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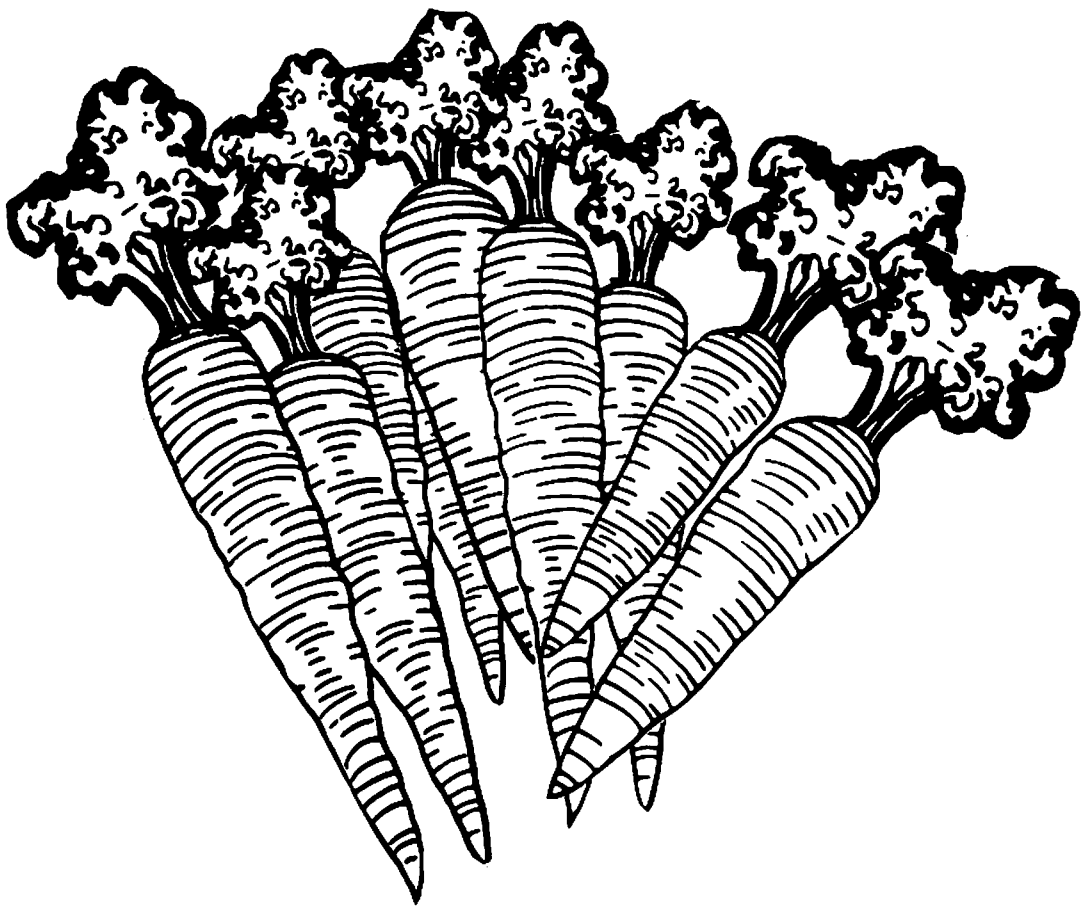
ECONOMIC FEASIBILITY OF CARROT PRODUCTION, MARKETING, AND PROCESSING IN NORTH DAKOTA

Joel T. Golz, Theresa K. Golz,
Delmer L. Helgeson, and Hugh J. Dufner



Department of Agricultural Economics • Agricultural Experiment Station
North Dakota State University • Fargo, ND 58105-5636

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Highlights

A yield of 250 masters per acre and a price of $9 per master would be needed for a commercial-sized carrot producer to cover all costs in North Dakota. When transportation costs from North Dakota and competing production areas were compared, North Dakota primarily had transportation advantages in local but not regional and national markets.

In an earlier study on the "Economic Feasibility of Vegetable Production, Marketing, and Processing in the Red River Valley of North Dakota," Dufner et al. found that both onions and carrots have production and marketing potential in North Dakota.

This paper is a summary of the economic feasibility of carrot production, marketing, and processing in North Dakota. Case study data from Dufner et al. and an expanded model developed from a study by the Agricultural Economics Department of Michigan State University were used to evaluate the economic feasibility of commercial onion production.

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North Dakota's agricultural production depends on support crops such as wheat, barley, and sugarbeets. A change in farm policy may have severe economic ramifications both to the farmers and rural communities which are dependent on them. Expanded marketing of nonsupport crops, such as carrots, may help to mitigate any economic consequences if national farm programs shift toward a more market oriented agricultural economy. Development in agricultural processing could provide new jobs in North Dakota as well as complement agriculture, its major industry. These secondary benefits may be of growing importance in light of a possible major change in national farm legislation.

Dufner et al. in a study entitled "Economic Feasibility of Vegetable Production, Marketing, and Processing in the Red River Valley of North Dakota," found that carrots and onions have the best production and marketing potential for North Dakota. The following is a summary of the feasibility of carrot production, marketing, and processing in North Dakota.

Analysis of Carrots

Carrots which thrive in Northern cool climates are raised for processing in southern Minnesota. Several large operators produce carrots in the Anoka area, and a firm has started a large carrot packaging operation in Traill, Minnesota and a carrot dehydration operation at Fosston, Minnesota. Carrot production around Anoka and Traill is mainly on organic[1] peat or muck soils, with some on mineral soils.

