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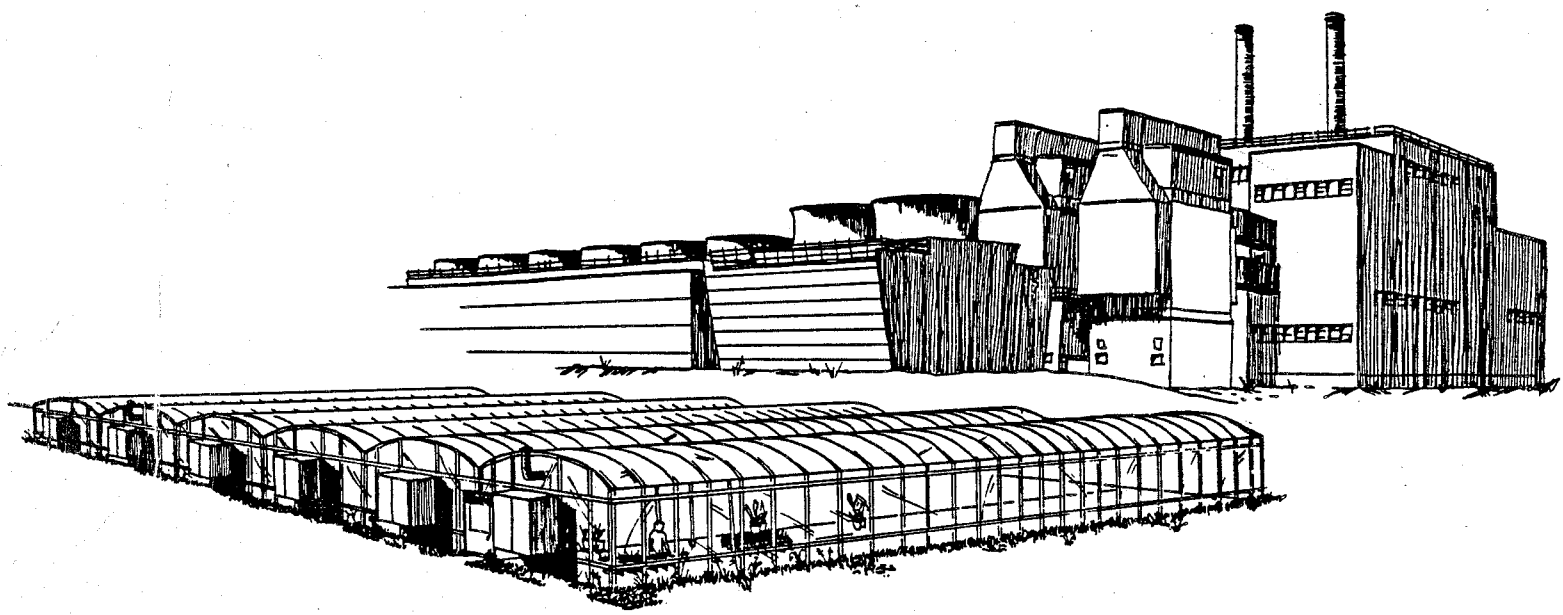
ECONOMIC FEASIBILITY OF UTILIZING WASTE-WATER HEAT FROM COAL-FIRED ELECTRICAL GENERATING PLANTS IN COMMERCIAL GREENHOUSES IN NORTH DAKOTA



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FOREWORD

This study provides information on the economic feasibility of establishing commercial greenhouses utilizing waste-water heat in North Dakota. The authors are indebted to the numerous private and governmental agencies who have provided support and data for this study. This research has been conducted under contract with Basin Electric Power Cooperative, Bismarck, North Dakota. The financial support provided by the United States Department of Commerce, the North Dakota Agricultural Experiment Station and the North Dakota Economic Development Commission has made this in-depth study possible.

Considerable data and informational support were provided by greenhouse operators, food wholesalers and other industry and governmental support units to whom the authors express their appreciation. The authors are indebted to Gary C. Ashley, Ashley Engineering, Inc., who provided information on the model greenhouse design and construction cost estimates. The authors gratefully acknowledge the assistance provided by Earl W. Scholz, Associate Professor, Department of Horticulture and Forestry; and Gary V. Cole and Dale F. Zetocha, former Research Assistants, Department of Agricultural Economics, North Dakota State University. The authors express their appreciation for the assistance and dedication of Cindy Danielson in typing the final report.

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Highlights

A large percentage of the fresh vegetables and floral products consumed in North Dakota are imported into the state. Dramatic increases in energy and transportation costs in recent years have resulted in large price increases for fresh vegetables and floral products at the retail level. These changes have created a need to assess alternative strategies in the production of horticultural commodities for local consumption. This study estimates the economic feasibility of constructing a two-acre greenhouse which utilizes waste-water heat from a coal-fired electrical generating plant in North Dakota.

Numerous commodities were defined as suitable for greenhouse production in North Dakota, including tomatoes, leaf lettuce and cucumbers; cut roses, carnations and chrysanthemums; potted chrysanthemums, geraniums, hydrangeas, lilies and poinsettias; and bedding plants.

Sixty-seven greenhouses were operating in North Dakota in 1980. Of the 36 operators surveyed, 34 grew bedding plants, 13 grew potted plants, three grew vegetables and two grew cut flowers. Cut flower producers operated greenhouses throughout the year and had the largest greenhouse production areas, while bedding plant producers operated their greenhouses less than six months.

Consumption, yield, cost of production, crop production and price estimates were incorporated into a linear programming model to determine maximum profits for a simulated two-acre greenhouse under various production and marketing scenarios. An operator would need to capture between 20 and 25 percent of the North Dakota market if the greenhouse were to operate profitably if it were constructed on a turnkey basis. Return on investment would increase four to five percentage points if the greenhouse were constructed with local labor and another four to seven percentage points if a grower could attain a revenue 10 percent above those used in the analysis. The most potential may exist for greenhouse firms currently operating in North Dakota to expand or relocate by building facilities near a coal-fired electrical generating plant since these firms already have an established share of the market and are aware of the potential for increasing sales of specific crops.

ECONOMIC FEASIBILITY OF UTILIZING WASTE-WATER HEAT FROM COAL-FIRED ELECTRICAL GENERATING PLANTS IN COMMERCIAL GREENHOUSES IN NORTH DAKOTA

by

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North Dakota and the surrounding region import nearly all fresh vegetables consumed, especially in the winter months. The vast majority of cut flowers also are imported into the state. Currently, most vegetables are imported into the region from Florida, Texas, California and Mexico. As such, they are picked before maturity and shipped into the region, restricting residents to nonvine-ripened produce. Nonvine-ripened vegetables are identified as being less palatable and less appealing to consumers. Cut flowers are imported into the region from as far as California, South America and the Middle East. Some potted plants also are imported into the state.

Dramatic increases in energy costs and transportation rates in recent years have resulted in large price increases for fresh vegetables, cut flowers and potted plants at the retail level. Greenhouse operators in North Dakota using conventional heat sources (e.g., natural gas, fuel oil or electricity) are finding it increasingly difficult to operate profitably. These changes have created a need to assess alternative strategies in the production of horticultural commodities for local consumption. North Dakota appears to be in an excellent position to supply at least a portion of the fresh vegetables, cut flowers and potted plants consumed in the region through the utilization of waste-water heat supplied by coal-fired electrical generating plants located throughout the state.

Study Objectives

This study was designed to determine the feasibility of establishing commercial greenhouses which utilize a coal-fired electrical generating plant's condensor cooling water and to determine their impact on employment and income levels in the state. Specific objectives were to:

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1. Identify present production and consumption markets for commodities grown under greenhouse conditions and project market requirements of relevant commodities to 1990.

2. Identify capital investment and operating costs for a North Dakota plant location.

3. Analyze the competitive position of a North Dakota based greenhouse.

4. Project direct and indirect benefits of greenhouse facilities on employment and income levels of the state and local economy.

Scope of Study

The majority of fresh vegetables and cut flowers consumed in North Dakota are imported from as far away as California, Florida, Texas, Mexico, South America and the Middle East, with a small percentage being produced locally. Rising fuel costs have had an adverse impact on greenhouse operations in northern climates. The potential exists to lower these costs by using waste-water heat which, in turn, may restore the competitive position that existed prior to the high energy cost era. A major question to be answered is whether the use of waste heat will lower production costs to the extent that local greenhouses could be price competitive. Cost and return relationships of greenhouse facilities utilizing low grade waste heat in North Dakota will be estimated.

This report will provide information to business firms and individuals interested in the development of greenhouse facilities. Study results are intended to guide the evaluation of the economic feasibility of utilizing low grade waste heat in North Dakota greenhouse operations.

Existing greenhouse locations in North Dakota and production areas in the United States are described. Floricultural and horticultural consumption for North Dakota is analyzed to estimate future demand. Cost and returns for a two-acre greenhouse facility will be estimated using data provided by Ashley Engineering, Inc. (Ashley, 1981). The competitive position of a North Dakota based greenhouse will be determined using current greenhouse production costs and average prices. The anticipated expenditures of a simulated two-acre greenhouse facility will be analyzed to determine the potential impact on employment and income levels on the regional economy of North Dakota using input-output techniques.

Procedures and Methodology

Numerous sources of data and data analysis techniques were utilized in this study. Data on production areas, foreign competition and the greenhouse industry in the United States were obtained from USDA publications and private sources. A personal survey of greenhouse operators in North Dakota was conducted to obtain information on firm size, products grown, marketing channels and prices received.

Food wholesalers in North Dakota were surveyed to obtain information on marketing channels, volume and prices of fresh vegetables. Wholesalers were asked their attitudes toward purchasing locally grown vine-ripened produce.

Consumption of horticultural products in North Dakota was computed using USDA production, import and export data and North Dakota population estimates. Projections of per capita consumption for the United States and North Dakota to 1990 were computed using linear, log, quadratic and reciprocal estimating functions utilizing historic consumption data.

Seasonality of prices was computed using the Statistical Analysis System X-11 program. Seasonality of prices was analyzed for fresh tomatoes, leaf lettuce, cucumbers, cut chrysanthemums, cut carnations and cut roses. Analysis of potted and bedding plants was not conducted since these plants are produced and marketed seasonally. Prices used for the analysis were obtained from USDA sources.

Estimates of cost and return were computed using numerous data sources. Variable production costs were determined using data from growers and USDA and other published sources while fixed production costs were supplied by Ashley Engineering, Inc. of Minneapolis, Minnesota (Ashley, 1981). Yield estimates were obtained from growers and USDA publications, while price data were obtained from USDA sources. These data were incorporated into a linear programming model to determine optimum profits under four different production scenarios.

Input-output analysis was used to determine the economic impact of construction and operation of a two-acre greenhouse facility. Construction and operating costs accruing within the state were utilized to determine potential impacts.

Crops Selected as Suitable for Greenhouse Production in North Dakota

Several commodities were defined as relevant to greenhouse production after consultation with numerous greenhouse operators, nursery employees,

florists and USDA Forest Service personnel. Major crops identified as having the highest potential for greenhouse production in North Dakota were:

1. Fresh vegetables
   a. Tomatoes
   b. Leaf lettuce
   c. Cucumbers

2. Cut flowers
   a. Roses
   b. Carnations
   c. Chrysanthemums

3. Potted plants
   a. Chrysanthemums
   b. Geraniums
   c. Hydrangeas
   d. Lilies
   e. Poinsettias

4. Bedding plants
   a. Petunias
   b. Pansies
   c. Marigolds
   d. Geraniums
   e. Begonias
   f. Coleus
   g. Tomatoes
   h. Peppers.

Production, production cycles, cost of production, marketing channels, consumption and prices for these crops will be discussed throughout the study.

Description of the Horticultural Industry in the United States

The commercial greenhouse industry in the United States became established during the nineteenth century. It has been a dynamic industry in that changes in technology have caused significant changes in location of production. Commercial greenhouse operators in northern areas generally are growing products that are difficult and expensive to transport due to recent increases in heating costs. Advances in transportation and packaging technology have increased competition from producers in foreign countries.

Consumers are placing increased importance on the aesthetic value of floral and plant products. The traditional full service florist has faced an inelastic demand for product for funerals, weddings and other special occasions. A mass market is developing based on impulse purchasing patterns of consumers and is expected to increase significantly in future years.

Vegetable Production[1]

United States production of tomatoes has increased 35 percent from 18,179,000 cwts. in 1970 to 24,575,000 cwts. in 1980 (Table 1). The heaviest production period was in the summer, accounting for 33 percent of production in 1980, followed by spring (27 percent), fall (25 percent) and winter (15 percent).

Production of commercially grown fresh lettuce has increased 33 percent from 46,484,000 cwt. in 1970 to 61,750,000 cwt. in 1980 (Table 1). Production has been relatively constant throughout the marketing year (approximately 25 percent per season). Approximately 77 percent of lettuce production in 1974 was head lettuce, 5 percent was romaine and 18 percent "other" (U.S. Dept. of Commerce, 1974). The "other" category consisted mainly of leaf lettuce.

Production of commercially grown cucumbers increased 35 percent from 4,440,000 cwt. in 1970 to 6,011,000 cwt. in 1980 (Table 1). Production of cucumbers generally has been highest in the spring, accounting for 40 percent of production in 1980. Summer production accounted for 33 percent and fall production 27 percent of the total.

The greenhouse vegetable industry in the United States is relatively small when compared to floriculture. Both climate and distance to market provide economic constraints on location of vegetable production. Greenhouses in northern areas near population centers require little transportation for vegetables produced in greenhouses but require large amounts of heat to offset the cold climate. Distant areas have little need for greenhouse structures and environmental controls but have major marketing requirements including transport time and cost. Technological advances in vegetable handling, transportation equipment and improved highway systems along with significantly

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[1]Production estimates cover 80 percent or more of the national commercial production of all fresh market vegetables (USDA, ESCS, 1980b). See Appendix Tables A-1 through A-3 for detailed production data on fresh tomatoes, lettuce and cucumbers.

TABLE 1. PRODUCTION OF COMMERCIALLY GROWN FRESH TOMATOES, LETTUCE AND CUCUMBERS, BY SEASON, UNITED STATES, 1970-1980[a]

Commodity and Season	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 cwt.										
Tomatoes	18,179	17,784	19,892	19,516	19,919	20,928	21,683	19,719	22,062	23,046	24,575
Winter	1,368	1,696	2,349	1,769	2,380	3,131	2,817	1,059	2,240	2,583	3,725
Spring	4,253	3,813	4,744	4,517	4,494	4,348	5,668	5,622	5,989	6,670	6,631
Summer	8,591	8,423	8,544	8,531	8,666	8,537	8,407	8,126	8,534	8,044	8,190
Fall	3,967	3,852	4,255	4,699	4,379	4,912	4,791	4,912	5,299	5,749	6,029
Lettuce	46,484	47,317	48,672	50,478	51,338	53,554	53,869	56,169	60,159	61,191	61,750
Winter	11,497	11,010	11,832	12,180	13,611	12,864	13,588	13,590	14,342	14,231	15,117
Spring	12,040	12,616	12,406	12,517	12,424	14,443	14,354	14,286	15,700	17,291	17,189
Summer	11,840	12,927	12,223	12,712	13,415	13,547	13,082	14,546	16,425	15,086	15,730
Fall	11,107	10,764	12,211	13,069	11,888	12,700	12,845	13,747	13,692	14,583	13,714
Cucumbers	4,440	4,291	4,664	4,166	4,602	4,782	5,030	5,573	5,843	5,819	6,011
Spring	1,721	1,436	1,800	1,562	1,629	1,776	2,239	2,254	2,258	2,413	2,403
Summer	1,757	1,683	1,536	1,577	1,595	1,679	1,641	1,800	1,773	1,863	1,977
Fall	962	1,172	1,328	1,027	1,378	1,327	1,150	1,519	1,812	1,543	1,631

[a]Hawaii production not included.

SOURCES: USDA, ESCS, 1980b; USDA, ESS, 1980; USDA, ESS, 1981; USDA, ERS, 1977.

higher heating costs have reduced advantages of locations near centers of population (Cravens, 1977).

There were 37.2 million square feet of greenhouse capacity for growing vegetables, excluding mushrooms, in 1974, compared to 45 million square feet in 1969 (U.S. Dept. of Commerce, 1974). Tomatoes were the most important crop with 23.6 million square feet. Lettuce was grown on 7.3 million square feet, cucumbers on 3.2 million square feet and other vegetables on 3.1 million square feet. Both tomatoes and lettuce declined in importance from 1969 to 1974; however, cucumber space doubled due to the popularity of a recently introduced European seedless variety.

Ohio was the leading producer of greenhouse tomatoes and lettuce in 1974 with California the leading producer of greenhouse cucumbers and other vegetables. The marketing of greenhouse vegetables may be as simple as direct sales to consumers or very complex involving several wholesaling functions.

Foreign Competition

Imports of fresh tomatoes increased from a low of 5,671,460 cwt. in 1975 to a high of 8,177,781 cwt. in 1978 and declined to 6,517,370 cwt. in 1980 (Table 2). Exports of fresh tomatoes have nearly tripled from 891,700 cwt. in 1970 to 2,630,379 cwt. in 1980.

The United States has been a net exporter of lettuce since 1970. Over 3 million cwt. of lettuce were exported in 1980 versus approximately 150,000 cwt. imported.

Imports of cucumbers more than doubled from 1,433,050 cwt. in 1970 to 3,162,240 cwt. in 1980. Exports of cucumbers have increased by 128 percent over the same time period from 131,790 cwt. in 1970 to 300,600 cwt. in 1980.

Floriculture Production[2]

Cut Flowers

Twenty-seven states accounted for more than 90 percent of U.S. production of cut flowers in 1980. They include: Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa,

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[2]Production estimates include only the major producing states (USDA, ESS, 1977-1981). See Appendix Tables B-1 through B-13 for detailed production data on cut flowers and potted plants.

TABLE 2. IMPORTS AND EXPORTS OF FRESH TOMATOES, LETTUCE AND CUCUMBERS, UNITED STATES, FISCAL YEARS 1970-1980

Year	Tomatoes			Lettuce			Cucumbers		
	Imports	Exports	Net Imports	Imports	Exports	Net Imports	Imports	Exports	Net Imports
	cwt.								
1970	6,467,240	891,700	5,575,540	23,370	2,505,180	-2,481,810	1,433,050	131,790	1,301,260
1971	5,753,520	1,075,920	4,677,600	45,140	2,928,490	-2,883,350	1,573,650	119,580	1,454,070
1972	5,868,440	1,367,510	4,500,930	12,480	3,382,830	-3,370,350	1,695,180	169,150	1,526,030
1973	7,531,000	1,506,600	6,024,400	15,090	3,454,960	-3,439,870	1,775,530	165,160	1,610,370
1974	5,958,350	1,612,190	4,346,160	33,050	3,005,750	-2,972,700	1,822,300	175,260	1,647,040
1975	5,671,460	2,055,730	3,615,730	22,350	3,291,760	-3,269,410	1,310,960	222,160	1,088,800
1976	6,533,470	2,123,740	4,409,730	30,360	3,608,010	-3,577,650	2,139,020	297,610	1,841,410
1977	7,918,710	1,691,180	6,227,530	38,190	3,595,130	-3,556,940	2,509,570	254,570	2,255,000
1978	8,177,781	2,096,088	6,081,693	56,791	3,673,628	-3,616,837	3,049,786	368,547	3,681,239
1979	7,133,319	2,480,905	4,652,414	129,786	3,302,080	-3,172,294	3,199,634	343,105	3,856,529
1980	6,517,370	2,630,379	3,886,991	151,568	3,021,060	-2,869,492	3,162,240	300,600	2,861,640

SOURCES: USDA, ERS, 1971-78; USDA, ESS, 1979-1981.

Kansas, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Virginia, Washington and Wisconsin (USDA, ESS, 1977-1981).

United States production of standard carnations has declined in recent years from a high of 619 million blooms in 1970 to a low of 379 million blooms in 1980 (Table 3). Production of miniature carnations in the United States has more than doubled in the past 10 years from 2.5 million bunches in 1970 to 5.9 million bunches in 1980.

United States production of pompon chrysanthemums has remained relatively stable since 1970 with 1980 production levels at 35 million bunches (Table 3). Production of standard chrysanthemums in the United States has decreased dramatically since 1970 with production at 147 million blooms in 1970 and 94 million blooms in 1980.

Production of roses has remained relatively stable since 1970. Hybrid tea rose production has increased only 2 percent from 309 million blooms in 1970 to 315 million blooms in 1980 (Table 3). Production of miniature

TABLE 3. PRODUCTION OF CUT CARNATIONS, CHRYSANTHEMUMS AND ROSES IN THE UNITED STATES, 1970-1980

	Carnations		Chrysanthemums		Roses	
Year	Standard	Miniature	Standard	Pompon	Hybrid Tea	Miniature Sweetheart
	000 blooms	000 bunches	000 blooms	000 bunches	000 blooms	000 blooms
1970	619,052	2,539	147,000	32,431	308,713	130,152
1971	589,157	2,293	144,765	34,464	308,441	120,374
1972	584,395	3,302	137,144	33,649	309,596	122,007
1973	616,051	3,001	137,658	36,129	297,355	120,413
1974	601,768	3,874	144,042	37,864	319,161	123,653
1975	578,867	4,136	139,340	36,70	317,828	115,469
1976	517,880	4,736	140,397	35,603	307,584	114,689
1977	501,799	4,703	111,738	35,936	301,107	118,028
1978	466,363	4,844	124,424	37,892	306,806	112,449
1979	408,840	5,838	107,578	34,992	327,824	119,463
1980	379,375	5,859	94,205	34,791	314,693	113,085

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

sweetheart roses declined by 13 percent over the same time period from 130 million blooms in 1970 to 113 million blooms in 1980.

Potted Plants

Production of potted chrysanthemums has increased by 76 percent from 16.1 million pots in 1970 to 28.4 million pots in 1980 (Table 4). Production of potted geraniums, hydrangeas and lilies have remained relatively stable since 1976, while potted poinsettia production increased 48 percent between 1976 and 1980.

TABLE 4. PRODUCTION OF POTTED CHRYSANTHEMUMS, GERANIUMS, HYDRANGEAS, LILIES AND POINSETTIAS, UNITED STATES, 1971-1980

Year	Chrysanthemums	Geraniums	Hydrangeas	Lilies	Poinsettias
	----------	----------	000 pots	----------	----------
1970	16,117	a	a	a	a
1971	17,504	a	a	a	a
1972	19,141	a	a	a	a
1973	20,595	a	a	a	a
1974	21,655	a	a	a	a
1975	21,274	a	a	a	a
1976	26,481	47,992	2,689	6,807	15,672
1977	28,336	45,936	2,528	7,589	19,969
1978	27,544	47,397	3,052	7,340	22,222
1979	27,941	47,050	2,824	7,030	22,230
1980	28,439	50,240	2,680	6,907	23,183

[a]Not available.

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

Bedding Plants

Production of flowering and foliar bedding plants in the United States has increased in recent years, while production of vegetable bedding plants has declined. Flowering and foliar bedding plant production has increased by 38 percent from 19 million flats in 1976 to 26 million flats in 1980 (Table 5). Production of vegetable bedding plants has declined by 10 percent from 11.8 million flats in 1976 to 10.7 million flats in 1980.

TABLE 5. PRODUCTION OF BEDDING PLANTS, UNITED STATES, 1976-1980

Year	Flowering and Foliar	Vegetable
	----------000 flats----------	
1976	18,971	11,843
1977	23,567	11,086
1978	25,397	8,681
1979	24,704	10,072
1980	26,187	10,673

SOURCE: USDA, ESS, 1977-1981.

Foreign Competition

U.S. floral imports are primarily in the cut flower category and have increased significantly since the late 1960's. Latin America, especially Colombia, has been a major source of carnations, chrysanthemums and roses. Israel and the Netherlands also are important sources of roses. Approximately 36 percent of the U.S. supply of carnations, 42 percent of pompon chrysanthemums and 2 percent of roses were imported in 1977 (Sullivan et al., 1980). In addition to favorable weather conditions, labor costs are significantly lower in the exporting countries than in the United States.

Imports of cut flowers have increased dramatically in the past decade. Imports of carnations have increased from 33 million blooms in 1971 to 383 million in 1980 (Table 6). Imports of standard chrysanthemums have nearly doubled from 11.4 million blooms in 1971 to 22.4 million blooms in 1980, while imports of pompon chrysanthemums have increased from 2 million bunches to 38 million bunches over the same time period. Only 1 million blooms of roses were imported in 1971, compared to over 44 million blooms in 1980. (Very few, if any, potted plants and bedding plants are imported to or exported from the United States.)

Marketing Patterns of Horticultural Crops

A rapid expansion of area devoted to floral crop production occurred in the United States during the 1950's. During that time, the Midwest and East were dominant production regions. However, during the late 1960's and early 1970's production shifted west, particularly to California and Colorado (Sullivan et al., 1980).

TABLE 6. IMPORTS OF CUT CARNATIONS, CHRYSANTHEMUMS AND ROSES, UNITED STATES, 1971-1980

Year	Carnations	Standard Chrysanthemums	Pompon Chrysanthemums	Roses
	000 blooms	000 blooms	000 bunches	000 blooms
1971	33,244	11,398	2,054	1,038
1972	56,153	15,866	4,207	1,676
1973	129,490	23,231	7,245	3,396
1974	179,969	25,892	10,725	3,551
1975	162,268	17,384	12,632	4,192
1976	204,188	12,560	19,127	6,245
1977	284,583	18,996	23,439	10,346
1978	346,134	18,416	29,628	16,447
1979	376,511	20,448	36,438	34,965
1980	383,245	22,419	38,344	44,494

SOURCE: Federal-State, Calif., 1971-1981.

Marketing Channels

Fresh (Cut) Flowers

Cut flowers account for almost 50 percent of the wholesale value of the total floricultural crop in the United States. The five major cut flower crops--roses, standard chrysanthemums, pompon chrysanthemums, carnations and gladioli--make up approximately 80 percent of the wholesale value of all cut flower crops produced in the United States (Sullivan et al., 1980).

In 1980, California produced 62 percent of the pompon chrysanthemums, 62 percent of the standard chrysanthemums, 67 percent of the carnations and 42 percent of the tea roses produced in the United States (USDA, ESS, 1977-1981). The increasing importance of California is due to several factors. It has a relatively mild climate, and relatively large population (market). Favorable air freight rates existed to the east at the time production shifted (Nelson, 1977).

Generally, cut flower producers in California and Florida have an economic advantage in most U.S. markets over other domestic and foreign producers. Most cut flower producers in the Eastern and Midwestern United States are at a competitive disadvantage because of relatively high production costs and greater seasonal fluctuations in cut flower quality and quantity (Sullivan et al., 1980).

Historically, cut flowers have been sold by full-service retail florists. They purchase flowers from wholesalers, who in turn purchase them from growers. In some cases, a firm is vertically integrated and performs growing, wholesaling and retailing functions. Most of the retailer's business is in the sale of cut flowers for special occasions and holidays. In addition to cut flowers, a major service that retailers provide is professional consultation and preparation, arrangement and possible delivery of the cut flower purchase.

A relatively recent development in retailing cut flowers is the mass market comprised of supermarkets, large discount stores, etc. Customer purchases at these establishments generally are spontaneous so prices must be lower than at full-service florists. Relatively large quantities of flowers are displayed in similar arrangements and located in high traffic areas of the store. The market channel for cut flowers is shown in Figure 1.

