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DENMARK AND NORWAY — TWO HORTICULTURAL COUNTRIES

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A one week trip through Denmark and Norway allowed renewal with a part of European horticulture. The general feeling is a bubbling as these countries take up advanced computerization and advanced technology with what appears to be a relatively young age group.

During August, 1983, I was able to attend a conference in Nyborg, Denmark, on production planning in greenhouses. The number of commercial establishments visited was limited, and probably highly selected for that reason. It was one of the more interesting trips taken in recent years. This was combined with a one day tour in the vicinity of Oslo to visit Svinningen's rose operation, and to spend about half a day each at Bergerud and Son's and the Agricultural University at Ås. Arne Beisland, Grower Manager for Svinningen was the guide.

The symposium at Nyborg covered a wide range of greenhouse operations, although the majority of papers, especially during the last day, covered the utilization of linear programming in greenhouses in Denmark (CGGA Bul. 389). The Danes, with a group of young workers associated with GASA, the central cooperative marketing group, have implemented linear programming for a number of grower operations. Little has been published largely because the group is not associated with a government research organization. The Germans also presented papers on linear programming, and although the Dutch said little, it was my understanding that they are very active in the field. The extreme importance of pot plant export from Denmark into other European countries, especially Germany, makes a very good use for advanced linear programming techniques.

One of the interesting side-lights of the trip, while on the train from Copenhagen, was a chance to spend some time with an Electrical Engineer whose company builds electrostatic precipitators for cement and power plants, and uses linear programming techniques. He pulled from his briefcase a very thick manual on linear programming, published by a research group in Georgia. Although work on this software started in 1979 at CSU, progress has been limited by lack of industry interest and support.

Another interesting paper was presented by one of the Dutch workers on characterizing the managerial ability and technological status of greenhouse businesses. This is the first time I have heard of a full investigation of this type for greenhouses. They have assigned scoring values to such items as educational aspects, modernity of the firm, policy decision and execution, crop planning and execution, and other social aspects. For each of the above, they then assigned ratings to various enterprises. Under modernity of the enterprise, they evaluated modernity of the greenhouses, heating plant, climate control, irrigation, use of key figures in policy and cropping plan decisions and worker participation in policy decisions. Thus, they could rate the enterprise. Given the fact that management is probably one of our biggest problems in the industry, this effort by the Dutch promises to be highly interesting and may offer possibilities in the U.S.

The research establishment in Denmark was moved from the Royal Veterinary and Agricultural College, at Copenhagen, to the vicinity of Nyborg a few years ago. Two key individuals in the research and teaching establishment are Asger Klougart and Ole Christensen (Fig. 1). Klougart was instrumental in early CO_2 research in Europe, and Christensen spent more than a year at CSU in the early 1960's. The research operation was thoroughly modern, with considerable effort on energy utilization, clean stock programs, flower keeping, as well as other research work. It was impressive to see the research effort for such a small country, and the number of young people that have taken up careers in research and commercial operation. The growers are closely connected with research, and a massive effort is underway to outline and detail pot plant production for the major species. One such effort is shown in Fig. 2, where 6 rather large greenhouses are being utilized in an experiment with 80,000 Kalanchoes. There are a total of 16 treatments, which includes 5 cultivars. I do not know of any floricultural research establishment in the U.S. capable of this kind of program. Nor, is there sufficient support for such an effort were the facilities available.

[1]*Professor of Horticulture.*

Some statistics on the Danish greenhouse industry are given in Tables 1 through 4. The average size of an ornamental greenhouse operation is probably larger than our average, and the importance of potted plants may be noted (Table 1). Energy is the single greatest cost, accounting for 25% of all costs, with hired labor merely 18%. This does not include labor by the owner and family members. The average profit per establishment appears low (Table 1). Of

Fig. 1: Asger Kougart (left), Professor of Horticulture at the Royal Veterinary and Agricultural University, Copenhagen. He was instrumental in the early CO_2 research in Europe. Ole Christensen (right), principal floricultural investigator at the major floricultural research institution now located at Aarslev on the island of Funen, Denmark.