Carrots for Packaging

North Dakota's mineral rather than peat soils limit to the production of carrots for packaging because of the following problems:

a. Spring emergence -- Carrot seedlings have difficulty penetrating a crusted soil surface.
b. Carrot length -- The production of long carrot varieties, which have become the norm for packaged product, is more difficult in mineral soils because carrots must be grown on raised beds to permit root penetration and development. Harvesting long carrots with a mechanical harvester is more difficult on mineral soils because the soil clings to the roots resulting in a higher percentage of misses and broken product.
c. Wet conditions -- Harvesting on mineral soils in wet conditions is not feasible.

Spring emergence can be overcome partially through early spring planting or irrigation. Misses and breakage can be overcome by loosening the carrots before harvest and by planting shorter varieties, but acceptance of a short carrot limits

[1]Defined by NDSU Soils Department as soil having 40% or more organic matter.

regional and national markets. Harvesting in sticky soils can be changed to time harvest during dry periods.

Carrots for Processing

Since short carrot varieties are used for processing, the processed carrot market has potential for North Dakota. However, the closest carrot processing plant is United Foods Company at Fairmont, Minnesota, 280 miles from Fargo, North Dakota.

Carrots grown for processing in Minnesota are raised on beds and are crowned (i.e., the stem is cut off) before harvest to reduce hand labor. Crowning machines used for sugarbeets likely would work for carrots. Carrots are mechanically dug and hauled to the processing plant where they are purchased on the basis of proper crowning. Deeper crowning represents yield loss to the producer but a higher product grade, since less post-harvest labor is required to trim the roots.

Yields of processed carrots in southern Minnesota were reported to be as high as 30 tons per acre. Grower contract prices in 1988 were around $43 per ton, based on normal percentages of 75% properly crowned and 30% oversized product, this amounts to gross returns of $1,290/acre.[2]

Carrot Production Potential for North Dakota

U.S. carrot production increased from 20.6 million cwt. in 1978 to 25.5 million cwt. in 1987 because of increased yield and acreage. The 1978-82 average yield was 273.8 cwt. per acre compared to 289.4 cwt. for the 1983-87 period (Table 1). Harvested acreage averaged 76.1 thousand acres between 1978-1982, rising to 78.8 between 1983-1987.

Population growth and increased per-capita consumption have increased production to meet the growing demand for carrots. From 1978 to 1987, U.S. resident population increased 21 million, or 10 percent. Per capita consumption of carrots during the same period increased from 9 to 11.8 pounds (Figure 1).

State Production

Collection of seasonal production data was discontinued by the USDA in 1978. The largest carrot producing state was California, accounting for 50 percent of total U.S. production from 1983 to 1987 (Table 2), followed by Texas at 9.4 percent, Washington at 9.3 percent, Wisconsin at 7.2 percent, and Michigan at 6.9 percent. Comparing 1978-82 averages with 1983-87 averages indicates California, Wisconsin, Arizona, and Washington increased market share, while Florida, Oregon, Texas, Michigan, Minnesota, and Ohio/New Jersey lost market share.

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[2]Telephone interview with Jerry Voyles, Agricultural Manager for United Foods Company, Fairmont, Minnesota, March 25, 1988.

TABLE 1. U.S. CARROT PRODUCTION, YIELDS, AND HARVESTED ACREAGE, 1978-1987

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	5 Year Averages 1978-82	5 Year Averages 1983-87
Production (million cwt)	20.6	22.4	20.9	21.8	24.1	23.2	23.7	22.9	23.4	25.5	22.0	23.8
Yield[a] (cwt/acre)	258	269	270	277	295	285	277	278	305	302	273.8	289.4
Harvested[a] Acreage (1,000 acres)	76.8	78.2	72.5	73.9	79.4	77.4	83	78.7	73.9	81	76.1	78.8

[a]Excludes Florida from 1982 to 1987, to make series consistent, as Florida was not included before 1982.

SOURCE: The Almanac of the Canning, Freezing, Preserving Industries, 1988

TABLE 2. U.S. CARROT PRODUCTION AND FIVE YEAR AVERAGE MARKET SHARE BY STATE, 1978-1987

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	5 Year Average 1978-82	5 Year Average 1983-87
	1,000 cwt										%	
Arizona	255	241	294	223	449	543	377	396	396	400	1.32	1.78
California	8,536	10,291	10,385	9,735	11,447	11,490	12,011	10,959	12,568	12,580	45.81	50.19
Colorado	250	245	264	385	350	248	280	350	408	449	1.36	1.46
Florida	1,216[a]	1,245[a]	1,349[a]	1,365[a]	921[a]	1,100	731	1,058	849	1,065	5.59	4.05
Michigan	1,614	1,713	1,340	1,316	1,710	1,655	2,025	1,664	926	1,926	7.00	6.89
Minnesota	553	609	494	416	555	441	429	456	479	541	2.39	1.97
New York	571	551	365	391	527	520	568	539	560	432	2.19	2.21
Oregon	449	617	699	889	1,002	540	516	527	460	381	3.30	2.05
Texas	3,107	2,176	2,049	2,751	2,446	2,751	2,175	2,001	2,030	2,185	11.46	9.40
Washington	1,821	2,237	1,938	1,760	2,088	1,600	1,829	2,264	2,407	3,037	8.96	9.33
Other states	1,236	1,403	588	710	788	760	895	1,152	828	798	4.29	3.74
Wisconsin	1,025	1,118	1,125	1,890	1,800	1,488	1,898	1,551	1,523	1,750	6.32	6.92
Total	20,633	22,446	20,890	21,831	24,083	23,136	23,734	22,917	23,434	25,544	100.0	100.0

[a]Florida was not included in original data from 1978 to 1982, included by authors.
SOURCE: The Almanac of Canning, Freezing, Preserving Industries, 1988.