Potted Plants

Foliage plants, also called green plants, have increased in importance during the past decade. The wholesale value was $27 million in 1970 compared to $295 million in 1980. Numerous plant species make up this group, with over 1,000 different foliage plant types currently being sold (Larson, 1980).

Many of these plants are of tropical origin and can be best produced in subtropical areas. Florida was the leading state in production of foliage plants in 1980 with 70 percent of production. Following in order of importance were California with 12 percent, Texas with 7 percent, Hawaii with 2 percent and Ohio with 1 percent of production in 1980.

Foliage plants are produced in areas where heat is required in greenhouses, especially in highly populated areas. Hanging basket plants, which are expensive to transport, have become an important crop in northern areas (Nelson, 1977). Hanging baskets are a complementary crop because fixed costs can be shared with other crops simultaneously produced on benches.

Since consumer demand is increasing, foliage plants are sold in several types of retail stores (Figure 2). The mass market is emerging as a dominant retail source of foliage plants. As large chain stores command more of the market in the future, relatively large, dependable growers will be required to service the mass market.

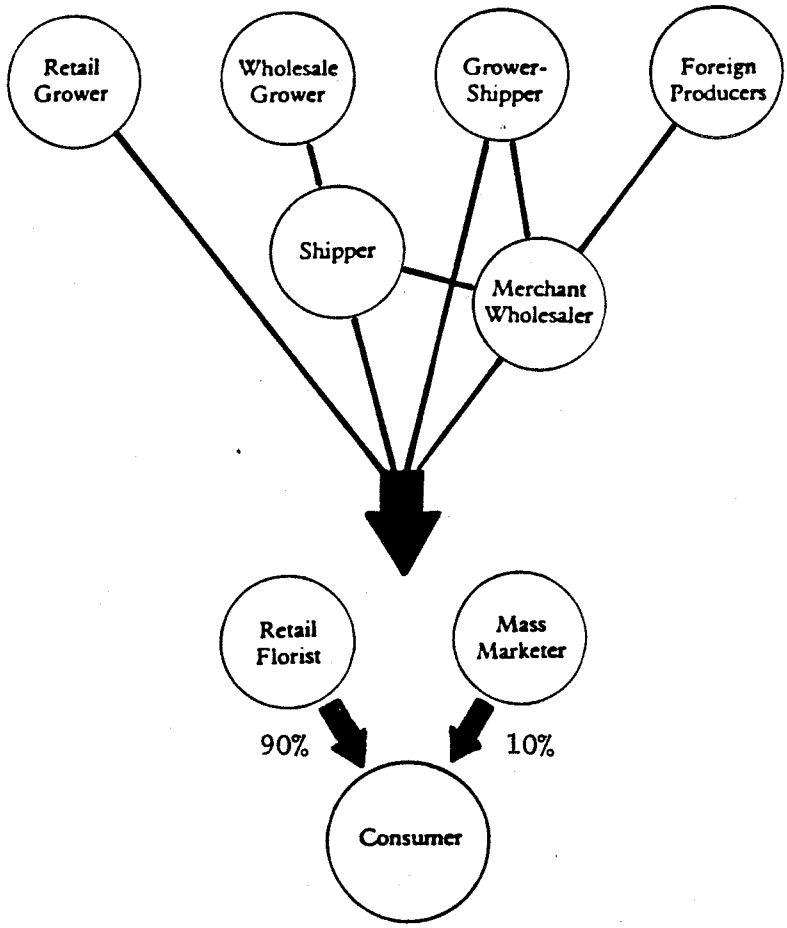

Figure 1. Market Channel for Cut Flowers

SOURCE: Sullivan et al., 1980.

Potted flowering plants are second only to cut flowers in importance as an ornamental crop. Several kinds of flowering plants are grown only for special holidays, such as poinsettias for Christmas. Others, such as chrysanthemums (mums), are generally grown for sale the year around.

Potted chrysanthemums were first in terms of importance, with a wholesale value of $68 million in 1980. Following in order of importance were poinsettias at $66 million, geraniums at $42 million, lilies at $19 million and hydrangeas at $7 million wholesale value in 1980.

The production of flowering plants requires a high level of management expertise because of the very seasonal demand that exists, especially for

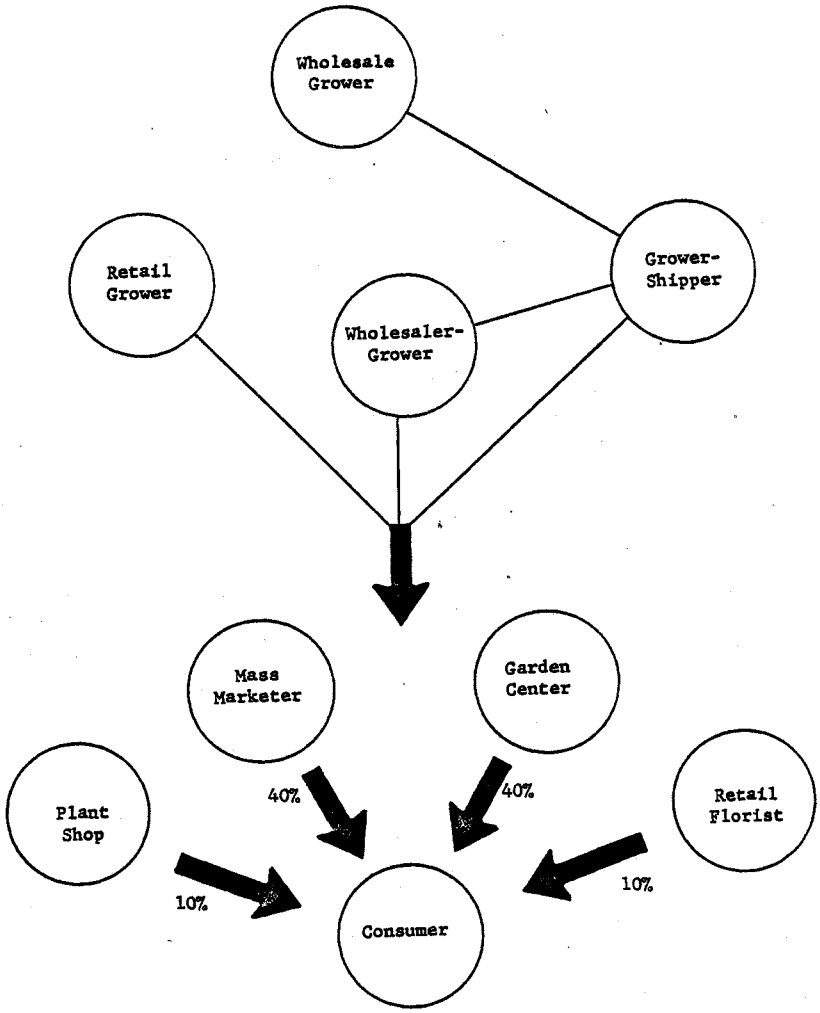

Figure 2. Market Channel for Foliage Plants

SOURCE: Sullivan et al., 1980.

lilies and poinsettias. Flowering plants are generally grown closer to areas of consumption than cut flowers because of the difficulty in packaging and relatively heavy weight. The leading state in production of flowering plants in 1980 was California, followed by Ohio, Texas and Michigan. The wholesale value of the five most important flowering plants for California was double that for second place Ohio in 1980.

Growers of flowering plants generally sell directly to retailers (Figure 3). Flowering plants are generally available in-season and on a year-around basis at retail florist stores. Mass retailers are important outlets during holiday periods.

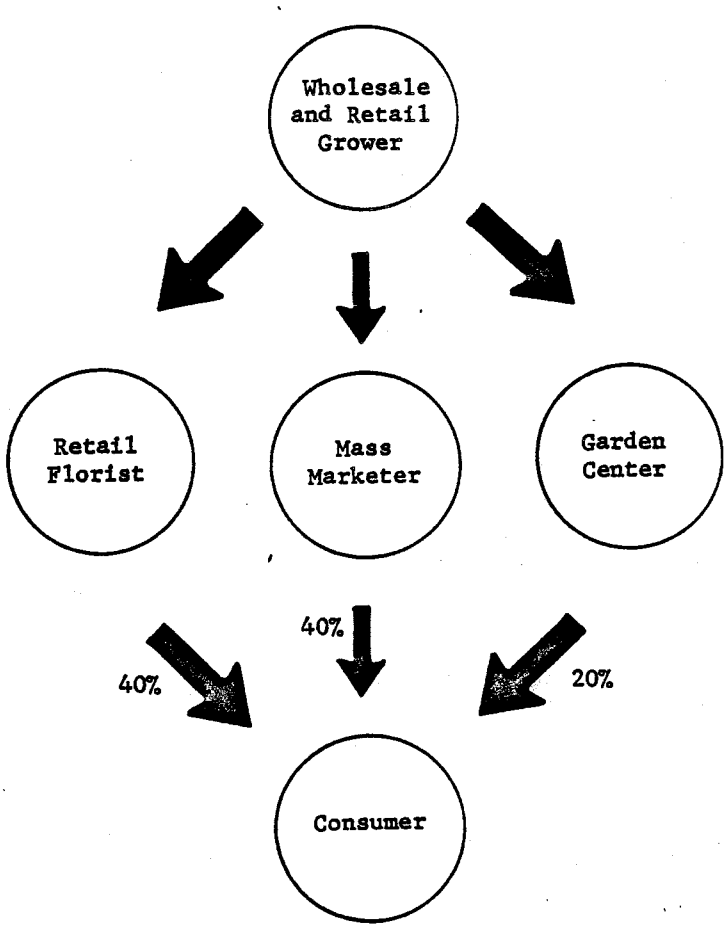

Figure 3. Market Channel for Potted Flowering Plants

SOURCE: Sullivan et al., 1980.

Bedding Plants

Bedding plants are produced for spring sales to consumers for flower beds and vegetable gardens. Fifty plant species or more are grown, ranging from vegetables such as tomato, pepper and cabbage, to flowers such as petunia, marigold and impatiens (Nelson, 1977). The wholesale value of flowering and foliar types of bedding plants was $125 million and the wholesale value of vegetable bedding plants was $47.5 million in 1980--a combined value of $172.5 million.

The production of bedding plants is more regionalized than other floriculture crops for several reasons. The varieties must be adaptable to climatic conditions in the area where they are sold since these plants will be

transplanted to an outdoor environment. Furthermore, they are bulky and somewhat difficult to transport.

California, Michigan and Ohio were leading producing states in 1980 with wholesale sales values of $32.5 million, $21.8 million and $19 million respectively. However, 21 additional states had wholesale sales volumes over $2 million each in 1980. Bedding plants often are marketed directly by growers to retailers (Figure 4).

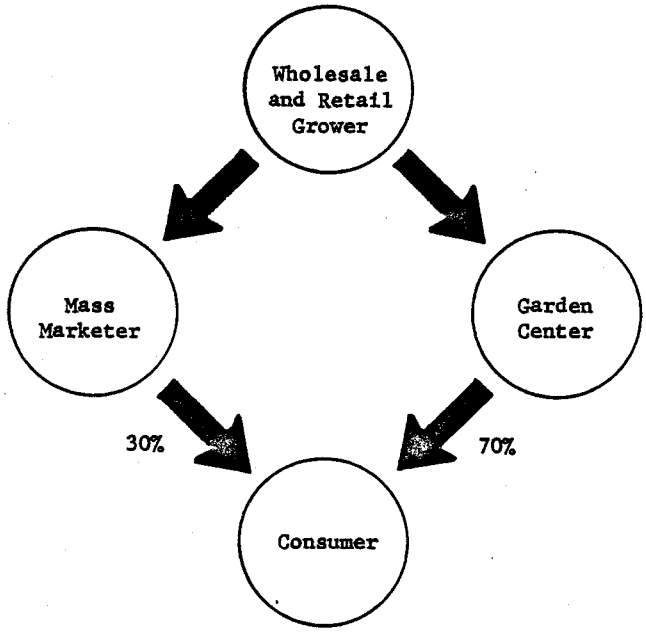

Figure 4. Market Channel for Bedding Plants

SOURCE: Sullivan et al., 1980.

Geraniums accounted for 16 percent of all bedding plant sales in the United States in 1980, followed by petunias (15 percent), impatiens, marigolds and tomatoes (each with 10 percent), begonias (5 percent), peppers (4 percent) and cabbage (2.5 percent) (Table 7). Each of these plants also increased in sales in 1980.

Analysis of Seasonal Prices

Agricultural prices are typically subject to four types of fluctuation. These are price variation due to trend, seasonality, cycles and irregular fluctuations. Trend (T) refers to the long-run effect covering a period of 10 years of more. This price fluctuation is important for its role in forecasting

TABLE 7. MARKET SHARES OF VARIOUS BEDDING PLANTS, UNITED STATES, 1980

Plant	Percent of Market Share	Plant	Percent of Market Share
Ageratum	1.5	Pansy	1.5
Alyssum	1.5	Petunia[a]	15.0
Aster	1.0	Phlox	1.0
Begonia[a]	5.0	Portulacas	1.5
Browallia	1.0	Salvia	1.5
Celosius	1.0	Snapdragon	2.0
Coleus	1.5	Verbena	1.0
Dahlia	1.0	Vinca	1.0
Dianthuses	1.0	Zinnia	1.0
Dusty Miller	1.0	Cabbage[a]	2.5
Geranium[a]	16.0	Pepper[a]	4.0
Impatiens[a]	10.0	Strawberry	1.0
Lobelias	1.0	Tomato[a]	10.0
Marigold[a]	10.0	Others	3.0
Mum	1.0		

[a]Denotes increase in sales.

SOURCE: Voigt, 1981.

future price behavior, especially the general level of prices. A moving average was used to identify the trend for the 11-year period.

Seasonality (S) refers to the pattern of prices that exhibits a rhythmic movement each 12-month period, usually tied to biological characteristics. Seasonal price indexes are important for decisions made with respect to timing of planting (and therefore harvest). Operators and managers of year-around greenhouse enterprises are concerned especially with these first two types of price movements.

Price cycles (C) refer to price movements that follow a similar pattern over a few years, such as the hog cycle. A true cycle is self-energizing, which

means that when prices are low, producers cut back on production and eventually prices begin to rise. As prices rise, output is increased and prices again turn down. Cycles were not investigated in this study, largely because of the relatively short time lag between planting and harvest and the perishability (nonstorable nature) of the products. Cycles are generally less discernible under such conditions.

A final type of price fluctuation is termed irregular (I) and is caused by unusual disturbances, such as drought or war, which are difficult to foresee or predict.

Time series analysis consists of the decomposition of prices over a period of years, segregating the four components described above. It was assumed that the effects of trend (T), cycle (C), seasonality (S) and irregular (I) patterns are multiplicative and not additive; that is, observed price = T x C x S x I. The analytical procedure utilized the following order. Trend was established by computing the moving average; then each observation was divided by the moving average for that particular month to obtain the SI indexes. The irregular effect (I) was then removed to obtain seasonality (S).

Current prices (not adjusted for inflation) were used throughout. Monthly prices used in the analyses were obtained by systematically calculating a monthly price based on the weekly price series.

Vegetables

Prices for three vegetables--tomatoes, cucumbers and lettuce--were analyzed to determine seasonal patterns. Monthly prices for these commodities were analyzed for the 11-year period 1970-1980. The reported data represented sales on the Minneapolis Wholesale Produce Market in less than carlot quantities delivered to the retailer (Federal-State, Minn., 1971-1981). The 11-year period was selected to present background information on the price behavior over time for these products.

Tomatoes

Tomato prices are subject to substantial variation. Wholesale prices during the study period ranged from a low of $5.044 per carton in October 1970 to a high of $14.917 per carton in May 1978 (Table 8).

TABLE 8. MINNEAPOLIS WHOLESALE PRICES FOR FRESH TOMATOES DELIVERED TO RETAILERS, BY MONTHS, 1970-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	dollars per carton											
1970	7.063	5.406	7.406	6.000	7.375	8.181	6.544	5.281	5.685	5.044	7.700	7.205
1971	7.756	7.562	8.405	8.625	6.544	7.917	8.481	6.669	5.560	7.056	9.037	9.475
1972	9.125	6.563	5.900	6.344	7.813	8.675	6.925	6.813	7.270	6.262	9.987	9.225
1973	9.875	7.313	6.165	6.375	6.656	8.050	8.906	7.575	5.435	6.312	7.719	8.825
1974	7.725	10.875	6.765	9.625	9.313	10.385	7.681	7.881	6.550	7.094	11.106	10.450
1975	10.719	10.294	8.915	8.188	8.494	13.220	10.156	7.531	7.775	7.512	8.969	9.850
1976	9.175	6.844	10.600	10.156	9.219	12.188	8.313	8.656	8.400	10.875	11.344	10.006
1977	12.087	11.294	12.700	12.494	9.600	9.450	9.813	8.250	8.775	8.006	11.206	11.000
1978	10.762	7.744	10.060	13.512	14.917	12.986	11.056	9.125	9.625	9.275	8.563	9.000
1979	10.742	9.938	10.469	12.742	9.608	13.125	9.912	10.458	9.656	9.600	9.625	9.875
1980	10.125	10.000	9.400	9.063	10.500	13.750	10.344	11.656	11.225	9.688	10.325	10.550

SOURCE: Adapted from Federal-State, Minn., 1971-1981.

Each year's production is subject to a seasonality pattern with the highest prices in April and June and the lowest prices in September and October. Data for some years deviated from this general price pattern. The seasonality indexes (Table 9) for the period may be interpreted as follows. The seasonal index for January 1970 (115.5) means that the January price for that year was 15.5 percent above the annual average. The September index (81.8) indicates the September price was 18.2 percent below the annual average price in that year.

Seasonal indexes were projected one year ahead to 1981 (Table 9). This is helpful in that it serves to combine the seasonal pattern with the trend. Greenhouse operators would strive to market their tomatoes in the months when prices were above the annual average, such as June (123.7), April (121.8) and January (103.5). Conversely, it would be prudent to avoid months such as October when prices may be expected to fall to 87.3 percent of the annual average.

An important distinction should be made between the historical price of green-ripened tomatoes, frequently shipped from Mexico and other southern locations, and the vine-ripened fruit that would be locally produced and marketed. While tomatoes imported from these distant producing areas were selling at retail counters at $.69 per pound, vine-ripened tomatoes (when available) were selling up to $1.29 per pound in the spring of 1981.

Leaf Lettuce

One characteristic of lettuce prices that differs from tomatoes and cucumbers is that lettuce will increase sharply in price for perhaps a single month and then drop just as quickly to the original position (Table 10). The prices of lettuce ranged from $3.375 per carton in April 1970 to $14.512 per carton in May 1978.

The seasonality pattern for lettuce is similar to the tomato pattern (Table 11). July and September tend to be the months with low prices, and March tends to have the highest prices (117.1).

Cucumbers

Cucumber prices exhibited a pattern similar to tomatoes, but showed greater variation. Prices ranged from a low of $4.025 per bushel in August 1970 to $27.500 per bushel in April 1979 (Table 12).

TABLE 9. SEASONAL INDEXES FOR FRESH TOMATO PRICES, 1970-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970	115.5	92.1	98.4	94.7	102.5	112.8	98.9	86.9	81.8	82.8	117.3	116.1
1971	115.2	93.2	96.6	95.8	102.6	113.4	98.2	87.8	80.9	82.7	117.0	115.9
1972	115.4	96.0	93.6	96.5	101.2	114.9	98.3	89.1	80.1	83.2	115.6	116.0
1973	114.1	98.3	91.4	97.6	100.3	118.1	96.9	89.3	80.1	83.7	113.9	113.7
1974	113.2	100.9	91.9	99.2	98.0	121.1	96.6	89.3	80.6	84.7	110.8	110.8
1975	110.0	101.9	94.3	103.6	97.4	123.7	95.8	87.9	82.0	85.4	107.5	106.0
1976	107.9	102.6	97.9	108.4	95.4	124.7	96.7	87.0	84.1	86.7	103.4	102.3
1977	105.6	101.8	99.7	113.4	95.0	124.7	96.2	87.9	87.3	88.0	99.7	98.3
1978	105.3	100.7	100.0	116.8	94.3	124.2	96.4	90.6	90.4	88.3	96.6	96.3
1979	103.9	99.5	98.4	120.0	95.0	123.6	96.3	93.3	92.4	88.1	94.4	94.6
1980	103.6	99.2	97.1	121.2	95.2	123.7	97.2	94.5	93.5	87.6	92.5	94.0
Seasonal Factors, One Year Ahead												
1981	103.5	99.0	96.4	121.8	95.3	123.7	97.6	95.1	94.0	87.3	91.6	93.7

TABLE 10. MINNEAPOLIS WHOLESALE PRICES FOR FRESH LEAF LETTUCE DELIVERED TO RETAILERS, BY MONTHS, 1970-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	dollars per carton											
1970	4.156	3.656	3.975	3.375	4.331	3.860	4.181	5.094	6.855	4.375	4.563	4.120
1971	4.825	4.031	5.960	4.637	4.550	4.995	4.750	4.769	4.560	5.975	8.175	6.475
1972	7.188	7.000	4.225	5.250	3.725	4.550	3.750	5.000	5.000	4.688	6.688	6.000
1973	6.169	5.344	5.835	7.181	9.481	10.305	7.133	6.287	5.475	4.906	4.719	4.640
1974	4.569	6.662	5.520	5.106	7.606	7.690	6.762	5.887	6.060	7.563	8.525	6.313
1975	7.906	6.656	5.450	6.431	5.744	5.670	5.931	6.281	6.860	6.444	6.844	7.275
1976	7.000	5.500	6.660	7.188	5.681	5.925	8.563	8.169	9.024	12.219	8.287	6.625
1977	7.938	6.719	7.735	5.500	6.056	6.300	6.375	6.625	7.525	8.469	9.487	7.020
1978	10.531	8.875	8.065	14.406	14.512	11.710	8.156	6.375	7.225	7.706	8.781	10.075
1979	14.188	13.500	12.063	6.625	8.313	8.150	8.031	10.063	8.069	10.208	8.444	8.460
1980	7.931	8.063	9.315	12.094	11.219	8.225	8.250	9.025	9.965	9.281	10.312	8.850

SOURCE: Adapted from Federal-State, Minn., 1971-1981.

TABLE 11. SEASONAL INDEXES FOR FRESH LEAF LETTUCE PRICES, 1970-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970	111.7	98.2	90.4	96.7	99.8	101.7	92.2	102.4	93.7	96.3	116.7	101.1
1971	109.9	97.4	90.5	96.0	102.0	103.5	93.3	101.1	93.4	97.0	115.9	100.0
1972	108.3	96.7	89.5	96.9	103.8	105.8	94.8	99.3	93.8	97.5	114.8	99.0
1973	106.6	96.3	89.3	98.0	103.8	106.3	96.8	98.2	95.8	98.3	112.9	97.0
1974	106.0	95.0	91.4	98.8	103.2	105.6	98.9	97.2	98.0	99.4	110.2	94.2
1975	105.9	93.8	96.4	99.7	102.8	103.8	99.3	95.9	98.7	100.0	107.4	91.7
1976	109.1	93.2	102.5	101.2	101.2	101.1	97.8	95.2	97.6	100.6	104.8	90.8
1977	111.5	93.8	107.8	104.1	101.1	98.0	94.5	94.7	95.8	99.6	102.7	91.0
1978	113.9	95.1	112.6	105.5	102.7	96.0	91.0	94.6	93.7	98.9	100.9	91.7
1979	113.8	96.1	115.6	106.8	106.7	95.7	87.9	93.2	91.3	97.6	99.8	92.4
1980	114.8	97.0	116.6	107.9	108.9	96.0	85.9	92.9	89.7	96.8	99.0	93.8
Seasonal Factors, One Year Ahead												
1981	115.2	97.5	117.1	108.4	110.0	96.2	84.9	92.7	88.9	96.5	98.6	94.5

TABLE 12. MINNEAPOLIS WHOLESALE PRICES FOR FRESH CUCUMBERS DELIVERED TO RETAILERS, BY MONTHS, 1970-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	dollars per bushel											
1970	12.750	11.125	11.200	12.212	6.219	6.810	5.417	4.025	5.030	5.333	6.362	6.870
1971	7.837	8.250	12.265	16.056	8.875	7.385	5.750	5.250	4.605	6.592	7.350	7.555
1972	8.688	11.358	8.925	14.000	6.844	7.775	7.125	5.281	5.370	5.083	5.712	7.160
1973	9.675	12.813	14.583	10.813	8.225	12.525	7.938	5.000	6.260	9.137	8.169	10.120
1974	9.119	10.281	9.835	13.856	12.169	9.985	13.500	9.275	5.590	10.144	7.125	9.044
1975	17.881	16.025	24.005	12.750	9.063	14.000	8.083	6.438	6.375	7.063	9.750	12.825
1976	12.906	11.775	16.050	10.375	8.556	10.445	9.500	6.875	8.175	10.681	12.906	13.200
1977	12.594	13.987	21.675	14.337	9.125	9.025	8.781	6.625	6.870	8.625	10.563	9.275
1978	10.775	13.188	18.725	24.125	12.337	15.465	14.750	8.938	10.275	11.000	10.500	13.225
1979	12.875	14.688	15.375	27.500	13.520	13.688	13.900	12.333	9.900	14.500	15.331	17.400
1980	13.912	12.750	13.925	24.906	10.619	12.245	5.262	9.125	9.900	11.438	12.662	19.600

SOURCE: Adapted from Federal-State, Minn., 1971-1981.

A similar analysis was made for cucumber prices to determine the seasonal indexes (Table 13). Again, it is obvious that greenhouse operators would strive to have their cucumbers ready for market in April and March when the seasonal index was projected to be 173.1 and 146.2, respectively.

Cut Flowers

The price behavior patterns of six cut flowers were analyzed to determine seasonal patterns. These flowers were tea roses, sweetheart roses, standard carnations, miniature carnations, pompon chrysanthemums and extra large chrysanthemums. Monthly prices for these commodities were analyzed for the eight-year period 1973-1980 (Federal-State, Minn., 1974-1981). An analysis of prices was not conducted for potted and bedding plants as these normally are produced seasonally.

Tea Roses

Roses enjoy immense popularity at least two days per year--Valentine's Day and Mother's Day. Prices for tea roses ranged from $.1750 per bloom in July in 1974 and 1975 to a high of $1.04375 per bloom in February 1980 (Table 14).

Projected seasonal indexes for 1981 for tea roses reveal that February prices would be expected to be 179.3 percent of the annual average price, and that the six months of June through November would not exceed 83.7 percent of average annual price (Table 15).

Sweetheart Roses

Prices for sweetheart roses follow the same pattern as that of tea roses, but not to the same extremes. Prices ranged from $.12750 per bloom in August 1974 to $.47875 per bloom in February 1980 (Table 16).

The projected seasonal index for sweetheart roses in 1981 was 140.0 for February and 129.0 for May (Table 17). These numbers are not as high as the corresponding numbers for tea roses, nor do the index numbers for the June through November season fall as low.

Standard Carnations

Carnations bring the highest prices at the same two holidays when roses are enjoying high prices, but do not fall as low during the remaining months.

