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An Economic Analysis of Producing Carrots in the Red River Valley

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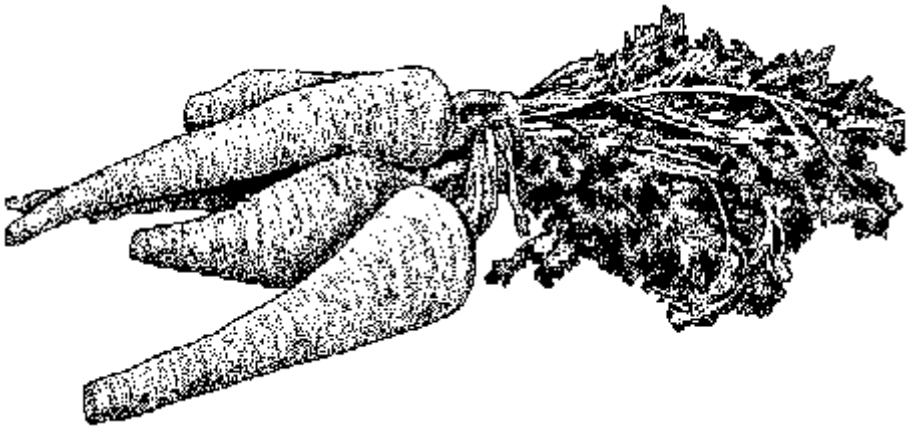

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Abstract

This report evaluates the U.S. carrot market using a quadratic programming algorithm. North Dakota ships carrots locally and to Minnesota under both the base and 1,000 acre scenarios. North Dakota starts to ship carrots to Illinois as it produces more under other alternative scenarios. This clearly indicates that North Dakota has a comparative advantage in producing carrots over other neighboring states. North Dakota could produce about 8,000 acres of carrots and market them to North Dakota, Minnesota, and Illinois.

Additional production of carrots in North Dakota may not affect the national average price of carrots, but local prices may be affected due to regional competition.

Key Words: carrots, quadratic programming, North Dakota

Highlights

The U.S. fresh carrot market is dominated by producers in California. Historically, they have produced 75% of the fresh carrots grown in the United States. Michigan, Washington, and Florida produce 5% each.

Domestic fresh carrot consumption has almost doubled in the past 25 years. Carrot consumption is expected to grow even further in the near future mainly because of the growth in the elderly population. Carrot production in the United States has increased substantially during the last two decades. The increased production is due to increases in both carrot acres planted and yields.

Wholesale prices of fresh carrots have increased from 7.2 cents per pound in 1993 to 13.1 cents per pound in 1997, while the retail prices of fresh carrots have increased from 22.0 cents per pound to 51.2 cents per pound. Average producer prices are the highest in Florida, followed by New York, and are lowest in Colorado. In most regions, prices increased gradually for the 1992-1995 period and then decreased in 1996 and 1997.

U.S. imports of carrots have grown from 48.0 million pounds in 1973 to 223.0 million pounds in 1997, while U.S. exports have grown from 63.3 million pounds to 230.1 million pounds.

In the base model, California, the largest producer of carrots, produces more than 70% of carrots produced in the United States, followed by Michigan. North Dakota produces 10.7 million pounds, equivalent to 0.3% of the total carrots produced.

As North Dakota increases its production, some other marginal producing regions reduce their production. North Dakota may be able to increase its carrot production area to 8,000 acres.

Average prices of carrots remain almost the same in the base and alternative scenarios, mainly because increased carrot production in North Dakota results in reductions in carrot production in other regions, resulting in a small increase in the total supply. However, local prices may be affected due to regional competition.

To avoid price reductions in the region, supply of carrots should be spread over the year to stabilize price fluctuations. This implies that growers should be able to store carrots for more than six months without losing the quality of carrots to avoid the problem of low market prices at the harvest. In addition, North Dakota should differentiate its carrots from those produced in other regions in terms of quality and farming methods.

This study also indicates that Colorado and North Dakota are most competitive in producing carrots with the given production capacity under the given demand conditions in consuming regions.

An Economic Analysis of Producing Carrots in the Red River Valley

Won W. Koo and Richard D. Taylor*

Introduction

Traditionally, vegetables were grown on small truck farms located near large population centers, but since the advent of the large super market chain stores, vegetable production has become centralized in several states. California is the leading producing state, followed by Florida and Texas.

The U.S. fresh carrot market is dominated by producers in California. Historically, they have produced 75% of the fresh carrots grown in the United States. Michigan, Washington, and Florida follow with about 5% each.

Fresh carrots are typically washed, graded, and packaged at the production areas because of transportation costs and storage requirements. The packages are chilled and trucked to distribution centers around the country for the retail markets. Many production areas in the United States are seasonal producers of carrots. Because of weather constraints, the northern growers in Michigan, Washington, New York, Ohio, and Minnesota grow one crop per year, harvested in September and October. Fresh carrots retain their quality for six to nine months with proper storage procedures. Other producing regions, including California and Arizona, produce multiple crops per year.

Domestic fresh carrot consumption has almost doubled in the past 25 years. Per capita consumption of fresh carrots has grown from 6.7 pounds per person in 1973 to 12.5 pounds per person in 1997. California has supplied most of the increased production. Carrot consumption is expected to grow even further in the near future mainly because of the growth in the elderly population, who tend to consume more vegetables, and the increased popularity of processed carrot products such as baby carrots and sliced carrots in ready-made salads.

The Red River Valley (RRV) of North Dakota and Minnesota is known to have a comparative advantage in producing carrots compared to other Midwestern regions. The region has a higher yield of fresh carrots due to its unique soil type, and carrots produced in this region contain more sugar because of large differences in temperature between days and nights. As a result, carrots are considered a viable alternative crop in this region. For the last two years, the RRV has grown a limited amount of carrots -- the region raised 1,300 acres of fresh carrots in 1996, but production fell to an average of 350 acres in 1997 and 1998. The reduced production of carrots in this region is attributed to competition in major Midwestern markets during the harvest period. North Dakota producers, being seasonal producers of carrots, were not able to develop out of state markets for their production. The local carrot price fell during and after harvest to a point lower than production costs. The inability to store carrots forced the producers to sell at the reduced price.

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The objective of this study is to investigate the economic feasibility of carrot production in the RRV. Special attention is given to determine the amount of carrots which the RRV should produce and to analyze market conditions for carrots produced in this region.

The following section briefly reviews the U.S. carrot industry. An econometric analysis of the U.S. carrot industry is presented in the third section. The fourth section presents a spatial equilibrium model of the U.S. carrot industry. Results from the model are presented in the fifth section. The conclusion of the study is presented in the last section.

Brief Summary of the U.S. Carrot Industry and Outlook

Demand and supply of carrots produced in the United States are presented in this section. Historical changes in carrot prices are summarized. In addition, U.S. imports and exports of carrots are discussed.

Production

Carrot production in the United States has increased substantially during the last two decades (Figure 1). The increased production is due to increases in both carrot acres planted and yields.

