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RESEARCH AND CULTURE--GLASSHOUSE VEGETABLES IN HOLLAND

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1. Vegetables under glass in Europe

Before I tell you something about the research and culture of the glasshouse crops, I will start by showing the Dutch position compared to that of the other European countries (Table 1, VAN SOEST, 1968).

Table 1. Vegetables under glass in Europe

	1956	1968/1969
Netherlands	5,600 acres	13,700 acres
Belgium	700	2,800
France	60	1,200
W. Germany	2,000	1,900
Great Britain	4,400	3,400
Ireland	150	400
Scandinavia	1,500	1,100
Bulgaria	50	1,500
Roumania	-	1,600 (1970)
Russia	-	2,000
Czechoslovakia	-	1,500
Hungary	-	100
Total	15,000 acres	31,000 acres

Vegetable production in glasshouses is practiced at this moment in a lot of countries of Europe. The glasshouse area expanded very rapidly; it has more than doubled during the last 12 years. The demand for fresh vegetables of good quality is growing fast. It is caused by increasing prosperity and purchasing power of the consumers.

Together with Great Britain, Holland was the first country in Europe that reacted to this demand. In Britain, however, the expansion stopped with the beginning of World War II. In contrast to that country, Holland extended its glasshouse area until about 1965 and realized the greatest expansion of vegetable growing under glass in Europe.

Until 1964 the vegetable growing in glasshouses in the Netherlands was very profitable. This situation, however, was noticed in the neighbouring countries. Belgium was the first country which got interested in building glass houses, followed by France and Italy. In later years the Balkan States, Bulgaria and Roumania, started to build glasshouses. The European Economic Community has stimulated this development. In the European Free Trade Association, the glasshouse expansion was of little importance until a few years ago.

2. Development of vegetable production in the Netherlands

The growing of vegetables, fruit, and flowers under glass started around 1900. The growers worked with Dutch lights (frames) for slicing cucumber and lettuce growing. Special cucumber-houses were imported from England and grape houses from Belgium. Both types were single bay houses. Just before World War I, growers started to build multibay glasshouses for tomato growing (Table 2).

Table 2. Glasshouse area in the Netherlands (acres)

Year	Vegetables (including strawberries)		Fruit	Flowers
	Dutch Lights (frames)	Glasshouses	Glasshouses	Glasshouses
1906	450	-	70	
1912	1,200	270	210	
1940	2,300	3,000	2,140	710
1950	2,380	3,300	1,950	700
1960	2,320	8,500	1,170	1,230
1965	930	11,900	780	2,230
1969	± 500	13,200	590	3,770

The western part of the country was and is the most important glasshouse center. The neighbourhood of big cities, the cheap way of transportation on canals, rivers, and across the sea as well as the influence of the sea on the climate are important factors in this development. At the moment 80% of the glasshouse vegetable production in the Netherlands comes from the Westland area, a district of 10 by 20 miles between Rotterdam and The Hague.

After World War II three developments have caused an important change in our glasshouse industry.

- a. In the period from 1960 to 1965 the Mediterranean countries started their export of relatively cheap grapes of good taste to the northern European countries. This competition resulted in a dramatic dwindling of the grape growing area under glass in Holland.
- b. Secondly, labor became expensive in Holland after 1960. Especially the growing under Dutch lights and in cucumber-houses is very laborious work. The cucumber growers switched over to growing their cucumber in multibay (Venlo) glasshouses. The area of Dutch lights and special cucumber houses reduced rapidly after 1960.
- c. The third development is the increased demand for flowers and the decreasing profit of vegetable production in glasshouses caused by the great expansion in Europe after 1963. Since then many vegetable growers switched from tomatoes, cucumbers, and lettuce to carnations, roses, all year round chrysanthemums, Asparagus plumosus, and Anthurium andreanum.

3. Type of holding

At present the minimum size of a glasshouse holding is about $1\frac{1}{2}$ acres. With this size nearly everything can be done by the grower and one laborer. The grower can earn an income big enough for supporting his family. On such a holding it is profitable to have an automatic boiler with heavy oil usage, an automatic ventilation system, equipment for application of fertilizers through the irrigation system and a grading machine for slicing cucumbers or tomatoes. An important part of our holdings have between 2 and 4 acres under glass. Besides this type of holding, we have now some holdings (10 to 20) with 10 to 40 acres of glasshouses. At the moment about 65% of the vegetable glasshouses are heated with heating pipes. Of this area 87% is heated with heavy oil, about 10% with paraffin, 1% with natural gas and less than 1% with coal. I think more than 50% of the heated glasshouses will be heated with natural gas within 5 years. The most important reason for this expected changeover is considerable air pollution caused by burning heavy oil (SO_2).