TABLE 13. SEASONAL INDEXES FOR FRESH CUCUMBER PRICES, 1970-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970	116.5	128.8	138.6	168.5	92.3	99.7	79.8	61.2	65.1	76.1	82.8	92.4
1971	115.0	128.1	139.7	163.7	93.5	100.7	81.9	62.3	64.0	78.0	82.3	92.1
1972	112.0	128.1	143.7	156.0	94.7	104.0	83.7	63.2	62.2	79.4	82.4	94.0
1973	111.1	128.0	146.7	145.0	94.5	106.2	86.6	64.7	61.1	79.8	82.9	95.4
1974	111.1	127.9	155.2	132.5	92.5	107.9	87.0	64.5	61.4	81.3	86.2	97.8
1975	111.1	124.3	158.9	126.2	90.4	106.2	89.3	65.1	63.1	82.1	88.3	97.5
1976	109.0	119.8	162.9	129.4	88.5	103.5	88.6	65.4	64.7	82.9	91.5	99.1
1977	105.6	113.6	159.1	140.6	86.8	99.7	89.4	66.3	66.8	82.7	92.1	100.9
1978	101.3	109.1	156.3	152.3	85.1	96.8	88.9	67.0	68.5	83.7	92.8	103.8
1979	96.5	103.6	150.5	163.3	85.3	94.8	90.2	68.1	69.0	84.1	90.7	105.3
1980	93.5	101.7	147.6	169.9	85.5	95.0	90.5	68.6	68.7	83.5	89.2	106.5
Seasonal Factors, One Year Ahead												
1981	92.0	100.7	146.2	173.1	85.6	95.0	90.7	68.9	68.5	83.3	88.4	107.1

TABLE 14. MINNEAPOLIS WHOLESALE PRICES FOR CUT TEA ROSES, BY MONTHS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	cents per bloom											
1973	26.000	31.250	24.000	24.000	28.000	23.000	19.000	19.000	20.200	20.500	22.000	28.800
1974	30.000	37.250	28.800	31.500	34.250	25.900	17.500	19.750	26.600	26.000	26.000	28.000
1975	31.750	37.500	32.600	30.750	30.875	23.700	17.500	20.250	24.000	25.500	27.500	32.400
1976	36.000	48.500	27.800	40.750	48.375	27.400	19.000	20.250	25.200	28.500	33.250	38.600
1977	39.500	57.875	36.300	36.250	42.875	32.400	23.000	30.750	35.000	35.750	37.500	41.000
1978	51.875	81.375	54.000	40.875	61.250	33.300	35.188	35.250	32.400	36.250	39.500	52.500
1979	59.625	91.250	54.000	51.875	59.500	41.500	35.000	41.250	40.900	43.250	44.375	44.400
1980	69.125	104.375	42.700	43.750	61.250	42.000	36.500	36.000	42.000	42.750	40.800	53.500

SOURCE: Adapted from Federal-State, Minn., 1974-1981.

TABLE 15. SEASONAL INDEXES FOR CUT TEA ROSES, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	117.9	143.9	108.9	113.1	120.8	91.4	62.5	72.5	82.3	86.8	91.8	107.7
1974	117.4	146.0	108.8	112.6	121.0	90.9	62.2	72.5	82.0	86.4	91.6	106.9
1975	116.7	150.2	109.2	111.5	121.9	89.2	62.0	72.7	81.1	85.8	91.3	106.0
1976	116.4	156.6	109.3	109.5	122.0	87.0	62.2	73.6	80.0	84.8	90.2	104.5
1977	116.7	164.1	109.7	106.3	122.8	84.7	63.2	74.1	78.7	83.7	88.7	103.9
1978	117.5	171.0	109.5	102.6	122.7	83.3	64.4	74.9	78.4	82.8	86.9	103.3
1979	118.1	175.8	109.5	99.5	123.3	82.3	65.7	75.2	78.2	82.4	85.2	103.2
1980	118.7	178.1	109.7	98.1	123.3	81.7	66.4	75.6	78.1	82.2	84.2	103.1
Seasonal Factors, One Year Ahead												
1981	118.9	179.3	109.8	97.5	123.4	81.4	66.8	75.8	78.0	82.1	83.7	103.0

TABLE 16. MINNEAPOLIS WHOLESALE PRICES FOR CUT SWEETHEART ROSES, BY MONTHS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	cents per bloom											
1973	16.000	18.625	15.800	15.250	17.750	16.600	13.000	14.500	15.800	14.500	15.000	18.400
1974	19.250	28.500	18.400	18.750	23.250	21.400	13.000	12.750	13.000	13.000	13.000	17.000
1975	21.000	24.750	20.600	20.000	24.250	19.800	17.000	17.000	15.000	17.250	21.250	22.800
1976	23.500	28.250	17.800	24.750	28.500	23.800	21.500	19.000	19.000	19.750	23.500	27.700
1977	27.250	30.500	28.300	27.875	28.750	23.400	17.250	21.250	25.400	25.500	26.500	27.400
1978	29.000	35.875	31.300	28.000	32.750	27.080	22.500	22.875	25.000	24.000	24.750	29.000
1979	30.000	42.500	31.800	32.750	41.250	30.200	21.000	21.875	22.000	23.875	26.000	26.000
1980	38.625	47.875	23.100	38.250	39.875	27.000	22.000	22.000	25.300	28.875	28.000	31.200

SOURCE: Adapted from Federal-State, Minn., 1974-1981.

TABLE 17. SEASONAL INDEXES FOR CUT SWEETHEART ROSES, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	112.8	134.0	108.3	105.9	124.9	102.1	79.8	80.6	81.8	80.0	86.9	103.2
1974	112.3	133.9	108.6	106.5	124.2	101.5	79.8	80.6	81.7	80.8	87.9	103.2
1975	111.1	133.7	109.3	107.1	123.7	100.4	79.9	80.4	81.5	81.8	89.1	103.3
1976	109.8	134.1	109.9	107.4	123.3	99.2	79.6	80.0	81.3	83.0	90.3	102.5
1977	108.0	135.2	110.4	107.6	124.4	98.2	78.8	79.2	81.2	84.3	90.7	101.5
1978	106.8	136.9	110.8	107.8	125.5	97.3	77.6	78.5	81.6	85.9	90.6	100.0
1979	105.7	138.4	111.0	107.7	127.3	96.9	76.7	77.8	82.2	86.9	89.6	98.6
1980	105.6	139.4	111.3	107.4	128.4	96.7	76.2	77.4	82.5	87.2	88.9	97.9
Seasonal Factors, One Year Ahead												
1981	105.5	140.0	111.4	107.3	129.0	96.7	75.9	77.3	82.6	87.3	88.6	97.5

Carnations ranged in price from $.15625 per bloom in July 1977 to $.39375 per bloom in February 1980 (Table 18).

The fact that the prices of carnations do not fluctuate as widely throughout the year is supported by the seasonal indexes (Table 19). Valentine's Day causes the peak to occur in February with prices 136.6 percent of the annual average, and Mother's Day in May with 113.0 percent of the average.

Miniature Carnations

Prices of miniature carnations ranged from $2.56250 per bunch in July 1973 to $4.31250 per bunch in February 1980 (Table 20).

A definite seasonal pattern is discernible in the prices of miniature carnations, but it is much less volatile than the other cut flowers analyzed. The projected seasonal indexes range only from a low of 87.3 in July to a high of 108.0 in February (Table 21). The timing of planting and harvest is much less critical than with the other floral products considered.

Pompon Chrysanthemums

The prices of pompon chrysanthemums ranged from $1.65625 per bunch in July 1977 to $3.05625 per bunch in May 1980 (Table 22). The seasonal indexes show a stable seasonal pattern, but the extreme peaks and troughs are missing (Table 23). The seasonal indexes vary only from 90.6 in September to 112.6 in February.

Extra Large Chrysanthemums

Extra large chrysanthemums showed the least amount of seasonal price fluctuations. The prices ranged from $.48750 per bloom in June, July, and August of 1974 to $.83125 cents per bloom in May 1980 (Table 24). The extreme values of the seasonal indexes were 92.3 in August and 110.2 in February (Table 25).

Summary

This section has identified the unique price characteristics of selected vegetables and cut flowers. The analysis has focused on the trend and seasonal pattern using monthly prices for an eight to 11-year period. Projections have been made beyond the study period to present an up-to-date indication of realistic expectations based on both historic trend and seasonal behavior.

TABLE 18. MINNEAPOLIS WHOLESALE PRICES FOR CUT STANDARD CARNATIONS, BY MONTHS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	cents per bloom											
1973	19.000	19.750	18.400	17.250	19.125	17.100	17.500	17.125	19.000	19.000	17.000	19.000
1974	19.000	19.250	19.100	20.375	21.000	18.900	17.500	16.750	17.800	18.250	16.000	17.600
1975	21.000	23.250	23.100	22.750	20.250	17.200	17.875	16.750	17.400	20.625	21.625	23.200
1976	24.125	28.250	22.400	26.625	26.000	21.200	20.125	19.750	20.500	20.500	20.500	23.900
1977	23.750	28.250	23.800	27.250	27.375	22.800	15.625	22.250	23.000	23.625	23.250	23.400
1978	24.250	34.500	28.200	22.875	32.500	20.800	20.500	17.750	18.000	20.000	21.000	26.400
1979	30.250	33.250	31.100	28.750	26.500	24.300	18.000	18.000	22.000	22.750	26.000	29.400
1980	34.000	39.375	27.000	26.375	35.000	30.200	26.000	28.000	29.600	31.250	27.750	30.100

SOURCE: Adapted from Federal-State, Minn., 1974-1981.

TABLE 19. SEASONAL INDEXES FOR CUT STANDARD CARNATIONS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	106.9	117.1	107.0	113.4	109.0	93.6	91.3	86.6	91.3	95.5	87.9	100.1
1974	106.6	117.9	106.7	113.8	109.6	93.5	90.7	86.5	90.8	94.8	88.2	99.8
1975	105.6	120.5	107.0	114.4	110.8	93.0	89.7	85.6	89.2	93.4	88.4	100.1
1976	105.6	123.6	108.6	115.0	111.4	92.6	87.8	83.9	87.2	91.6	89.3	100.7
1977	106.0	127.9	109.8	114.7	112.3	92.6	85.4	82.0	85.5	89.9	89.6	101.4
1978	107.5	131.3	111.0	114.1	112.6	93.0	82.8	80.5	84.8	89.0	90.1	101.7
1979	108.1	134.3	111.5	112.9	113.1	93.4	81.1	79.5	84.4	88.6	89.8	101.5
1980	108.7	135.8	112.5	112.5	113.1	93.6	80.5	78.8	84.0	88.5	89.8	101.8
Seasonal Factors, One Year Ahead												
1981	108.9	136.6	113.1	112.3	113.0	93.7	80.1	78.4	83.8	88.5	89.8	101.9

TABLE 20. MINNEAPOLIS WHOLESALE PRICES FOR CUT MINIATURE CARNATIONS, BY MONTHS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	cents per bunch											
1973	275.000	281.250	272.500	281.250	293.750	297.500	256.250	281.250	300.000	262.500	287.500	300.000
1974	300.000	300.000	292.500	306.250	350.000	325.000	300.000	300.000	320.000	300.000	300.000	305.000
1975	312.500	340.625	352.500	337.500	325.000	320.000	293.750	281.250	309.000	340.625	350.000	360.000
1976	331.250	350.000	330.000	359.375	365.625	334.500	332.500	336.250	337.500	337.500	337.500	357.500
1977	365.625	371.875	360.000	368.750	365.625	355.000	312.500	334.375	362.500	362.500	362.500	362.500
1978	362.500	375.000	370.000	350.000	415.625	317.500	309.375	296.875	362.500	350.000	367.500	377.500
1979	375.000	387.500	350.000	359.375	378.125	352.500	325.000	315.625	360.000	375.000	362.500	362.500
1980	412.500	431.250	382.500	368.750	409.375	352.500	318.750	356.250	350.000	384.375	375.000	380.000

SOURCE: Adapted from Federal-State, Minn., 1974-1981.

TABLE 21. SEASONAL INDEXES FOR CUT MINIATURE CARNATIONS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	100.1	103.6	98.1	103.0	104.2	102.4	92.9	96.1	99.9	98.6	98.8	101.9
1974	100.3	103.7	98.3	103.2	104.3	101.9	92.7	95.9	99.8	98.7	98.8	101.9
1975	100.5	104.1	98.9	103.3	104.4	101.0	92.4	95.3	99.6	98.7	99.2	102.2
1976	101.1	105.0	99.7	103.2	104.3	99.8	91.4	94.0	99.3	99.3	99.8	102.4
1977	102.1	105.8	100.3	102.5	104.9	98.5	90.4	93.0	99.1	99.7	100.1	102.3
1978	103.6	106.9	100.9	101.7	105.3	97.6	89.1	92.1	99.2	100.5	100.4	102.1
1979	104.8	107.3	101.3	100.5	105.9	97.1	88.2	91.7	99.4	100.9	100.5	101.8
1980	105.4	107.8	101.6	100.0	106.1	96.9	87.6	91.2	99.5	101.2	100.7	101.8
Seasonal Factors, One Year Ahead												
1981	105.7	108.0	101.8	99.8	106.2	96.8	87.3	91.0	99.6	101.3	100.8	101.8

TABLE 22. MINNEAPOLIS WHOLESALE PRICES FOR CUT POMPON CHRYSANTHEMUMS, BY MONTHS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	cents per bunch											
1973	171.250	188.125	174.000	167.500	180.000	181.500	168.750	167.500	174.000	166.250	178.750	180.000
1974	180.000	181.250	185.000	189.375	191.875	190.500	190.000	187.500	172.000	177.500	193.125	192.500
1975	192.500	200.000	193.500	189.375	185.000	183.500	187.500	187.500	176.000	175.000	191.875	195.000
1976	193.125	216.250	192.500	204.375	210.000	202.000	197.500	197.500	197.500	199.375	215.625	228.500
1977	225.000	265.625	228.000	237.500	226.250	199.000	165.625	188.125	212.500	212.500	225.000	225.500
1978	240.625	250.625	241.500	235.625	231.250	245.500	222.500	198.125	200.000	214.375	222.500	234.500
1979	246.875	270.625	236.500	243.750	250.625	236.000	237.500	231.875	230.000	236.250	247.500	248.500
1980	256.250	291.250	287.500	276.250	305.625	279.000	267.500	273.750	262.000	259.375	266.875	283.500

SOURCE: Adapted from Federal-State, Minn., 1974-1981.

TABLE 23. SEASONAL INDEXES FOR CUT POMPON CHRYSANTHEMUMS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	101.0	109.2	101.6	101.2	102.2	100.7	98.2	97.1	92.6	93.0	100.7	102.0
1974	101.0	109.8	101.6	101.7	102.6	100.2	97.9	96.4	92.4	93.2	100.6	101.8
1975	101.4	110.2	101.9	102.5	103.0	99.3	97.6	95.6	91.9	93.4	100.3	101.9
1976	102.1	110.9	102.3	103.2	103.4	98.2	97.3	94.7	91.4	93.7	99.8	101.5
1977	102.8	111.7	102.8	103.5	104.4	97.7	96.8	94.0	91.0	93.7	98.9	101.2
1978	103.2	112.5	103.5	103.5	105.4	97.4	96.3	93.5	91.0	94.0	98.4	100.8
1979	103.3	112.7	104.0	103.2	106.2	97.5	95.9	93.4	90.9	93.9	97.7	100.5
1980	103.6	112.6	104.5	103.0	106.4	97.6	96.0	93.6	90.7	93.8	97.4	100.3
Seasonal Factors, One Year Ahead												
1981	103.7	112.6	104.7	103.0	106.5	97.6	96.0	93.7	90.6	93.8	97.3	100.1

TABLE 24. MINNEAPOLIS WHOLESALE PRICES FOR CUT EXTRA LARGE CHRYSANTHEMUMS, BY MONTHS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	cents per bloom											
1973	53.125	55.000	53.000	50.625	50.000	50.000	50.000	50.000	50.000	50.000	50.000	53.500
1974	53.750	53.750	53.750	53.750	53.750	48.750	48.750	48.750	53.250	53.250	53.250	53.250
1975	55.291	56.665	56.665	55.082	53.500	53.500	51.813	51.250	51.250	53.957	56.665	74.232
1976	60.415	61.979	60.832	60.415	60.415	60.415	60.415	60.832	61.250	61.250	63.188	64.500
1977	65.886	67.190	63.330	64.580	66.670	66.670	61.199	61.977	65.414	68.750	69.170	69.170
1978	70.002	76.332	77.433	63.675	63.750	69.000	71.250	55.000	51.600	71.875	77.800	58.000
1979	73.750	77.500	66.500	63.750	67.500	72.000	65.000	63.750	65.500	73.750	78.750	78.500
1980	78.750	77.500	78.500	80.000	83.125	79.300	77.500	78.125	77.499	78.332	80.000	82.500

SOURCE: Adapted from Federal-State, Minn., 1974-1981.

TABLE 25. SEASONAL INDEXES FOR CUT EXTRA LARGE CHRYSANTHEMUMS, 1973-1980

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	103.9	105.8	104.1	101.6	99.7	97.2	95.5	94.8	95.9	98.5	99.4	103.6
1974	104.0	105.9	103.7	101.4	99.9	97.4	95.3	94.7	96.0	98.6	99.7	103.4
1975	104.1	106.3	103.2	101.0	99.9	98.2	94.9	94.4	95.9	98.9	100.3	103.3
1976	104.3	107.2	102.3	100.0	99.6	99.5	94.4	93.6	95.4	99.2	101.2	103.3
1977	104.6	108.2	101.5	99.0	99.5	100.4	94.0	93.2	94.9	99.3	101.9	103.5
1978	105.1	109.1	100.7	98.0	99.5	101.2	93.6	92.8	94.5	99.5	102.6	103.9
1979	105.2	109.5	100.2	97.5	99.6	101.3	93.4	92.6	94.2	99.5	102.9	104.0
1980	105.3	109.9	100.1	97.1	99.5	101.6	93.3	92.4	93.9	99.6	103.1	104.2
Seasonal Factors, One Year Ahead												
1981	105.3	110.2	100.0	96.9	99.5	101.8	93.2	92.3	93.7	99.6	103.2	104.3

The seasonal index provides a guide to planting and harvesting intentions. Locally produced vegetables coming on the market in August and September depress prices to about two-thirds of the annual average in some cases. These prices reflect the seasonal effect only--the effects of trend, cycles and irregular disturbances have been removed.

The prices of six cut flowers were analyzed. The seasonality varied from greatest to least in the following order: tea roses, sweetheart roses, standard carnations, miniature carnations, pompon chrysanthemums and extra large chrysanthemums.

Other products potentially feasible for greenhouse production were not included in this section on price analysis. Poinsettias, for example, are in high demand at Christmas time only. Bedding plants are in demand during the spring months only. Since markets and, therefore, prices exist for only a part of each year, no analysis was needed to determine the seasonality pattern.

Greenhouse Industry in North Dakota

North Dakota had only 67 greenhouses in operation in 1980 (N.D. Dept. of Agriculture, n d.) with the majority utilized for bedding plant production. Thirty greenhouse operators in South Dakota were involved in commercial flower production, 142 in bedding plant production and 83 in growing vegetables in 1980 (Prashar et al., 1980). Seventy-one greenhouse operators were growing flowers commercially in Minnesota during the same time period (Minn. Commercial Flower Growers, n.d.).

Greenhouse operators in North Dakota were surveyed in the spring of 1981 to obtain information on size of operations, types of products grown, marketing channels and prices of products grown (Appendix C). Operators were selected from a list of licensed and certified greenhouses (N.D. Dept. of Agriculture, n.d.) and from personal communications with industry personnel. The survey was conducted in an area within a 125-mile radius of Velva, North Dakota and included 35 operators (Figure 5). One vegetable grower who operated outside the study area was also surveyed to assure inclusion of 100 percent of the growers producing vegetables. The radius within 125 miles of Velva was selected as the study area since many of the major trade areas in North Dakota are favorably situated within that perimeter.

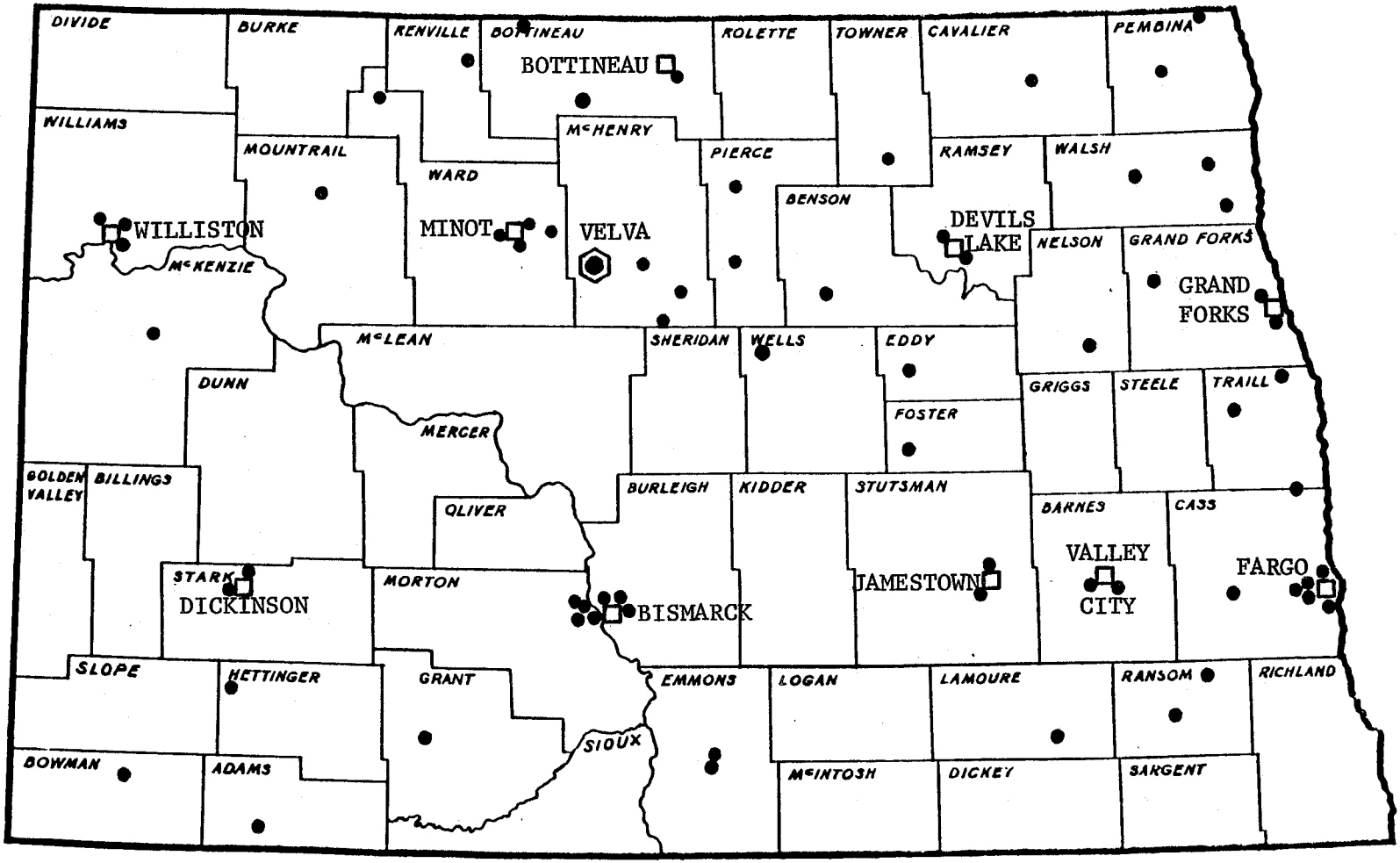

Figure 5. Location of Greenhouse Structures in North Dakota, 1980

□ Designates major trade areas.

● Designates location of greenhouse facilities.

Thirty-four of the 36 greenhouse operators interviewed grew bedding plants, 13 grew potted plants, 3 grew vegetables and 2 grew cut flowers (Table 26). Cut flower growers operated greenhouses year-around, followed by vegetable growers (9.7 months per year), potted plant growers (7 months per year) and bedding plant growers (5.5 months per year). Cut flower growers were by far the largest, operating 6.5 greenhouses with an average total capacity of 30,000 square feet for the total operation. Vegetable growers were in business the shortest amount of time (four years). Natural gas was the primary fuel source used by 17 growers, followed by propane, coal and fuel oil. Natural gas and propane were the principal secondary heat sources utilized.

Caution must be taken when interpreting the results. For example, cut flower growers had an average of 30,000 square feet of total greenhouse space. However, a portion of this space also was devoted to producing potted and bedding plants. Therefore, some double counting exists since these operators were involved in the production of more than one type of product. Results for other types of products may be interpreted similarly.

Twenty-two of the growers indicated they foresaw no changes in their future production and marketing practices, while seven growers planned to expand their production facilities. Eighteen growers indicated that rising fuel costs were the major problem facing the industry, while five growers expressed concern about poor sales. Vegetable growers indicated that retailers were their primary sales outlet (81.5 percent), while cut flowers, bedding plant and potted plant growers relied upon direct sales to consumers (60, 79.4 and 64.7 percent, respectively).

Growers were asked to define their trade area by type of purchaser. In general, vegetable producers supplied the local area, while cut flower growers supplied retailers and consumers up to 100 miles away.

Tomato producers in North Dakota averaged 14,633 pounds per year (Table 27). Production levels for leaf lettuce, cucumbers and cut flowers were deleted to avoid disclosure of individual operations.

Petunias and geraniums constituted the majority of production by North Dakota greenhouse operators with producers growing an average of 5,616 and 5,235 6-packs, respectively, in 1981. Chrysanthemums and poinsettias were the most popular potted plants grown by North Dakota producers in 1981 with average production levels of 2,960 and 2,735 pots, respectively (Table 27).

TABLE 26. OPERATING CHARACTERISTICS OF THIRTY-SIX GREENHOUSE OPERATORS IN NORTH DAKOTA, 1981[a]

Item	Type of Product Grown				
	Vegetables	Cut Flowers	Bedding Plants	Potted Plants	Total
Number of Growers	3	2	34	13	36
Avg. No. of Months Operating	9.67	12.00	5.51	7.00	7.39
Avg. No. of Greenhouses	2.0	6.5	3.12	4.77	2.94
Avg. of Total Greenhouse Space (In Sq. Ft.)	5,967	30,000	9,207	14,193	8,730
Avg. No. of Years in Operation	4.0	44.0	9.96	13.38	9.48
Source of Heat					
Primary					
Natural Gas	0	2	17	8	17
Electricity	1	0	3	1	3
Coal	2	0	2	2	4
Propane	0	0	8	2	8
Fuel Oil	0	0	4	0	4
No Response	0	0	0	0	0
Secondary					
Natural Gas	1	1	4	1	5
Electricity	0	0	2	1	2
Propane	1	0	1	1	2
Fuel Oil	1	1	5	3	5
Wood	0	0	2	1	2
No Response	0	0	20	6	20
Future Plans					
No Change	2	0	21	7	22
Expand Facilities	1	1	6	2	7
Expand Production	0	0	1	0	1
Lower Production	0	0	1	1	1
Other	0	0	1	1	1
No Response	0	1	4	2	4
Problems Facing the Industry					
Rising Fuel Cost	0	2	18	8	18
High Labor Cost	2	0	2	1	3
Poor Sales	1	0	4	0	5
Other	0	0	7	3	7
No Response	0	0	3	1	3
Purchasers of Product (Percent)					
Wholesalers	11.4	0	0	0	--
Retailers	81.5	40	20.6	35.3	--
Consumers	7.1	60	79.4	64.7	--
Avg. Distance to Market (In Miles)					
Wholesalers	50	NA	NA	NA	--
Retailers	15	100	84	111	--
Consumers	10	100	51	59	--

[a]The descriptive characteristics in this table contain some double counting since many operators are involved in the production of more than one type of product.