Harvested acres have increased 16.3%, from 83.8 thousand acres in 1973 to 97.5 thousand acres in 1997. During the 1973-92 period, there was a steady increase in harvested acres, but harvested acres fell by 28.7 thousand acres in 1993. Table 1 shows the harvested acres and production shares of fresh carrot producing states. California leads the U.S. carrot production. Its harvested acres have increased 38.8%, from 60 thousand acres in 1992 to 83.8 thousand acres in 1997. However, Florida, Michigan, Texas, Washington, New York, and Minnesota have all reduced their harvested acres of carrots. Colorado and Arizona have increased their harvested acres by 84.6% and 66.7%, respectively. California harvests 85.4% of the carrots produced in the United States.

Yields have increased 101.2%, from 171.3 cwt. per acre in 1973 to 344.7 cwt. per acre in 1997. Figure 2 shows the U.S. yield of carrots between 1973 and 1997. Yields increased sharply after 1992. Table 2 shows the fresh carrot yield in the leading states. The highest yields are in Washington and Colorado, followed by New York, California, and Michigan. Yields have increased in most states except for New York, Michigan, and Texas.

Figure 3 shows the distribution of U.S. production during 1995-97. California leads production with 25,819 thousand cwt., followed by Colorado and Michigan. Many states produce carrots in small truck farms for seasonal local markets, but most production is limited to these nine areas.