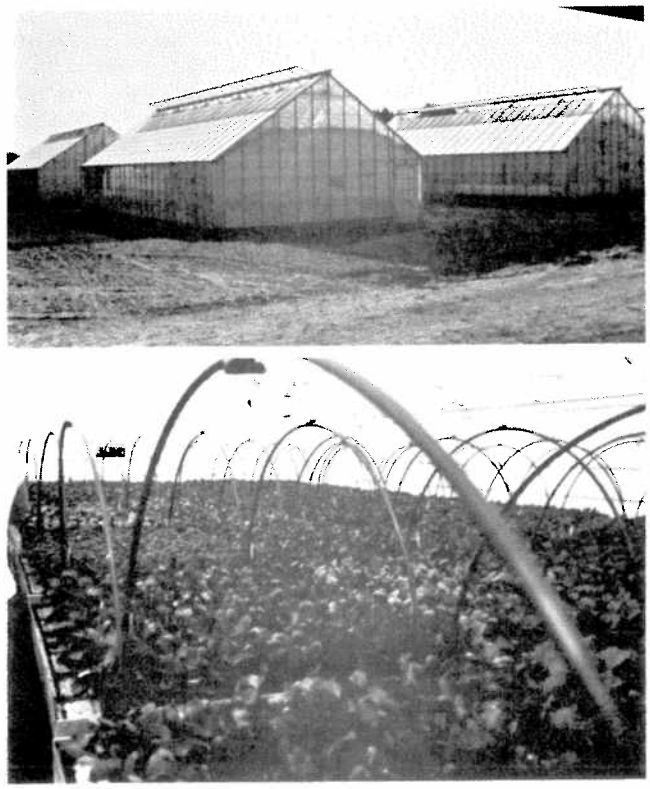

Fig. 2: Major research effort on Kalanchoes. There are six of the houses shown in the upper picture with 80,000 plants divided into 3 CO_2 level treatments, 2 irrigation frequencies, 2 ammonium-nitrate treatments, 2 nutrient concentrations, 2 pH levels and 5 cultivars. The experiment is funded and controlled by the growers. The objective is to provide a standard Kalanchoe growing program for commercial operators.

Table 1: Statistics on Denmark's horticultural industry, 1981.[1] (Figures are rounded to nearest $100.)

Average size for all farms (greenhouse and outdoor horticulture):		33,400 sq.ft.
Average size for all vegetable greenhouses:		15,100 sq.ft.
Average size for all ornamental greenhouses:		59,200 sq.ft
Average labor input for greenhouses:	Farmer or owner:	2,228 hrs
	Other unpaid family members:	821 hrs
	Hired labor:	3,644 hrs
Average commercial value of all greenhouse operations:	Real estate, horticulture:	$100,500
	Dwelling:	$ 37,000
	Operating capital:	$ 28,700
Average gross output for greenhouses:	Vegetables	$ 22,000
	Flowers for cutting, bouquet foliage	$ 6,700
	Bulbs and tubes	$ 1,300
	Potted green plants	$ 28,500
	Potted flowering plants	$ 45,300
Average costs per greenhouse:	Seeds, bulbs, cuttings, etc.	$ 15,500
	Pots and containers	$ 2,600
	Fertilizers	$ 1,400
	Growth media (potting soils)	$ 2,600
	Chemicals	$ 750
	Energy	$ 23,800
	Maintenance	$ 3,500
	Packing	$ 3,300
	Sales levy	$ 11,200
	Freight charges	$ 1,000
	Miscellaneous	$ 4,500
	Depreciation	$ 9,400
	Hired labor	$ 17,100
Total costs (Note; not all costs given in original figures are included in this total)		$ 97,000
Average current operating profit for greenhouses		$ 10,000

[1]$1.00 = 10 Danish Kroner. Data taken from Gartneriregnskabsstatistik, 1981, Jordbrugsokonomisk Institut, Serie D, nr 2.

