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RELATION BETWEEN LAND LAYOUT AND PROFITABLILTY OF HOLDINGS WITH HORTICULTURE UNDER GLASS

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INTRODUCTION

Up to the nineteensixties, land layout research in horticultural areas in the Netherlands provoked only slight interest, especially so for areas with horticulture under glass. During the seventies, however, this attitude gradually changed as a result of the rising prices of energy and the deteriorating profitability in this branch of agriculture. Today much research is done in the field of less energy consuming production techniques. Next to better isolation, more efficient processes of combustion, introduction of less heat requiring crop varieties etc., the dimensions and the equipment of glasshouses are attracting attention.

In this paper some developments in Dutch horticulture under glass during the period 1960 through 1979, as well as the results of a study to determine the optimum size and dimensions of strongly heated Dutch glasshouses for the production of tomatoes will be discussed.

SIGNIFICANCE OF THE DUTCH HORTICULTURE UNDER GLASS

The total area of horticulture under glass in the Netherlands has increased from about 5000 ha in 1960 to nearly 8500 ha in 1979 (1 ha = 2.47 acres). The expansion is still in progress, though at a less rapid rate than in the preceding decade (table 1).

Table 1. Development of the number of holdings and the area with horticulture under glass in the Netherlands in the period 1960 through 1979

	1960	1965	1970	1975	1979
Flowers under glass					
area (ha)	501	904	1,634	3,060	3,715
number of holdings	4,638	6,729	7,087	8,352	7,962
mean area per holding (ha)	0.11	0.13	0.23	0.37	0.47
Vegetables under glass					
area (ha)	4,017	5,122	5,374	4,683	4,615
number of holdings	15,515	15,860	13,167	9,769	8,052
mean area per holding (ha)	0.26	0.32	0.41	0.48	0.57
Fruit under glass					
area (ha)	468	313	210	117	67
number of holdings	4,185	3,336	2,308	1,255	721
mean area per holding (ha)	0.11	0.09	0.09	0.09	0.09
Tree nursery crops under glass					
area (ha)	9	11	20	40	58
number of holdings	239	303	521	740	837
mean area per holding (ha)	0.04	0.04	0.04	0.05	0.07
Total horticulture under glass					
area (ha)	4,995	6,350	7,238	7,900	8,455
number of holdings	19,854	21,706	19,503	17,571	15,965
mean area per holding (ha)	0.25	0.29	0.37	0.45	0.53
number (percentage) of holdings with					
<0.5 ha glasshouses	16,555 (83)	17,215 (79)	13,897 (71)	11,095 (63)	9,024 (56)
0.5 - 1 ha glasshouses	2,754 (14)	3,702 (17)	4,544 (23)	4,727 (27)	4,583 (29)
≥1 ha glasshouses	545 (3)	789 (4)	1,062 (6)	1,749 (10)	2,338 (15)

In a few districts the cultivation of flowers and vegetables is predominant. Especially the region between the towns of Rotterdam and The Hague (the Zuidholland glassdistrict) is very well-known in this respect. More than 50% of the total area of horticulture under glass is concentrated in this region. But also the districts near the towns of Aalsmeer, Venlo and Breda are of considerable importance. Finally there are many other districts scattered over the country where glasshouses are to be found.

From 1965 onwards the number of holdings having glasshouses is decreasing and simultaneously the area covered with glass per holding is rapidly increasing, due to economics of scale. Obviously, quite a number of horticultural entrepreneurs could not always find the right answer to any new development during that period. Some of them did not have the financial facilities, while others did not possess enough managerial and technical