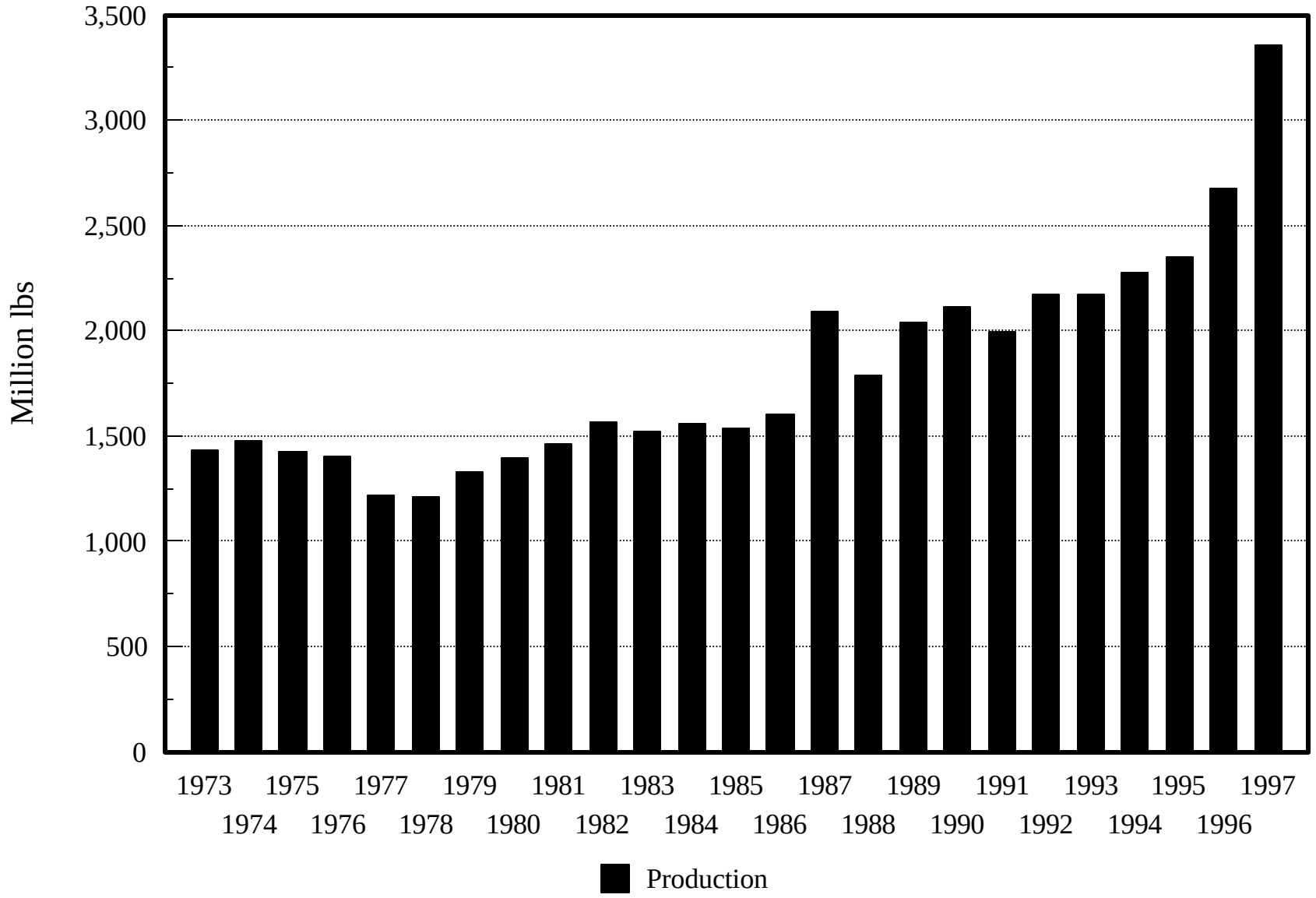

Figure 1. The United States Production of Fresh Carrots

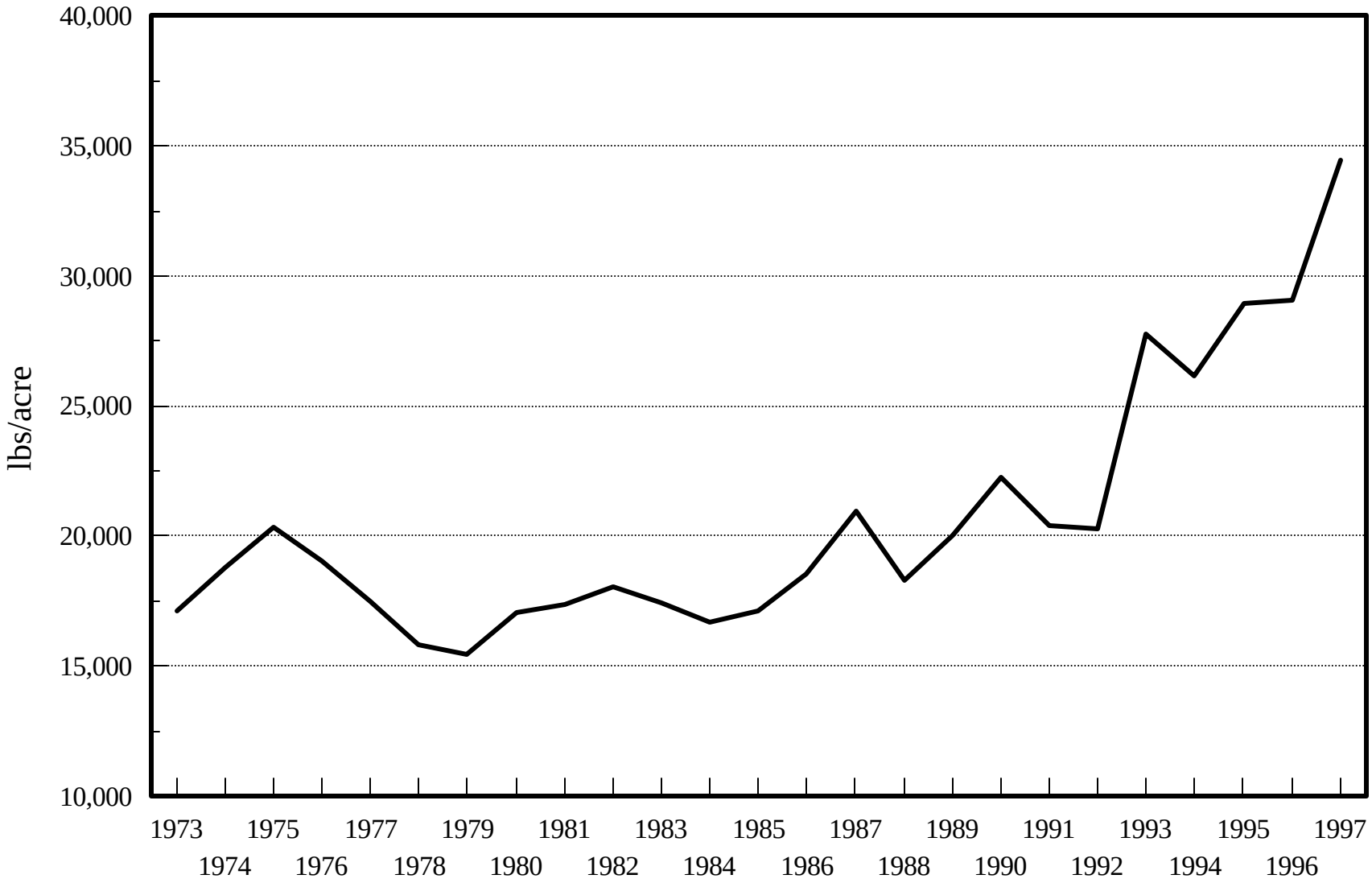

Figure 2. The United States Fresh Carrot Yield

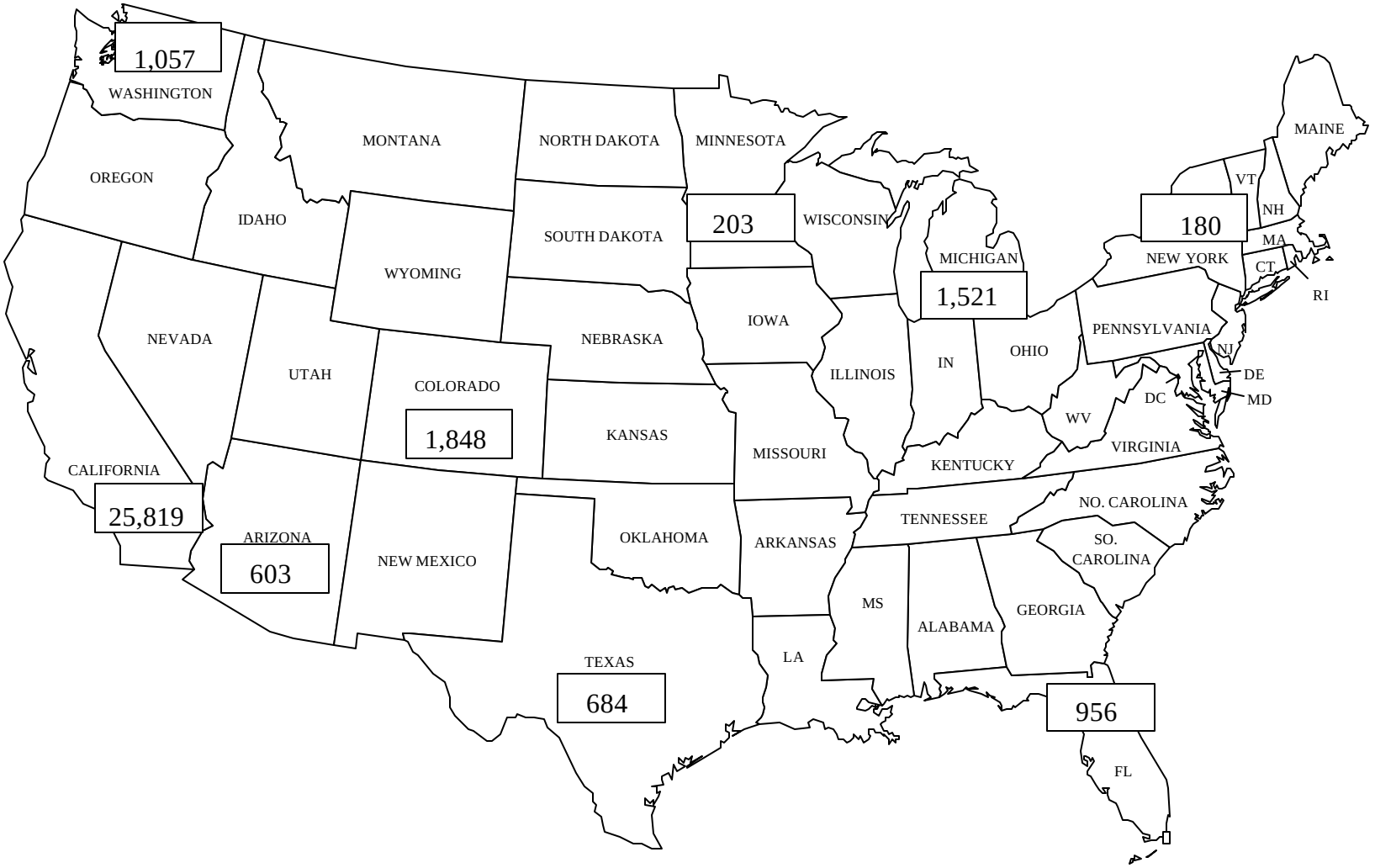

Figure 3. Production Distribution of Fresh Carrots in the United States,
1995 through 1997 Average, 1000 cwt

Table 1. Harvested Acres of Fresh Carrots

	1992	1993	1994	1995	1996	1997	Six Year Average	Average Share
	----------(000) acres----------							%
California	60.0	75.2	75.9	72.5	85.7	83.3	75.4	72.5
Florida	9.0	8.5	7.7	5.8	5.6	7.6	7.4	7.0
Michigan	6.7	5.3	5.9	5.7	5.0	5.3	5.7	5.0
Texas	7.8	4.9	5.5	5.0	4.9	2.4	5.1	4.9
Colorado	2.6	2.8	3.1	3.6	4.1	4.8	3.5	3.4
Washington	7.4	2.1	2.1	2.5	2.5	2.8	3.2	3.1
Arizona	1.5	1.4	2.2	1.9	2.4	2.5	2.0	1.9
New York	1.3	0.7	0.7	0.8	0.6	0.6	0.8	0.8
Minnesota	2.2	0.5	0.6	0.4	0.5	1.0	0.9	0.9

Table 2. Yield of Fresh Carrots

	1992	1993	1994	1995	1996	1997	Six Year Average	Rank
	----------cwt./acre----------							
California	285	300	360	300	300	360	318	4
Florida	145	180	115	140	150	160	148	9
Michigan	340	240	250	340	260	250	280	5
Texas	170	160	160	150	185	165	165	8
Colorado	365	380	380	475	350	500	408	2
Washington	570	385	320	400	420	400	416	1
Arizona	155	170	140	275	260	265	211	7
New York	390	335	395	320	220	280	323	3
Minnesota	340	145	275	210	230	400	267	6

California maintains a 76.4% market share in the United States (Table 3). The market shares of Michigan, Washington, and Colorado are 5.1%, 4.7% and 4.6%, respectively. Total production has increased in California, Colorado, and Arizona. The remaining states have reduced their carrot production. U.S. fresh carrot production has increased 134.7%, from 14,357 thousand cwt. to 33,599 thousand cwt. during the 1973-1997 period.