TABLE 27. AVERAGE PRODUCTION OF VEGETABLES, CUT FLOWERS, BEDDING PLANTS AND POTTED PLANTS BY THIRTY-SIX GREENHOUSES IN NORTH DAKOTA, 1981

Type of Plant	Unit of Measurement	No. of Growers	No. of Observations	Average Production
Vegetables				
Tomatoes	pounds	3	3	14,633
Leaf Lettuce	bunches	a	a	a
Cucumbers	pounds	a	a	a
Cut Flowers				
Carnations	blooms	2	2	a
Chrysanthemums	blooms	2	2	a
Roses	stems	2	2	a
Bedding Plants				
Begonias	6-packs	3	0	--
Coleus	6-packs	3	1	20
Geraniums	6-packs	17	10	5,235
Marigolds	6-packs	28	19	2,682
Pansies	6-packs	6	3	1,320
Petunias	6-packs	33	21	5,616
Peppers	6-packs	14	7	1,914
Tomatoes	6-packs	32	22	3,003
Potted Plants				
Chrysanthemums	pots	4	3	2,960
Geraniums	pots	4	3	1,233
Hydrangeas	pots	0	0	--
Lilies	pots	8	5	805
Poinsettias	pots	9	5	2,735

[a]Deleted to avoid disclosure of individual firms.

Growers were asked to indicate prices charged to wholesalers, retailers and producers. Growers charged an average of $.88 per pound for tomatoes to wholesalers and $.89 per pound to retailers and consumers (Table 28). Again, prices charged for leaf lettuce, cucumbers and cut flowers were deleted to avoid disclosure.

Prices charged for bedding plants to retailers ranged from a high of $1.03 per 6-pack for geraniums to a low of $.71 per 6-pack for tomatoes (Table 28). Prices to consumers ranged from a high of $1.50 per 6-pack for geraniums to $.84 per 6-pack for coleus. Caution must be taken when comparing prices due to the small number of observations available for some plants.

TABLE 28. AVERAGE PRICES CHARGED BY THIRTY-SIX GROWERS OF VEGETABLES, CUT FLOWERS, BEDDING PLANTS AND POTTED PLANTS TO WHOLESALERS, RETAILERS AND CONSUMERS, NORTH DAKOTA, 1981

Item	Unit of Measurement	No. of Growers	Wholesaler		Retailer		Consumer	
			Price	No. of Obs.	Price	No. of Obs.	Price	No. of Obs.
			dollars	number	dollars	number	dollars	number
Vegetables								
Tomatoes	Per Pound	3	.88	2	.89	2	.89	2
Cucumbers	Per Pound	a	a	a	a	a	a	a
Leaf Lettuce	Per Bunch	a	a	a	a	a	a	a
Cut Flowers								
Carnations	Per Bloom	2	a	a	a	a	a	a
Chrysanthemums	Per Bloom	2	a	a	a	a	a	a
Roses	Per Stem	2	a	a	a	a	a	a
Bedding Plants								
Begonias	Per 6-Pack	3	b	b	.75	1	.91	3
Coleus	Per 6-Pack	3	b	b	.75	1	.84	3
Geraniums	Per 6-Pack	17	b	b	1.03	5	1.50	14
Marigolds	Per 6-Pack	28	b	b	.74	6	1.01	23
Pansies	Per 6-Pack	6	b	b	.83	2	.97	6
Petunias	Per 6-Pack	33	b	b	.72	7	1.01	28
Peppers	Per 6-pack	14	b	b	.81	3	.95	11
Tomatoes	Per 6-Pack	22	b	b	.71	7	1.03	28
Potted Plants								
Chrysanthemums	Per Pot	4	b	b	5.25	2	11.50	3
Geraniums	Per Pot	4	b	b	--	0	2.30	1
Hydrangeas	Per Pot	0	b	b	--	--	--	--
Lilies	Per Pot	8	b	b	4.03	3	7.50	4
Poinsettias	Per Pot	9	b	b	4.63	3	11.81	4

[a]Deleted to avoid disclosure of individual firms.
[b]Not applicable.

The largest price differential between prices to retailers and consumers occurred for potted plants. Retailers were charged an average of $5.25 per pot for chrysanthemums while consumers were charged an average of $11.50 per pot. Similar price differentials were noted for geraniums, lilies and poinsettias.

Food Wholesale Industry in North Dakota

Sixteen food wholesalers in North Dakota were surveyed in the summer of 1981 to obtain information on marketing channels, volume of products and prices of fresh tomatoes, leaf lettuce and cucumbers supplied to retailers, hotels-motels, institutions and restaurants (Appendix D). Names of food wholesalers were obtained from the most recent telephone directories available at the time.

Food wholesalers indicated average weekly volumes of 5,108 pounds of tomatoes, 734 bunches of leaf lettuce and 68 bushels of cucumbers (Table 29).

TABLE 29. PURCHASING AND SALES CHARACTERISTICS OF FOOD WHOLESALERS IN NORTH DAKOTA, 1980

Item	Tomatoes	Leaf Lettuce	Cucumbers
Avg. Weekly Volume	5,108 lbs.	734 bunches	68 bushels
Avg. Months Supplied By State			
Florida	5.2	0.0	4.7
Texas	0.6	0.0	1.5
California	3.5	10.5	1.1
Mexico	2.6	0.0	1.5
Georgia & North Carolina	0.0	0.0	0.3
Local Outdoor	0.0	0.7	2.9
Local Indoor	0.1	0.8	0.0
Percent of Volume Supplied to:			
Retail	42.4	.5	74.7
Hotel, Restuarant, Institutions	57.6	99.5	25.3
Average Distance to Market (Percent)			
0-25 Miles	40	40	40
26-100 Miles	50	50	50
101-200 Miles	10	10	10
Purchase Price[a]			
Average	.51/lb.	5.94/carton	14.70/bu.
High	.81/lb.	8.88/carton	21.20/bu.
Low	.20/lb.	5.00/carton	6.61/bu.

[a]Includes freight.

Food wholesalers relied on Florida for their supply of tomatoes nearly half the year. Wholesalers utilized Mexican grown tomatoes only 2.6 months per year. California was the main source of supply of leaf lettuce, accounting for 10.5 months supply per year. Cucumbers were purchased from Florida producers 4.7 months per year, while wholesalers relied on local outdoor production 2.9 months per year.

Nearly 58 percent of the tomatoes were purchased by the hotel, restaurant and institutional (HRI) sector, while the remaining portion was utilized by the retail grocery store sector. Leaf lettuce was utilized almost exclusively by the HRI sector, accounting for 99.5 percent of total utilization. Approximately 75 percent of the cucumbers were purchased by the retail grocery store sector with the remaining portion being purchased by the HRI sector.

Wholesalers indicated that 50 percent of their tomatoes, leaf lettuce and cucumbers were being shipped an average of 26 to 100 miles, while 40 percent was shipped within 25 miles and 10 percent was shipped over 100 miles.

Wholesalers paid an average of $.51 per pound for tomatoes in 1980, from a seasonal low of $.20 per pound to a high of $.81 per pound. Leaf lettuce prices per carton to wholesalers averaged $5.94, from a high of $8.88 to a low of $5.00. Cucumber prices ranged from a low of $6.61 per bushel to a high of $21.20 per bushel, with an average purchase price of $14.70 per bushel.

Fifteen of 16 wholesalers indicated they would be interested in purchasing locally grown vine-ripened produce (Table 30). Wholesalers were asked to rank,

TABLE 30. WHOLESALERS' ATTITUDES TOWARD PURCHASING LOCALLY GROWN VINE-RIPENED PRODUCE, NORTH DAKOTA, 1981

Reply	Number	Percent of Total
Yes	15	93.75
No	0	0.00
Undecided	1	6.25

in order of importance, reasons for adding or changing suppliers (Table 31). Over 87 percent of the respondents indicated higher quality would be the first reason to change or add suppliers. A guaranteed supply was ranked as the second most important factor by 73 percent of the respondents, followed by standardization (70 percent of respondents).

TABLE 31. RANKING OF REASONS NEEDED TO ENTICE WHOLESALERS TO CHANGE OR ADD A NEW SUPPLIER, NORTH DAKOTA, 1981[a]

Item	Ranking					
	1	2	3	4	5	6
	percent					
Lower Price	6.7	20.0	6.7	46.7	20.0	0.0
Higher Quality	87.5	6.25	6.25	0.0	0.0	0.0
Guaranteed Supply	6.7	73.3	20.0	0.0	0.0	0.0
Proximity of Suppliers	0.0	0.0	0.0	21.4	14.3	64.3
Delivery by Suppliers	0.0	7.1	14.3	14.3	64.3	0.0
Standardization	0.0	0.0	70.0	20.0	0.0	10.0

[a]Underlined value indicates highest ranking for that item.

Consumption of Vegetables and Floriculture in the United States and North Dakota

United States consumption of horticultural commodities was determined for each of the following crops: (a) vegetables--tomatoes, leaf lettuce and cucumbers; (b) cut flowers--carnations (standard and miniatures), chrysanthemums (standard and pompons) and roses (sweetheart and tea); (c) potted plants--chrysanthemums, geraniums, hydrangeas, lilies and poinsettias; and (d) bedding plants--vegetable and flowering and foliar. Specific procedures used to estimate historic and projected consumption will be discussed in this section of the report. Historic and projected consumption estimates for specific horticultural commodities also will be discussed.

Methodology

Vegetables

Historic per capita consumption estimates for vegetables in the United States were used to project estimates to the year 1990 through the use of trend analysis. Trend analysis is a linear regression procedure which utilizes historic data to extrapolate predictive values into the future.

Per capita consumption of fresh vegetables in North Dakota and the North Central Region was estimated to be less than that for the United States. Adjustments were made in the consumption estimates for North Dakota to account for these differences and will be discussed in detail later.

Floriculture

Regression analysis was used to project total utilization for each crop to 1990. The general form of regression analysis used was total utilization = f(year). Four different regression analysis techniques (linear, quadratic, log and reciprocal) were used to project total utilization of horticultural crops to 1990. Quadratic regression analysis provided the highest R^2 (coefficient of multiple determination) or explained the largest amount of variation in the dependent variable. However, the projection results were unrealistic, given many of the crops would have had a negative consumption value. Therefore, the projection techniques that provided the highest coefficient of multiple determination and the most realistic projection of total utilization, given historic trends, were used. Linear regression was used to project utilization of cut carnations, pompon chrysanthemums, roses and potted chrysanthemums. Reciprocals were used to project utilization of standard chrysanthemums. Only five years of data could be obtained for potted poinsettias, lilies, geraniums, hydrangeas and for both flowering and foliar and vegetable bedding plants. The arithmetic mean was used to project utilization for each crop for which only five years of data could be obtained.

Both actual and projected total United States utilization for each floricultural crop was divided by the actual and estimated United States population for the years 1970-1990 to obtain per capita consumption. It was assumed that North Dakota per capita consumption of floral products was the same as United States per capita consumption. Total North Dakota consumption was obtained by multiplying per capita consumption times the estimated North Dakota population through 1990.

Bedding plants were estimated in flats. Total "6-pack" utilization was obtained by multiplying total flats (summation of flowering and foliar and vegetable bedding plants) by 12 (number of 6-packs per flat). Total consumption of bedding plants (in 6-packs) was calculated for begonias, coleus, geraniums, marigolds, pansies, petunias, peppers, tomatoes, other flowering and foliar and other vegetable plants as the market share by specific plant type in 1980 times total consumption of all bedding plants (in 6-packs) in 1980.

Results

Vegetables

Per capita consumption of tomatoes in the United States has fluctuated between 11.4 and 13.4 pounds over the last 15 years, while lettuce consumption has increased from 21.7 pounds in 1965 to 26.0 pounds per capita in 1979 (Table 32). Per capita consumption of cucumbers has fluctuated from 2.9 pounds to 4.3 pounds over the same time period. United States per capita consumption of tomatoes was projected to increase from 12.75 pounds in 1980 to 13.32 pounds in 1990, lettuce from 26.28 pounds in 1980 to 29.56 pounds in 1990 and cucumbers from 4.08 pounds in 1980 to 4.94 pounds in 1990.

Per capita consumption of commercially produced fresh tomatoes and cucumbers was estimated to be less in the North Central Region (Figure 6) than the average for the United States, while lettuce consumption was estimated to be higher (Table 33). The difference between the North Central and United States consumption patterns (i.e., for tomatoes, .71/.84 = .8452) was multiplied by the projected United States consumption patterns to arrive at a North Central consumption figure. For example, per capita tomato consumption in the United States was projected to be 12.75 pounds in 1980 (Table 32). Per capita tomato consumption for the North Central Region was .8452 of consumption in the United States (Table 33). Per capita consumption for the North Central Region was projected to increase from 10.78 pounds (12.75 x .8452) in 1980 to 11.26 pounds in 1990, while per capita consumption of lettuce and cucumbers was projected to increase from 27.56 and 3.71 pounds in 1980 to 31 and 4.49 pounds in 1990, respectively, over the same time period (Table 32).

Leaf lettuce consumption for the North Central Region was estimated using the following equation:

$$C_{LL(Yx)} = C_{TL(Yx)} \times \{(A \times B) / [1 - (A \times B)]\}$$

where $C_{LL(Yx)}$ = Consumption of leaf lettuce in year x

$C_{TL(Yx)}$ = Consumption of total lettuce in year x

A = Percent of total acreage for leaf lettuce (18 percent)

B = Percent yield of leaf lettuce to head lettuce (50 percent).

Consumption of leaf lettuce in the North Central Region was estimated at 2.73 pounds per capita in 1980 and projected to increase to 3.07 pounds in 1990 (Table 34).

TABLE 32. ESTIMATED AND PROJECTED PER CAPITA CONSUMPTION OF COMMERCIALLY PRODUCED FRESH TOMATOES, LETTUCE AND CUCUMBERS, UNITED STATES AND NORTH CENTRAL REGION, 1965-1990

Year	Tomatoes		Lettuce		Cucumbers	
	United States	North Central	United States	North Central	United States	North Central
	Estimated[a] Trend	Trend	Estimated[a] Trend	Trend	Estimated[a] Trend	Trend
	pounds					
1965	12.0		21.7		3.1	
1966	12.4		21.6		3.0	
1967	12.4		22.1		3.1	
1968	11.9		22.5		2.9	
1969	11.9		22.5		3.2	
1970	12.3		23.1		3.2	
1971	11.4		23.2		3.1	
1972	12.2		23.3		3.3	
1973	12.6		23.9		3.0	
1974	12.0		24.5		3.4	
1975	12.1		24.5		3.2	
1976	12.7		24.3		3.7	
1977	12.5		25.1		4.0	
1978	13.4		26.6		4.3	
1979	12.7		26.0		4.3	
1980		12.75	10.78	26.28	27.56	4.08	3.71
1981		12.81	10.83	26.61	27.91	4.16	3.78
1982		12.86	10.87	26.94	28.25	4.25	3.86
1983		12.92	10.92	27.27	28.60	4.34	3.95
1984		13.00	10.99	27.59	28.94	4.42	4.02
1985		13.03	11.01	27.92	29.28	4.51	4.10
1986		13.09	11.06	28.25	29.63	4.60	4.18
1987		13.15	11.11	28.58	29.97	4.68	4.25
1988		13.20	11.16	28.91	30.32	4.77	4.34
1989		13.26	11.21	29.23	30.66	4.86	4.42
1990		13.32	11.26	29.56	31.00	4.94	4.49

[a]USDA, ESCS, 1980a.

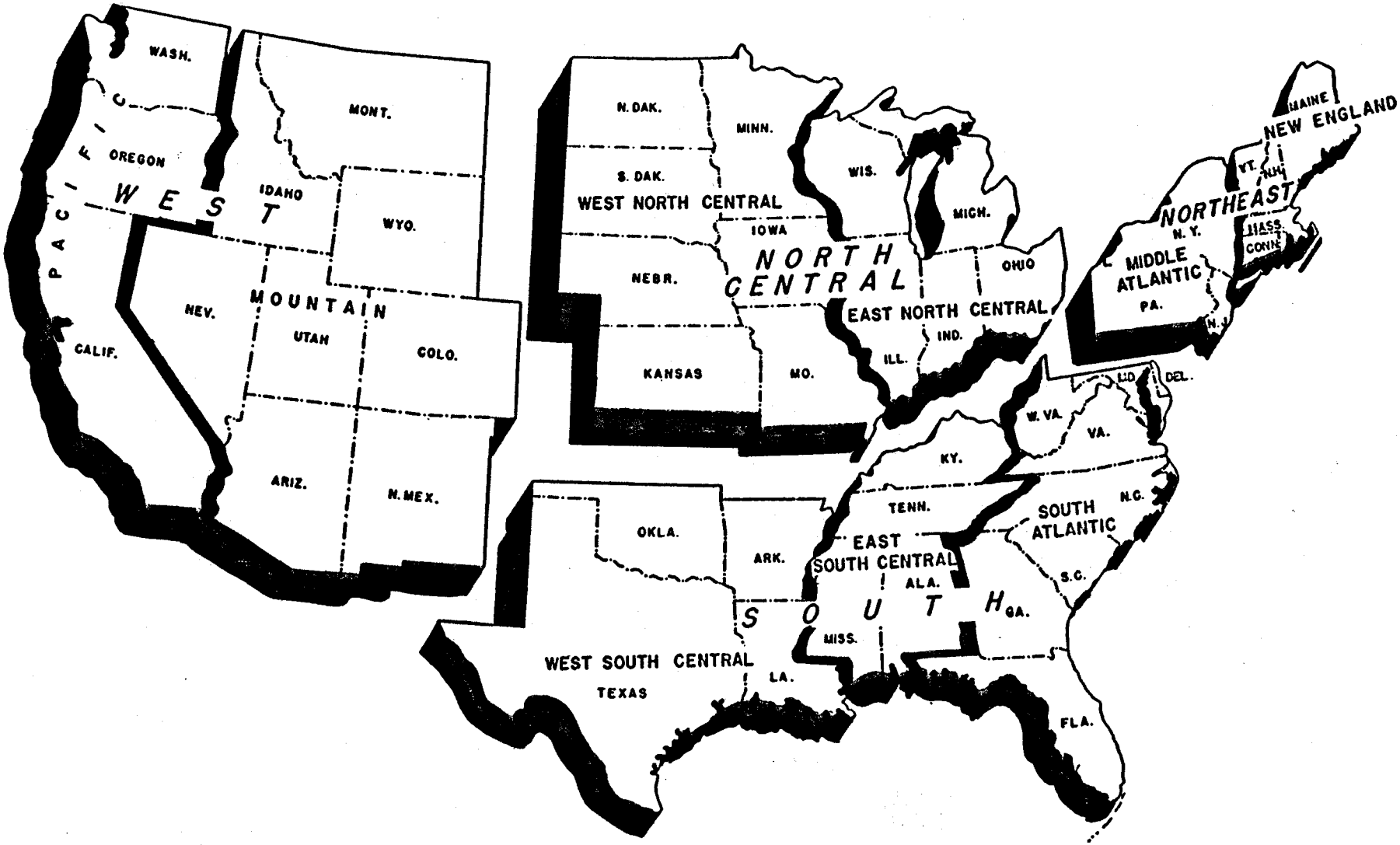

Figure 6. Regions and Geographic Divisions of the United States

TABLE 33. WEEKLY CONSUMPTION OF PURCHASED FRESH TOMATOES, LETTUCE AND CUCUMBERS PER HOUSEHOLD, UNITED STATES AND NORTH CENTRAL REGION, 1965-1966

Crop	United States	North Central Region	North Central/ United States
	----------in pounds----------		---percent----
Tomatoes	.84	.71	.8452
Lettuce	1.23	1.29	1.0488
Cucumbers	.22	.20	.9091

SOURCES: USDA, 1972a; USDA, 1972b.

TABLE 34. PROJECTED PER CAPITA CONSUMPTION OF LEAF LETTUCE, NORTH CENTRAL REGION, 1980-1990

Year	Per Capita Consumption
	pounds
1980	2.73
1981	2.76
1982	2.79
1983	2.83
1984	2.86
1985	2.90
1986	2.93
1987	2.96
1988	3.00
1989	3.03
1990	3.07

Comparisons indicate differences between utilization as specified by food wholesalers and consumption estimates based on USDA data for consumption of fresh tomatoes, leaf lettuce and cucumbers. Food wholesalers' product flows were converted to per capita consumption of 6.51, 1.28 and 4.16 pounds of tomatoes, leaf lettuce and cucumbers, respectively, in 1980 (average weekly

flows x number of suppliers x 52 weeks ÷ population). These compare with consumption estimates using USDA data of 10.78, 2.73 and 3.71 pounds of tomatoes, leaf lettuce and cucumbers, respectively (Tables 32 and 34). The average of the two estimates, was used to project North Dakota consumption estimates for several reasons. First, some retail grocery stores and restaurants in North Dakota do not purchase fresh vegetables through the food wholesalers surveyed and either have their own distribution system or purchase produce from outside the state. Second, retail grocery stores may purchase locally grown outdoor produce during the summer months and greenhouse grown produce throughout the year. Produce moving directly from grower to retailer would not be included in the wholesalers' product flows. Third, the proximity of North Dakota in relation to production areas and the remainder of the North Central Region necessitates early harvesting, technical packaging and extended times in transportation which causes produce to become less palatable and less attractive to consumers. Finally, the heritage of North Dakotans is personified in their "meat-and-potatoes" eating habits.

The percent difference between the average per capita consumption estimates for the North Central Region (Tables 32 and 34) and food wholesaler product flows (Table 29) were multiplied by the North Central Region per capita consumption projections for 1981 through 1990 to determine projected per capita consumption estimates for North Dakota (Table 35). For example, per capita tomato consumption in the North Central Region was projected to be 10.78 pounds in 1980 (Table 32). Estimates from food wholesalers in North Dakota yielded per capital consumption of 6.51 pounds. The average of the two estimates was 8.645 pounds, or .8019 of the projected North Central Region consumption estimate. Therefore, .8019 was multiplied by the North Central Region per capita consumption estimates to arrive at North Dakota consumption estimates for tomatoes.

Per capita consumption of fresh tomatoes, leaf lettuce and cucumbers was projected to increase from 8.68, 2.03 and 4.01 pounds in 1981 to 9.03, 2.25 and 4.76 pounds in 1990, respectively (Table 35). Annual and seasonal consumption of fresh tomatoes, lettuce and cucumbers for North Dakota were based on estimates and projections of consumption for North Dakota. Per capita consumption estimates for North Dakota were multiplied by the North Dakota population estimates (Table 36) to determine annual purchases of fresh tomatoes, lettuce and cucumbers [i.e., for tomatoes in 1981, 8.68257 pounds (Table 35) x 655,960 (Table 36) = 5,695,420 pounds (Table 37)].

TABLE 35. PROJECTED PER CAPITA CONSUMPTION OF COMMERCIALLY PRODUCED FRESH TOMATOES, LEAF LETTUCE AND CUCUMBERS, NORTH DAKOTA, 1981-1990

Year	Tomatoes	Leaf Lettuce	Cucumbers
	pounds		
1981	8.68	2.03	4.01
1982	8.72	2.05	4.10
1983	8.76	2.08	4.18
1984	8.81	2.10	4.26
1985	8.83	2.13	4.35
1986	8.87	2.15	4.44
1987	8.91	2.18	4.51
1988	8.95	2.20	4.60
1989	8.99	2.23	4.69
1990	9.03	2.25	4.76

TABLE 36. NORTH DAKOTA POPULATION ESTIMATES, 1981-1990

Year	Population
1981	655,960
1982	659,483
1983	663,005
1984	666,528
1985	670,051
1986	672,908
1987	675,765
1988	678,622
1989	681,479
1990	684,336

SOURCE: Murdock and Ostenson, 1976.

Tomato consumption in North Dakota was projected to increase from 5,695,420 pounds in 1981 to 6,178,355 pounds in 1990 (Table 37). Over 43 percent of estimated consumption occurs in summer, followed by 27 percent in spring, 15 percent in fall and 14 percent in winter (Table 38). Leaf lettuce consumption was estimated at 1,329,645 pounds in 1981 and projected to

TABLE 37. PROJECTED SEASONAL AND ANNUAL CONSUMPTION OF PURCHASED TOMATOES, LEAF LETTUCE AND CUCUMBERS, NORTH DAKOTA, 1981-1990[a]

Year	Tomatoes					Leaf Lettuce					Cucumbers				
	Spring	Summer	Fall	Winter	Total	Spring	Summer	Fall	Winter	Total	Spring	Summer	Fall	Winter	Total
	pounds														
1981	1,545,737	2,481,495	854,313	813,876	5,695,420	334,406	339,458	321,375	334,406	1,329,645	822,204	887,980	493,322	427,546	2,631,053
1982	1,560,105	2,504,560	862,254	821,440	5,748,359	340,371	345,514	327,108	340,371	1,353,364	844,504	912,064	506,702	439,142	2,702,411
1983	1,575,754	2,529,683	870,903	829,680	5,806,021	346,381	351,614	332,883	346,381	1,377,259	866,993	936,352	520,196	450,836	2,774,377
1984	1,593,936	2,558,872	880,952	839,254	5,873,014	352,307	357,630	338,579	352,307	1,400,824	887,666	958,679	532,600	461,586	2,840,531
1985	1,606,059	2,578,334	887,652	845,637	5,917,681	358,406	363,821	344,440	358,406	1,425,072	910,528	983,370	546,317	473,475	2,913,690
1986	1,620,334	2,601,250	895,542	853,153	5,970,279	364,188	369,691	349,997	364,188	1,448,064	932,658	1,007,271	559,595	484,982	2,984,506
1987	1,634,672	2,624,269	903,466	860,702	6,023,109	370,007	375,597	355,589	370,007	1,471,199	952,907	1,029,140	571,744	495,512	3,049,302
1988	1,647,825	2,645,384	910,736	867,628	6,071,572	375,861	381,540	361,215	375,861	1,494,478	975,338	1,053,365	585,203	507,176	3,121,083
1989	1,662,284	2,668,596	918,727	875,241	6,124,847	381,622	387,388	366,751	381,622	1,517,382	997,925	1,077,759	598,755	518,921	3,193,359
1990	1,676,806	2,691,909	926,753	882,887	6,178,355	387,548	393,403	372,447	387,548	1,540,946	1,018,604	1,100,092	611,162	529,674	3,259,532

[a]Columns may not add to total due to rounding.

TABLE 38. SEASONALITY OF CONSUMPTION OF PURCHASED FRESH TOMATOES, LETTUCE AND CUCUMBERS PER HOUSEHOLD, NORTH CENTRAL REGION, 1965-1966

Season	Tomatoes		Lettuce		Cucumbers	
	Pounds	Percent of Total	Pounds	Percent of Total	Pounds	Percent of Total
Spring	.76	.2714	1.30	.2515	.25	.3125
Summer	1.22	.4357	1.32	.2553	.27	.3375
Fall	.42	.1500	1.25	.2417	.15	.1875
Winter	.40	.1429	1.30	.2515	.13	.1625
TOTAL	2.80		5.17		.80	

SOURCE: USDA, 1972a.

increase to 1,540,946 pounds in 1990 with consumption being relatively evenly distributed throughout the year. Cucumber consumption was projected to increase 24 percent from 2,631,053 pounds in 1981 to 3,259,532 pounds in 1990. In 1981, nearly 34 percent of consumption (887,980 pounds) would be consumed in summer, 31 percent (822,204 pounds) in spring, 19 percent (493,322 pounds) in fall and 16 percent (427,546 pounds) in winter.