Table 2: The Danish greenhouse industry. Number of farms according to size.[1]

	Under 11,000 sq.ft.	11,000 to 32,400 sq.ft.	33,000 to 54,000 sq.ft.	Over 54,000 sq.ft.
Vegetables in greenhouses	0	143	46	52
Potted plants in greenhouses	236	415	190	178

[1]Data from Gartneriregnskabsstatistik, 1981.

Table 3: Percent distribution of farms by size in a sample of 111.[1]

Under 11,000 sq.ft.	5%
11,000 to 32,400 sq.ft.	36%
33,000 to 54,000 sq.ft.	26%
Over 54,000 sq.ft.	33%

[1]Data from Gartneriregnskabsstatistik, 1981.

the over 1000 operators in Denmark (Table 2), the majority belong to the central cooperative, GASA, with the members contributing 1/2 of 1% to research and marketing — which may be a part of the Sales Levy Cost given in Table 1. The industry members appear relatively young with more than 2/3rds of the "holders" under the age of 54, and 1/3rd less than 44 years old (Table 4). Of course, we are unable to make direct comparisons with U.S. industry since such information for the U.S. is unavailable.

I was impressed with the up-to-date facilities we visited in the different commercial greenhouses. Nearly all appear to use single, glass glazing (Fig. 3), with extensive use of thermal screens and a second layer of cheesecloth utilized for shading as well as for energy conservation (Figures 3 and 4). Side walls and gable ends use double acrylic with heavier insulation in some instances. High intensity supplemental irradiation was noted, with all places being heated with hot water in welded pipe and extensive use of hot water tubing under the plants. A number of places were using power plant waste heat, and since the price was influenced by how low one could cool the return water, this undoubtedly influenced the use of small tubing in the benches. All the places we visited had movable benches with capillary mat overlaid with a perforated black plastic to reduce algal formation (Figures 3 and 5).

Table 4: Percent distribution of farms in a sample of 279 by age of the individual operating the farm.[1]

Under 35 years	10%
35 to 44 years	28%
45 to 54 years	28%
55 to 64 years	24%
65 years and over	10%

[1]Data from Gartneriregnskabsstatistik, 1981.

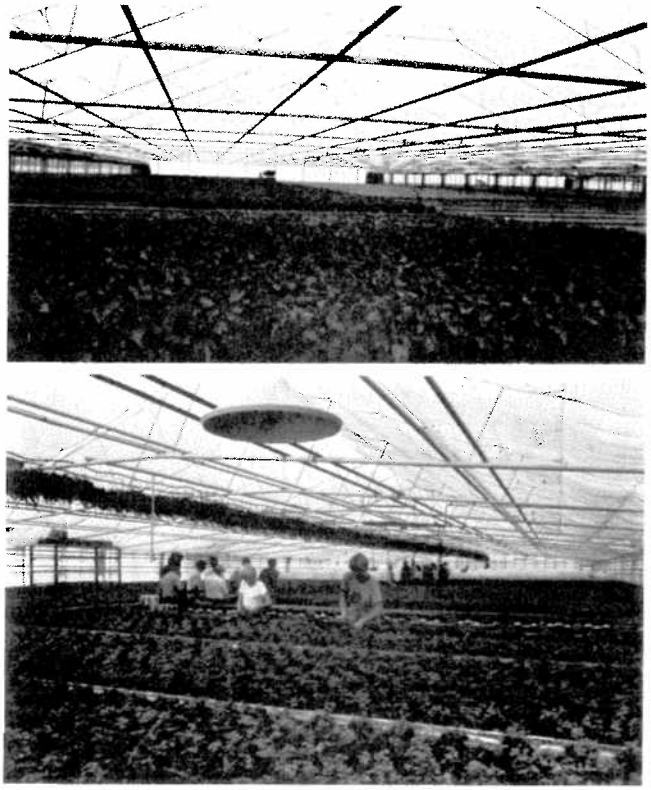

Fig. 3: Typical interior of a pot plant range visited in Denmark. All wide, clear-span houses with a single glass glazing, with two layers of automatic screening (cheesecloth will be noted drawn in both pictures, August), movable benches with capillary mat watering and hot water heating.