Table 3. Total Production of Fresh Carrots

	1992	1993	1994	1995	1996	1997	Six Year Average	Production Share
	---------- (000) cwt----------							%
California	17,100	22,560	27,324	21,750	25,710	29,998	24,074	76.41
Florida	1,305	1,530	886	812	840	1,216	1,098	3.48
Michigan	2,278	1,272	1,475	1,938	1,300	1,325	1,598	5.07
Texas	1,340	793	882	750	907	396	845	2.68
Colorado	949	1,064	1,178	1,710	1,435	2,400	1,456	4.62
Washington	4,218	808	680	1,000	1,050	1,120	1,479	4.69
Arizona	233	238	308	523	624	663	432	1.37
New York	507	228	277	240	132	168	259	0.82
Minnesota	748	67	170	84	124	400	266	0.84

Consumption

Figure 4 shows the U.S. domestic demand for fresh carrots between 1973 and 1997. The demand for fresh carrots has risen substantially during this period. Reasons include health concerns, the availability of ready-made salads, and the introduction of baby carrots in recent years. The U.S. domestic consumption of fresh carrots has increased 92.9% between 1973 and 1997. Per capita consumption has increased 86.6% during the same time period. Since 1995 fresh carrots consumption has increased 38.9%.

Prices

Wholesale prices of fresh carrots have increased from 7.2 cents per lb. to 13.1 cents per lb. between 1973 and 1997, while the retail prices of fresh carrots have increased from 22.0 cents per lb. to 51.2 cents per lb. (Figure 5). The price spread between wholesale and retail has grown from 14.80 cents per lb. in 1973 to 38.07 cents per lb. in 1997. This implies that labor, transportation, processing, and distribution costs have risen faster than wholesale prices. In recent years, ready-made salad and baby carrots have been introduced and are capturing a larger share of the fresh carrot market compared to regular fresh carrots. The per unit cost of these processed carrots is naturally higher than for regular carrots, as more labor and mechanization is involved in their production. With the additional costs involved, the required retail prices are also higher. The retail price of fresh carrots was four times of the wholesale price in 1997.