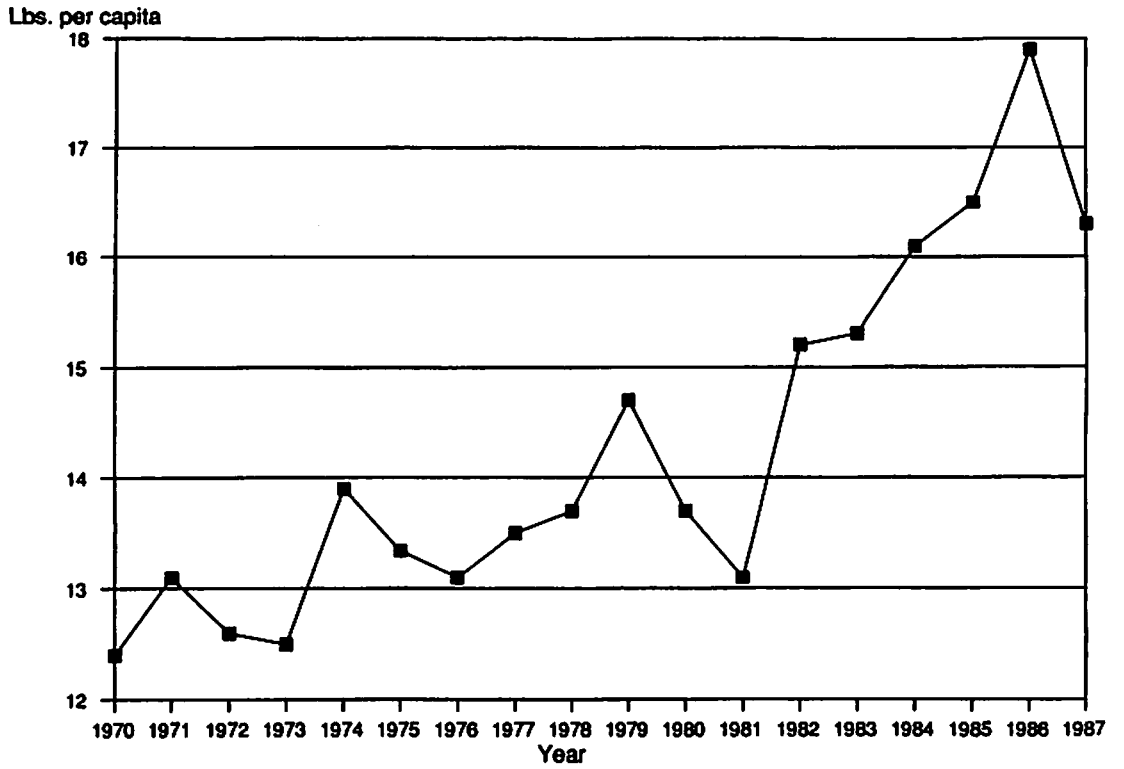

Figure 1. U.S. Per Capita Carrot Consumption, 1970-1987.

SOURCE: USDA, Food Consumption, Prices and Expenditures, 1989.

Fresh Versus Processed Carrots

Carrot production and consumption are comprised of the fresh and the processed markets, each with different characteristics. Although per capita carrot consumption has increased, the consumption of processed carrots has declined. Throughout the 1970s the fresh market accounted for 58 to 64 percent of consumption increaseing to about 70 percent of all consumption by the 1980s (Table 3). Consequently per-capita consumption of carrots has increased.

The fresh market accounts for 70 percent (1983-87 average) of total carrot production, however, this varies among states. Three states, Arizona, Colorado, and Florida, produce entirely for the fresh market (Table 4).

Over 80 percent of the carrots (1983-1987 average) in California and Texas were produced for the fresh market. Production in Wisconsin, Ohio, Minnesota, New York, Oregon, and Washington was primarily for the processed market. Michigan's production was similar to the national average with 64 percent of production sold in the fresh market. Wisconsin/Ohio/New Jersey produced almost entirely for the processed market (Table 4). Increased consumption of fresh carrots is due to (1) a shift away from processed carrots, and an increase in (2) overall per capita consumption and (3) population. Since population increases have offset declining per capita consumption, total production of processed carrots has not decreased. This has resulted in a 64 percent increase in fresh market production since 1970, from 10.95 million cwt. to 17.9 million cwt. in 1987.

TABLE 3. MARKET SHARES AND PER-CAPITA CONSUMPTION OF FRESH AND PROCESSED CARROTS IN THE U.S., 1970-1987

Year	Market Share		Per Capita Consumption		
	Fresh	Processed	Fresh	Processed	Total
	%		lbs. per capita		
1970	62.5	37.5	6.0	3.6	9.6
1971	64.2	35.8	6.1	3.4	9.5
1972	62.5	37.5	6.5	3.9	10.4
1973	63.2	36.8	6.7	3.9	10.6
1974	64.5	35.5	6.9	3.8	10.7
1975	64.0	36.0	6.4	3.6	10.0
1976	64.0	36.0	6.4	3.6	10.0
1977	58.0	42.0	5.1	3.7	8.8
1978	62.2	37.8	5.6	3.4	9.0
1979	63.4	36.6	6.4	3.7	10.1
1980	67.3	32.7	7.0	3.4	10.4
1981	67.6	32.4	7.1	3.4	10.5
1982	71.6	28.4	7.3	2.9	10.2
1983	71.4	28.6	7.5	3.0	10.5
1984	66.4	33.6	7.9	4.0	11.9
1985	70.4	29.6	7.6	3.2	10.8
1986	72.0	28.0	7.7	3.0	10.7
1987	72.0	28.0	8.5	3.3	11.8

SOURCE: USDA, ERS, Food Consumption, Prices and Expenditures, 1989.