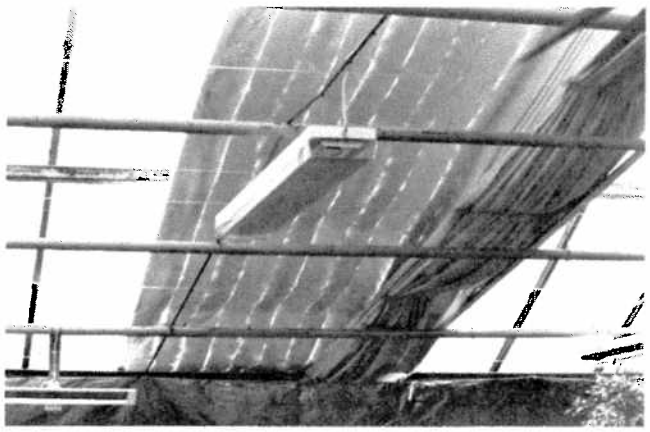

Fig. 4: Fairly typical arrangement of thermal screening in Danish and Norwegian greenhouses. Opaque thermal screen above a shading cloth, capable of being controlled independently.

Fig. 5: Fairly typical movable bench with capillary mat overlaid by a perforated black plastic to reduce algal formation. Benches may have thermal hot water heating with small tubing in the bench, and hot water lines under the bench. Note the main water distribution tube down the center.

All the growers we visited in Denmark and Norway measured solar radiation (Fig. 6) and utilized this for shading control. Most equipment appeared relatively new and in good condition. No mist propagation was noted, all propagation being carried out under white plastic, covering the benches (Fig. 7). Clean stock and tissue culture is employed for several species, with very well documented cultural programs, and a high degree of standardization — especially in handling plants in the market chain. Several growers have installed CO_2 analyzers for monitoring levels in the greenhouse, and liquid CO_2 injection appears to be very common. CO_2 in Europe is coming back as a major procedure after some trouble with sources in the early years. Although liquid CO_2 is much more expensive than from fossil fuels, control is much easier and there is less danger from combustion products such as ethylene. Considerable savings are available with automatic analysis and control, and the system is easily adaptable to environmental computer control. Not every grower employs movable benches. At Bergerud and Son's an overhead track system permitted trays to be moved horizontally and vertically as required (Fig. 8).

The marketing situation in Norway is completely different from Denmark, the latter a member of the European Common Market. Export by countries outside the EEC to EEC members is difficult, and the customs regulations in Norway prevent imports during their summer. The result is that a large operation as Svinningen can produce cut flowers (Fig. 9) at a profit. The importance of single roof layers was emphasized by the comment that cut rose production was lower under double acrylic as compared to old, single glass houses. However, this might have been due to the fact that all production under acrylic was on own-root rose plants, established in rockwool blocks. The type of data obtained for Norway was different from the information on greenhouses in Denmark. Tables 5 and 6 provide some in-

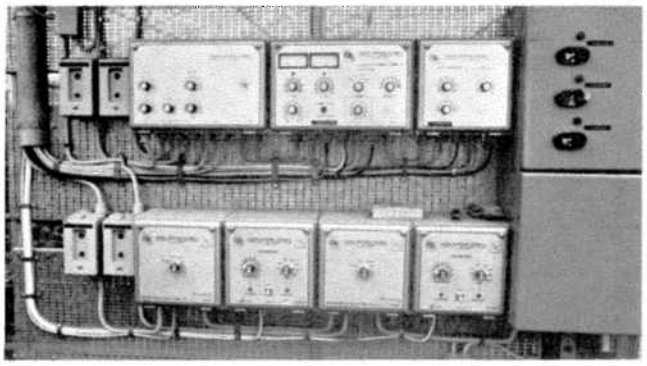

Fig. 6: Typical control panel in a Danish greenhouse. Light levels can be continuously monitored with automatic shading. Some houses have automatic CO_2 control, all visited had hot water heating.