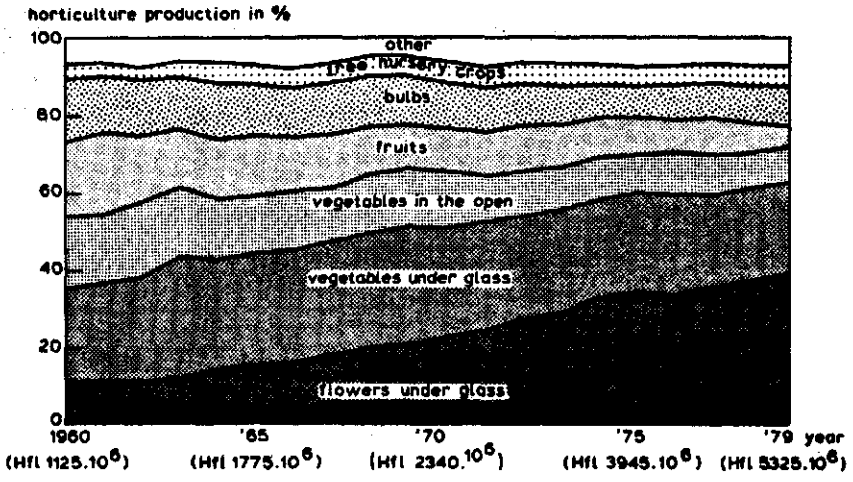


Fig. 1. Value of production of the various branches of horticulture in the Netherlands in the period 1960 through 1979, expressed in per cent of total value of horticultural production (for the absolute values in the various years, see the amounts in brackets)

capacities. It is clear therefore that a large number of mainly small holdings had to give up. At the moment nearly 50% of all holdings do have an area of over 0.5 ha with horticulture under glass. Just now the number of holdings in this class amounts to more than twice that number as it was in 1960.

Table 1 also shows that especially the production of flowers (including potplants) expanded rapidly, partly at the cost of vegetable and fruit production. The reason is the smaller profitability and the less pleasant working conditions of the latter. Production of fruit under glass is of small importance now, though formerly, especially grapes were produced in considerable quantities.

The increasing importance both relative and absolute, of the production of flowers under glass also shows in fig. 1. As a percentage of total horticultural production a rise of 10% in 1960 to nearly 40% in 1979 did occur. Roughly speaking the relative position of vegetables under glass remained constant, whereas the value of production of vegetables in the open and especially of fruit deteriorated.

During the last twenty years the total value of horticultural production increased with about 475% to Hfl 5.3 x 10^9 in 1979, which is 24% of the total value of agricultural production in the Netherlands at the time, against only 16% in 1960. So the relative position of horticulture strengthened considerably during those twenty years.

DEVELOPMENTS IN COST STRUCTURE AND PROFITABILITY

Data on structure and profitability of agricultural holdings in the Netherlands are collected by the Agricultural Economic Institute (LEI). Data concerning horticultural holdings with production of vegetables and cut flowers under glass are presented in fig. 2 and 3 respectively.

The most striking feature in both figures is the enormous rise in production value and at the same time in total cost per holding during the period 1960 through 1979. No doubt this is partly the result of a substantial inflation. On the other hand the production volume per holding also rose considerably. This rise in production volume amounted to nearly 200% for vegetables and to even over 300% for cut flowers. The average total investment per holding with vegetables is almost Hfl 10^6 at the moment, being nearly twice the amount for holdings with cut flowers.

Fig. 2 shows that the profitability of vegetable production under glass was reasonable during the period 1960-1972. After that period, however, the situation changed. Especially during the last three years a substantial net loss occurred. Fig. 3 shows a high net profit in the sixties for holdings with cut flowers under glass. This resulted in a shift from market gardening to flowers. But here also the net profit turned into a net loss during the last decade.

Total cost are subdivided in a number of components viz.: cost of family labour, cost of hired labour, capital cost, cost of energy and other costs. Remarkably as a percentage of total cost, these cost components prove to remain more or less constant, although the cost of labour during the period considered rose from Hfl 2.3 to Hfl 19 per hour. This means that the productivity of labour improved enormously. So the production of tomatoes for example did increase from 10 to about 30 kg per manhour. This was made possible by substituting expensive labour for relatively cheap capital.