TABLE 4. MARKET SHARE OF STATES' FIVE-YEAR CONSUMPTION AS A PERCENT OF STATES PRODUCTION FOR FRESH CARROTS FIVE-YEAR AVERAGES, 1978-82 AND 1983-87

State	1978-82	1983-87	State	1978-82	1983-87
	%			%	
Arizona	100.00	100.00	New York	47.16	42.07
California	77.99	84.84	Oregon	16.30	24.02
Colorado	100.00	100.00	Texas	78.98	84.07
Florida	100.00	100.00	Washington	21.27	22.46
Michigan	65.18	63.72	Other states[a]	7.38	7.85
Minnesota	42.10	37.24	United States	62.89	70.44

[a]Includes Wisconsin, Ohio, and New Jersey.

SOURCE: USDA, ERS, Food Consumption, Prices and Expenditures, 1989.

A market shift to the fresh market is occurring in California, Oregon and Texas, while Michigan, Minnesota, and New York are shifting from fresh to processed. California, Washington, and Wisconsin/Ohio/New Jersey account for 75 percent of all processed carrots with five-year market shares of 23, 22, and 30 percent, respectively (1983-87 average) (Table 5). Two states, California and Texas, account for 75 percent of the fresh market with 63 and 12 percent of the market, respectively.

TABLE 5. MARKET SHARE OF PROCESSED CARROTS, AS A PERCENT OF STATES PRODUCTION, FIVE-YEAR AVERAGES, 1978-1982 AND 1983-1987

State	1978-82	1983-87
	%	
California	26.79	23.03
Michigan	6.57	7.42
Minnesota	3.73	3.78
New York	3.08	3.87
Oregon	7.57	4.77
Texas	6.62	4.68
Washington	19.00	22.43
Other[1]	26.65	30.01
Total	100.00	100.00

[1]Includes New Jersey, Ohio, and Wisconsin.

SOURCE: USDA, ERS, Food Consumption, Prices, and Expenditures.

Foreign Trade

Before 1979 the United States was a net exporter of carrots. Two exceptions were 1970 and 1974 when the United States was a net importer. Since 1980, the United States has been a net importer of carrots. In 1984, the trade deficit peaked at 1.3 million cwt. or 5.6 percent of domestic product. By 1987, the trade deficit was reduced to .44 million cwt. or 1.7 percent of production (Table 6).

Imports are seasonal in nature. Most imports in 1987 were between September and December. Canada was the major supplier, accounting for over 80 percent of the 1987 shipments (Table 7).

TABLE 6. U.S. CARROT EXPORTS, IMPORTS AND NET EXPORTS (IMPORTS) 1970-1987

Year	Imports	Exports	Net Exports
	1,000 lbs		
1970	56,185	50,628	(5,557)
1971	52,647	69,647	17,000
1972	51,030	80,188	29,158
1973	48,008	63,255	15,247
1974	70,063	65,882	(4,181)
1975	60,797	92,971	32,174
1976	67,300	69,285	1,985
1977	72,557	119,443	46,886
1978	72,308	117,867	45,559
1979	94,825	104,201	9,376
1980	108,683	62,464	(46,219)
1981	87,882	87,396	(486)
1982	105,126	78,423	(26,703)
1983	102,515	69,252	(33,263)
1984	212,870	80,634	(132,236)
1985	147,789	60,184	(87,605)
1986	113,473	58,956	(54,517)
1987	99,760	55,586	(44,174)

SOURCE: USDA, Vegetables and Specialties, November 1988.

TABLE 7. CARROT IMPORTS BY COUNTRY OF ORIGIN, 1987

Import	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	1,000 cwt												
Belgium	5	2	3	5	4	2	3	2	3	3	3	2	37
Canada	57	12	3	1	-	-	11	66	141	166	186	173	816
Israel	1	2	2	4	3	7	9	2	1	3	1	1	36
Mexico	5	4	6	8	2	2	2	1	4	21	28	41	124
IMPORT TOTAL	68	20	14	18	9	11	25	71	149	193	218	217	1,013

SOURCE: Foreign Agricultural Trade of the United States, 1988.

Seasonal Shipments

Carrot shipments are greater from January to June than from August to December. Data do not exist to determine whether carrot consumption is seasonal in nature. However, one possible explanation for seasonal shipments is that during late summer and fall homegrown produce and local truck farms may supply a significant portion of the demand.

Shipping seasons vary among states. Central California is the major supplier year-round. Southern California and its Imperial Valley, Arizona, Florida, and Texas are major suppliers from December through May (Table 8). Michigan and Washington ship primarily from August through November. Shipments in 1987 were primarily by truck (77 percent) with rail accounting for 23 percent (4 percent of which was by piggyback rail).