Floriculture

Per capita consumption of carnations increased from 2.48 blooms in 1971 to 4.44 blooms in 1980 and was projected to increase to 6.23 blooms in 1990 (Table 39). Per capita consumption of standard chrysanthemums has declined from .77 blooms in 1971 to .53 blooms in 1980 and estimated to decline to .40 blooms in 1990, while per capita consumption of pompon chrysanthemums increased from 1.12 to 1.98 bunches over the same time period and was projected to increase to 2.87 bunches by 1990. Per capita consumption of roses remained relatively constant between 1971 and 1980 at 2.10 blooms and was projected to remain at 2.08 blooms through 1990.

Potted chrysanthemum consumption rose from .086 pots per capita in 1971 to .128 pots per capita in 1980 and were projected to increase to .177 pots per capita in 1990 (Table 40). Projected per capita consumption estimates of geraniums, hydrangeas and lilies were calculated as the average consumption for 1976 through 1980 since the data base was insufficient to make reliable

TABLE 39. ESTIMATED AND PROJECTED PER CAPITA CONSUMPTION OF CUT CARNATIONS, CHRYSANTHEMUMS AND ROSES, UNITED STATES, 1971-1990

Year	Carnations		Standard Chrysanthemums		Pompon Chrysanthemums		Roses	
	Estimated	Projected	Estimated	Projected	Estimated	Projected	Estimated	Projected
	blooms	blooms	blooms	blooms	bunches	bunches	blooms	blooms
1971	2.48		0.768		1.12		2.116	
1972	3.69		0.741		1.10		2.098	
1973	3.49		0.770		1.25		2.024	
1974	4.41		0.810		1.39		2.127	
1975	4.23		0.741		1.40		2.069	
1976	4.21		0.718		1.54		2.011	
1977	4.47		0.608		1.66		2.000	
1978	4.58		0.660		1.87		2.013	
1979	4.58		0.586		1.96		2.207	
1980	4.44		0.528		1.98		2.139	
1981		4.96069		0.547613		2.08705		2.08262
1982		5.11182		0.527726		2.18106		2.08264
1983		5.25781		0.508771		2.27231		2.08174
1984		5.40565		0.491324		2.36383		2.08266
1985		5.54850		0.474633		2.45268		2.08268
1986		5.68915		0.458879		2.54010		2.08284
1987		5.82729		0.443959		2.62595		2.08301
1988		5.96297		0.429812		2.71027		2.08318
1989		6.09624		0.416379		2.79310		2.08333
1990		6.22717		0.403614		2.87447		2.08348

TABLE 40. ESTIMATED AND PROJECTED PER CAPITA CONSUMPTION OF POTTED CHRYSANTHEMUMS, GERANIUMS, HYDRANGEAS, LILIES AND POINSETTIAS, UNITED STATES, 1971-1990

Year	Chrysanthemums		Geraniums		Hydrangeas		Lilies		Poinsettias	
	Estimated	Projected	Estimated	Projected	Estimated	Projected	Estimated	Projected	Estimated	Projected
	pots									
1971	0.086									
1972	0.093									
1973	0.098									
1974	0.103									
1975	0.100									
1976	0.124		0.225		0.013		0.0319		0.074	
1977	0.131		0.214		0.012		0.0350		0.093	
1978	0.127		0.218		0.015		0.0340		0.103	
1979	0.128		0.215		0.013		0.0320		0.102	
1980	0.128		0.227		0.012		0.0310		0.105	
1981		0.138935		0.22		0.013		0.0328		0.0954
1982		0.143483		0.22		0.013		0.0328		0.0954
1983		0.147881		0.22		0.013		0.0328		0.0954
1984		0.152325		0.22		0.013		0.0328		0.0954
1985		0.156624		0.22		0.013		0.0328		0.0954
1986		0.160855		0.22		0.013		0.0328		0.0954
1987		0.165011		0.22		0.013		0.0328		0.0954
1988		0.169094		0.22		0.013		0.0328		0.0954
1989		0.173103		0.22		0.013		0.0328		0.0954
1990		0.177042		0.22		0.013		0.0328		0.0954

projections. Projected per capita consumption of geraniums, hydrangeas, lilies and poinsettias for 1981 through 1990 were .220, .013, .033 and .095 pots, respectively.

Per capita consumption projections of bedding plants also were based on the average for the years 1976 through 1980 since the data base was insufficient to make reliable estimates. Per capita consumption of flowering and foliar bedding plants was held constant at .109 flats and .050 flats for vegetable bedding plants for the years 1981 through 1990 (Table 41).

TABLE 41. ESTIMATED AND PROJECTED PER CAPITA CONSUMPTION OF BEDDING PLANTS, UNITED STATES, 1976-1990

Year	Flowering & Foliar		Vegetable	
	Estimated	Projected	Estimated	Projected
	flats			
1976	0.089		0.055	
1977	0.109		0.052	
1978	0.117		0.040	
1979	0.113		0.046	
1980	0.119		0.048	
1981		0.109		0.05
1982		0.109		0.05
1983		0.109		0.05
1984		0.109		0.05
1985		0.109		0.05
1986		0.109		0.05
1987		0.109		0.05
1988		0.109		0.05
1989		0.109		0.05
1990		0.109		0.05

An attempt was made to determine consumption of floral products in North Dakota through a survey of retail florists. However, retail florists were unable to provide complete data on sales of specific floral products. Therefore, United States per capita consumption estimates and projections for cut flowers and potted and bedding plants (Tables 39, 40 and 41) were multiplied by the North Dakota population estimates (Table 36) to determine total consumption for North Dakota assuming that per capita consumption in

North Dakota was equivalent to the U.S. average. Total consumption of all cut flowers, potted plants and bedding plants in North Dakota were projected to increase between 1981 and 1990, except for standard chrysanthemums which were projected to decline by 23 percent over that time period (Tables 42, 43 and 44). Major increases were noted in cut carnations and pompon chrysanthemums.

TABLE 42. PROJECTED CONSUMPTION OF CUT CARNATIONS, CHRYSANTHEMUMS AND ROSES, NORTH DAKOTA, 1981-1990

Year	Carnations	Standard Chrysanthemums	Pompon Chrysanthemums	Roses
	blooms	blooms	bunches	blooms
1981	3,254,012	359,212	1,369,022	1,366,118
1982	3,371,160	348,026	1,438,372	1,373,464
1983	3,485,956	337,318	1,506,551	1,380,203
1984	3,603,018	327,482	1,575,557	1,388,154
1985	3,717,777	318,028	1,643,422	1,395,499
1986	3,828,272	308,783	1,709,251	1,401,560
1987	3,937,879	300,012	1,774,524	1,407,625
1988	4,046,605	291,680	1,839,251	1,413,689
1989	4,154,458	283,754	1,903,437	1,419,746
1990	4,261,475	276,207	1,967,104	1,425,802

Summary

North Dakota consumption projections for vegetables, cut flowers, potted plants and bedding plants were estimated for 1981 through 1990. The greatest increases in consumption were estimated to occur for cut pompon chrystanthemums, cucumbers, potted chrysanthemums and cut carnations--all over 30 percent. Consumption of cut standard chrysanthemums was projected to decline, while all other commodities were projected to increase nominally.

Model Greenhouse Design[3]

Preliminary engineering estimates and designs were prepared for a simulated two-acre greenhouse structure and were used to establish cost

[3]Ashley, Gary C. 1980. Utilization of Waste Heat From the William J. Neal Station for Commercial Greenhouses. Minneapolis: Ashley Engineering, Inc.

TABLE 43. PROJECTED CONSUMPTION OF POTTED CHRYSANTHEMUMS, GERANIUMS, HYDRANGEAS, LILIES AND POINSETTIAS, NORTH DAKOTA, 1981-1990

Year	Chrysanthemums	Geraniums	Hydrangeas	Lilies	Poinsettias
			pots		
1981	91,136	144,311	8,527.48	21,515.5	62,578.6
1982	94,625	145,086	8,573.28	21,631.0	62,914.7
1983	98,046	145,861	8,619.06	21,746.6	63,250.7
1984	101,529	146,636	8,664.86	21,862.1	63,586.8
1985	104,946	147,411	8,710.66	21,977.7	63,922.9
1986	108,241	148,040	8,747.80	22,071.4	64,195.4
1987	111,509	148,668	8,784.94	22,165.1	64,468.0
1988	114,751	149,297	8,822.09	22,258.8	64,740.5
1989	117,966	149,925	8,859.23	22,352.5	65,013.1
1990	121,156	150,554	8,896.37	22,446.2	65,285.7

requirements for a site located near Velva, North Dakota. A pipeline network was designed which was capable of moving warm waste water from a coal-fired electrical generating plant to the simulated two-acre greenhouse. The simulated greenhouse was designed to utilize this warm waste water as its primary heat source.

Description of Model Greenhouse

A two-acre production facility was designed as representative of what a prospective commercial grower would consider as an economically viable unit. The arrangement of the simulated two-acre greenhouse is shown in Figure 7. Each of the two greenhouses has an outside dimension of 144 feet by 288 feet, or 41,472 square feet each, and are connected by a covered walkway. The service building, connected by another covered walkway, contains 4,800 square feet.

Construction costs for the greenhouse were calculated for the following design. The greenhouse would be constructed in a rigid frame, gutter connected style with a free span width of 36 feet. It would be covered with double polyethylene with the potential to change to a rigid double skin in the future. The sidewalls and endwalls would be covered similarly and gutter height would be 10 feet.

TABLE 44. PROJECTED CONSUMPTION OF BEDDING PLANTS, NORTH DAKOTA, 1981-1990

Year	Begonias	Coleus	Geraniums	Marigolds	Pansies	Petunias	Other Flowering Foliar	Total Flowering and Foliar	Peppers	Tomatoes	Other Vegetable	Total Vegetable
	6-packs											
1981	62,027.6	18,608.3	198,488	124,055	18,608.3	186,083	415,585	861,144	49,622.1	124,055	43,419.3	379,407
1982	62,360.7	18,708.2	199,554	124,721	18,708.2	187,082	417,817	865,768	49,888.6	124,721	43,652.5	381,445
1983	62,693.8	18,808.1	200,620	125,388	18,808.1	188,081	420,048	870,393	50,155.0	125,388	43,885.6	383,482
1984	63,026.9	18,908.1	201,686	126,054	18,908.1	189,081	422,280	875,018	50,421.5	126,054	44,118.8	385,520
1985	63,360.0	19,008.0	202,752	126,720	19,008.0	190,080	424,512	879,643	50,688.0	126,720	44,352.0	387,557
1986	63,630.2	19,089.1	203,617	127,260	19,089.1	190,891	426,322	883,394	50,904.1	127,260	44,541.1	389,210
1987	63,900.3	19,170.1	204,481	127,801	19,170.1	191,701	428,132	887,144	51,120.3	127,801	44,730.2	390,862
1988	64,170.5	19,251.1	205,346	128,341	19,251.1	192,511	429,942	890,895	51,336.4	128,341	44,919.3	392,515
1989	64,440.7	19,332.2	206,210	128,881	19,332.2	193,322	431,752	894,646	51,552.5	128,881	45,108.5	394,167
1990	64,710.8	19,413.2	207,075	129,422	19,413.2	194,132	433,562	898,396	51,768.6	129,422	45,297.6	395,820

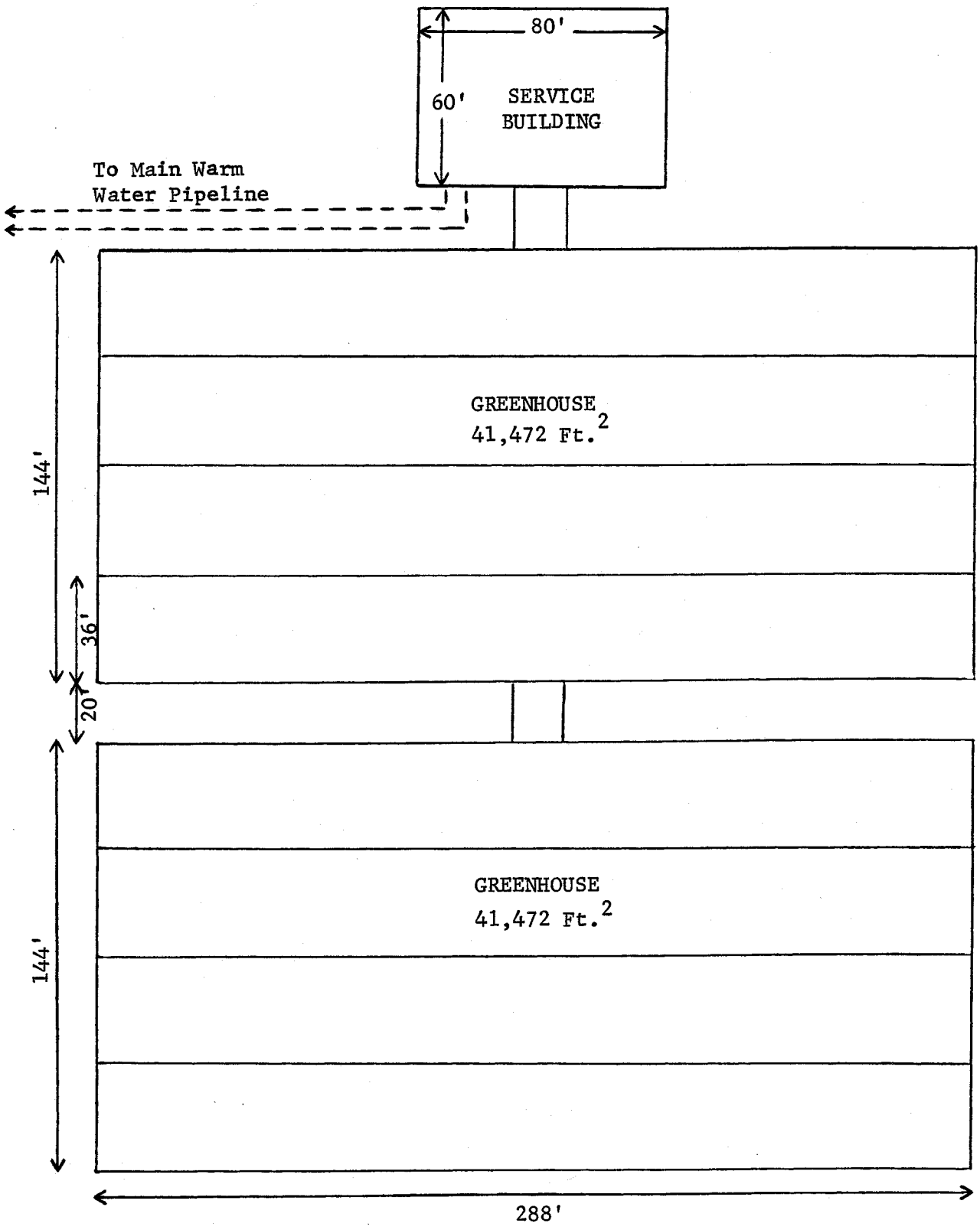

Figure 7. Simulated Two-Acre Greenhouse Design

The greenhouse site would be serviced with warm water for heating and would have a septic tank and drainfield for sewage, a well for irrigation and potable water, underground electric service and propane tanks for supplemental fuel supply. The site would be graded level and a compacted base established for the access roads and main entrance area parking. Several systems are included in the greenhouse: the greenhouse structure, heating system, back-up heating system, ventilation and evaporative cooling, electrical system and controls, domestic water and irrigation, service building and other optional items.

The primary greenhouse heating system consists of packaged centrifugal air handlers with two units located in each bay (36 feet by 288 feet) for a total of eight per acre. The packaged air handling units include multi-row (six or eight row) finned tube heat exchangers, inlet air dampers and filters, fans and motors. The air handling units are of the vertical casing design suitable for floor mounting (on a concrete pad usually) with top air discharge. The eight air handlers in the interior greenhouse bays would be rated to provide 400,000 Btuh/each, while the right units in the exterior bays would be rated to provide 500,000 Btuh/each.

The warm water from the power plant heats the greenhouse air through the use of the multi-row finned tube heat exchangers located in each air handler. The warm air from the air handler is discharged into a sheet metal duct that transitions to two standard 30-inch diameter polyethylene air distribution tubes which extend 144 feet, or one-half the length of each greenhouse bay. The warm air cools and returns freely through the growing space back to the air handler inlet.

Back-up heating is essential for a waste heat greenhouse because the warm condenser water is not always available. While several options exist for providing back-up heating, experience has shown that propane fired unit heaters may be the most cost-effective system that meets the design requirements. Propane fuel is selected because growers typically need a clean fuel for carbon dioxide production, and the capital cost of propane fired heating equipment is relatively modest.

The back-up heating system consists of eight propane-fired unit heaters per acre, two located in each greenhouse bay. The unit heaters are rated at 320,000 Btuh output each and are capable of maintaining the greenhouse at a minimum of 40°F. The back-up heating system can be designed to maintain

higher temperatures, if desired, by the addition of unit heaters. The back-up system also includes a 5,000-gallon propane storage tank and a vaporizer unit for the two-acre greenhouse.

Most greenhouse operations today have some means of mechanical exhaust ventilation and evaporative cooling systems. These systems are required to off-set the solar heat gains which occur during certain times of the year. The need for evaporative cooling depends on whether the crop grown can tolerate the peak temperature generated within the greenhouse. In Velva, this peak would result in a greenhouse air temperature of about 105° - 110°F, which is too high for most crops. For this reason, it is expected that an evaporative pad cooling system is a necessary part of the greenhouse.

Evaporative pad coolers are commercially available as either packed aspen fiber pads or as corrugated paper matrix systems, the latter being used most extensively today. The pads would be located along the north wall and 16 exhaust fans per acre would be located along the opposite wall. An automatic continuous louver admits cooling air into the pads, and the exhaust fans draw the evaporatively cooled air through the growing space. Included with the evaporative cooling pads are the necessary sump tanks, pumps and water piping.

Major electrical loads include the air handler motors, back-up heater motors and cooling fan motors. The total connected load for a two-acre greenhouse is in excess of 300 kilowatts, and a 1,200 Amp service entrance at 208V/3 phase is required. (Higher voltage electrical service could reduce wiring costs and is completely acceptable, but the present design and cost estimates are based on 208 Volt service.) Throughout the greenhouse, high voltage services are run in buried plastic conduits to service the air handlers, and overhead rigid conduit for all other equipment.

The control system designed for the greenhouse is made up of simple thermostats that provide on-off switching for heating and cooling system fans. In addition, a central panel which provides day-night switching and shows status of the heating and cooling systems also is included. All control wiring is 24 volt and control cable bundles are tie-wrapped to the greenhouse superstructure. While more sophisticated and flexible control can be achieved by the use of micro-processor based systems, the added cost is considered a grower option.

A standby electrical generating system is considered a necessary part of a commercial greenhouse operation. The system's primary function is to provide sufficient electrical power to drive emergency heating systems in the

event of electrical power loss. The system also can be used to provide the necessary power for operation of a cooling system in the event of a summer-time loss of electrical power.

The emergency electrical system is designed to provide power to the back-up heating system, the cooling system during the summer months and some accessory loads. Allowance was made for automatic load transfer of the back-up heating system to the emergency system and start-up of the emergency system in the event of a power outage. The cost estimates for the system were made using commercially available equipment. A design rating of 30 kilowatts is adequate to serve the needs of a two-acre greenhouse.

For adequate protection in the event of failures, the emergency system should be activated by several parallel alarm systems. Desirable parameters to monitor are: supply water temperature, greenhouse air temperature and power supply. The emergency electrical system is designed using a propane fired generator, automated load transfer and starting hardware, alarms and alarm interfaces.

Domestic water and irrigation water for the crops would be provided from a well and submersible pump system designed to supply 100 gpm of water for a two-acre greenhouse. The domestic water system includes the pump, pneumatic receiver tanks, water softener, water heater and domestic hot and cold water piping out to four convenience hose bibbs in each one-acre greenhouse.

The irrigation system includes a fertilizer injector, adjustable pressure regulator and all irrigation system header piping in each greenhouse. The irrigation system piping is suspended from the greenhouse superstructure and each bay is serviced with 1-1/2 inch drop pipes terminating in a 1-1/2 inch ball valve. The particular irrigation piping needed in each growing bed is not part of the present design and is treated as a grower option.

Construction Cost Estimates

The estimated capital cost for the two-acre greenhouse unit was based on vendor quotations for major equipment items and engineering cost estimates for other items (Table 45). All cost estimates are based on rates for materials and labor as of June 1981. All major equipment items including the greenhouse structure were bid to include freight to the jobsite.

The greenhouse structure was bid on the basis of vendor supplied labor for erection. This portion of the bid is $47,692 for one acre or about 30

TABLE 45. TWO-ACRE GREENHOUSE CONSTRUCTION COST ESTIMATES, NORTH DAKOTA, 1981

Item	Cost
Site preparation and services	$ 28,100
Greenhouse structure	295,400
Heating system	220,200
Back-up heating system	39,200
Exhaust fans	30,200
Evaporative cooling pads and louver	57,000
Electrical system and controls	77,800
Concrete work	10,000
Domestic water and irrigation	21,400
Service building	120,000
Service building: mechanical and electrical systems	20,200
Total	$919,500

percent of the cost of the greenhouse itself. Labor for all the other work required would average about 40 percent of the total cost or about $240,000 for a two-acre greenhouse. Since many commercial growers build portions of their greenhouses and related facilities themselves, it is possible that the actual cost to the grower-owner might be less than the present estimate due to the substitution of lower cost labor. A precise estimate is difficult, but a savings of $100,000 to $150,000 for a two-acre greenhouse is reasonable.

Several additional optional items are available to growers which are dependent on crops being grown in the structure. Costs for these optional items are shown in Table 46.

Pipeline Design and Cost Estimates

The preliminary design basis for the warm water pipeline was to use uninsulated ductile iron slip joint pipe buried beneath the soil surface. The warm water supply and return pipe would be placed side by side in a common trench. The system was designed to eliminate the need for pumping in the network and thereby simplify the operation of the pipeline.

TABLE 46. COST OF OPTIONAL GREENHOUSE ITEMS, NORTH DAKOTA, 1981

Item	Cost
	$/ft.^{2}
Soil heating	.50
Crop supports	.15
Bed irrigation pipes	.10
Cooler	.20
Drainage tiles	.10
Metal benches	1.50
Rigid double skin (Qualex)	3.25
Microprocessor	.50

The capital cost estimate of the required pipeline system capable of supporting a two-acre greenhouse was based on using ductile iron slip joint pipe and included clearing and stripping; trench excavation; supply, placement and compaction of bedding sand; pipe handling and installation labor; trench backfill; and restoration (Table 47). In addition to the unit costs used to estimate the installed pipeline cost, a separate estimate of the cost of valves, vaults, tap-ins, chlorine injectors, highway and railroad crossings and warm water service entrance piping and meters also was made. Because the pipeline cost estimates are based on preliminary designs, a contingency allowance of 25 percent also was included.

Cost and Benefit of Using Waste Heat

Waste heat cannot be considered free because there is an incremental cost associated with the delivery and use of waste heat. The capital cost of the delivery system is about $83,400 per acre of greenhouse serviced. This cost must be paid by the heat user, either as a one-time hook-up fee or amortized at prevailing interest rates over several years.

The incremental operating cost associated with waste heat use is comprised of extra electric power costs and the cost of supplemental fuel.

TABLE 47. WARM WASTE-WATER PIPELINE COST ESTIMATES, LOCATED APPROXIMATELY 1,500 FEET FROM COOLING TOWERS, CAPABLE OF SUPPORTING A TWO-ACRE GREENHOUSE, NORTH DAKOTA, 1981

Item	Cost
Pipeline	$ 53,000
Below grade valves	3,100
Vaults	7,600
Tap-in with valve	5,500
Chlorine injection	15,000
Highway and railroad crossing castings	32,100
Service entrances	5,000
Sub-total	121,300
Contingencies @ 25 percent	30,300
Sub-total	151,600
Engineering and construction supervision @ 10 percent	15,200
Total	$166,800

The benefit of using waste heat is the difference between the total cost of using waste heat as opposed to any other fuel that is readily available and practical for the grower to use.

The costs of heating a two-acre greenhouse in North Dakota with natural gas, No. 2 oil and waste heat were compared (Table 48). The comparison, based on fuel prices in effect in July 1981, indicated that the use of waste heat resulted in annual savings of $400 to $95,800 per year compared to natural gas and fuel oil, respectively.

Natural gas prices in the area are artifically low at present. If both gas and oil prices increase in the future, the benefit of waste heat will be more dramatic.

Estimated Costs and Returns From A Simulated Two-Acre Greenhouse Using Waste Heat

Estimates of operating and fixed costs associated with a two-acre greenhouse are presented in this section. Estimates of expected returns from

TABLE 48. COST COMPARISON OF CONVENTIONAL AND WASTE HEATING SYSTEMS FOR A TWO-ACRE GREENHOUSE, NORTH DAKOTA, 1981[a]

Item	Conventional Heating		
	Natural Gas	No. 2 Oil	Waste Heat
Fuel	$50,400[b]	$145,800[c]	--
Electricity	9,600	9,600	$24,400
Supplemental fuel	--	--	3,600
Waste heat charges			
Fixed[d]	--	--	29,600
Operating and maintenance	--	--	2,000
Total	$60,000	$155,400	$59,600

[a]Based on maintaining a space temperature of 60°F.
[b]Based on a price of $2.91 per MCF.
[c]Based on a price of $1.18 per gallon.
[d]Amortization based on 12 percent interest and 10 year life.

the sale of vegetables and floral crops also are included. A return on investment will be calculated under various production and marketing scenarios as a measure of the economic feasibility of operating a two-acre greenhouse facility in North Dakota.

The costs presented in this section are estimates for a potential North Dakota location. The returns from the sale of products were estimated from various sources, based on 1980 prices. Costs were estimated on the basis of 1981 prices.

Operating Costs

Operating costs, also called variable costs, change with the volume of finished product. Heating, cooling and electrical charges are normally allocated as operating costs that vary with output. These costs were allocated as fixed costs in this study, since it was assumed that the entire greenhouse would be heated or cooled throughout the year, regardless of the amount of space used and rotation of crops grown. Marketing costs, which

may vary between 7 and 18 percent of total costs, were excluded from the budgets since they are dependent on the market strategy of the firm. For example, marketing costs allocated to the greenhouse would be much lower for an operation which was directly tied to a retail outlet versus one which was selling to a number of wholesalers, retailers and consumers.

Operating costs were calculated specifically for tomatoes, leaf lettuce, cucumbers, cut carnations, cut chrysanthemums, cut roses, potted chrysanthemums, potted geraniums, potted hydrangeas, potted lilies, potted poinsettias and bedding plants (Tables 49 through 52). Operating costs were based on the cost per square foot of greenhouse assuming a space utilization of 75 percent for vegetables, potted plants and bedding plants; 65 percent for cut chrysanthemums and roses; and 63 percent for cut carnations.

TABLE 49. VARIABLE PRODUCTION COST ESTIMATES FOR GROWING GREENHOUSE TOMATOES, LEAF LETTUCE AND CUCUMBERS, PER CROP, 1981[a]

Item	Tomatoes	Leaf Lettuce	Cucumbers
	-----dollars per sq. foot of greenhouse area-----		
Plants	$.039	$.010	$.040
Production Supplies	.017	.007	.010
Labor and Fringe Benefits[b]	.527	.200	.345
Interest on Working Capital	.102	.050	.090
Packaging	.395	.240	.240
Total	1.08	.507	.725

[a]Excludes heating, cooling, electricity and marketing.
[b]Includes management and office workers.