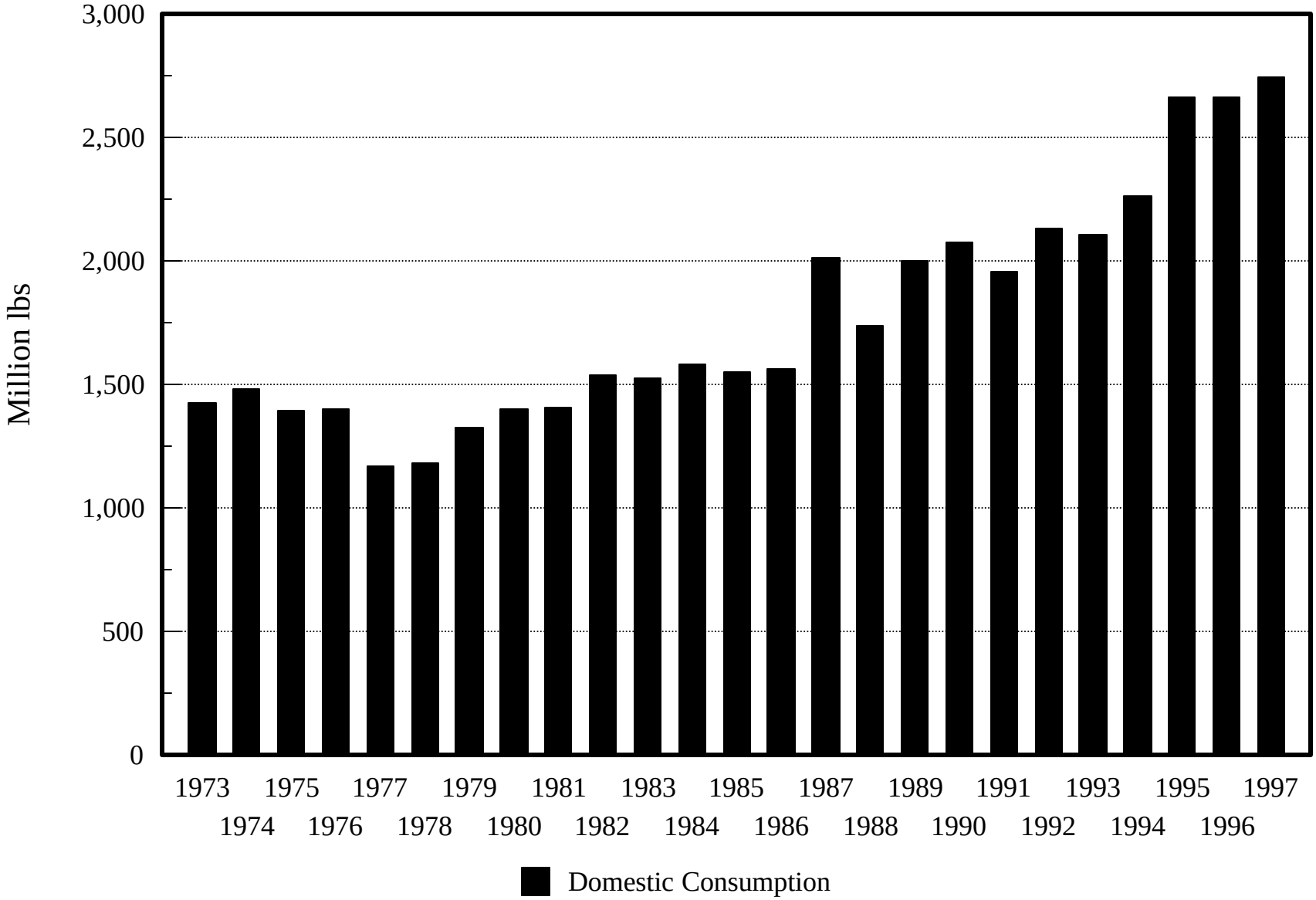

Figure 4. The United States Domestic Consumption of Fresh Carrots

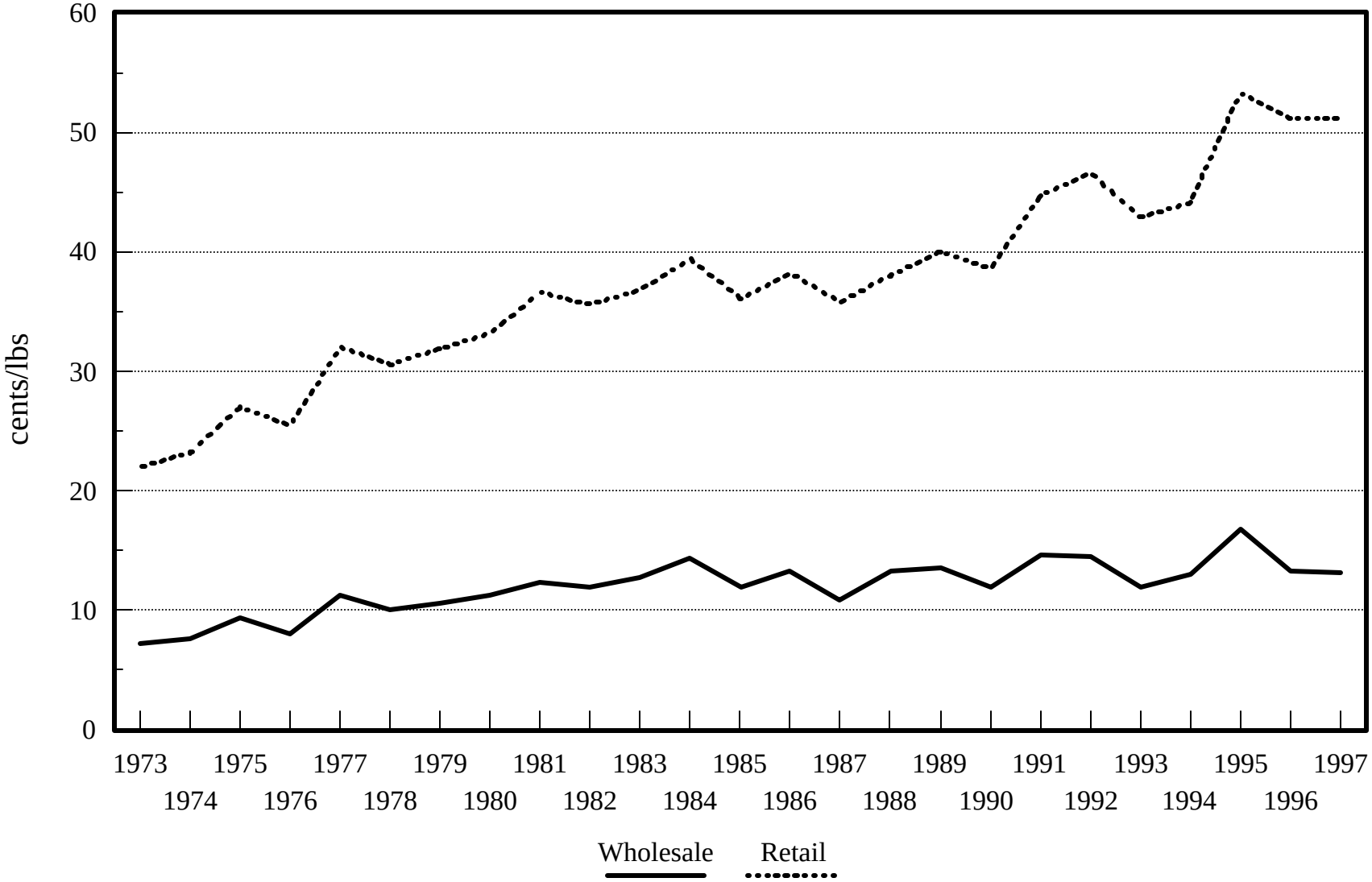

Figure 5. The United States Fresh Carrot Wholesale and Retail Prices

Average producer prices are the highest in Florida, followed by New York, and are lowest in Colorado (Table 4). In most regions, prices increased gradually for the 1992-1995 period and then decreased in 1996 and 1997. High prices of carrots in 1995 are due mainly to substantial reductions in carrot production in California in that year.

Table 4. Prices Received by Producers

	1992	1993	1994	1995	1996	1997	Six Year Average	Rank
	----------$ /cwt----------							
CA	12.70	11.10	12.70	16.60	13.60	13.00	13.28	6
FL	15.50	16.70	12.70	20.90	14.90	13.60	15.72	1
MI	10.60	12.30	15.10	16.80	11.80	12.50	13.18	7
TX	10.30	14.60	11.50	19.80	15.30	17.30	14.80	3
CO	10.60	8.60	10.00	13.50	7.10	10.00	9.97	9
WA	6.44	13.60	17.40	16.80	15.00	14.00	13.87	4
AZ	14.00	11.30	11.70	17.60	12.70	13.30	13.43	5
NY	15.40	16.00	16.00	14.00	15.00	16.00	15.40	2
MN	4.93	10.00	14.90	16.60	12.50	8.60	11.26	8

Imports and Exports

U.S. imports have grown from 48.0 million lbs. in 1973 to 223.0 million lbs. in 1997, while U.S. exports have grown from 63.3 million lbs. to 230.1 million lbs. (Figure 6). The U.S. trade surplus for fresh carrots has narrowed in recent years. In most years, the United States is a net exporter.

Canada is the largest exporter of fresh carrots into the United States. Mexican exports have grown 136.2% since implementation of the North American Free Trade Agreement (NAFTA) (Table 5). Table 6 shows U.S. exports of fresh carrots. Canada is the largest importer of U.S. fresh carrots. Canadian imports of U.S. fresh carrots have grown 83.8% in the past four years under the U.S. and Canada free trade agreement. The United States also exports small amounts of carrots to Mexico and Japan.