TABLE 8. CARROT SHIPMENTS BY STATE OF ORIGIN, 1987

Origin	Ja	Fe	Mr	Ap	My	Jn	Jy	Au	Se	Oc	No	De	Total
	1,000 cwt.												
Carrots - rail													
Arizona	2	–	3	3	12	4	3	–	–	–	–	–	27
Arizona[a]	–	–	1	5	5	–	1	–	–	–	–	–	12
Calif cent	232	159	154	171	181	228	230	82	106	93	157	175	1,968
Calif cent[a]	7	13	10	18	7	21	19	–	–	–	1	2	98
Calif south	9	1	22	22	8	3	–	–	–	–	2	5	72
Calif south[a]	–	–	1	9	16	16	7	–	–	–	–	–	49
Calif Imp Vly	7	15	38	59	45	33	1	–	–	–	–	–	198
Calif Imp Vly[a]	5	19	54	103	115	27	–	–	–	–	–	–	323
Texas	5	6	13	13	4	–	–	–	–	–	–	–	42
TOTAL	267	214	304	410	393	323	254	82	106	93	161	182	2,789
Carrots - piggyback													
Arizona	1	–	1	3	1	–	–	–	–	–	–	–	6
Calif cent	35	26	18	26	28	50	41	14	18	20	25	37	338
Calif south	13	12	14	10	14	3	1	–	–	–	–	1	68
Calif Imp Vly	10	16	19	16	11	3	–	–	–	–	–	7	82
Florida	6	12	13	17	14	4	–	–	–	–	–	4	70
TOTAL	65	66	65	72	68	60	42	14	18	20	25	49	564
Carrots - available truck													
Arizona	21	11	25	35	43	51	29	2	–	–	–	–	217
Calif cent	630	481	444	417	447	679	693	539	558	549	611	542	6,590
Calif south	100	108	109	110	83	31	–	–	–	–	12	40	593
Calif Imp Vly	73	136	200	249	218	72	–	–	–	–	–	38	986
Florida	105	143	171	136	98	52	–	–	–	–	–	40	746
Florida[a]	11	7	2	3	1	2	–	–	–	–	–	–	26
Michigan	–	–	–	–	–	–	50	290	221	240	83	–	884
Texas	118	161	225	202	93	1	–	–	–	–	9	47	856
Washington	2	–	–	–	–	–	30	43	56	70	88	35	324
TOTAL	1,060	1,047	1,176	1,152	983	888	802	874	835	859	804	742	11,222
U.S. TOTAL	1,392	1,327	1,545	1,634	1,444	1,271	1,098	970	959	972	990	973	14,575

[a]Export.

SOURCE: USDA Fresh Fruits and Vegetable Shipments, 1988.

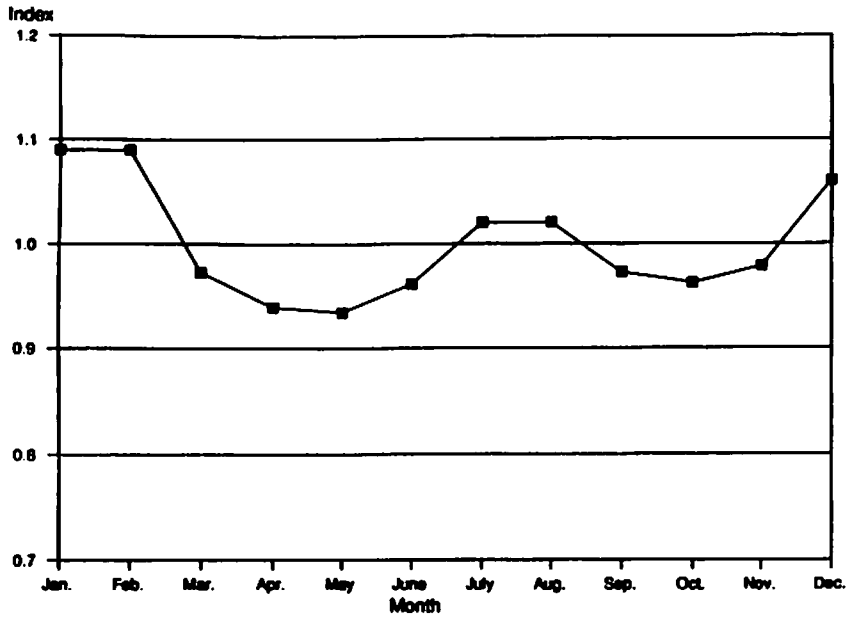

Figure 2. Monthly Price Indices for California Carrots Using Wholesale Chicago Prices.
SOURCE: USDA, Fresh Fruit and Vegetable Prices, 1978-1988.

Seasonal Pricing and Returns to Storage

A major terminal market was chosen as prices would more clearly reflect the overall U.S. market condition and not be subject to individual local factors. The USDA only publishes comprehensive wholesale prices for the major markets of New York and Chicago. Chicago wholesale prices were used to determine seasonality of prices and returns to storage. The price at Chicago is the result of local supply and demand factors. The Chicago market was used as the most likely major market for North Dakota produce. A monthly index of Chicago wholesale prices was completed for a 10-year period from 1978 to 1987. These prices were based on a calendar year basis; a distinctive crop production and marketing year does not exist since production occurs throughout the year.