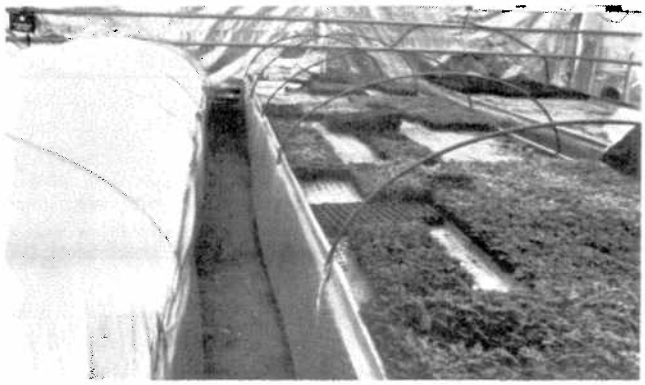

Fig. 7: Fern production at an early stage in Norway. To the left is a typical propagation bed with white plastic for a cover. No mist propagation beds were noted. Observe the reflective thermal blanket along wall in the background.

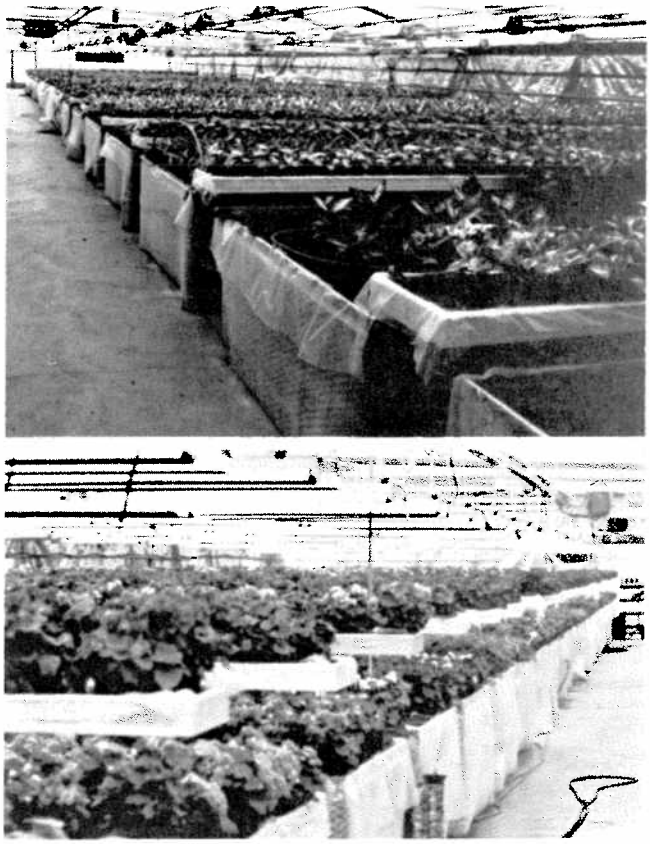

Fig. 8: One method of achieving high production area in a Norwegian greenhouse. The trays may be moved horizontally and vertically by a system hung from the greenhouse trusses. The benches are not movable in this structure. Note the fluorescent fixtures overhead for supplemental irradiation.

Fig. 9: Own-root roses under double acrylic and growing in rockwool in Norway. Rose production appears profitable for this particular company.