SOURCE: Personal communication with growers.

Plant costs include those costs incurred in the growing of plants from seed to producing greenhouse stock and include seed, growing medium, containers, labor, etc. Production supplies include items such as fertilizer, insecticide, pesticide, containers, shade cloth, etc. Labor costs include wages, salaries and fringe benefits paid to labor, management and office

TABLE 50. VARIABLE PRODUCTION COST ESTIMATES FOR GROWING GREENHOUSE CUT CARNATIONS, CHRYSANTHEMUMS AND ROSES, PER YEAR, 1981[a]

Item	Carnations	Chrysanthemums	Roses
	dollars per square foot of greenhouse area		
Plants--Production Supplies and Packaging	$ .470	$ .520	$ .540
Labor and Fringe Benefits[b]	2.540	1.950	2.160
Vehicle Maintenance	.070	.090	.120
Office Expense	.010	.010	.020
Water	.052	.050	.030
Telephone	.020	.020	.030
Interest on Working Capital	.134	.134	.134
Total	3.296	2.774	3.034

[a]Excludes heating, cooling, electricity and marketing.
[b]Includes management and office workers.

SOURCE: Adapted from Fisher et al., 1976; Sullivan et al., 1980.

workers involved in the production and harvesting of the greenhouse produce. Packaging costs include labor and packaging material requirements for marketing greenhouse produce.

Fixed Costs

Fixed costs are those which do not vary with the level of output, such as amortization, insurance and property taxes. For purposes of simplicity, maintenance, heating, cooling and electrical charges also were calculated as fixed costs.

Waste-water heat, supplemental heat and electricity requirements were based on greenhouse requirements at the Velva location for 1981 and included a pipeline capable of supporting a two-acre greenhouse facility (Table 53). Property taxes were estimated at 2 percent of property value. Amortization was calculated at a 12 percent annual interest rate with a 10-year repayment period.

TABLE 51. VARIABLE PRODUCTION COST ESTIMATES FOR GROWING GREENHOUSE POTTED CHRYSANTHEMUMS, GERANIUMS, HYDRANGEAS, LILIES AND POINSETTIAS, PER CROP, 1981[a]

Item	Chrysanthemums	Geraniums	Hydrangeas	Lilies	Poinsettias
	--------dollars per square foot of greenhouse area--------				
Root Cuttings, Bulbs, or Seedlings	$ .851	$ .507	$ .655	$1.193	$1.056
Production Supplies	1.064	.762	.748	.682	.493
Labor and Fringe Benefits[b]	.909	.756	1.500	.770	.599
Office Supplies	.012	.009	.004	.004	.006
Plant Loss	.029	.006	.030	.027	.015
Interest on Working Capital	.331	.709	.333	.303	.164
Total	3.196	2.749	3.270	2.979	2.333

[a]Excludes heating, cooling, electricity and marketing.
[b]Includes management, office workers and harvesting.

SOURCE: Adapted from Sullivan et al., 1980.

TABLE 52. VARIABLE PRODUCTION COST ESTIMATES FOR GROWING GREENHOUSE BEDDING PLANTS, PER CROP, 1981[a]

Item	Cost Per Square Foot of Greenhouse Area
	dollars
Seed	$ .113
Production Supplies	.607
Labor and Fringe Benefits[b]	.661
Vehicle Maintenance	.012
Office Supplies	.004
Miscellaneous	.018
Plant Loss	.030
Interest on Working Capital	.083
Total	1.528

[a]Excludes heating, cooling, electricity and marketing.
[b]Includes management and harvesting.

SOURCE: Adapted from Sullivan et al., 1980.

TABLE 53. FIXED COST ESTIMATES FOR A TWO-ACRE GREENHOUSE USING WASTE HEAT, NORTH DAKOTA, 1981

Item	Cost
Waste and Supplemental Heat[a]	$ 35,000
Electricity	24,400
Property Taxes	18,000
Insurance	5,400
Maintenance	9,000
Amortization	160,000
Total	$251,800

[a]Includes amortization of waste heat delivery pipeline capable of supporting a two-acre facility.

Revenue Estimates

Revenue estimates were based on 1980 average price data (Table 54). Vegetable prices were obtained from regional greenhouse operators while cut flowers and potted plant prices were obtained from Minneapolis Ornamental Crops Wholesale Market Prices, 1980 (Federal-State, Minn., 1974-1981). Survey results revealed average prices received for bedding plants by growers in North Dakota (Table 28) were 164 to 178 percent higher than those received by Minnesota growers (USDA, ESS, 1977-1981). It appears unrealistic to assume that growers in North Dakota would receive a price so much higher than adjacent Minnesota growers, especially considering the potential output of the two-acre reference greenhouse. Therefore, a more conservative price estimate was used to estimate revenue. Average prices received by Minnesota growers in 1980 plus 25 percent ($6.75 per flat for flowering and foliar bedding plants and $6.95 per flat for vegetable bedding plants) were used to estimate revenue.

The Linear Programming Model

Linear programming (LP) is a mathematical planning method that may be used to choose among a large number of alternatives. The programming procedure was

TABLE 54. AVERAGE PRICES FOR FRESH VEGETABLES, CUT FLOWERS, POTTED PLANTS AND BEDDING PLANTS, 1981

Crop	Price
	$/Unit
Vegetables	
Tomatoes	
No. 1	.89/pound
No. 2	.55/pound
Leaf Lettuce	.27/pound
Cucumbers	.41/pound
Cut Flowers	
Carnations	.23/bloom
Chrysanthemums	
Standard	.79/bloom
Pompon	2.76/bunch
Roses	.45/bloom
Potted Plants	
Chrysanthemums	3.66/pot
Geraniums	.93/pot
Hydrangeas	2.50/pot
Lilies	3.13/pot
Poinsettias	4.13/pot
Bedding Plants	
Flowering and foliar	.563/6-pack
Vegetable	.579/6-pack

SOURCES: Federal-State, Minn., 1974-1981; interviews with growers; USDA, ESS, 1980; USDA, ESS, 1977-1981.

designed to specify the utilization of greenhouse space which would yield maximum profit for a two-acre facility given the constraints, such as anticipated price, yield and cost of production. The model assumed that the greenhouse facility was in operation during 1981.

A major assumption (constraint) in this model was that the total two-acre greenhouse area would be heated or cooled for the entire year although, at any time, the greenhouse space may not be fully utilized. This constraint was included because of the numerous crop rotations that are available. Since some crops would be produced in months of more than one calendar year, allocation of heating and cooling costs on a crop basis was nearly impossible. Therefore, heating and cooling costs were combined with other fixed costs in the LP model and the horticultural crop budgets were used for the respective variable costs.

Production Cycles

Twenty-four time periods were included in the LP model because of the rotational considerations for the different horticultural crops. Production cycles and output of salable product were defined for each crop (Table 55).

Tomato production included 70 percent "firsts," 28 percent "seconds" and 2 percent "culls." Four different rotations were included for tomatoes--August 16-December 15, March 1-July 15, March 15-December 31 and November 1-May 15. Leaf lettuce crops could be produced every six weeks. Twenty-four different production periods were possible since lettuce can be produced year-around. Two different cucumber production rotations were included in the LP model--February 16-August 15 and August 16-February 15.

Carnations, standard chrysanthemums, pompon chrysanthemums and roses normally are grown throughout the year, so production cycles were included to allow for year-around production.

Potted chrysanthemums require 10 weeks of production time. Twenty-four different production periods were included in the LP model for chrysanthemums since potted mums are sold throughout the year, while other potted plants have a limited marketing period, usually around certain holidays. Potted geraniums were produced from April 1-May 16 while hydrangeas were produced either from January 16-April 15 or February 16-May 15. Potted lilies were planted December 16 and harvested for Easter while potted poinsettias were started August 1 for pre-Christmas harvest.

Flowering and foliar bedding plants were started March 1 while vegetable bedding plants were started March 16. Both flowering and foliar and vegetable bedding plants were marketed on May 15.

Parameters of the Linear Programming Model

Plant-specific operating costs, fixed costs, product prices, production cycles and production output were programmed into the LP model. The LP model was used to select the commodities which would result in the highest profitability to the greenhouse, given the production and cost constraints. Four production scenarios were performed, based on the greenhouse firm's

TABLE 55. PRODUCTION CYCLES AND PRODUCTION OUTPUT OF FRESH VEGETABLES, CUT FLOWERS, POTTED PLANTS AND BEDDING PLANTS

Crop	Production Cycle	Production of Saleable Product Per Square Foot of Greenhouse Area
Vegetable		
Tomatoes	4-10 months	1.5-2.25 lbs.[a]
Leaf Lettuce	1 1/2 months	2.46 lbs.[a]
Cucumbers	6 months	.8-1.6 lbs.[a]
Cut Flowers		
Carnations	18 months	14.75 blooms[b]
Chrysanthemums		
Standard	24 months	6.05 blooms[b]
Pompon	24 months	1.03 bunches[b]
Roses	4-7 years	16.07 blooms[b]
Potted Plants		
Chrysanthemums	2 1/2 months	1.45 pots[a]
Geraniums	1 1/2 months	3.11 pots[a]
Hydrangeas	3 months	.73 pots[a]
Lilies	4 months	1.33 pots[a]
Poinsettias	4 1/2 months	.72 pots[a]
Bedding Plants		
Flowering & Foliar	2 1/2 months	5.36 6-packs[a]
Vegetable	2 months	5.36 6-packs[a]

[a]Per crop.
[b]Per year.

SOURCES: Interviews with growers; USDA, ESS, 1977-1981.

ability to capture either 10, 20, 25 or 33 percent of the North Dakota market. Different market shares were used so the effect of changes in market shares on the firm's profitability could be determined. The model was run so that for each specific scenario, only a maximum of that percentage of the North Dakota market could be produced for each specific crop. For example, given the 10 percent market share, a maximum of 569,542 pounds of tomatoes [5,695,420 pounds (Table 37) X 10 percent] could be produced, 132,965 pounds of leaf lettuce [1,329,645 pounds (Table 37) X 10 percent], etc.

The LP model was constructed so that profitability for each and every commodity was computed simultaneously and calculated as follows. Plant-specific operational costs were subtracted from revenues (price X output). The crop was retained in the model if revenue exceeded operating costs. (Fixed costs were carried as a one line value, regardless of crops selected by the model.) Corresponding production cycles then were included for each commodity with a positive return. A restraint was included so that a maximum of 87,120 square feet (two-acres) was available for greenhouse production. Only a maximum of 10, 20, 25 or 33 percent of total consumption in North Dakota for each crop could be produced in the greenhouse, depending on which scenario was being performed at the time. The crop with the highest net return was selected first by the model up to the maximum production possible or until all available greenhouse space was utilized, the crop with the second highest net return was selected next, up to the maximum production allowed or until all available greenhouse space was utilized, etc.

Although one crop may have a higher return than others, the production cycle of the first may be longer than others. It may be possible, in such an instance, to raise two or more other crops which will yield a higher net return. For example, tomatoes yield a higher net return per crop than does leaf lettuce. However, since numerous leaf lettuce crops can be grown in the same amount of time that it takes to produce one tomato crop, leaf lettuce becomes the more profitable crop to grow. At this point, the model reevaluated its solution, taking this parameter into account. The final solution, therefore, included not only the maximum profit possible but also the most efficient use of available greenhouse space.

The LP model also provided a sensitivity analysis, which is a mathematical technique used to explore the effect of changes in the parameters of the optimum solution. Sensitivity analysis was used to indicate how sensitive the price structure of commodities was to changes in production output, also known as shadow prices. The shadow price provided an estimation of the price that would be required for a given crop currently not in the solution before it would be grown. The shadow price also provided an estimation of the price at which a crop included in the optimum solution would be either included at a lower level of production or excluded from the solution. In essence, shadow prices indicated how sensitive production was to changes in price.

Results

A net loss of $111,490 would occur if only a 10 percent market share could be obtained, resulting in a negative return on investment of 12.13 percent (Table 56). A total revenue of $348,260 was generated with a total cost of $459,750.

Production included tomatoes, leaf lettuce, cut and potted chrysanthemums, cut roses, potted lilies and flowering and foliar and vegetable bedding plants. Each of these crops was produced at its market limit, except for tomatoes which were at 23 percent of their market limit. Cut carnations and leaf lettuce were the most sensitive to changes in price. Leaf lettuce production would decrease if the price fell from $.27 per pound to $.21 per pound. [Actual crop prices are included in parentheses immediately following the respective crop under "Shadow Price" (Table 56).] The shadow price for crops not presently grown in the greenhouse indicated the minimum price that would be needed before the crop would be produced in the greenhouse. For example, the price of cut carnations would have to increase $.04 per bloom to a price of $.27 per bloom before they would be produced in the greenhouse.

The greenhouse was fully utilized under the 10 percent market scenario except during January, February, May 16-31 and December 16-31 (Table 57). Tomatoes were produced during two different time periods--March 1 through December 31 and August 16 through December 15, while leaf lettuce was produced during five different time periods.

A loss of $29,398 would accrue to the greenhouse if a 20 percent market share could be obtained, with a negative return on investment of 3.20 percent (Table 56). A revenue of $554,214 would be generated with a total cost of $573,612. The crops produced were the same as those under the 10 percent market share scenario. Each crop was produced at its market share limit, except for tomatoes. The sensitivity of prices was the same as those under the 10 percent market share.

Tomatoes, leaf lettuce and potted chrysanthemums would be produced during two, five and two different production cycles, respectively (Table 57). Utilization of greenhouse space was lower under the 20 percent market share than the 10 percent market share scenario, even though the loss was less. The greenhouse was fully utilized in only 15 of the 24 production periods.

TABLE 56. RETURN ON INVESTMENT, PROFIT, REVENUE, COST,[a] PRODUCTION AND SHADOW PRICES FOR A TWO-ACRE GREENHOUSE GIVEN A 10, 20, 25 AND 33 PERCENT MARKET SHARE, NORTH DAKOTA, 1981

Item	Percent of Market Share			
	10	20	25	33
	----------percent----------			
Return on Investment	- 12.13	- 3.20	0.33	4.38
	----------dollars----------			
Profit	-111,490	- 29,398	3,031	40,254
Revenue	348,260	554,214	611,073	665,329
Total Cost	459,750	573,612	608,042	625,075
Variable Cost	207,950	321,812	356,242	373,275
Fixed Cost	251,800	251,800	251,800	251,800
Annual Production				
Tomatoes (pounds)	130,465	84,513	68,882	20,166
Leaf Lettuce (pounds)	130,610	261,220	326,526	435,368
Cut Chrysanthemums (blooms)	35,921	71,842	89,803	119,737
Cut Roses (blooms)	136,612	273,224	341,530	455,373
Potted Chrysanthemums (pots)	9,114	18,228	22,784	30,379
Potted Lilies (pots)	2,152	4,304	0	0
Vegetable Bedding Plants (6-packs)	37,941	75,882	94,852	126,469
Flowering and Foliar Bedding Plants (6-packs)	86,114	172,228	178,636	82,528
Shadow Prices	----------dollars----------			
Vegetables				
Tomatoes				
($.89/pound for #1)	.81	.81	.81	.81
($.55/pound for #2)	.35	.35	.35	.35
Leaf Lettuce ($.27/pound)	.21	.21	.21	.22
Cucumbers ($.41/pound)	.82	.82	1.01	1.08
Cut Flowers				
Carnations ($.23/bloom)	.27	.27	.33	.34
Chrysanthemums-standard ($.79/bloom)	.57	.57	.71	.74
-pompon ($2.76/bunch)	3.34	3.34	4.22	4.34
Roses ($.45/bloom)	.23	.23	.29	.29
Potted Plants				
Chrysanthemums ($3.66/pot)	2.20	2.20	2.20	2.24
Geraniums ($.93/pot)	1.07	1.07	1.36	1.00
Hydrangeas ($2.50/pot)	5.28	5.28	6.52	6.08
Lilies ($3.13/pot)	2.67	2.67	3.36	3.29
Poinsettias ($4.13/pot)	--	--	--	--
Bedding Plants				
Vegetables ($.58/6-pack)	.39	.39	.56	.56
Flowering and Foliar ($.56/6-pack)	.39	.39	.51	.52

[a]Excludes marketing costs.

TABLE 57. SPACE UTILIZATION FOR A TWO-ACRE GREENHOUSE GIVEN A 10, 20, 25 AND 33 PERCENT MARKET SHARE, BY CROP, NORTH DAKOTA, 1981

Crop and Production Cycle	Percent of Market Share			
	10	20	25	33
	square feet			
Tomatoes				
March 1-December 31	47,919	0	0	0
August 16-December 15	27,763	49,525	51,024	14,937
November 1-March 15	0	8,718	0	0
Leaf Lettuce				
January 16-February 28	0	36,954	17,615	9,250
February 1-March 15	7,079	0	17,696	8,791
April 16-May 31	1,618	0	0	0
May 1-June 15	0	3,236	0	0
May 16-June 31	18,477	0	28,703	38,992
June 1-July 15	0	55,007	22,301	0
July 1-August 15	18,477	0	28,703	38,992
July 16-August 31	0	2,272	0	24,054
September 1-October 15	0	8,718	0	0
October 1-November 15	0	0	0	24,054
November 16-December 31	0	0	0	24,054
December 16-January 31	7,443	0	17,696	8,791
Cut Chrysanthemums				
January 1-December 31	5,937	11,875	14,843	19,791
Cut Roses				
January 1-December 31	8,501	17,002	21,253	28,337
Potted Chrysanthemums				
January 1-March 15	0	0	0	14,804
June 1-August 15	6,286	0	0	0
June 16-August 31	0	3,236	0	0
December 16-March 15	0	9,335	15,713	6,147
Potted Lilies				
December 16-April 15	1,618	3,236	0	0
Bedding Plants				
Flowering and Foliar				
March 1-May 15	16,066	32,132	33,328	15,397
Vegetable				
March 16-May 15	7,079	14,157	17,696	23,595
Total				
January 1-15	23,499	50,166	69,505	77,870
16-31	23,499	87,120	87,120	87,120
February 1-15	23,135	87,120	87,120	87,120
16-28	23,135	87,120	87,120	87,120
March 1-15	87,120	72,963	87,120	87,120
16-31	87,120	87,120	87,120	87,120
April 1-15	87,120	87,120	87,120	87,120
16-30	87,120	83,884	87,120	87,120
May 1-15	87,120	87,120	87,120	87,120
16-31	82,452	32,113	64,799	87,120
June 1-15	87,120	87,120	87,120	87,120
16-30	87,120	87,120	87,120	87,120
July 1-15	87,120	87,120	87,120	87,120
16-31	87,120	34,385	64,799	87,120
August 1-15	87,120	34,385	64,799	87,120
16-31	87,120	83,910	87,120	87,120
September 1-15	87,120	87,120	87,120	87,120
16-30	87,120	87,120	87,120	87,120
October 1-15	87,120	87,120	87,120	87,120
16-31	87,120	78,402	87,120	87,120
November 1-15	87,120	87,120	87,120	87,120
16-30	87,120	87,120	87,120	87,120
December 1-15	87,120	87,120	87,120	87,120
16-31	71,418	50,166	69,505	87,120

Twenty-five percent of the total North Dakota market would be required before the greenhouse would be profitable. A return on investment of .33 percent would be realized at a 25 percent market share with total cost and revenues of $608,042 and $611,073, respectively (Table 56). Crops produced at their market share limit would include leaf lettuce, cut chrysanthemums and roses, potted chrysanthemums and vegetable bedding plants. Tomatoes would be produced at 5 percent of their market share and flowering and foliar bedding plants at 83 percent.

The greenhouse would be fully utilized except for January 1-15, May 16-31, July 16-August 15 and December 15-31 (Table 57). One tomato crop, six leaf lettuce crops and one chrysanthemum crop would be grown.

A profit and return on investment of $40,254 and 4.38 percent, respectively, would accrue to the greenhouse under the 33 percent market share scenario (Table 56). Crops entering the solution were tomatoes, leaf lettuce, cut chrysanthemums and roses, potted chrysanthemums and flowering and foliar and vegetable bedding plants. All crops produced were at their market share limits except tomatoes and flowering and foliar bedding plants. Cut chrysanthemums, leaf lettuce and all bedding plants became quite sensitive to price. A reduction in price of up to $.05 would cause a decline in production of each of these crops.

The greenhouse would be fully utilized under the 33 percent market share scenario except for the first two weeks in January (Table 57). Tomatoes would be grown during only one production cycle, while leaf lettuce would be produced during eight production cycles.

Three additional models were constructed to determine the effect of changes in parameters on profitability of the greenhouse. The first two models were the same as the one previously discussed, except that production was limited to certain commodities.

The first model allowed for only vegetable production. Losses of $185,236, $176,890, $172,716 and $165,761 would occur annually under the 10, 20, 25 and 33 percent market share limit, respectively, for the two-acre reference greenhouse growing only vegetables.

The second model allowed for the production of cut flowers, potted plants and bedding plants. Losses of $149,722, $54,902 and $22,197 would occur under the 10, 20 and 25 percent market share limits, respectively. A profit of $11,156 would occur under the 33 percent market share limit scenario.

The final model was constructed the same as the first and allowed for the production of both vegetables and floriculture simultaneously. Labor costs associated with the construction of the reference two-acre greenhouse were reduced by one-half to simulate those associated with a grower who constructed the greenhouse utilizing local labor. (Total labor cost for construction was estimated at $301,670).

Total construction cost for the two-acre greenhouse would decline from $919,500 to $768,665 if half of the cost of construction labor could be saved. A loss of $83,652 would accrue under the 10 percent market share scenario, with a negative return on investment of 10.88 percent, while a profit of $1,560 would accrue under the 20 percent market share for a return on investment of 0.20 percent. A profit of $30,870 and return on investment of 4.02 percent would be realized if 25 percent of the North Dakota market could be obtained. Profit and return on investment of $68,092 and 8.86 percent, respectively, would be realized under the 33 percent market share scenario. Crops produced in the greenhouse and their production levels were the same as those in the first model (see Table 57).

Competitive Position of a Two-Acre Greenhouse in North Dakota

The competitive position of a two-acre greenhouse in North Dakota is an integral part of determining the overall feasibility of the project. The greenhouse operator must be aware of the competitive climate in which he or she is operating and must realize efficiencies not available to distant producers if the greenhouse is to operate profitably. Several factors will be discussed in this section of the report which will describe the situation faced by an operator of a two-acre greenhouse utilizing waste-water heat in North Dakota.

Location

Numerous advantages and disadvantages are inherent in the production of greenhouse grown commodities in North Dakota. North Dakota is sparsely populated and, as such, total consumption of greenhouse grown commodities is quite small compared to other states. Population of bordering states to the south and west of North Dakota also is sparse, while Minnesota is more heavily populated. Each of these states has greenhouses in operation. Transportation costs for locally grown greenhouse products throughout North Dakota and into

bordering states would be quite high. A relatively large market lies to the north in Canada. Not only would transportation costs be excessive but barriers to entry exist for that market, namely import duties.

The heritage of the people and the location of the state result in lower consumption patterns of fresh vegetables for residents compared to other parts of the nation. Much of the produce currently consumed in the state is picked before maturity and shipped long distances, resulting in a less palatable product. This also contributes to low consumption patterns. Locally grown produce may result in increased consumption due to improved flavor of the produce.

Energy costs have increased dramatically in recent years, contributing to high transportation costs. Some greenhouse operators are changing their production patterns to grow items that are expensive or difficult to ship long distances. Local producers can benefit from the cost advantage of being near consumers and avoiding transportation from a distance. However, advances in technology, both in packaging and transportation, have increased competition from distant and foreign producers. Producers may incur lower annual heating costs by utilizing waste-water heat. However, the cost savings may be completely offset by the higher capital investment costs.

Competition from Local Growers

Sixty-seven greenhouses were operating in North Dakota in 1981, with the majority being utilized for bedding plant production. Only three growers in the state produced vegetables. Thirty-four operators within 125 miles of Velva grew bedding plants, 13 grew potted plants, two grew cut flowers and two grew vegetables.

The majority of bedding and potted plants consumed in the state are either grown locally or in bordering states, while cut flowers and vegetables generally are shipped into the state. Nearly 17 percent of all bedding plants consumed in North Dakota would be produced under the 33 percent market share scenario in the two-acre reference greenhouse. It would appear unlikely that an operator could capture that magnitude of the market due to the proximity of other greenhouses in the state. Also, costs to transport bedding plants relatively long distances from the greenhouse may become prohibitive because of their bulky nature.

The same disadvantages would occur in the production of potted plants. Chrysanthemums were the only potted plant being produced in the two-acre reference greenhouse, accounting for one-third of North Dakota consumption. Four growers within 125 miles of Velva were producing potted chrysanthemums in 1981, accounting for 13 percent of North Dakota consumption. Again, it appears unlikely that an operator could capture that great a portion of the market, especially when transportation costs to relatively distant markets are considered.

Few growers within 125 miles of Velva and within the state were producing cut flowers and vegetables in 1981. Significant quantities of cut flowers and vegetables entered into the profit maximization solutions. Profit was maximized in the 33 percent market scenario where production of leaf lettuce, cut chrysanthemums and roses was at the maximum allowable limit. Competition from local growers growing these crops would not be as great as with those growing potted or bedding plants. However, the magnitude of the market share required to create a profit for the two-acre greenhouse is quite large and may be difficult to obtain.

Food Wholesalers' Attitudes

Fifteen of 16 food wholesalers in North Dakota expressed interest in purchasing locally grown vine-ripened produce. Food wholesalers were most concerned that the product be of higher quality than what is currently purchased, followed by a guaranteed supply. Price was not as important as had been expected, ranking fourth.

A grower interested in producing fresh vegetables would need to supply wholesalers with superior products the year around. However, if growers were motivated to maximize profit they would not be able to supply food wholesalers with greenhouse grown produce the year around (see Table 54).

Seasonality of Prices

Prices of vegetables generally are quite volatile throughout the year. Prices are generally highest in early spring and become depressed in the summer and early fall.

Prices for cut flowers react in a similar manner. Prices generally are highest in the winter and early spring months, followed by depressed prices during the remainder of the year.

The potential exists to increase profits by producing and selling commodities when the price is typically at its seasonal high. Conversely, growers may find it extremely difficult to retain their market share under this condition, since those who purchase from them expect to be supplied with products throughout the year.

Cost and Return

Construction and operating costs for a greenhouse have increased dramatically in recent years. Growers using conventional energy sources are finding it increasingly difficult to operate profitably. The use of waste-water heat may reduce the energy requirements of a greenhouse, but may be offset by additional capital costs.

A 25 percent market share would be required for the two-acre reference greenhouse to break even if construction of the greenhouse was contracted to private enterprises. The return on investment would be only 4.4 percent at 33 percent of the total North Dakota market. It would appear unrealistic to assume that a greenhouse operator would be able to capture that magnitude of the market. Even if the operator were able to do so, the return on investment would be very low compared to potential returns from other alternatives. An operator would also need to be diversified in production, growing vegetables, cut flowers, potted plants and bedding plants. If the greenhouse could be constructed at half the estimated labor construction cost, profitability would increase by four to five percentage points.

Summary

Numerous disadvantages detract from the feasibility of establishing a two-acre greenhouse utilizing waste heat in North Dakota. First, a large marketing area is required to distribute the commodities grown in the greenhouse to consumers, which results in increased transportation and operating costs to the greenhouse. Second, local growers currently supply the majority of potted and bedding plants consumed in the state. An additional operator would have to compete with existing growers for that market as well

as with distant growers for the cut flower and vegetable market. Third, food wholesalers require a high quality product with a guaranteed supply. A grower interested in maximizing profits would not grow vegetables year around.