Carrots from Northern states generally are marketed during late summer and fall while carrots from Southern states are marketed from late winter to spring. Central California markets throughout the year. A 10-year index (1978-1987) of Chicago wholesale carrot prices (Table 9) is presented in Figure 2. The price index has two peaks, a major peak of 1.09 in January and a minor peak of 1.02 in July. These correspond approximately with seasonal production of Northern and Southern states. Prices are lowest during and shortly after harvest of the winter crop in April and May and rise as supply decreases until the Northern states start to supply the marketplace in late summer. Prices drop during the harvest in the Northern states and rise until winter production is marketed in January and February. The price index summarizes monthly price behavior over a 10-year period. However, monthly prices may differ within individual years. To check the accuracy of the index, monthly prices from individual years were analyzed to determine if they followed predicted patterns. In nine of the 10 years, prices declined from January to May. During 1978 to 1987, the average decline was $1.59 for 48 lbs. Although prices on average increased from May to August, prices actually increased in five of 10 years. Prices decreased an average of $.59 from August to October in seven of the 10 years. Prices increased from October to January during eight years, decreasing in 1980 and 1986. The 10-year average change in price from October to January was $1.50 (Table 10).

The strongest pattern in prices was the decrease from January to May and the increase from October to January, indicating a positive return to storage does exist for carrots harvested in the fall and marketed in the winter.

TABLE 9. CHICAGO WHOLESALE CARROT PRICES WITH CALIFORNIA ORIGIN, 1977-1988

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	$/48 lb. Film Bag											
1977	12.94	12.50	9.23	8.92	8.30	7.30	7.02	6.98	7.75	8.00	7.33	8.45
1978	8.91	9.71	7.20	7.25	8.00	8.13	11.81	10.65	9.31	8.90	7.75	8.45
1979	10.70	10.25	9.06	8.38	8.75	8.75	10.08	8.63	8.50	7.85	7.63	7.63
1980	8.85	8.56	7.48	7.85	8.19	8.66	10.85	9.88	10.60	11.67	12.66	13.00
1981	11.25	11.06	10.15	9.50	11.83	11.25	11.06	11.50	10.40	10.18	11.00	11.70
1982	12.75	12.94	12.15	11.63	10.38	9.40	9.69	8.80	8.13	8.38	8.75	11.63
1983	12.06	12.13	10.50	8.88	8.69	9.81	13.13	13.80	11.56	10.87	11.10	12.75
1984	12.60	15.25	12.69	13.75	10.75	9.88	10.60	10.44	9.56	9.50	9.56	9.63
1985	10.38	11.44	10.31	9.38	8.75	9.00	8.80	9.75	10.10	9.56	9.88	11.18
1986	11.44	9.75	9.30	9.38	9.50	10.60	11.25	12.31	11.00	12.75	11.56	11.15
1987	11.69	11.06	9.95	9.56	9.88	12.25	9.69	8.45	8.81	8.69	9.60	11.38
1988	11.63	10.85	9.88	9.75	10.81	10.75	11.44	12.70	12.75	10.95	10.38	10.38

SOURCE: USDA Fresh Fruit and Vegetable Prices, 1978-1988.

TABLE 10. SEASONAL PRICE CHANGES FOR CARROTS, CHICAGO, 1977-1988

Year	January to May	May to August	August to October	October to January
	$/48 lb. Film Bag			
1977	-4.64	-1.32	1.02	.91
1978	-.91	2.65	-1.75	1.80
1979	-1.95	-.12	-.78	1.00
1980	-.66	1.69	1.79	-.42
1981	.58	-.33	-1.32	2.57
1982	-2.37	-1.58	-.42	3.68
1983	-3.37	5.11	-2.93	1.73
1984	-1.85	-.31	-.94	.88
1985	-1.63	1.00	-.19	1.88
1986	-1.94	2.81	.44	-1.06
1987	-1.81	-1.43	.24	2.94
1988	-.82	1.89	-1.75	
10-year average (1978-1987)	-1.59	.95	-.59	1.50
5-year average (1983-1987)	-2.12	1.44	-.68	1.27

SOURCE: USDA, Fresh Fruit and Vegetable Prices, 1978-1988.

Market Competitiveness

The market competitiveness of North Dakota depends upon its delivering acceptable quality products to a market at equal or less cost than other suppliers. Production and shipping costs are the major components in determining final cost. Published data were not available on production costs for major producing regions in the United States. However, North Dakota's advantage (disadvantage) in shipping costs can be estimated. Assuming a standard product, North Dakota is a competitive supplier if the differential in production cost does not exceed the shipping cost advantage.

Because primary production of fresh carrots is in the Southwest, primarily California, potential market areas for North Dakota would be population centers near North Dakota and those to the east. This would include North Dakota, South Dakota, Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio.

Although many of these states produce carrots for the fresh market, they remain net importers, except for Minnesota and Michigan. The eight-state region accounts for 19.5 percent of the population but only 9 percent of the fresh carrot production (Table 11). However, because carrots from Michigan, Minnesota, and Wisconsin are marketed during the late summer, fall, and early winter, this region may remain a net importer. Since some of Michigan's production would likely move east, limited market potential may exist for this region.

TABLE 11. POPULATION AND FRESH CARROT PRODUCTION FOR SELECTED STATES

State	U.S. Population	U.S. Fresh Carrot Production
	----------%----------	
Illinois	4.76	--
Indiana	2.27	--
Michigan	3.78	6.7
Minnesota	1.74	1.1
North Dakota	.28	--
South Dakota	.29	--
Ohio	4.43	1.2[a]
Wisconsin	1.97	--
Total	19.52	9.0

[a]Wisconsin and Ohio combined.
SOURCE: U.S. Census 1980 and Table 2.