4. Marketing

More than 95% of the glasshouse vegetables are sold on the auction markets. The auction markets are co-operatively owned by the growers. The auction markets have 2 functions. The first function is the public determination of prices. The second function is the collection and redistribution of the products. The vegetables are bought by exporters and wholesalers for the highest prices. This is done by the auction clock. The indicator runs from high to low prices. The first man who stops the indicator with his push button is the buyer. So the product realises the highest price.

The individual auction markets have an annual turnover of $\frac{1}{2}$ to 30 million dollars. Excluding the costs of containers, the growers have to pay for the auctions about 2.5-4% of their turnover. About 80% of the glasshouse vegetables are exported (JACOBS, 1970) mainly to West Germany, the United Kingdom, Scandinavia, and France.

5. New developments in the production of greenhouse vegetable crops

The most important development is the specialization at the holdings. Before World War II, one could find glasshouses as well as Dutch lights for outdoor fruit and vegetables at one holding. At the moment the majority of the holdings have glasshouses only. In a later stage the growers specialized in 1 or 2 crops. The majority of our growers have only tomatoes and lettuce or slicing cucumbers and lettuce. The Dutch growers have specialized more and more in the problem "How to grow vegetables." The selling of the products has already been done for years by the auctions. The potting soils are being prepared by specialized holdings already for a long time. Now also disease control (spraying with chemicals), tillage and raising young plants are pushed off on many nurseries. A specialized disease controller has better equipment and more knowledge and experience. The specialized plant raiser has a better mechanized nursery (pressing soilblocks, sowing of seed pellets, lifting up young plants). At present about 55% of all tomato plants, 85% of the cucumber plants and 45% of the lettuce plants are grown in specialized nurseries (VIJVERBERG, 1970).

The concentration of growing young plants in specialized nurseries requires a planned production and cooperation between plant raiser and grower. Therefore VAN DER HOEVEN & GROENEWEGEN (1970) have published a sowing, planting, and harvesting scheme for all year round production of lettuce.

6. The development of the different crops

The most important vegetable crops and their areas are mentioned in Table 3. Most of the growers have 2 crops per year in their glasshouses, mostly tomatoes and slicing cucumbers in winter, spring and summer, and lettuce in the autumn and winter. In the 1968/1969 season the lettuce area was 9300 acres. Many growers have an annual growing scheme of tomatoes, slicing cucumbers or pickling cucumbers and 2 or even 3 times a lettuce crop. Other growers have only 1, a very long culture of tomatoes per year.

Table 3. Vegetables under glass in the Netherlands

	Area of the different crops in acres		
	1950	1960	1969
Tomatoes			
Heated	880	3,240	5,450
Cold	1,860	3,160	2,630
Cucumbers			
Glasshouses	130	680	2,120
Frames	1,160	920	< 25
Pickling Cucumbers	--	--	510
Other Crops	250	530	2,480

6.1 Tomatoes

The tomato is the more important glasshouse vegetable crop (Table 3). The crop is grown in heated and cold houses. Therefore there is a large

difference in planting dates (Table 4). The Western European market is supplied with Dutch tomatoes from the beginning of March until the end of December. One of the problems is sowing directly into pots. The cultivation of young plants is mostly done by sowing on a seedbed and thereafter pricking out into soilblocks or plastic pots. The poor quality of the seed blocks can be overcome by direct sowing into pots. Direct sowing in pots means saving of labor and results in faster growing plants. GEERS (1970) has found that the quality of the seed can be improved with better growing conditions during seed production and sizing. Another important development is the application of carbon dioxide. The application started around 1964 and now in nearly all heated glasshouses carbon dioxide is applied.

Table 4. Planting dates of tomatoes during the 1968/1969 season

Planting date	Area in acres	
November	30	
December	610	
January	2,390	Heated
February	920	
March	1,400	
April	1,470	
May	1,040	Cold
June	670	
July	420	Heated

During the last years we paid much attention to climate regulation. Most of the growers have a basic temperature regime of 16°C night and 21°C day. During sunshine the temperature is several degrees higher. If the temperature is too high the grower opens the ventilators. We have noticed two kinds of troubles with this regime. First, on dull, relatively warm days the air humidity is too high and the temperature of the heating pipes regulated by thermostats is too low. The effect is slow transpiration, a weak crop, poor fruit setting, and attack of several fungus diseases. On the other hand, on days with alternating cloudy and bright sky, the grower has to ventilate during sunshine because of the high air temperature. The air humidity decreases very sharply; TMV, flower abortion, and fruits of poor quality are the result.

Therefore, we needed a climate regulation that is not only regulating the temperature but also the air humidity and through this the transpiration of the canopy.

