivated Plot	170	288	265	65

Acer platanoides

	6 to 8 ft	8 to 10 ft	1¼ - 1½"	1½ - 1¾"	1¾ - 2"
Uncultivated Plot	212	352	210	18	-
Cultivated Plot	92	220	361	124	4

Ligustrum ovalifolium

	18 to 24 in	2 to 3 ft	3 to 4 ft.	4 to 5 ft
Uncultivated Plot	890	1410	645	-
Cultivated Plot	87	1060	1643	211

Taxus cusp. densiformis

	12 to 15 in	15 to 18 in.	18 to 24 in	2 to 2½ ft
Uncultivated Plot	315	420	172	
Cultivated Plot	121	450	260	88

Multiplying the above figures by the prices of each grade of material shows at once that if all plants were sold the upward shift in grades more than compensated for the added costs of cultivating each pot so handled and turned in substantial profit as well. Costs of cultivating such a small area were very difficult to arrive at and were roughly estimated at about forty dollars per plot for the total of seven cultivations.

Sample diggings at monthly intervals in each plot showed that the soil dried out more rapidly in the uncultivated areas, although both started on an equal basis in early May. The most marked difference was the degree of penetration after our one substantial rain last summer. In the cultivated plot the moisture had penetrated over 14 inches in three days time, while in the hard surfaced uncultivated plots the rain did not enter more than 4 inches of the soil, and runoff was substantial.

The results of this little test are certainly not remarkable, but they gave us concrete and indisputable evidence that proper shallow surface cultivation does preserve soil moisture and enhance the growth of the nursery crops tested.

MODERATOR SHUGERT: Are there any questions?

ROLAND DEWILDE: I would like to ask Bill Flemer, isn't it true that the biggest benefit that you get from cultivation is that the moisture you do get, particularly in dry times, has greater penetration, rather than preserving that which was already there?

BILL FLEMER: I think both are involved, Roland. If you have ever seen some of the shade tree growers in the Portland area, you can see the results of good cultivation. I think they practice better cultivation than you see anywhere else in this country. In the Portland area, after June or shortly after that, they have no rain what-so-ever for the rest of the summer. You get some cool fogs, but no rain. And yet by cultivating constantly, very shallowly, dragging a chain behind the cultivator teeth and what not, they preserve the moisture that is in the soil and get fabulous growth on shade tree whips. But back East where we do get rain I think you're right. You get twice the value out of it — that is, compared with uncultivated soil. We had a little contest one time with a neighboring New Jersey Nursery. He said that he could get better growth of shade trees with sod culture than we could with clean culture. So we bet $25.00 on the thing. We took a row of his plane trees and calibrated them very carefully, as well as ours. Then we went through the summer. Well, his seemed to grow faster at first. We had two or three good rains during the summer. Ours grew considerably faster during the latter part of the period, and I got my $25.00 dollars hands down.

MR. LOWENFELS: Did you say you used herbicide or not?

WILLIAM FLEMER: We do use herbicides. We used them in both plots in this test. In the plots which were cultivated we sprayed just in a band where the plants were. This is our normal practice. The other plot was sprayed so as to cover the whole surface and then not cultivated throughout the summer. We use the band spraying for herbicides because we believe we are going to have to cultivate anyhow to control moisture. And we use one third less herbicide by spraying in a band; and if there is any possibility of build up, which I sincerely believe does exist with Simazine, the fact that we use only a third or a fourth

as much on the acreage, means that you are going to have that much less problem with build up. We spray just where the plants are, in a banded spray, directed at the bases of the plants, but not on the roots.

PETER VERMEULEN: The one and three quarter cent cost that you had for the poly, did that include labor? What mil poly did you use outside and inside? What degree of shade did you have on the saran?

BILL CUNNINGHAM: The one and three quarter cent cost does not include labor. We started to use 40% shade saran but found that 36% shade was better. We used four mil poly on both the outside and the inside. We tried the 6 mil and, although it works well, the cost is too high. Four mil is adequate. You can use 2 mil inside and certainly it is as good as four mil, but we prefer to have all the poly the same guage so that once we remove it from the house, we have the opportunity to use it for other purposes. Four mil polyethylene will overwinter well as long as it is put on drum tight. Put it on just as tight as you can so there is no movement in the poly. But if it flaps in the breeze it will wear out.

CASE HOOGENDOORN: Do you mean to tell me that you use your poly the second winter again?

BILL CUNNINGHAM: No. We use it only one time. But as everyone knows there are dozens of uses for polyethylene, if it is reasonably good.

VOICE: This question is to Bill Flemer. What is the depth of cultivation of small material and the intervals between cultivation?

BILL FLEMER: About 2½ inches in the ground. We set the teeth more shallow by the plants and deeper in the center of the row; it averages out to about 2½ inches. We used seven cultivations last summer, because it was a dry summer and once the dust mulch was established we did not have rains to break it up again. So we averaged out to once every 10 days to two weeks. Had we had a rainy summer we would have had to cultivate more.

MODERATOR SHUGERT: Before I turn the program back to the President, I would like to make a few comments. First of all I want to acknowledge with deep thanks and appreciation, all the speakers we had this afternoon. They did an excellent job, and I am certain you appreciated it as much as I did. I would also like to acknowledge the standby speakers. As the program began to gel, we put out a request for a few more speakers and the following people volunteered to appear on the program: Merton Congdon, Hoy Grigsby, Al Pridham, Howard Johnson from the University of Minnesota, Al Fordham, and Albert Lowenfels. I would like to direct a comment to the program chairman for next year. Going back through the Proceedings, back in 1962, I quote — "That future speaker-exhibitor

symposiums be comprised of a certain number of the most appropriate papers submitted during the previous year. It would be preferable but not required to have the author present his own paper. This paper should not be previously circulated." This statement was made by Peter Vermeulen and certainly it was one of the points he stressed in his communications talk that we all remember quite vividly. Also in 1962, Steve O'Rourke said, "I have attended every meeting of the Plant Propaagtors' Society since 1951 when we started except when I was overseas. My personal experience is that we derive more information from short speaker-exhibitor talks than from any other feature of the program. So let us try to further participation among the membership at large." All I can say to both of those remarks is 'Amen' — I do hope that next year the program chairman will entertain the idea of having the speaker-exhibitor symposium last through an entire afternoon. I will now turn the program back to President Roller.

PRESIDENT ROLLER: Thank you, Ralph. I think you have done what Dr. Chadwick once said: "The mind can only absorb what the seat can endure." The only thing I want to say is that I absent-mindedly neglected to announce that Case Hoogendoorn is a member of the 1966 site committee.

DR. HESS: I would like to suggest that those members who did not have an opportunity to present a paper this afternoon, send them to me for publishing in the Plant Propagator.