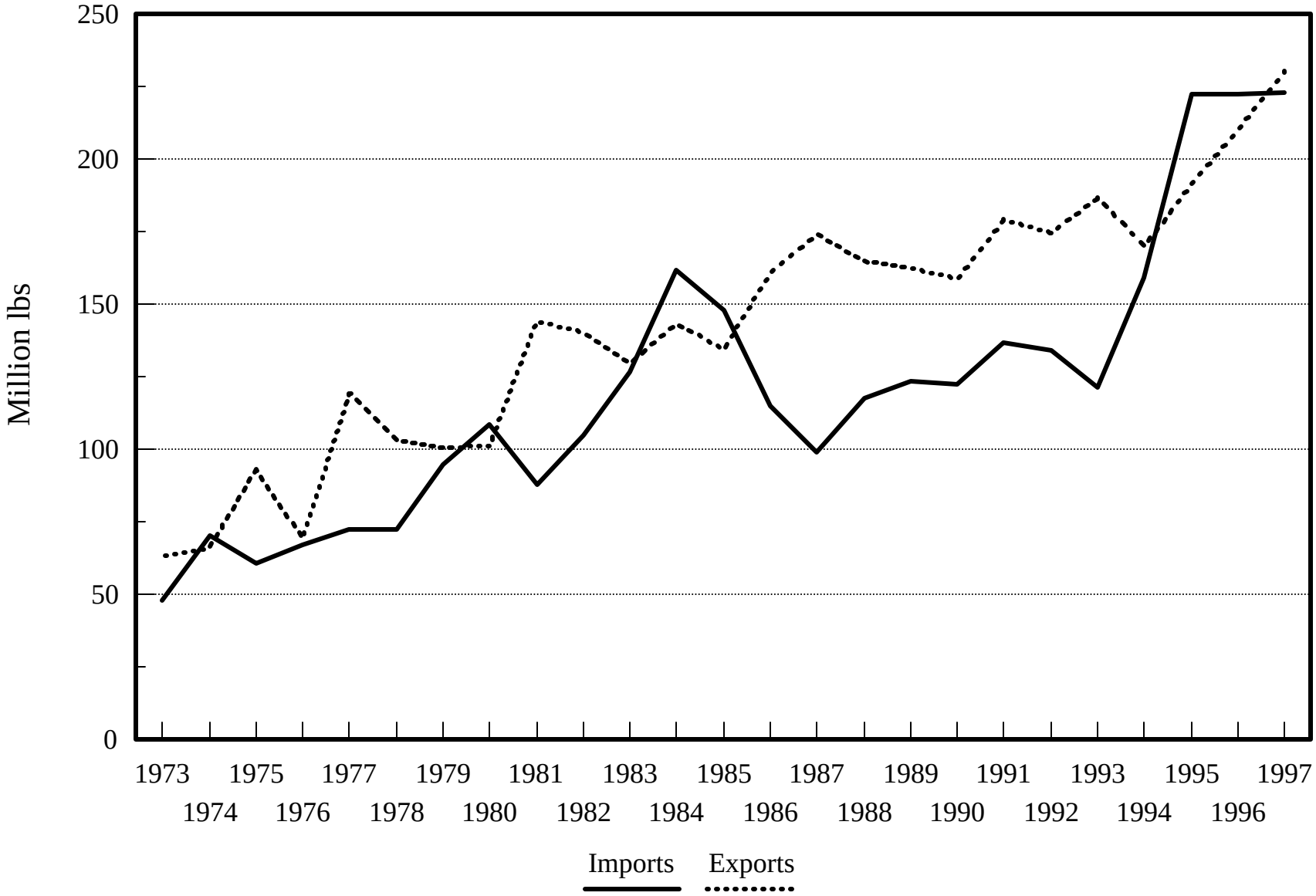

Figure 6. The United States Imports and Exports of Fresh Carrots

Table 5. U.S. Imports of Fresh Carrots

	Canada	Mexico	Other
	----------1,000 cwt----------		
1994	1,640	260	24
1995	2,162	473	25
1996	1,696	594	21
1997	1,652	614	22

Table 6. U.S. Exports of Carrots

	Canada	Mexico	Japan	Other
	----------1,000 cwt----------			
1994	1,207	20	58	220
1995	1,819	15	98	120
1996	1,776	22	161	255
1997	2,218	23	55	263

Outlook

Per capita consumption of carrots is expected to increase approximately 17%, from 12.5 pounds in 1997 to 14.6 pounds in 2005. This increase in per capita consumption is mainly because the carrot industry has introduced various carrot products, such as baby carrots and ready-made salad, and because of the growing elderly population, who tend to consume more vegetables. Assuming that U.S. population increases from 268 million in 1997 to 288 million in 2005, total carrot consumption would increase 25.5% for the same time period.

Total carrot production is projected to increase approximately 23.7%, from 3,359 million pounds in 1997 to 4,157 million pounds in 2005. The increase in production is due mainly to the increased carrot production area and increased yield during the 1997-2005 period. For the period, production area is expected to increase by about 14% and yields are expected to increase by about 9.1%.

Since domestic consumption is expected to increase faster than domestic production, the difference is expected to be filled by imports mainly from Mexico. U.S. imports of carrots are expected to increase from 223 million pounds in 1997 to 287.4 million pounds in 2005, a 28.7% increase. On the other hand, U.S. exports of carrots are expected to increase about 4.9% during 1997-2005.

Development of a Spatial Equilibrium Model

The spatial equilibrium model for the U.S. carrot industry was developed on the basis of a quadratic programming algorithm. Figure 7 shows a domestic demand schedule for carrots in consuming regions and supply schedule of carrots in producing regions. The equilibrium price of carrots is *op* and the quantity of carrots traded is *oq*, assuming zero transportation costs. With positive transportation costs, measured by distance, *ab* in Figure 7, the price of carrots in consuming regions increases from *op* to op_1, and the price decreases in producing regions from *op* to op_2. The incidence of transportation costs borne by consumers and producers depends upon the price elasticities of export supply in producing regions and import demand in consuming regions. The increased price in the consuming region results in a decrease in the quantity of carrots traded from *oq* to oq_1 . The proportion of price change borne by consumers (pp_1) and that borne by producers (pp_2) can be calculated as a function of supply and demand elasticities as follows:

$$pp_1 = (e_x/(e_m+e_x))ab$$

$$pp_2 = (e_m/(e_m+e_x))ab.$$

Where e_x is price elasticity of supply and e_m is price elasticity of demand.

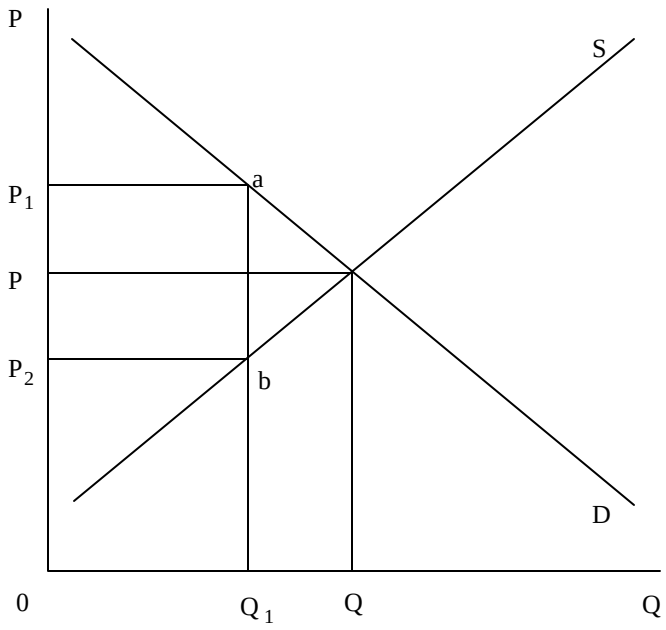

Figure 7. Equilibrium Market Condition for the U.S. Carrot Industry

Model Development

A partial equilibrium model based on a quadratic programming algorithm was developed for the U.S. carrot industry. The objective of the model is to maximize net consumer and producer surplus in Figure 7. The objective function was constrained by a system of linear equations. Producing and consuming regions are linked through transportation activities.

The model contains 11 domestic carrot producing regions and 19 domestic consuming regions (Figure 8). Production regions are identified with states and consuming regions are based on major metropolitan markets. The carrots are assumed to be graded and packaged in the regions where they are grown. Fresh carrots are shipped to the consuming regions and export ports by truck and imported carrots are shipped from import ports to consuming regions by truck. Canada and Mexico are the only major exporters of fresh carrots and Canada, Japan, and Mexico are the major importers of fresh carrots.

Inverse demand and supply equations of carrots are specified as a function of quantities as:

$$P_f^s = \alpha + \beta Q_f$$

$$P_j^d = a - bQ_j$$

Where

P_j^d = price of carrots in consuming region j
Q_j = quantity of carrots consumed in region j
P_f^s = price of carrots in producing region f
Q_f = quantity of carrots produced in region f.