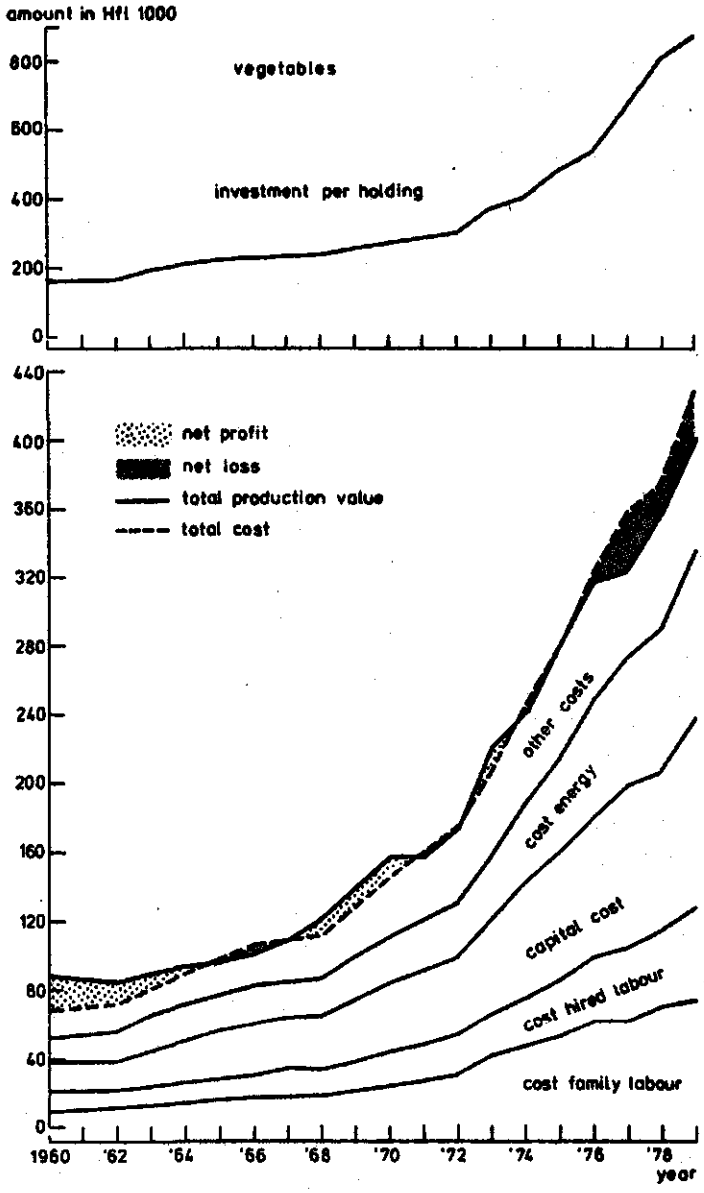


Fig. 2. Investment, cost structure and profits per holding with vegetables under glass in the Zuidholland glassdistrict in the Netherlands, during the period 1960 through 1979

Together with the introduction of improved crop varieties, improved production techniques and improved climate control in glasshouses, the increase in labour productivity caused the production of tomatoes per square meter to rise about 100%, viz. from about 7 kg to nearly 15 kg. Clearly large invest-