To determine North Dakota's transportation advantage (disadvantage) in supplying specific markets, transportation costs were estimated for six local, regional, and national markets: Fargo, Minneapolis, Chicago, New York, Atlanta, and Sioux Falls and four supply points: Grand Forks, California, Minnesota, and Michigan. Estimated transportation advantage (disadvantage) for the Red River Valley (RRV) are presented in Tables 12 and 13. The RRV has a transportation advantage over California in supplying all markets and an advantage over Michigan in supplying Fargo, Minneapolis, and Sioux

TABLE 12. ESTIMATED TRANSPORTATION COSTS FOR CARROTS FROM SELECTED ORIGINS TO SELECTED MARKETS[a], 1989

Destinations	Origins			
	Grand Forks[b]	California	Michigan	Minnesota
	$/50 lb.			
Fargo	.23	2.61	1.15	.59
Minneapolis	.57	2.69	.82	.25
Chicago	1.15	2.95	.25	.66
New York	2.28	4.00	1.38	1.78
Atlanta	2.09	3.15	1.26	1.67
Sioux Falls	.58	2.32	1.03	.36

[a]Rates estimated by following formula: Rate/50 lb. unit = (100 + 1.25 * miles)/880 units.
[b]Represents Red River Valley of North Dakota.

SOURCE: Based on tariffs derived from industry sources.

TABLE 13. ESTIMATED RED RIVER VALLEY'S TRANSPORTATION COST ADVANTAGE (DISADVANTAGE) IN SUPPLY SELECTED MARKETS, 1989

Destinations	Origins		
	California	Michigan	Minnesota
	$/50 lb.		
Fargo	2.38	.92	.36
Minneapolis	2.12	.25	(.32)
Chicago	1.80	(.90)	(.49)
New York	1.72	(.90)	(.50)
Atlanta	1.06	(.83)	(.42)
Sioux Falls	1.74	.45	(.22)

SOURCE: Adapted from Table 12.

Falls. Both Minnesota and Michigan have an advantage in supplying the Chicago, New York, and Atlanta markets. Additionally, Minnesota has an advantage in supplying the Minneapolis and Sioux Falls markets.

Case Study for the Red River Valley of North Dakota, 1987-1988

A case study of a small vegetable production and marketing operation in the central Red River Valley of North Dakota was made to assess practical difficulties and profitability of a beginning enterprise and to develop an expanded model fo a commercial operation. The operation, on an existing farm, used traditional farm equipment when possible and specialized production and handling equipment when required (Table 14). A potato warehouse and used potato production and handling equipment were utilized for producing, storing, and packaging the product whenever possible.

TABLE 14. UTILIZATION OF EQUIPMENT BY A CENTRAL RED RIVER VALLEY VEGETABLE OPERATION, NORTH DAKOTA, 1988

Specialized Production Equipment	Carrots	Transplant Onions	Seeded Onions	Greentop Onions	Potatoes	Broccoli
4-row Planet Jr. planters (used)	x		x	x		
4-row beet cultivator (used)	x	x	x	x		x
4-row transplanter (used)						
1-row onion digger with gas engine (used)			x			
FMC one row carrot harvester (used)	x					
Other equipment:						
Pickup with insulated topper to deliver product (used)	x	x	x	x	x	x
18 Hp. tractor for planting (used)			x		x	x
18 Hp. tractor for cultivating (used)[a]	x	x	x	x		x
30 Hp. tractor with side-mount tanks; transplanting (used)[a]		x				x
30 Hp. tractor for pulling harvester (used)[a]	x					
Spraycoupe sprayer for insect control/fertility program[a]					x	
PTO driven duster for insect control (used)[a]					x	x
80 Hp. tractor with cultivator for spring and fall till[a]		x	x	x	x	x
Single-axle truck with tank for hauling water (used)[a]						
Flatbed trailer for hauling (used)[a]	x	x	x			
Processing/packaging equipment:						
Two-wheel conveyor bottom trailer (used)	x					
Baskets (65 @ $5.00) (used)	x			x		x
Burlap sacks (900 @ $.50) (new)	x	x	x		x	x
Potato conveyor for offloading with gearhead (used)	x		x			
Large drum carrot washer (used)	x					
Small carrot washer (used)	x					
Conveyor from washer to packing belt (used)	x					x
Packing belt conveyor (used)	x	x	x			
Round collection table (used)	x		x			
Over/under packaging scales (used)	x		x			x
100 wooden pallets (used)		x	x			
Basket fans for circulating air (used)		x	x			
Platform scale, sackholders, tables (used)	x	x	x	x	x	x
Forklift (used)[a]	x	x	x			
Storage Equipment:						
Cooler, approx 20/10 ft installed (used)	x			x		x
Insulated bin built by cooler approx 25/15 ft (new)	x	x	x			
Refrigeration unit installed (new)	x			x		x

[a]Equipment rented or borrowed from other operations.

Source: Case study, central Red River Valley, North Dakota 1988.

The soil is classified as "Beardon loam" and represents the type of soil used to produce potatoes, sugarbeets, dry beans, small grains, and other crops in the Red River Valley. Average yearly rainfall in the area is 21 inches. No irrigation was available.

The operation began in 1987 when 20 acres were planted to several varieties of carrots and 1.5 acres to other vegetables: winter squash, summer squash, melons, cabbage, broccoli, and tomatoes. Most of the 1.5 acres of vegetables were harvested successfully and about 15 acres of carrots were harvested although the carrot yield was low due to poor seed emergence. While, the 1987 harvest was encouraging because high quality products were produced and successfully marketed, returns were below variable production costs due to producer inexperience and lack of preparation, causing production, storage, and marketing difficulties. Products were marketed locally, primarily in Fargo and Grand Forks. Total product sales for 1987 were only around $5,000. Two major accomplishments in 1987 were gaining production and marketing experience and opening market channels for a short, locally grown sweet carrot.