Prices of potential greenhouse-grown commodities typically are quite volatile throughout the year. A grower attempting to sell a product during periods of high prices and not produce that product during low price periods may not be able to retain the market share required for the greenhouse to remain profitable.

Finally, large market shares are required before the greenhouse would generate a competitive return on investment, given current cost data. A return on investment of 4.4 to 8.9 percent is realized, given a 33 percent market share for North Dakota. When market shares fall below 33 percent, returns on investment deteriorate rapidly and become negative between 20 and 25 percent of the North Dakota market.

Economic Impact

The introduction of a greenhouse utilizing waste heat from a coal-fired electric generating plant near Velva, North Dakota will have numerous direct and indirect economic impacts on the local community. Economic impacts of the greenhouse would accrue to State Planning Region 2, where Minot is the major trade center. Direct expenditures in the local region would increase the region's level of business activity throughout the trade and service sectors of the economy.

Assumptions and Results

The impact of the greenhouse was estimated using the North Dakota input-output model. The input-output model can predict gross business volume at the state planning region level. Economic impact was calculated by multiplying the local expenditures by the corresponding sector multiplier (Table 58). How multipliers (or interdependence coefficients) were used can be illustrated for the household sector (this sector consists principally of wages, salaries and profits). Each dollar paid to the household sector will generate $.0674 to the agriculture, livestock sector; $.0266 to the

TABLE 58. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL FOR STATE REGIONS

Sector	Lvstk. (1)	Crops (2)	S&G (3)	Const. (4)	Tran. (5)	C&U (6)	W&MM. (7)	Ret. (8)	F,I,&RE (9)	B&PS (10)	P&SS (11)	HH (12)	Govt. (13)	Coal (14)	E. Gen. (15)	Pet. Exp./Ext. (16)	Pet. Ref. (17)
1. Ag. Livestock	1.2072	0.0774	0.0445	0.0343	0.0455	0.0379	0.1911	0.0889	0.0617	0.0384	0.0571	0.0674	0.0000	0.0375	0.0250	0.0159	0.0040
2. Ag. Crops	0.3938	1.0921	0.0174	0.0134	0.0178	0.0151	0.6488	0.0317	0.0368	0.0152	0.0229	0.0266	0.0000	0.0284	0.0321	0.0062	0.0016
3. Sand and Gravel Mining	0.0083	0.0068	1.0395	0.0302	0.0092	0.0043	0.0063	0.0024	0.0049	0.0043	0.0050	0.0000	0.0031	0.0019	0.0019	0.0045	0.0007
4. Construction	0.0722	0.0794	0.0521	1.0501	0.0496	0.0653	0.0618	0.0347	0.0740	0.0546	0.0787	0.0902	0.0000	0.0514	0.0320	0.1148	0.0168
5. Transportation	0.0151	0.0113	0.0284	0.0105	1.0079	0.0135	0.0128	0.0104	0.0120	0.0118	0.0100	0.0093	0.0000	0.0082	0.0046	0.0180	0.0063
6. Comm. & Util.	0.0921	0.0836	0.1556	0.0604	0.0839	1.1006	0.0766	0.0529	0.1321	0.1104	0.1192	0.1055	0.0000	0.0707	0.0374	0.0610	0.0166
7. Whls. Trade & Misc. Mfg.	0.5730	0.1612	0.0272	0.0207	0.0277	0.0239	1.7401	0.0452	0.0704	0.0237	0.0362	0.0417	0.0000	0.0617	0.0781	0.0097	0.0125
8. Retail	0.7071	0.8130	0.5232	0.4100	0.5475	0.4317	0.6113	1.2734	0.6764	0.4525	0.6668	0.7447	0.0000	0.3975	0.2254	0.1888	0.0452
9. Fin., Ins., Real Estate	0.1526	0.1677	0.1139	0.0837	0.1204	0.1128	0.1322	0.0577	1.1424	0.1084	0.1401	0.1681	0.0000	0.0767	0.0975	0.0888	0.0101
10. Bus. & Pers. Services	0.0562	0.0684	0.0430	0.0287	0.0461	0.0374	0.0514	0.0194	0.0766	1.0509	0.0455	0.0605	0.0000	0.0287	0.0200	0.0139	0.0055
11. Prof. & Soc. Services	0.0710	0.0643	0.0559	0.0402	0.0519	0.0526	0.0530	0.0276	0.0816	0.0497	1.1026	0.0982	0.0000	0.0491	0.0300	0.0210	0.0055
12. Households	1.0458	0.9642	0.8424	0.6089	0.7876	0.7951	0.7859	0.4034	1.2018	0.7160	1.0437	1.5524	0.0000	0.6630	0.3951	0.3206	0.0623
13. Government	0.0987	0.0957	0.0853	0.0519	0.2583	0.0999	0.0796	0.0394	0.1071	0.0774	0.0881	0.1080	1.0000	0.0603	0.0443	0.0280	0.0004
14. Coal Mining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.1582	0.0003	0.0000
15. Electric Generating	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
16. Pet. Exp./Ext.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0010	1.0981	0.0954
17. Pet. Refining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0168	0.0102	0.0000	1.0000
Gross Receipts Multiplier	4.4931	3.6851	3.0284	2.4430	3.0534	2.7901	4.4509	2.0871	3.6778	2.7133	3.4159	3.0783	1.0000	2.5452	2.1928	1.9245	1.2940

agriculture, crops sector; and so forth for the remaining sectors. The wages, salaries and profits will generate $1.5524 to the household sector (the $1.00 originally paid to the households plus an additional $.5524 of wages, salaries and profits induced via the multiplier process). The gross receipts multiplier is the total gross business volume that $1.00 of output for final demand will generate in gross business volume in all other sectors. Each sector of the economy has a different set of multipliers.

Economic impacts of a greenhouse were broken into two phases, construction and operation. The construction impact refers to the "one time" total gross business volume generated as a result of the construction of the greenhouse. Gross business volume generated from the operation of the greenhouse would take place each year the greenhouse is in operation. Gross business volume generated each year the greenhouse is in operation was assumed to be the same. The impact analysis was computed in terms of 1981 dollars.

Economic Impact Resulting From Construction Phase

Some of the expenditures for building materials and equipment was expected to occur out of state, so the multiplier effect would not apply to those expenditures. The remaining materials, equipment and labor were assumed to be available in State Planning Region 2. Local expenditures for the construction phase were to two sectors of the economy--construction and household. Local construction expenditures included greenhouse costs plus the two-acre capacity warm water pipeline with a cost of $166,800. Household expenditures were for labor during the construction phase. Local expenditures for construction of the greenhouse are presented in Table 59. These expenditures will generate a gross business volume to all sectors of the region's economy but the principal impacts will be in the construction, retail trade and household sectors. The economic impact in State Planning Region 2 would be a $1,685,000 increase in gross business volume (Table 60). Construction of the greenhouse would occur over a five-month time period. During this time, the peak construction workforce would reach 20 workers with an average workforce of 13 people. The increased level of business activity resulting from the greenhouse construction would provide employment for 28 indirect workers during this time period. The economic impact from the

TABLE 59. LOCAL EXPENDITURES BY ECONOMIC SECTOR RESULTING FROM CONSTRUCTION OF A TWO-ACRE GREENHOUSE, STATE PLANNING REGION 2, NORTH DAKOTA, 1981

Sector	Expenditure
Construction	$570,170
Household	95,400
Total	$665,570

TABLE 60. ADDITIONAL GROSS BUSINESS VOLUMES OF ECONOMIC SECTORS RESULTING FROM THE CONSTRUCTION OF A TWO-ACRE GREENHOUSE, NORTH DAKOTA, 1981

Resulting Increase in Gross Business Volume by Sector	Sector to Which Expenditure is Made		
	Construction	Household	Total
	----------$000----------		
Construction	599	9	608
Household	347	147	494
Other[1]	447	136	583
Total	1,393	292	1,685

[1]Includes agriculture (livestock and crops), sand and gravel mining, transportation, communications and public utilities, wholesale trade and miscellaneous manufacturing, retail trade, finance-insurance-real estate, business and personal service, professional and social service, government, coal mining, electric generation, petroleum exploration/extraction and petroleum refining.

construction of the greenhouse is nonrecurring and occurs only over the construction time period, regardless of the length of time.

Economic Impact Resulting From Operational Phase

The operational phase of a greenhouse will also have an impact on the local economy. Operational impacts differ from construction in that operational impacts occur annually and continue to take place as long as the greenhouse is in operation, while construction impacts occur only once. The majority of operational expenditures were in the local region resulting in an economic impact. A small amount of operational expenditures were out of state

so they had no impact on State Planning Region 2. Local expenditures during the operational phase were to the communication and public utilities sector; wholesale trade and miscellaneous manufacturing sector; retail trade sector; finance, insurance and real estate sector; business and personal service sector; and the household sector. The largest annual expenditure during the operational phase was $202,002 to the household sector for wages and salaries. Expenditures to the remaining sectors are presented in Table 61.

TABLE 61. LOCAL EXPENDITURES BY ECONOMIC SECTOR RESULTING FROM OPERATION OF A TWO-ACRE GREENHOUSE, STATE PLANNING REGION 2, NORTH DAKOTA, 1981

Sector	Expenditure
Communication and Public Utilities	$ 26,714
Wholesale Trade and Miscellaneous Manufacturing	13,003
Retail Trade	59,281
Finance, Insurance and Real Estate	5,400
Business and Personal Service	4,499
Households	202,002
Total	$310,899

The economic impact of the greenhouse during the operational phase would be an increase in gross business volume of $914,000 annually in the local region (Table 62). The retail trade and household sectors of the economy realize the largest increase in the level of business activity. Permanent employment at the greenhouse would be in the eight to twelve employee range. Increase in the level of business activity resulting from operation of the greenhouse would provide jobs for nine indirect workers. These local economic impacts of operating a greenhouse would occur annually for as long as the greenhouse is operational.

Summary and Conclusions

Summary

This study was designed to determine if a commercial greenhouse utilizing power plant waste heat as the primary heat source is feasible in North Dakota. An economic approach was used to identify present production

TABLE 62. ADDITIONAL GROSS BUSINESS VOLUME OF ECONOMIC SECTORS RESULTING FROM THE OPERATION OF A TWO-ACRE GREENHOUSE, NORTH DAKOTA, 1981

Resulting Increase In Gross Business Volume by Sector	Sector to Which Expenditure Is Made						
	Comm & P. Util.	Whls. Trade & Misc. Mfg.	Retail Trade	Fin. Ins. & Real Est.	Bus. & Pers. Serv.	Households	Total
	$000	$000	$000	$000	$000	$000	$000
Comm. & P. Util.	30	1	3	1	1	21	57
Whls. Trade & Misc. Mfg.	1	23	3	0	0	8	35
Retail Trade	12	8	78	3	2	150	253
Fin. Ins. & Real Estate	3	2	4	6	1	34	50
Bus. & Pers. Serv.	1	1	1	0	5	12	20
Households	21	10	24	6	4	314	379
Other[1]	7	13	14	2	1	83	120
Total	75	58	127	18	14	622	914

[1]Includes agriculture (livestock and crops), sand and gravel mining, construction, transportation, professional and social service, government, coal mining, electric generation, petroleum exploration/extraction, and petroleum refining.

and consumption for commodities, project market requirements to 1990, identify capital investment and operating costs, analyze the competitive position of a North Dakota based greenhouse and project direct and indirect benefits of greenhouse facilities on employment and income levels of the state and local economy.

A number of commodities were defined as suitable for greenhouse production in North Dakota. These included fresh vegetables (tomatoes, leaf lettuce and cucumbers), cut flowers (roses, carnations and chrysanthemums), potted plants (chrysanthemums, geraniums, poinsettias, hydrangeas and lilies) and bedding plants (petunias, pansies, marigolds, geraniums, begonias, coleus, tomatoes and peppers).

Numerous steps were taken to determine economic feasibility. National historic production areas and quantities of floriculture and vegetable commodities were described and import and export data were addressed. Historic consumption of vegetables and floriculture in the United States were estimated. Historic market channels were identified and price behavior patterns for selected commodities were analyzed to determine seasonal price patterns. Existing greenhouse operators in North Dakota were surveyed to determine their production, marketing channels and prices for products sold. Food wholesalers in North Dakota were surveyed to obtain information concerning their marketing channels, volumes and prices of selected fresh vegetables, and their attitudes toward purchasing locally grown vine-ripened produce. Consumption estimates of selected fresh vegetables and floriculture were used to project consumption for North Dakota to 1990.

Several specific points were considered to determine the feasibility of locating a two-acre greenhouse utilizing waste heat in North Dakota with the preceding material as a base. Variable production cost estimates were calculated for selected crops and fixed costs estimated for the two-acre greenhouse. A linear programming model was constructed and utilized to determine the most profitable mix of commodities to grow in the greenhouse. Income from the sale of products was estimated. The difference between costs and returns was calculated and a return on investment determined as a measure of feasibility.

Finally, the competitive position of a two-acre greenhouse in North Dakota was estimated as another measure of feasibility. Considerations such as marketing area, competition from local growers, anticipated prices and

estimated returns were discussed to determine the overall feasibility of the reference greenhouse in North Dakota.

Conclusions

This report will be of interest to business firms and individuals interested in the construction or expansion of greenhouse facilities in North Dakota. Those interested in reducing greenhouse heating costs should consider the process of utilizing waste heat as the primary energy source. This process is quite new in the industry; however, some firms do heat greenhouses with waste heat with apparent success.

Currently, the majority of fresh vegetables consumed in North Dakota are produced in Florida, Texas, California and Mexico, while cut flowers reaching the North Dakota market are shipped primarily from California and Colorado. Per capita consumption estimates indicate North Dakotans consume lower quantities of fresh vegetables than do consumers in other areas of the country. This may be due, at least in part, to the less palatable nature of nonvine-ripened produce currently imported into the state.

Price characteristics of selected vegetables and cut flowers were analyzed for an eight- to 11-year period, focusing on trends and seasonal patterns. Price projections were made one year beyond the study period to indicate price expectations based on historic trend and seasonal price behavior. Seasonality of prices varied the most for tea roses, followed by cucumbers and standard carnations. The least price seasonality was found in miniature carnations and extra large chrysanthmums. Seasonality and trends in prices were not analyzed for potted and bedding plants because of the highly seasonal nature of production for those plants.

Sixty-seven greenhouses were operating in North Dakota in 1980 with the majority being utilized for bedding plant production. Cut flower producers operated throughout the year, while bedding plant producers operated on the average less than six months. Cut flower growers also had the largest greenhouse production areas.

Most food wholesalers indicated an interest in purchasing locally grown vine-ripened produce. Higher quality product and a guaranteed supply were cited as the most important reasons for considering purchasing locally grown produce.

Resource costs required to produce selected horticultural commodities were estimated and presented in this study. A linear programming model was used to determine maximum profits for the two-acre reference greenhouse. Consumption, yield, price, cost of production and crop rotation data were included in the model. The model was run under four different production scenarios--10, 20, 25 and 33 percent of the available North Dakota market for each of the respective greenhouse products. The greenhouse would operate at a loss, given the 10 and 20 percent market share scenarios. An annual profit of $3,031 would be realized at a 25 percent share of the North Dakota market, while a 33 percent market share would yield a profit of $40,254 if construction of the greenhouse was on a turnkey basis. Return on investment, given the 25 and 33 percent market share scenarios, were .33 and 4.38 percent, respectively. Profitability of the greenhouse would be four to five percentage points higher if a grower constructed the greenhouse using local labor.

The economic impact of a two-acre greenhouse was determined. Construction of the facility would increase the gross business volume in State Planning Region 2 by $1,685,000 over the five-month construction period. The annual operating impact would result in an increase in gross business volume of $914,000 in State Planning Region 2 and would provide jobs for approximately eight to 12 direct employees and nine indirect workers.

Several factors detract from the feasibility of establishing an additional two-acre greenhouse in North Dakota. Extensive market areas and market shares would be required to sell the commodities grown in the greenhouse. A large share of the bedding and potted plant market in North Dakota is already supplied by local growers. Potential purchases of greenhouse-grown commodities may require a year-around supply, which could result in lower profits to the greenhouse. Finally, the return on investment is quite low, given current cost data.

Additional considerations merit further analysis. The horticultural commodities produced in the reference greenhouse may exceed the quality of those commodities currently imported into the state and, therefore, may command a higher price. An additional revenue of 10 percent would result in returns on investment of -8.34, 3.92, 6.98 and 11.61 percent under the 10, 20, 25 and 33 percent market share scenarios, respectively. Profitability of the greenhouse would increase by an additional four to five percentage points if a grower could attain a price 10 percent above those used in the analysis and construct the greenhouse using local labor.

Possibly, the greatest potential exists for greenhouse firms currently operating in North Dakota to expand or relocate by building facilities near a coal-fired electrical generating plant. These firms already have an established share of the market and are well aware of the potential for increasing sales of specific crops. This study will be of interest to these firms for initial construction and operating cost information. However, they should consider performing their own price and production conditions based on conditions that actually exist for their firm.

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Appendix A

United States Production of Fresh Tomatoes, Lettuce and Cucumbers, 1970 to 1980

APPENDIX TABLE A-1. PRODUCTION OF COMMERCIALLY GROWN FRESH TOMATOES, BY SEASON AND STATE, 1970-1980

Season and State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 cwt.										
Total[a]	18,179	17,784	19,892	19,516	19,919	20,928	21,683	19,719	22,062	23,046	24,575
Winter	1,368	1,696	2,349	1,769	2,380	3,131	2,817	1,059	2,240	2,583	3,725
Spring	4,253	3,813	4,744	4,517	4,494	4,348	5,668	5,622	5,989	6,670	6,631
Summer	8,591	8,423	8,544	8,531	8,666	8,537	8,407	8,126	8,534	8,044	8,190
Fall	3,967	3,852	4,255	4,699	4,379	4,912	4,791	4,912	5,299	5,749	6,029
Winter											
Florida	1,368	1,696	2,349	1,769	2,380	3,131	2,817	1,059	2,240	2,583	3,725
Spring											
Alabama	174	51	178	100	179	139	175	132	126	141	111
Arkansas	136	66	209	44	192	128	180	306	216	336	234
California	878	440	1,088	678	816	424	706	688	840	834	700
Florida	2,178	2,492	2,419	3,080	2,618	2,880	3,643	3,526	3,925	4,475	4,680
Louisiana	99	92	72	70	99	68	60	70	47	40	28
South Carolina	512	409	570	348	440	488	638	700	690	696	698
Texas	81	263	208	197	150	221	266	200	135	148	180
Summer											
Alabama	223	243	373	420	353	364	413	350	300	335	290
Arkansas	179	297	209	264	245	179	257	36	50	66	7
California	3,651	3,313	3,652	3,475	3,888	3,960	3,875	4,043	4,368	3,726	4,030
Colorado	60	59	75	60	80	65					
Connecticut	120	113	91	98	75	83					
Georgia	202	168	199	166	183	166	218	186	168	186	147
Illinois	78	80	82	65	69	74					
Indiana	230	242	299	308	242	238	247	216	238	266	200
Kentucky	57	73	80	70	89	70	58	52			
Maryland	247	238	234	238	220	200	216	212	204	225	232
Massachusetts	143	150	133	142	123	132	121	125	141	118	168
Michigan	410	399	410	483	396	387	409	390	371	370	352
Missouri	70	70	67	67	80	58					
New Jersey	570	618	604	575	576	546	578	553	528	528	540
New York	442	466	290	348	354	346	311	279	330	390	416
North Carolina	446	336	273	304	240	285	290	280	270	238	270
Ohio	215	201	192	180	204	156	168	95	112	112	91
Pennsylvania	294	294	252	250	253	257	276	299	294	286	252
South Carolina	128	184	162	162	112	116	189	105	206	264	392
Tennessee	242	264	308	253	284	284	305	312	334	315	330
Texas	189	191	174	182	168	148	164	281	270	294	220
Virginia	330	345	308	338	351	312	312	312	350	325	253
Washington	65	79	77	83	81	111					
Fall											
Alabama	16	46	41	15	27	25	33	21	30	40	20
California	2,248	1,972	2,046	2,711	2,228	2,478	2,080	2,461	2,317	2,451	2,415
Florida	1,643	1,740	2,080	1,908	2,068	2,328	2,678	2,400	2,944	3,218	3,534
Texas	60	94	88	65	56	81		30	8	40	60
Hawaii	55	43	33	40	49	48	47	60	70	62	75

[a]Hawaii production not included.

SOURCES: USDA, ESCS, 1980b; USDA, ESS, 1980; USDA, ESS, 1981; USDA, ERS, 1977.

APPENDIX TABLE A-2. PRODUCTION OF COMMERCIALLY GROWN FRESH LETTUCE, BY SEASON AND STATE, 1970-1980

Season and State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 cwt.										
Total[a]	46,484	47,317	48,672	50,478	51,338	53,554	53,869	56,169	60,159	61,191	61,750
Winter	11,497	11,010	11,832	12,180	13,611	12,864	13,588	13,590	14,342	14,231	15,117
Spring	12,040	12,616	12,406	12,517	12,424	14,443	14,354	14,286	15,700	17,291	17,189
Summer	11,840	12,927	12,223	12,712	13,415	13,547	13,082	14,546	16,425	15,086	15,730
Fall	11,107	10,764	12,211	13,069	11,888	12,700	12,845	13,747	13,692	14,583	13,714
Winter											
Arizona	2,612	2,516	2,880	2,347	3,751	2,117	2,532	2,800	3,720	3,314	4,125
California	8,090	7,446	7,902	8,625	8,473	9,269	9,753	9,612	9,108	8,943	8,930
Florida	224	301	267	560	646	690	828	688	779	1,290	1,360
Texas	571	747	783	648	741	788	475	490	735	684	702
Spring											
Arizona	2,546	2,867	1,686	2,034	1,584	2,679	1,734	1,776	1,348	2,040	1,125
California	8,722	8,975	10,090	9,594	10,010	11,000	11,772	11,704	12,928	14,030	14,707
Florida	78	143	173	296	304	347	388	406	828	840	990
New Jersey	241	255	232	298	272	255	289	272	245	231	241
New Mexico	420	342	195	295	254	162	171	128	351	150	126
North Carolina	33	34	30	--	--	--	--	--	--	--	--
Summer											
California	8,694	9,965	9,915	9,716	10,640	11,070	10,360	11,890	13,640	12,200	13,233
Colorado	902	780	841	1,175	1,034	968	1,224	1,011	1,161	1,320	943
Connecticut	38	33	31	31	33	30	--	--	--	--	--
Massachusetts	64	54	51	51	50	56	--	--	--	--	--
Michigan	263	328	255	273	263	195	238	238	273	255	216
New Jersey	166	157	70	78	111	95	108	105	80	80	93
New York	777	734	313	640	635	616	504	660	665	702	798
Ohio	138	143	121	138	112	91	98	105	144	88	81
Oregon	108	104	100	108	102	114	--	--	--	--	--
Texas	58	13	85	25	--	--	--	--	--	--	--
Washington	296	264	252	202	215	204	228	215	204	204	240
Wisconsin	336	352	189	275	220	108	322	322	258	237	126
Fall											
Arizona	3,263	3,451	3,710	4,016	3,158	3,356	3,410	3,465	3,378	3,580	3,230
California	6,304	5,914	6,960	7,375	7,320	7,800	7,755	8,820	8,673	9,500	9,163
Florida	132	165	188	204	250	257	336	345	432	338	465
New Jersey	187	122	178	153	160	180	288	220	154	168	180
New Mexico	860	770	710	903	704	753	832	600	703	640	518
Texas	361	342	465	418	296	354	224	297	352	357	158
Hawaii	56	50	48	57	56	78	86	98	103	94	99

[a]Hawaii production not included.

SOURCES: USDA, ESCS, 1980b; USDA, ESS, 1980; USDA, ESS, 1981; USDA, ERS, 1977.

APPENDIX TABLE A-3. PRODUCTION OF COMMERCIALLY GROWN FRESH CUCUMBERS, BY SEASON AND STATE, 1970-1980

Season and State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 cwt.										
Total[a]	4,440	4,291	4,664	4,166	4,602	4,782	5,030	5,573	5,843	5,819	6,011
Spring	1,721	1,436	1,800	1,562	1,629	1,776	2,239	2,254	2,258	2,413	2,403
Summer	1,757	1,683	1,536	1,577	1,595	1,679	1,641	1,800	1,773	1,863	1,977
Fall	962	1,172	1,328	1,027	1,378	1,327	1,150	1,519	1,812	1,543	1,631
Spring											
California	169	168	270	204	232	220	265	225	208	371	264
Florida	950	767	975	840	863	1,044	1,287	1,160	1,200	1,155	1,368
North Carolina	182	122	118	153	161	168	171	210	133	238	188
South Carolina	273	220	252	192	205	217	380	369	360	365	329
Texas	147	159	185	173	168	127	136	290	357	284	254
Summer											
California	362	362	311	364	390	378	345	364	345	420	376
Maryland	204	204	153	170	155	155	155	150	147	134	135
Michigan	147	137	114	130	140	150	140	168	147	152	144
New Jersey	247	224	230	218	210	202	218	225	218	238	255
New York	297	240	198	231	210	273	253	253	263	311	352
North Carolina	182	226	276	200	242	215	265	220	281	249	275
Texas	60	66	81	68	50	102	96	216	155	156	260
Virginia	258	224	173	196	198	204	169	204	217	203	180
Fall											
California	80	91	126	144	147	123	117	133	168	174	165
Florida	612	771	851	580	888	798	665	936	1,160	863	923
South Carolina	92	91	84	78	65	88	64	61	70	55	30
Texas	86	139	188	147	176	181	165	305	304	374	414
Virginia	92	80	79	78	106	137	139	84	110	77	99
Hawaii	38	35	38	40	37	37	48	43	47	47	45

[a]Hawaii production not included.

SOURCES: USDA, ESCS, 1980b; USDA, ESS, 1980; USDA, ESS, 1981; USDA, ERS, 1977.