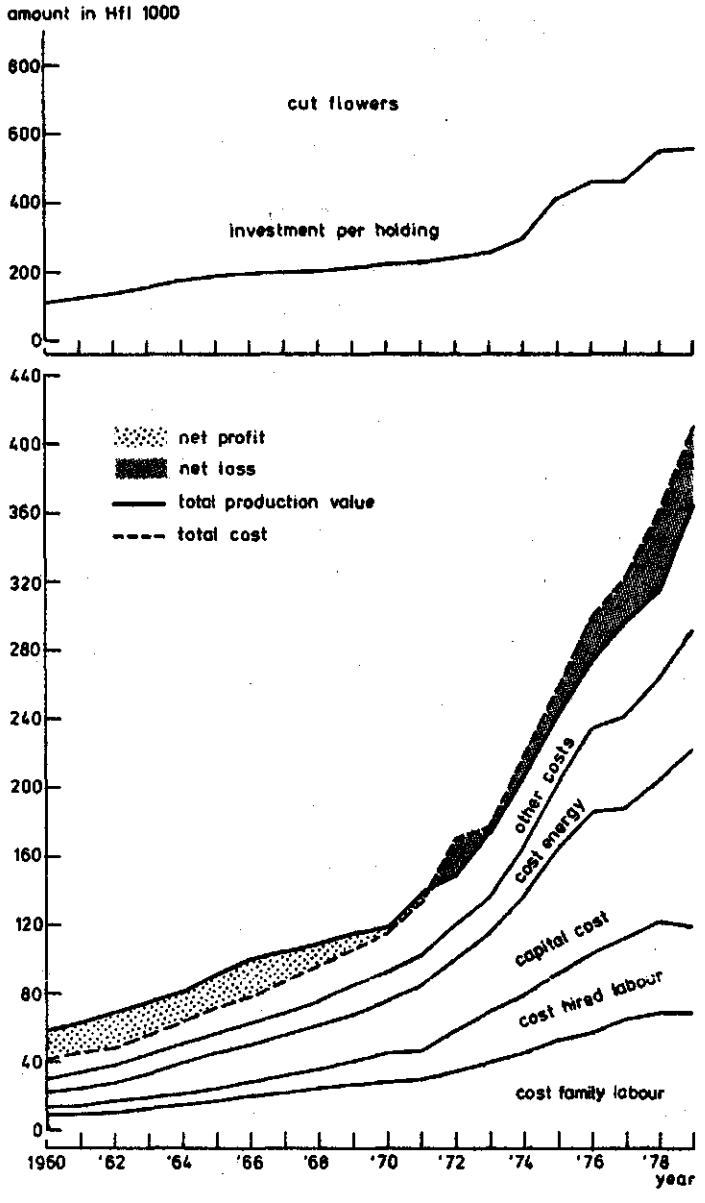
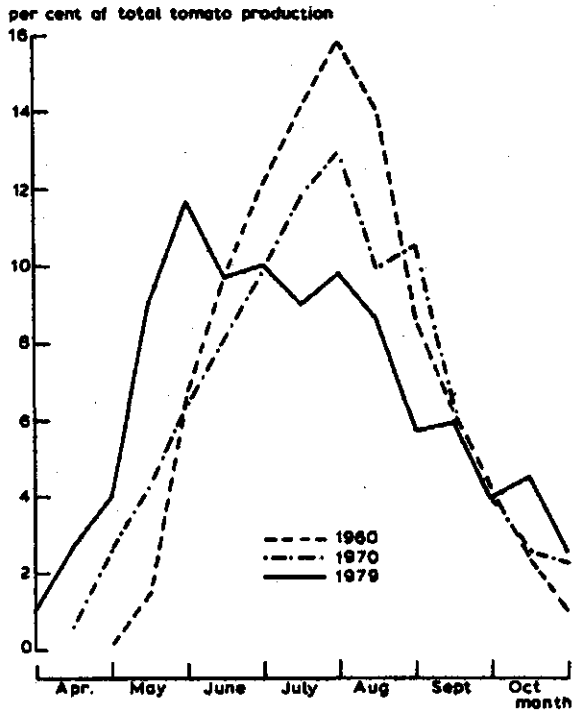


Fig. 3. Investment, cost structure and profits per holding with cut flowers under glass in Aalsmeer and De Venen districts in the Netherlands, during the period 1960 through 1979

ments were required as is shown in the figures. These investments were mainly done for expansion of the glass covered area, for changing over to heating with natural gas, for regulating temperature and air moisture, for

Fig. 4. Annual production distribution of tomatoes for the years 1960, 1970 and 1979 in the Netherlands



ventilation and the supply of carbon dioxide as well as automation and mechanization. From 1973 onwards a large rise in the cost of energy occurred viz. from Hfl 2.5 to Hfl 6 per 1000 mJ in 1979. As said much research is being done on less energy consuming production techniques. The first results of this are already operational.