During dull weather the transpiration has to be stimulated and during periods of high radiation the transpiration has to be limited. With the system developed at the Naaldwijk Research Station the air temperature is regulated, depending on the light intensity, between 16°C at darkness and 30°C at a light intensity of 100,000 lux. The pipe temperature is not restricted. If the air temperature is too low, the temperature of the heating pipes rises and does the reverse with a too high air temperature. If the temperature of the heating pipes decreases below a certain level, the

ventilators are opened to lower the air humidity and by this stimulates the transpiration. The higher the light intensity, the lower the pipe temperature is allowed to decrease before the ventilators are opened. If the light intensity is increasing, the ventilators cannot be opened before the pipe temperature is decreased below a certain level. This results in a higher air humidity by the plant transpiration during sunny periods and in a lower air humidity on dull days. In that way we never have the combination of high pipe temperatures and open ventilators during a period with high light intensity (VIJVERBERG, STRIJBOSCH 1968 AND GERMING 1969). Also we have noticed that with a high air humidity (70-80%) the optimum air temperature can be higher (up to 30-32°C).

Mechanisation and automation of the heating and ventilation system opens greater possibilities for a better regulation of the glasshouse climate. By coupling the light intensity to the temperature of the heating pipes and consequently indirectly to ventilation, an important improvement of the regulation of the glasshouse climate is obtained. A decrease in hours of labor gives the grower more freedom and decreases labor costs (VIJVERBERG, STRIJBOSCH 1968).

Another method to lower the air temperature on sunny days and to keep the air humidity on a high level is sprinkling water on the roofs of the glasshouses. This method was used on a big scale in Holland last year.

6.2 Slicing cucumber

The biggest development is the complete switchover from frames to multi-bay Venlo-houses between 1955 and 1965 (Table 3). This switchover decreased drastically the labor requirement. It made it possible to do the intensive tillage with machines and to use expedients for transporting the harvested fruits (70 lbs. per square yard for the total culture) with a monorail. Between 1963 and 1965 we found that in hot beds a horse manure-sod mixture or straw with muckwater could be replaced by straw bales without lowering production (SWEEP & VAN DER HOEVEN, 1965). Since that time this system has been applied on nearly all nurseries and is saving a lot of labor. At this moment the all-female varieties are increasing. A culture with these varieties saves a lot of pruning labor and gives a higher production in the first period with the heavily heated crops. Planting out in December and January, however, brings about a too weak growth yet.

6.3 Lettuce

I like to call attention to 4 improvements of lettuce culture. First, the abandoning of pricking out the seedlings from sowing bed to soilblock. With the direct sowing of pelleted seeds in soilblocks, the grower can decrease labor requirements because he can sow with a machine. The plant size is more homogeneous and the chance of disease spreading is diminished drastically.

The second development is the introduction of the transplanter for soilblocks. The use of this machine saves a lot of labor and makes the activity easier.

The third development is the shortening of the culture duration by a better knowledge of climate regulation. The higher air temperatures,

especially in the first part of the culture period and the application of carbon dioxide are most important factors in shortening the duration of the culture. When sowing in the first week of November, the culture duration has been reduced within a period of 3 weeks by about 20% or one month (VAN DER HOEVEN & GROENEWEGEN, 1970).

The fourth development is that of the use of expedients at the harvest and the post-harvest treatment such as the introduction of vacuum cooling. With vacuum cooling the lettuce remains of a better quality and it can be harvested the whole day. Now the growers are harvesting lettuce during the night and early morning hours with very high labor costs (BOER & MERKENS, 1970). On the other hand new, remote markets can be reached with a product of good quality now (MANN, 1970).

6.4 Pickling cucumber

Before 1964 we only had an outdoor production of pickling cucumbers. With the introduction of all female varieties the culture in glass houses was also possible. The area is increasing very rapidly up to 550 acres in 1970 (Table 3). The production in mostly cold and lightly heated glasshouses is increased about 5 times of that in the open and amounts to 20-30 lbs. per square yard. The most important reason for the introduction of this culture is the possibility of staggering the supply to the pickling industry and the low labor costs per pound.

One of the greatest problems was too small a number of female flowers and therefore the plants had too strong vegetative growth. The grower had to prune the plants and through the dense growth picking fruits took a lot of time. Now we have developed a plant type with very short lateral shoots and only 1 normally developed internode, terminating in a leaf-roset. In every leaf axill several female internode are developed (BOONEN, 1968). This variety--Kora--is saving a lot of labor and has a very high early production (SWEEP & BOONEN, 1968 and 1969).

7. Conclusions

I have given you a look into the position of the glasshouse vegetable industry and some recent developments of the different crops. I have not mentioned disease control, fertilization and varieties because of the short time. Perhaps we will have the opportunity to spend some time on it in the discussion.

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