The objective function of the model is mathematically expressed as :

$$Max\ Z = \sum_j \int_0^{Q_j} (a - bQ_j) dQ_j - \sum_f \int_0^{Q_f} (\alpha + \beta Q_f) dQ_f - \sum_f (PC_f - \overline{PC}) Q_f - \sum_f \sum_j t_{fj} Q_{fj}^d - \sum_f \sum_p t_{fp} Q_{fp}^x - \sum_e \sum_j t_{ej} Q_{ej}^m$$

Where

PC_f = production costs of carrots in producing region f
PC = average U.S. production costs of carrots
t_{fj} = transportation costs between producing region f and consuming region j
Q_{fj} = quantity of carrots shipped from producing region f to consuming region j
t_{fp} = transportation costs between producing region f and export port p
Q_{fp} = quantity of carrots shipped from producing region f to export port p
t_{ej} = transportation costs between import port e and consuming region j
Q_{ej} = quantity of carrots shipped from import port e to consuming region j

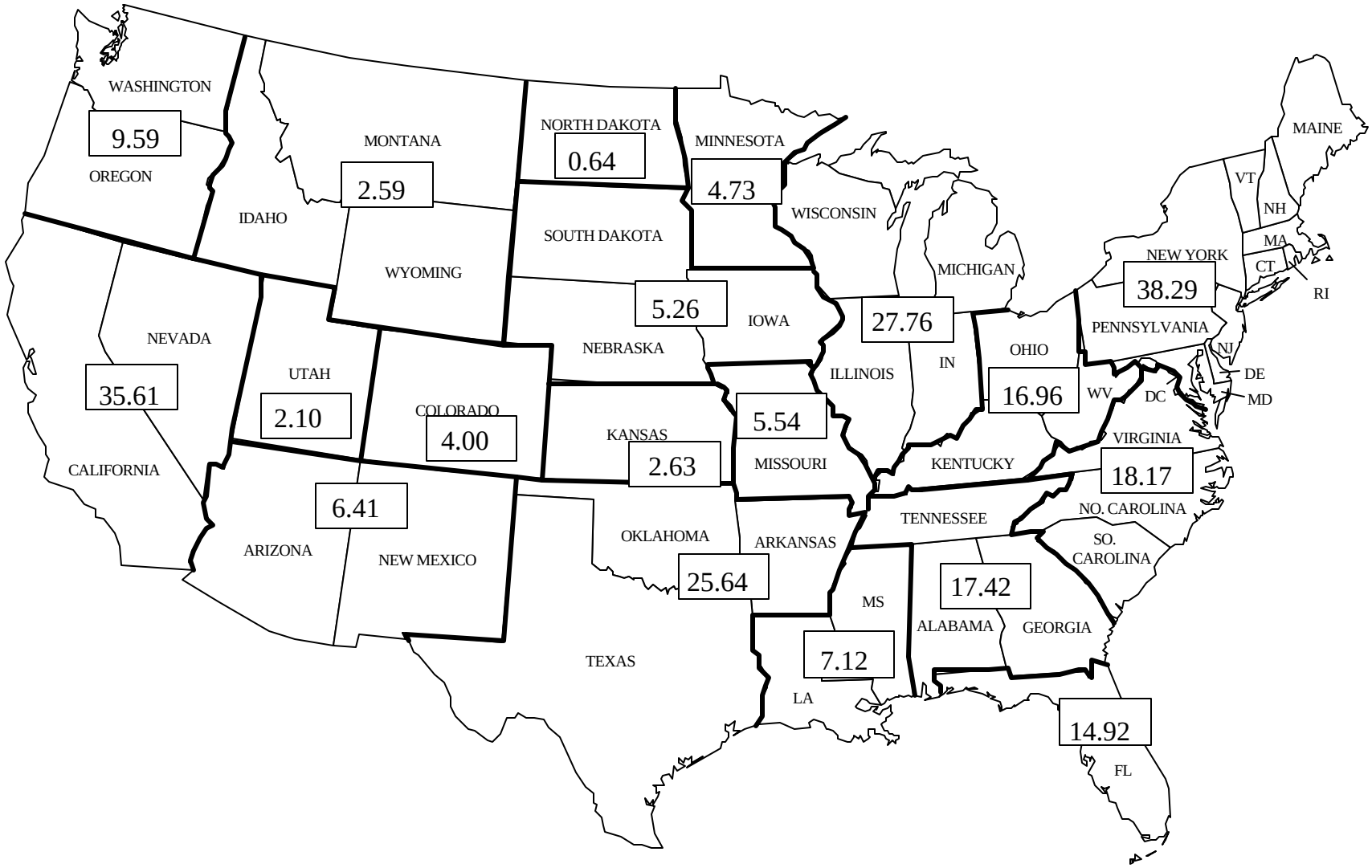

Figure 8. Consumption Regions in the United States, Population in Millions

The objective function is subject to the following constraints:

1. $Q_j = \sum_f Q_{fj} + \sum_e Q_{ej}^m$

2. $Q_f = \sum_j Q_{fj} + \sum_p Q_{fp}^x$

3. $Q_j \leq \overline{D_j}$

4. $Q_f \geq Min_f$

5. $\sum_j Q_{ej}^m = \overline{\overline{M_e}}$

6. $\sum_f Q_{fp}^x = \overline{X_f}$

7. $P_j^d - P_f^s \geq t_{fj}$

Where

D_j = quantity of carrots demanded in region j
Min_f = minimum quantity of carrots produced in region f
M_e = quantity of carrots imported into the United States
X_f = quantity of carrots exported from the United States

Equation 1 ensures that the total quantity of carrots received by each consuming region equals the sum of the quantity shipped from producing regions and imports. Equation 2 ensures that the quantity of carrots produced in each producing region is shipped to domestic consuming regions and ports for exports. Equation 3 indicates that total quantity of carrots shipped to each consuming region should be greater than or equal to the quantity demanded in the region. Equation 4 indicates that each producing region should ship out at least a minimum amount of carrots to consuming regions and ports. Equations 5 and 6 represent U.S. imports and exports, respectively, which are assumed to be constant. Equation 7 represents the price spread between wholesale and retail and it should be greater than or equal to transportation costs between two regions.

Data

The data used for the model are consumption of carrots in domestic consuming regions, supply of carrots in producing regions, and transportation cost in shipping carrots from producing regions to consuming regions. Supply and demand data were obtained from the United States Department of Agriculture (USDA). The model assumes constant imports and exports of fresh carrots which were also obtained from the USDA. The price elasticities were assumed to be 0.2 for demand and 0.8 for supply. Transportation costs were estimated from data obtained from USDA.

Results

This study is based on one base and five alternative models. The base model is developed on the basis of current supply and demand for carrots in the United States. The alternative models allow North Dakota to produce 1,000 acres, 2,000 acres, 3,000 acres, 5,000 acres, and 8,000 acres.

Fresh Carrot Production

Table 7 presents production of carrots in producing regions under the base and alternative scenarios. In the base model, California, the largest producer of carrots, produces more than 70% of carrots produced in the United States, followed by Michigan (11%). North Dakota produces 107 thousand cwt., equivalent to 0.3% of the total carrots produced. As North Dakota increases its production, some other producing regions reduce their production. When North Dakota increases its carrot production area to 8,000 acres, North Dakota would be the third largest carrot producer in the United States. Total carrot production under this scenario is 2,456 thousand cwt., which is about 17% of carrots produced in the United States. Under this scenario, California reduces production by 9.5% compared to the base model, followed by Texas (8.5%), and Washington (8.1%). Michigan, Minnesota, and New York maintain production at their base levels.