The rising energy prices did not negatively influence the supply pattern for any separate year for tomatoes for instance (fig. 4).
In 1960 the bulk of the total supply was concentrated within the period June-September. Increased competition from countries in southern and eastern Europe caused a shift in the supply pattern. It proved to be more profitable to cultivate tomatoes in more strongly heated glasshouses, as to sell them earlier in the season. This trend already shows in 1970 when much larger quantities were available during April and May than has been the case in 1960. In 1979 this tendency proves to have continued. Now almost 30% of the total annual production is supplied during this period. The supply proves to be increasing also late into autumn in consequence of the endeavour to supply the

market with vegetables during off-season periods. No doubt, profitability of production again was the decisive factor, though management adjustment in this way generally could not prevent a net loss for this type of horticultural holdings. With regard to flowers there is a different situation, since commercial production of flowers in the northern countries of Europe is almost entirely concentrated in glasshouses. Nevertheless here also a tendency of increasing production during winter occurs.

LAND LAYOUT AND PROFITABILITY

The financial results of holdings with horticulture under glass also depend on the land layout of horticultural areas with glass. Investigations into this phenomenon were done in the Zuidholland glassdistrict. An attempt was made to determine the optimal land layout for holdings with vegetables under glass, also taking into account the accessibility, water supply, water discharge, water quality and drainage. This investigation learned that especially size and shape of the lots are most important.

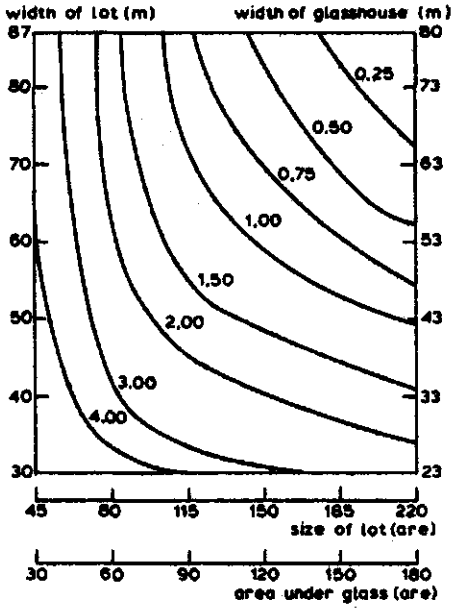
The influences of size and shape of lots, c.q. glasshouses on profitability appear as differences in:

. investment in glasshouses including equipment;
. investment in accessibility of the glasshouses;
. heat losses caused by transmission through the glass walls;
. size of cultivated area;
. yield;
. cost of harvesting.

It was proved that especially the annual cost of exploitation connected with the investment in glasshouses are important. These cost are influenced by width as well as size of the glasshouses. This is also true for the heat losses caused by transmission through the glass walls. In consequence of the rising energy prices, this cost factor is increasingly significant.

Differences in cost of accessibility (farm road under glass) and related differences in cultivated area are depending on the width of the glasshouse only.

Fig. 5. Differences in annual cost of exploitation (Hfl.m^{-2} area of glasshouse) for strongly heated Venlo glasshouses in relation with size and width of the glasshouse c.q. lot



Eventual variation in cost of harvesting and in yield has not been included in the calculations, because no reliable data were available. These factors seemed to be of minor importance, however.

The total effect all factors concerned has been compiled in fig. 5. A lot size of 2.2 ha and a width of 87 m has been taken as a reference level. The annual additional cost per square meter as compared with this reference level is represented by a number of iso-cost curves. Similar exploitation cost are valid for any point of each of these curves.

According to the graph, cost of exploitation for a lot of 80 are (area of glasshouse 6000 m^2) and a width of about 67 m (width of glasshouse being about 60 m) as compared with a lot of 150 are (area of glasshouse 12,000 m^2) and a width of a little over 40 m (width of glasshouse being about 35 m) for instance, are similar. This cost of exploitation per m^2 under glass proves to exceed cost of exploitation by Hfl 2 for a lot of 220 are and a width of 87 m.

It can be concluded that the annual cost of exploitation increases considerably for lots with a size of less than about 1.25 ha as well as for lots with a width of less than 60 m. On the other hand increasing the size of the glasshouse to over 18,000 m^2 or the width to over 80 m, proves to be of little economic importance.