Appendix B

United States Production of Floriculture, 1970 to 1980

APPENDIX TABLE B-1. PRODUCTION OF STANDARD CARNATIONS BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 blooms										
California	344,539	341,568	348,210	382,020	382,342	380,708	335,344	351,303	331,604	282,506	288,044
Colorado	152,221	146,722	148,447	165,091	163,717	154,823	136,621	129,510	119,698	113,898	79,850
Conneticut	5,173	4,833	4,631	3,857	2,063	1,983					
Illinois	5,717	4,551	4,030	2,573	2,132	1,591					
Indiana	2,708		2,466	2,507	1,806	1,433					
Iowa	813				269	244					
Maryland	2,615	2,075	1,405	1,225	1,044	975					
Massachusetts	23,289	17,067	14,580	11,140	9,403	5,549	5,853	3,851	1,603	1,238	752
Michigan	1,595	1,457	2,559	1,150	1,650	1,910					
Minnesota	1,171	1,035	724	918	526						
Missouri		2,596	2,338	1,423	1,435	1,210					
New Jersey	8,447	6,115	5,640	4,679	3,961	3,516					
New York	10,677	5,693	4,685	3,224	2,634	2,157					
North Carolina					5,048	3,101	5,579	4,964	2,369	2,414	4,493
Ohio	14,507	16,179	10,579	6,005	6,821	4,937	4,202	4,446	3,612	2,300	1,726
Pennsylvania	26,105	23,264	21,009	20,011	14,599	12,165	10,281	7,725	7,477	6,484	4,510
Tennessee	2,502	2,181	3,551	1,885	906	869					
Washington					98	127					
Wisconsin	2,058	1,875	913	1,818	536	535					
Unallocated	14,915	11,946	8,628	6,525	778	934					
TOTAL	619,052	589,157	584,395	616,051	601,768	578,867	517,880	501,799	466,363	408,840	379,375

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-2. PRODUCTION OF MINIATURE CARNATIONS BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 bunches										
California	1,028	1,032	1,482	1,607	2,028	2,260	2,984	2,976	2,940	4,303	4,246
Colorado	285	396	435	632	801	836	923	896	1,095	911	1,107
Connecticut	158	133	127	104	51	64	61	99	55	52	62
Florida					298	290	321	316	310	241	192
Illinois	14	33	35	24	23	12					
Indiana	2				8	12					
Iowa	2										
Maryland	10	5	6	7	7	6					
Massachusetts	254	219	218	271	278	273	256	222	252	175	105
Michigan	3	5	1	3							
Minnesota	5	4	3	26							
Missouri		16	10			7					
New Jersey	86	73	61	68	52	48					
New York	134	58	99	102	91	64					
Ohio	52	45	77	50	58	106	82	82	73	52	42
Pennsylvania	141	80	146	74	142	142	109	112	119	104	105
Wisconsin	4	4	10	10	2	2					
Unallocated	357	194	274	97	35	14					
TOTAL	2,539	2,293	3,302	3,001	3,874	4,136	4,736	4,703	4,844	5,838	5,859
BLOOMS[a]	93,943	84,841	122,174	111,037	143,338	153,032	175,232	174,011	179,228	216,006	216,783

[a]Thirty-seven blooms/bunch.

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-3. PRODUCTION OF POMPON CHRYSANTHEMUM BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 bunches										
California	9,956	12,644	75,093	82,404	17,420	17,606	18,506	21,362	23,727	22,969	24,422
Colorado	157	131	293	245	123	135					
Connecticut			1,739	1,083	312	247	467	147	137	132	140
Florida	11,829	11,899	7,390	5,073	11,362	10,616	10,484	8,955	8,696	7,641	6,278
Illinois	636	539	2,577	2,412	607	324	265	174	271	275	151
Indiana	317	291	3,447	3,096	261	304	291	255	229	186	122
Iowa	118	102	596	478	143	159					
Maryland	243	241	1,928	1,888	200	210					
Massachusetts	642	416	3,477	2,983	371	323	367	356	360	338	335
Michigan	309	295	1,065	877	353	681	305	259	302	223	198
Minnesota	431	485	743	627	446	537	389	645	412	411	374
Missouri	278	185	2,982	3,051	306	302	193	158	170	135	147
New Jersey	492	436	2,069	2,307	415	340	220	261	191	124	149
New York	1,461	1,465	4,672	4,160	855	744	520	603	580	516	527
North Carolina	869	925	7,590	7,357	838	788	502	463	263	238	203
Ohio	1,210	1,084	8,776	7,436	930	875	903	806	736	545	639
Oregon	114	93	134	132	135						
Pennsylvania	2,301	2,241	6,812	6,767	2,239	1,752	1,941	1,186	1,548	1,034	932
Tennessee	18	11	2,690	2,617	17	33					
Texas	73	96	1,244	1,330	66	273					
Washington	214	263	659	510	198	150					
Wisconsin	225	215	1,048	804	267	306	250	306	270	220	174
Delaware	31	28	120	81							
TOTAL	32,431	34,464	33,649	36,129	37,864	36,705	35,603	35,936	37,892	34,992	34,791

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-4. PRODUCTION OF STANDARD CHRYSANTHEMUMS BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 blooms										
California	81,465	80,518	75,093	82,404	88,687	93,328	99,275	72,378	90,181	82,201	73,169
Colorado	502	408	293	245	146	101					
Connecticut	1,389	1,565	1,739	1,083	794	559					
Florida	9,270	9,175	7,390	5,073	4,530	3,980	5,450	4,985	5,668	1,553	
Illinois	3,361	2,723	2,577	2,412	2,116	1,706	1,445	1,155	534	573	551
Indiana	3,228	3,490	3,447	3,096	2,708	1,762	2,071	1,644	1,485	1,310	1,125
Iowa	521	596	596	478	674	667					
Maryland	2,109	2,052	1,928	1,888	1,588	1,440	1,707	1,828	1,512	447	407
Massachusetts	4,127	3,167	3,477	2,983	2,412	2,341	1,774	1,721	1,545	1,355	841
Michigan	1,144	1,175	1,065	877	1,645	1,777	1,060	1,283	882	630	455
Minnesota	806	728	743	627	709	411					
Missouri	3,055	3,160	2,982	3,051	2,406	2,307	1,996	1,777	1,573	1,157	1,122
New Jersey	2,078	2,053	2,069	2,307	1,815	1,578	1,257	1,123	1,012	858	907
New York	4,952	5,215	4,671	4,100	3,050	2,711	2,520	2,596	2,337	1,773	1,902
North Carolina	6,130	6,784	7,590	1,351	8,973	6,550	6,233	6,774	5,082	5,048	3,748
Ohio	10,118	9,306	8,776	7,436	11,656	8,771	8,837	7,415	7,159	6,000	5,361
Oregon	257	207	134	132	165						
Pennsylvania	6,987	7,660	6,812	6,767	6,038	5,398	5,012	5,852	4,180	3,541	3,059
Tennessee	2,091	1,788	2,690	2,617	1,879	2,056	1,760	1,207	1,274	1,132	1,558
Texas	1,490	1,256	1,244	1,330	1,075	1,183					
Washington	764	676	659	510	429	232					
Wisconsin	1,177	880	1,048	804	547	472					
Delaware	67	95	120	81							
TOTAL	147,000	144,765	137,144	137,658	144,042	139,340	140,397	111,738	124,424	107,578	94,205

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-5. PRODUCTION OF HYBRID TEA ROSES BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 blooms										
California	123,102	134,071	133,262	108,823	137,503	137,270	146,858	145,793	150,650	178,947	177,070
Colorado	10,312	14,479	16,377	17,972	17,245	21,971	25,690	23,917	26,206	18,702	22,598
Illinois	18,694	14,472	14,741	20,730	16,830	17,041	15,030	14,759	12,387	13,507	10,084
Indiana	18,369				18,537	20,897	18,083	18,603	18,355	19,977	16,712
Iowa						2,391					
Maryland	1,534	1,280	1,433	1,215	1,077	1,120					
Massachusetts	17,161	14,440	17,144	17,166	19,708	13,483	12,636	10,575	12,514	13,651	10,565
Michigan	7,613	7,715	9,033	8,550	7,575	7,715	8,798	6,805	7,389	7,178	3,456
Minnesota	4,845	4,577	3,609	5,058	5,216	5,398	4,954	5,501	5,179	5,181	4,655
Missouri	2,379	2,206	2,091	2,019	1,692	1,773					
New Jersey	9,679	7,186	5,846	5,958	5,506	4,688	4,514	3,995	3,066	2,006	2,068
New York	18,923	16,261	16,870	19,402	18,459	18,851	16,476	17,899	17,205	15,924	17,563
North Carolina	2,403	1,853	2,096	2,280	2,618	2,640					
Ohio	10,443	9,245	9,593	9,497	10,369	10,893	8,804	11,343	11,445	11,005	11,425
Oregon					8,706	10,345					
Pennsylvania	28,468	31,531	31,251	30,876	29,230	26,097	22,473	21,233	20,909	23,428	17,942
Tennessee	2,649	2,933	2,078	1,682		894					
Texas				195							
Washington	4,068	5,908	5,830	4,954	5,151	4,034	3,776	3,547	3,174	3,091	2,451
Wisconsin	1,457	1,863	1,769	1,740	1,759	2,285					
Unallocated	26,614	38,421	36,573	39,243	11,980	8,036	19,492	17,137	18,327	15,227	18,104
TOTAL	308,713	308,441	309,596	297,355	319,161	317,828	307,584	301,107	306,806	327,824	314,693

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-6. PRODUCTION OF MINIATURE SWEETHEART ROSES BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 blooms										
California	33,597	33,514	37,657	32,673	36,955	34,797	34,526	41,138	42,512	53,734	50,017
Colorado	4,822	7,093	8,004	8,304	7,889				10,744	8,229	8,566
Illinois	11,157	7,454	5,235	6,030	7,759	6,917	7,201	5,795	4,231	4,520	2,387
Indiana	9,763				8,338	8,271	9,682	9,683	9,956	9,489	9,714
Iowa						286					
Maryland	644	580	546	432	411	505					
Massachusetts	9,185	8,944	9,432	9,635	8,930	9,114	6,174	6,537	5,401	7,020	8,889
Michigan	3,565	4,222	3,774	3,464	5,460	3,018	4,246	4,157	3,203	3,181	2,319
Minnesota	3,186	2,320	2,019	2,641	2,512	2,387	2,813	3,207	2,826	2,294	2,774
Missouri	1,105	1,060	605								
New Jersey	3,481	2,821	2,276	2,568	2,097	2,196	2,073	2,038			
New York	9,410	9,823	8,676	7,670	6,865	6,534	5,890	6,429	7,480	6,633	6,019
North Carolina	625	700	790	807	804	867					
Ohio	2,930	2,661	2,508	2,948	3,389	3,734	4,480	4,086	3,831	4,222	4,450
Pennsylvania	13,528	12,475	13,686	14,697	12,770	15,035	14,244	13,930	12,018	12,002	11,665
Washington	3,450	2,256	2,308	2,007	2,282	2,296	2,493	2,670	1,872	1,800	1,513
Wisconsin	1,071	864	834	912	878	912					
Unallocated	18,642	23,587	23,657	24,625	16,314	18,600	20,867	18,353	8,375	6,339	4,772
TOTAL	130,152	120,374	122,007	120,413	123,653	115,469	114,689	118,023	112,449	119,463	113,085

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-7. PRODUCTION OF POTTED CHRYSANTHEMUMS BY STATE, 1970-1980

State	Year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	000 pots										
California	3,064	3,921	4,251	4,634	5,218	4,774	6,559	7,623	7,274	7,729	9,251
Colorado	246	304	402	316	229	273	414	561	441	423	287
Connecticut	270	248	274	310	431	257	207	450	222	276	305
Florida	2,040	2,122	2,390	2,072	3,149	3,057	3,942	3,658	2,902	2,395	2,065
Illinois	679	675	819	1,090	1,034	1,052	1,040	1,160	1,177	1,240	1,187
Indiana	625	356	348	348	400	392	364	471	395	466	368
Iowa	442	491	662	607	584	538	545	576	532	517	456
Maryland	256	278	262		194	243	311	178	281	261	273
Massachusetts	332	371	369	414	503	391	609	421	402	562	762
Michigan	650	780	746	775	971	879	1,450	1,304	1,470	1,300	1,346
Minnesota	416	422	486	495	381	367	365	450	507	498	410
Missouri	610	609	637	879	751	822	846	723	1,418	1,346	1,346
New Jersey	284	435	592	360	254	450	560	697	412	426	775
New York	628	618	627	673	766	854	926	1,301	1,483	1,111	1,292
North Carolina	805	791	857	616	703	808	1,022	1,086	1,181	1,478	1,057
Ohio	1,425	1,207	1,690	1,572	1,516	1,826	2,050	2,251	2,388	1,970	2,015
Oregon	402	347	337	342	352						
Pennsylvania	640	768	889	983	1,036	1,083	1,079	1,157	996	1,645	954
Tennessee	345	411	432	495	446	355	342	431	696	440	446
Texas	1,447	1,374	1,331	1,915	1,769	1,857	2,786	2,861	2,479	2,795	2,946
Washington	409	472	502	503	399	514	488	506	438	484	399
Wisconsin	446	496	464	744	569	482	576	471	450	579	499
Delaware	15	8	6								
Unallocated				220							
TOTAL	16,117	17,504	19,141	20,595	21,655	21,274	26,481	28,336	27,544	27,941	28,439

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-8. PRODUCTION OF POTTED GERANIUMS BY STATE, 1976-1980

State	Year				
	1976	1977	1978	1979	1980
	000 pots				
California	308	579	795	984	1,236
Colorado	1,158	1,062	1,139	1,118	865
Connecticut	1,165	805	963	819	912
Georgia		598	632	366	550
Illinois	2,662	2,588	2,776	2,509	3,321
Indiana	1,595	2,365	1,927	1,639	1,926
Iowa	1,276	1,289	1,295	1,191	1,239
Massachusetts	5,755	3,183	3,125	3,631	3,111
Michigan	5,195	6,078	6,440	6,560	6,648
Minnesota	3,095	1,699	1,613	1,846	2,144
Missouri	971	965	856	1,037	1,058
New Jersey	2,131	2,337	2,033	1,806	2,499
New York	4,331	4,792	5,326	5,306	5,560
North Carolina	745	912	740	1,569	1,037
Ohio	8,752	8,172	9,257	8,480	10,082
Oregon	802	1,102	1,277	875	1,298
Pennsylvania	2,811	2,756	3,126	2,930	2,863
Texas	1,559	1,494	1,111	1,488	1,283
Washington	1,358	1,429	1,251	1,221	990
Wisconsin	2,323	1,731	1,710	1,675	1,618
TOTAL	47,992	45,936	47,397	47,050	50,240

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-9. PRODUCTION OF POTTED HYDRANGEAS BY STATE, 1976-1980

State	Year				
	1976	1977	1978	1979	1980
	----------	----------	000 pots	----------	----------
Alabama	61	52	52	34	48
Arkansas	46	58	48	47	46
California	295	208	355	464	370
Colorado	29	46	35	43	29
Florida	124	134	420	310	301
Georgia	56	59	61	61	48
Illinois	26	12	17	36	26
Indiana	45	50	44	52	65
Iowa	29	32	26	29	12
Kansas	128	18	12	23	23
Massachusetts	45	20	23	43	25
Michigan	58	66	65	72	60
Missouri	196	242	256	84	55
New Jersey	112	124	105	100	102
New York	149	146	270	167	215
North Carolina	136	84	124	156	96
Ohio	209	216	199		
Pennsylvania	119	98	67	31	31
Tennessee	32	78	95	61	61
Texas	276	308	217	289	289
Washington	23	24	32	25	25
Wisconsin	37	30	24	32	32
Unallocated	458	423	505	721	721
TOTAL	2,689	2,528	3,052	2,824	2,680

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-10. PRODUCTION OF POTTED LILIES BY STATE 1976-1980

State	Year				
	1976	1977	1978	1979	1980
	----------	----------	000 pots	----------	----------
Alaska	121	117	120	114	104
Arkansas	105	107	86	76	67
California	1,156	1,459	1,430	1,280	1,195
Colorado	177	199	177	99	139
Connecticut	127	123	86	96	110
Florida	259	329	352	374	303
Georgia	71	71	83	62	57
Illinois	597	524	380	381	341
Indiana	90	96	98	99	105
Iowa	182	209	191	148	158
Kansas	25	15	13	31	31
Maryland	67	84	104	91	80
Massachusetts	364	322	258	329	245
Michigan	570	603	579	560	536
Minnesota	204	282	286	296	277
Missouri	272	265	300	355	387
New Jersey	245	310	226	233	225
New York	253	345	375	338	414
North Carolina	131	169	234	177	171
Ohio	459	520	567	503	529
Oregon	68	129	151	130	114
Pennsylvania	385	373	354	298	302
Tennessee	54	107	107	132	123
Texas	283	296	218	259	368
Virginia	63	60	72	77	108
Washington	166	193	203	206	170
Wisconsin	313	282	290	278	248
TOTAL	6,807	7,589	7,340	7,030	6,907

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-11. PRODUCTION OF POTTED POINSETTIA BY STATE, FOR 1976-1980

State	Year				
	1976	1977	1978	1979	1980
	000 pots				
Alaska	271	312	508	336	351
Arkansas	165	217	229	192	198
California	2,069	3,509	3,531	3,933	3,892
Colorado	347	362	389	389	418
Connecticut	220	338	301	312	417
Florida	523	780	1,029	989	903
Georgia	184	352	454	440	472
Illinois	863	1,166	960	898	1,009
Indiana	304	338	387	335	466
Iowa	319	374	397	345	375
Kansas	166	129	131	426	431
Maryland	404	397	474	372	365
Massachusetts	634	741	750	751	760
Michigan	1,180	1,244	1,424	1,506	1,414
Minnesota	343	403	512	422	457
Missouri	449	567	468	601	607
New Jersey	666	799	935	894	1,247
New York	874	1,157	1,534	1,312	1,602
North Carolina	588	705	1,052	1,394	1,244
Ohio	1,678	1,955	2,249	1,725	1,905
Oregon	258	357	406	340	378
Pennsylvania	964	1,122	1,248	1,156	1,187
Tennessee	170	451	692	744	554
Texas	1,147	1,149	909	1,255	1,425
Washington	381	499	563	545	520
Wisconsin	505	546	690	608	586
TOTAL	15,672	19,969	22,222	22,230	23,183

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-12. PRODUCTION OF FLOWERING AND FOLIAR BEDDING PLANTS BY STATE, 1976-1980

State	Year				
	1976	1977	1978	1979	1980
	----------000 flats----------				
California	1,833	5,039	5,884	4,961	4,498
Colorado	478	469	570	559	575
Connecticut	602	625	645	597	619
Florida	894	1,410	813	1,065	1,151
Georgia	239	487	339	270	381
Illinois	803	758	811	924	759
Indiana	321	443	382	322	417
Iowa	199	222	176	228	253
Kansas	51	78	74	147	157
Maryland	680	481	620	579	456
Massachusetts	1,100	963	592	731	749
Michigan	3,475	3,583	3,852	3,998	4,268
Minnesota	384	628	567	654	695
Missouri	356	432	458	518	533
New Jersey	318	360	348	233	796
New York	1,233	1,268	1,442	1,114	1,544
North Carolina	343	350	633	528	618
Ohio	2,683	2,961	3,410	3,300	3,241
Oregon	401	316	317	296	267
Pennsylvania	867	662	756	695	1,245
Tennessee	103	235	283	260	410
Texas	500	636	743	1,265	1,008
Virginia	264	314	322	410	465
Washington	358	433	762	538	521
Wisconsin	486	414	598	512	561
TOTAL	18,971	23,567	25,397	24,704	26,187

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

APPENDIX TABLE B-13. PRODUCTION OF VEGETABLE BEDDING PLANTS, BY STATE, 1976-1980

State	Year				
	1976	1977	1978	1979	1980
	----------000 flats----------				
California	4,796	3,686	1,315	1,663	1,280
Colorado	119	134	161	166	125
Connecticut	383	363	316	306	458
Florida	136	394	272	459	596
Georgia	94	125	113	103	227
Illinois	280	251	326	319	295
Indiana	182	213	172	168	228
Iowa	111	107	107	160	152
Kansas	29	43	34	57	67
Maryland	196	190	185	196	1,152
Massachusetts	468	369	259	293	412
Michigan	1,288	1,281	1,237	1,589	1,427
Minnesota	168	282	188	195	311
Missouri	183	170	210	259	259
New Jersey	144	136	172	117	342
New York	589	551	651	621	699
North Carolina	196	182	274	331	389
Ohio	1,103	1,087	1,063	1,030	1,348
Oregon	125	156	138	145	118
Pennsylvania	421	290	344	311	415
Tennessee	57	165	167	147	214
Texas	296	441	493	901	587
Virginia	142	134	164	238	243
Washington	133	144	105	115	132
Wisconsin	204	192	215	183	197
TOTAL	11,843	11,086	8,681	10,072	10,673

SOURCES: USDA, ESS, 1972-1976; USDA, ESS, 1977-1981.

Appendix C

North Dakota Greenhouse Operator Survey

Date _____

Greenhouse Operator Survey
(Confidential Interview)

Firm _____ Address _____

Name of Respondent _____

1. Months operating greenhouses in 1980. (Circle appropriate months.)

J F M A M J J A S O N D

2. Number of greenhouses you operate _____

Dimensions of greenhouses _____ _____ _____

Structural Design

_____

_____

_____

_____

Site Setting: (Circle) North-South East-West Other _____

3. Hydroponics or soil (Circle).

4. Year firm was established _____

Type of Plant	Check if Grown	When Grown (Circle)	Sq. Ft. Area	Volume	Percent of Volume Supplied to: J W R I C*	Average Distance to Market J W R I C*	Price J W R I C*
<u>Vegetables</u>							
Tomatoes	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Cucumbers	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Lettuce							
Leaf	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Butterhead	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _

*J W R I C defined as jobbers; wholesalers; retailers; hotels, motels, restaurants and institutions; and consumers.

If not answered above, or if available:

Average Quarterly Prices

	Tomatoes	Cucumbers	Leaf Lettuce	Butterhead Lettuce	______	______	______
Jan-Mar	______	______	______	______	______	______	______
Apr-Jun	______	______	______	______	______	______	______
Jul-Sep	______	______	______	______	______	______	______
Oct-Dec	______	______	______	______	______	______	______

Type of Plant	Check if Grown	When Grown (Circle)	Sq. Ft. Area	Volume	Percent of Volume Supplied to: J W R I C*	Average Distance to Market J W R I C*	Price J W R I C*
Cut Flowers							
Tea Rose	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Sweetheart Rose	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Carnations							
(Mini)	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
(Std.)	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Chrysanthemums							
Standard	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Pom Pon	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Other	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	_____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _

*J W R I C defined as jobbers; wholesalers; retailers; hotels, motels, restaurants and institutions; and consumers.

If not answered above, or if available:

Average Quarterly Prices

	Tea Roses	Sweetheart Roses	Miniature Carnations	Standard Carnations	Standard Chrysanthemems	Pom Pon Chrysanthemums
Jan-Mar	________	________	________	________	________	________
Apr-Jun	________	________	________	________	________	________
Jul-Sep	________	________	________	________	________	________
Oct-Dec	________	________	________	________	________	________

Type of Plant	Check if Grown	When Grown (Circle)	Sq. Ft. Area	Volume	Percent of Volume Supplied to: J W R I C*	Average Distance to Market J W R I C*	Price J W R I C*
Bedding Plants							
Geraniums		JFMAMJJASOND					
Petunias		JFMAMJJASOND					
Pansies		JFMAMJJASOND					
Marigolds		JFMAMJJASOND					
Begonias		JFMAMJJASOND					
Coleus		JFMAMJJASOND					
Tomato Plants		JFMAMJJASOND					
Pepper Plants		JFMAMJJASOND					
Other		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					
		JFMAMJJASOND					

*J W R I C defined as jobbers; wholesalers; retailers; hotels, motels, restaurants and institutions; and consumers.

If not answered above, or if available:

Average Quarterly Prices

	Geraniums	Petunias	Pansies	Marigolds	Begonias	Coleus	Tomato Plants	Pepper Plants
Jan-Mar								
Apr-Jun								
Jul-Sep								
Oct-Dec								

Type of Plant	Check if Grown	When Grown (Circle)	Sq. Ft. Area	Volume	Percent of Volume Supplied to: J W R I C*	Average Distance to Market J W R I C*	Price J W R I C*
Potted Plants							
Chrysanthemums	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Geraniums	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Poisettias	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Lilies	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Hydrangeas	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
Other	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _
________	____	JFMAMJJASOND	______	______	_ _ _ _ _	_ _ _ _ _	_ _ _ _ _

*J W R I C defined as jobbers; wholesalers; retailers; hotels, motels, restaurants and institutions; and consumers.

If not answered above, or if available:

Average Quarterly Prices

	Chrysanthemums	Geraniums	Poinsettias	Lilies	Hydrangeas	______	______
Jan-Mar	______	______	______	______	______	______	______
Apr-Jun	______	______	______	______	______	______	______
Jul-Sep	______	______	______	______	______	______	______
Oct-Dec	______	______	______	______	______	______	______

Appendix D

North Dakota Food Wholesaler Survey

General Comments:

1. Source and Cost of Heat for Greenhouse in 1980.

Main Source	Annual Cost	Backup Source	Annual Cost
_____	_____	_____	_____

2. Was 1980 production significantly different from other years?

3. Plans for the future (expansion, quit business, change marketing strategy, etc.).

4. Problems facing the greenhouse industry.

5. Other Comments.

Date_____

FOOD WHOLESALER SURVEY
(Confidential Interview)

Firm_____ City_____

Name of Respondent_____

1. Type of Firm: Wholesaler _____
Food Broker _____

2. Major fresh vegetables you handle:

	Check if Supplied	Unit of Measurement	Volume by Quarter Jan-Mar	Apr-Jun	July-Sept	Oct-Dec
Tomatoes						
Cherry Tomatoes						
Cucumbers						
Lettuce						
Leaf						
Butterhead						
Asparagus						
Brussel Sprouts						
Watercress						

3. Source of supply and volume supplies of Tomatoes (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other States		Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Tomatoes.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Tomatoes (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

3. Source of supply and volume supplies of Leaf Lettuce (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other States _____	Other States _____	Local Outdoor	Local Indoor
Volume or Percent	_____	_____	_____	_____	_____	_____	_____	_____	_____
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Leaf Lettuce.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent	_____	_____	_____	_____
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25	_____	_____	_____	_____
26-100	_____	_____	_____	_____
100-200	_____	_____	_____	_____
200-300	_____	_____	_____	_____
Over 300	_____	_____	_____	_____

Alternative: Describe your market area.

5. Prices paid for Leaf Lettuce (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March	_____		
April - June	_____		
July - September	_____		
October - December	_____		
or Annual	_____		

3. Source of supply and volume supplies of Butterhead Lettuce (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other ____	States ____	Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Butterhead Lettuce.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Butterhead Lettuce (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

3. Source of supply and volume supplies of Cucumbers (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other States		Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Cucumbers.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Cucumbers (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

3. Source of supply and volume supplies of Asparagus (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other _____	States _____	Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Asparagus.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Asparagus (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

3. Source of supply and volume supplies of Brussel Sprouts (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other States		Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Brussel Sprouts.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Brussel Sprouts (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

3. Source of supply and volume supplies of Watercress (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other States		Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Watercress.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Watercress (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

3. Source of supply and volume supplies of Cherry Tomatoes (1980).

Supplied from:	Mexico	California	Florida	Texas	Arizona	Other _____	States _____	Local Outdoor	Local Indoor
Volume or Percent									
Months Supplied by Area	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND	JFMAMJ JASOND

4. To whom do you supply Cherry Tomatoes.

	Jobbers	Retail	Hotels/Restaurants/Institutions	Other
Volume or Percent				
Location of Sales Outlets (Volume or Percent)				
Miles				
0- 25				
26-100				
100-200				
200-300				
Over 300				

Alternative: Describe your market area.

5. Prices paid for Cherry Tomatoes (1980).

	Purchased Prices		
	High	Low	Yearly Average
January - March			
April - June			
July - September			
October - December			
or Annual			

6. Would you be willing to purchase locally produced vine-ripened fresh tomatoes, lettuce, and/or cucumbers from a local greenhouse?

Yes_____ No_____ Undecided_____

Explain: _____

_____

_____

7. What conditions would be necessary before you would change suppliers or add a new supplier?

	Rank in Order of Importance
Lower Price	_____
Higher Quality	_____
Guaranteed Supply	_____
Proximity of Suppliers	_____
Delivery of Suppliers	_____
Other _____	_____
_____	_____
_____	_____

8. What months of the year would you be interested in locally grown, vine-ripened fresh vegetables? (Indicate volume)

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Tomatoes												
Cucumbers												
Lettuce												
Leaf												
Butter-head												
Asparagus												
Brussel Sprouts												
Watercress												

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