Marketing of Carrots

Under the base model, California ships to all regions except North Dakota. Arizona ships locally and to Texas (Table 8). Colorado ships locally and to North Carolina. North Dakota ships locally and to Minnesota. The other regions ship mainly to local markets. The major reason is that shipping costs for fresh carrots are relatively high due to maintenance of the quality of carrots during shipping period.

The shipping pattern remains almost the same under alternative scenarios. North Dakota ships carrots locally and to Minnesota under both the base and 1,000 acre scenarios. Under the 2,000 acre scenario, North Dakota ships to Minnesota (485,000 cwt.) and Illinois (52,000 cwt.). The shipments to Illinois are increased as North Dakota produces more under other scenarios. This clearly indicates that North Dakota has a comparative advantage in producing carrots over other neighboring states.

Table 7. Fresh Carrot Production Under Various Scenarios

	Base	1,000 ac	2,000 ac	3,000 ac	5,000 ac	8,000 ac	Quantity Reduction	Percent Reduction
California	20,989	20,826	20,576	20,326	19,826	19,002	1,987	9.47
Arizona	506	502	496	491	479	477	29	5.73
Colorado	2,031	2,015	1,990	1,965	1,914	1,906	125	6.15
Florida	848	842	824	826	810	783	65	7.67
Michigan	2,647	2,647	2,647	2,647	2,647	2,647	0	0.00
Minnesota	352	352	352	352	352	352	0	0.00
New York	286	286	286	286	286	286	0	0.00
North Dakota	107	307	614	921	1,535	2,456	----	----
Washington	542	539	533	528	517	498	44	8.12
Texas	905	898	889	879	860	828	77	8.51
Ohio	287	285	283	280	274	265	22	7.67

Table 8. U.S. Fresh Carrot Shipments From Production Regions to Consumption Regions Under the Base Scenario

Consumption	Production Regions										
Regions	CA	AZ	CO	FL	MI	MN	NY	ND	WA	TX	OH
WA	X								X		
CA	X										
AZ	X	X									
MO	X										
CO	X		X								
MT	X										
ND								X			
NE	X										
KS	X										
TX	X	X							X	X	
MN	X					X		X			
UT	X										
LA	X										
GA	X										
FL	X			X							
NC	X		X								
NY	X						X				X
OH	X				X						X
IL	X										

The price flexibility coefficient in carrot supply is estimated to be 0.529, indicating that a 10% increase in supply will reduce the price of carrots by 5.29%. However, average prices of carrots remain almost the same in the base and alternative scenarios, mainly because increased carrot production in North Dakota results in reductions in carrot production in other regions, resulting in a small increase in the total supply.

It is important to recognize that regional price effects may differ from national effects. Since carrots are shipped to local markets, additional production in a region may affect the price of carrots in this region much more than national prices. In addition, since demand is almost constant over seasons within a year, a sharp increase in supply during the harvest period would result in a decrease in local prices of carrots in the region.

Under the 8,000 acre scenario, North Dakota increases its production of carrots to 17% of the national supply, but the total supply of carrots remains almost the same, so that the national carrot price remains unchanged. However, impacts on local prices of carrots may be significant, depending upon the volume of carrots supplied to markets in a particular month. To reduce price effects in local markets, supply of carrots should be spread over a year. This implies that growers should be able to store carrots more than six months without losing the quality of carrots. In addition, growers should differentiate their carrots from carrots produced in other regions in terms of quality to avoid price competition.

Competitiveness of Carrots

Shadow prices associated with production capacity are defined as changes in the objective function value when an additional unit is produced by relaxing production capacity in a particular producing region. In this study shadow prices associated with carrot production in each producing region are used to indicate competitiveness of producing additional carrots under given demand conditions.

Shadow prices are all zero except for Colorado and North Dakota, indicating that these two regions are most competitive in producing carrots under the given demand conditions in consuming regions (Table 9). In the base model, North Dakota is more competitive than Colorado. However, as North Dakota increases its production area, its shadow price decreases. The shadow price is positive in the 8,000 acre scenario, implying that North Dakota could increase its carrot area more than 8,000 acres. The other regions do not reach the maximum acreage restraint.

North Dakota and Colorado are more competitive in producing carrots than California because these two regions have lower production costs and lower shipping costs to major consuming regions in the eastern United States.

Table 9. Shadow Prices for the Upper Limit of Harvested Acres of Fresh Carrots

Region	Base	1,000	2,000	3,000	5,000	8,000
	----------dollars----------					
CA	0.00	0.00	0.00	0.00	0.00	0.00
AZ	0.00	0.00	0.00	0.00	0.00	0.00
CO	627.37	627.37	627.37	627.37	627.37	444.98
FL	0.00	0.00	0.00	0.00	0.00	0.00
MI	0.00	0.00	0.00	0.00	0.00	0.00
MN	0.00	0.00	0.00	0.00	0.00	0.00
NY	0.00	0.00	0.00	0.00	0.00	0.00
ND	669.43	638.87	511.85	439.44	351.16	136.79
WA	0.00	0.00	0.00	0.00	0.00	0.00
TX	0.00	0.00	0.00	0.00	0.00	0.00
OH	0.00	0.00	0.00	0.00	0.00	0.00

Conclusions and Implications

Domestic production of fresh carrots had more than doubled between 1973 and 1997. The main increase has been due to increased yields of carrots. California has captured most of the increased production. Domestic consumption has also increased during the same time period. The main reasons are increased health concerns, the availability of ready-made salads, and the recent introduction of baby carrots.

Prices of carrots have increased over time but the spread between wholesale and retail has widened. The spread was about 15 cents per lb. in 1973 and about 38 cents per lb. in 1997. This is due to increases in labor, transportation, storage, and processing costs of producing baby carrots and ready-made salads.

This study indicates that North Dakota has a competitive advantage in producing carrots over neighboring regions. North Dakota should produce at least 8,000 acres of carrots and market them to North Dakota, Minnesota, and Illinois.

Additional production of carrots in North Dakota may not affect the national average price of carrots, but local prices may be affected due to regional competition.

To avoid price reductions in the region, carrots produced in North Dakota should be differentiated from carrots produced in other regions in terms of quality. It is important for consumers to recognize that carrots produced in North Dakota have more sugar than those produced in other regions.

Also, growers in North Dakota should differentiate their farming methods to appeal to consumers. One example is organic production of carrots.

Supply of carrots produced in North Dakota should be spread over the year to stabilize price fluctuations. This implies that growers should have storage facilities to store harvested carrots for more than six months without losing the quality of carrots. In addition, competition among North Dakota producers must be avoided to prevent a harvest price collapse similar to the past. A marketing cooperative may be an alternative to avoid price competition among North Dakota growers.

Another marketing alternative is that growers could develop a joint-venture with an established processor/distributor to maintain orderly marketing of North Dakota carrots.

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