Table 2. Distribution of holdings with horticulture under glass according to the mean width of glasshouses per holding in 1976/1977

Mean width of glasshouses per holding (m)	Zuidholland glassdistrict (number in %)	Aalsmeer and De Venen districts (number in %)	The Netherlands (number in %)
≥60	6	1	5
40-60	30	5	23
20-40	62	40	58
<20	2	54	14

In comparison, in table 2 a survey is given of the number of holdings divided according to the mean width of the glasshouses per holding. Table 2 shows that in the Netherlands only 5% of the holdings have glasshouses with a mean width of over 60 m. According to table 1 it can be concluded that 15% of the holdings have more than 1 ha covered with glass. For an efficient management, size and shape of lots in areas with horticulture under glass in the Netherlands have to be adapted. To that purpose measures such as land layout, reconstruction and resiting of holdings with horticulture under glass are in preparation.

Finally with regard to other infrastructural requirements, investigations in the Zuidholland glassdistrict have proved that:

- All external roads should have a metalled width of at least 3.5 m;
- In general the percentage of open water in the area should be at least 4% to avoid trouble with the water supply and the water discharge;
- The chloride content of the irrigation water should be less than 200 mg chloride per liter. For irrigation purposes in the Zuidholland glass-district much water from the river Rhine is used, the chloride content of this water being very high periodically. For this reason several holdings already made reservoirs to collect rainwater from the glass roofs (about 11% of the holdings in the Netherlands now). In some areas more inland, the iron content of the groundwater used for irrigation purposes is a problem. About 50% of all holdings in the Netherlands are using open water for irrigation purposes, while 32% have the possibility of using groundwater;

. In areas with much horticulture under glass a great danger of virus infection exists. It is tried therefore to separate water supply and water discharge, though this system is still rarely realized by now;
. The land must be drained to a depth of at least 70 cm below soil surface, the distance of the drains depending on the permeability of the soil.

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SUMMARY

In consequence of the rising prices of energy and the deteriorating profitability of horticulture in the Netherlands, interest in land layout research for this type of holdings is increasing.

In the paper some developments in Dutch horticulture under glass during the period 1960 through 1979 are discussed and results of investigations in the optimum size and shape of lots c.q. glasshouses are given.

The total area of horticulture under glass increased from about 5000 ha in 1960 to nearly 8500 ha in 1979. Especially the production of flowers was rapidly expanded, partly at the cost of vegetables and fruit. From 1965 onwards the number of holdings with horticulture under glass decreased. Consequently the area of glasshouses per holding increased considerably.

It is shown that as percentage of total horticultural value of production, for the cultivation of flowers under glass a rise from 10% in 1960 to nearly 40% in 1979 did occur at the cost of the position of vegetables in the open and fruit.

Moreover the enormous rise in production value per holding and in total cost per holding is shown respectively for vegetables and cut flowers. The real rise in production volume amounted to approximately 200% for vegetables and to even over 300% for flowers.

It is also shown that the profitability of cultivation of vegetables and cut flowers was decreasing in the period considered. The cost components as a percentage of total cost, remained more or less constant, though the cost of labour rose over 800% in this period. It means that productivity of labour improved enormously.

In spite of the large rise in cost of energy since 1973 the tendency to use more strongly heated glasshouses is still in progress. In connection with this fact the endeavour to put on the market more and more tomatoes during the months April and May is demonstrated.

As a result of changing production conditions in horticulture under glass, present land layout conditions in areas with horticulture under glass should have changed simultaneously. An attempt is made to quantify cost factors depending on the width and the size of the glasshouse c.q. lot. The results are grafically presented by way of iso-cost curves. It may be concluded that glasshouses smaller than 10,000 m^2 (lot size approximately 1.25 ha) or having a width of less than about 55 m (lot width approximately 60 m), do have an annual extra cost of exploitation which is considerable. On the other hand increasing the size of the glasshouse to over 18,000 m^2 or the width to over 80 m proves to be of minor economic importance. In this respect it can be seen that many holdings in the Netherlands are not under conditions, where an efficient management is possible.

Finally some other infrastructural requirements in relation to accessibility of the holdings, water supply, water discharge and water quality for areas with horticulture under glass in the Netherlands are mentioned.