Table 5: Some statistics for Norwegian greenhouse production ($1.00 US = 7.5 Norwegian Kroner).*

	Year					
	1978	1979	1980	1981	1982	1983
Flowers and plants value	$53.9 million	59.7	68.7	76.7	84.3	
Total pot plants produced	19 million	20	21	23	24	
Total cut flowers	4.9 million sq.ft.	4.7	4.7	4.8	5.1	
Total pot plant import	5.2 million	6.2	7.2	7.5	8.5	
Total cut flower import	5.0 million	4.7	5.5	4.5	4.3	
Rose production (sq.ft.)						1.2 million
Carnation production (spray and standard, sq.ft.)						0.7 million
Chrysanthemum (sq.ft.)						1.3 million
Other (sq.ft.)						1.6 million

*Information supplied by Arne Beisland from Norwegian statistics.

Table 6: Foliage and flowering plants, home grown and imported for 1982 and 1983 for Norway.*

Foliage plants grown in Norway (1983)	5.4 million
Foliage plants finished in Norway (1983)	7.9 million
Foliage plants imported into Norway (1982)	5.4 million
Flowering plants imported into Norway (1982)	2.2 million
Young plants imported for cut flower production (1983)	4.3 million

*Information supplied by Arne Beisland from Norwegian statistics.

formation on total production and imports into Norway. The fact that this data was more readily available during my visit, may have been due to Svinningen's very marked influence on production and imports in Norway.

Apparently utilization of electricity for greenhouse heating in Norway is fairly prevalent. This may be due to their availability of hydroelectric generation. However, I understood their electricity to cost about 3¢ per kilowatt, which is comparable to domestic rates in the U.S. Bergerud and Son converted electrical energy to hot water, giving me a figure of about 80¢ per sq.ft. per year. This did not include the energy obtained from high intensity lamps which would probably double that amount. The electrical installation I saw appeared fairly new with the older back-up, oil-fired boilers still in place.

The research establishment at Ås was smaller, and the facilities older compared to Denmark's. Their equipment seemed to be in good order, and one of the experiments that was impressive was the effect of humidity on pot plant size (Fig. 10). The differences in size as the result of different humidity levels made me wonder about the problems in pot plant production we have in Colorado. Perhaps we should look into water stress relationships, for my feeling is that Colorado producers may not be utilizing Colorado climate (high light) to the fullest extent possible.

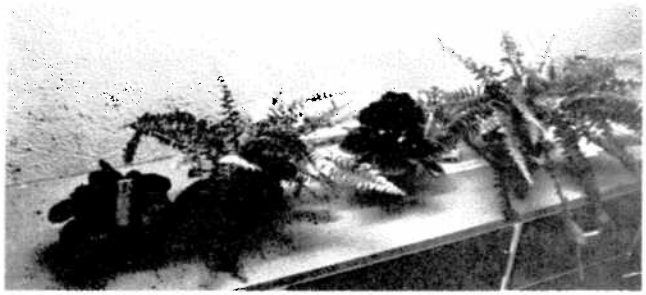

Fig. 10: Fern and African Violet grown in two humidity levels at the Agricultural Research Station in Norway. Differences in size are readily apparent, with the smaller grown at a lower humidity level.

Summary

What I saw, although limited, was good. Of course the impact of greenhouse production in Denmark is much greater than in the U.S. even though the relative size of the industry might be comparable. Probably three Denmark's could be fitted into Colorado with room left over. Of particular interest was the close grower organization, the high research effort, and the contributions by the industry to marketing and research efforts. The problem in the U.S. is the diffuse, widely spaced locations under a variety of climatic conditions. Another problem may be — even if the industry manages to pass Floraboard — is the fact that any funds available will be diffused by the large number of research establishments. The infighting for funding will be rather interesting in these days of reduced federal and state appropriations, with a built-in bureaucracy to be maintained at all costs.

The Europeans, in the past years since I visited that area in 1969, have made considerable strides in greenhouse technology, whereas we in the U.S., are failing to pull together. We need a special effort to encourage young people with the idea that greenhouses are where the action takes place.