Production in 1988 was better, with returns, in most cases, above variable production costs. However, returns were negative when operator labor and fixed costs were considered. The scale of operations was larger with 33 acres planted and 20.7 acres harvested. The product mix during 1988 shifted toward onions. All products harvested in 1988 were grown organically and most of the products were certified and marketed as organically grown. The major accomplishments for 1988 were achieving organic certification and opening market channels for organic products on local, regional, and national levels.

Carrot Crop of 1987

Carrots, the primary crop in 1987, were grown on three fields without chemical fertilizers. The primary obstacles were weed control and seedling emergence. An application of pre-emergent herbicide (treflan) was used on a 12.5 acre field, but due to its granular form and lack of rainfall, the herbicide only partially prevented weed growth. Due to slow carrot germination, weeds gained a head start on carrots, making postemergence herbicides questionable. Hand weeding the entire field was required, and 2.5 acres were abandoned due to excessive weed problems. A second planting of carrots was attempted on 3 acres of certified organic land. Slow emergence and weed competition, especially foxtail, were so severe the entire field was abandoned.

A third field of carrots was planted on 4.5 acres with no prior herbicide application. Weeds again emerged before the carrots and became too advanced for a postemergence herbicide. However, weed density was low, permitting hand weeding. The entire field was harvested.

Due to late planting and continued drought conditions, carrot seedlings failed to germinate, and those that did germinate after a short rain withered beneath crusted soil. The crop was watered extensively with tanks mounted on a tractor, applying one eighth to one quarter inch of water per pass. Watering this large acreage with tanks was tedious and inadequate in coping with the drought and early summer heat. The sun hardened the soil surface after each watering. Only the seedlings that penetrated through cracks in the earth and reached their third leaf stage became well rooted and survived the drought. Successful germination ranged between one and 50 percent, depending upon field and location. Larger seeds emerged more readily than smaller seeds.

An extended period of rain around July 1 germinated the balance of the seedlings in the soil, many of which successfully penetrated the soil surface. Despite their late emergence, most of these seedlings developed adequate sized roots for the fresh market before the late fall harvest.

The product was harvested with a mechanical harvester late in the fall and stored on trucks until a cooling bin and wash line could be installed in the potato warehouse. Before unloading, mold developed, and part of the product never reached storage. The remaining product on trucks was unloaded and stored in a cooler and adjacent storage bin set up for this purpose.

Despite the carrots being stored in a temperature and humidity controlled environment, the temperature could not be kept cool enough to prevent mold on the stored product. Approximately one-half of the stored product was discarded early in the spring, with the balance of the product marketed through mid-April.

Although quantity of the product was limited, the quality was good. However, sales were slow, because the carrots were sold in bulk 50 pound sacks. It became apparent in late November consumer sized packaging would be required to move the product faster. Packaging scales were purchased, and paper labels produced to meet legal marketing requirements (i.e., net weight, name of packer, and place of origin). The product was packaged in standard freezer bags and sold to local supermarkets. Sales volume increased considerably as local consumers discovered the products' homegrown flavor.

Carrot Crop of 1988

In late April, 1988, a 3.2 acre field was planted to carrots on certified organic land with several later plantings on 11 acres of land using chemicals. Drought was a major problem. Only the first planting was successful. Weed growth was moderate and required hand weeding. The later plantings either did not germinate or the seedlings failed to penetrate the crusted soil surface.

Since the carrots were planted early, they reached saleable size for harvest around August 1. Over one-half of the carrots were dug and sold before the final harvest, primarily in Fargo and Grand Forks. After organic certification was obtained, the carrots were promoted as organically grown. A portion of the product was sold to regional organic markets where flavor is the primary concern. Because of limited acreage, supplies began to run low toward the end of November. Some local sales were curtailed to supply organic markets. By the end of January, nearly all of the product had been sold.

Carrot Grade and Packout Percentages, 1988

Carrots were washed and packaged in several different package sizes to satisfy consumer demand. After carrots came out of the washer, a conveyor belt lifted them to a packaging belt where jumbos were removed manually for 25- and 50-pound bulk packages. Workers removed smaller carrots, placed them on packaging weigh-scales, and put them into 1.5- or 3-pound packages which were consolidated into master[3] containers

[3]A master weighs 50 pounds.

or bales. Each master contained packages of 24- or 32-ounce or 16- or 48-ounce packages. Mini-carrots were packaged at 16 ounces per bag and sold in master containers or bales of 20 bags per bale. Greentop carrots were mostly mini-carrot size and were sold in bunches of six to 20 carrots per bunch, depending on carrot size. Number 2 grade product, which consists of broken and crooked but otherwise sound product, normally was sold at half price or delivered to charitable organizations for packaging costs. Waste product, too inferior for human food, was returned to the field as organic matter. Carrot packout and grade percentages are shown in Figure 3.

The carrot operation yielded gross returns sufficient to cover all variable growing, harvesting, packaging, marketing, and delivery costs but not fixed costs (Tables 15 and 16). Therefore, the operation at this scale could not be considered profitable.

Carrot growing costs on a per master basis were $1.55 per master, similar to growing costs in Michigan and other areas (Table 15). Variable post-production costs including harvesting, grading, packaging, marketing, and delivery were $11.72 per master, which is high compared to other large-scale operations.

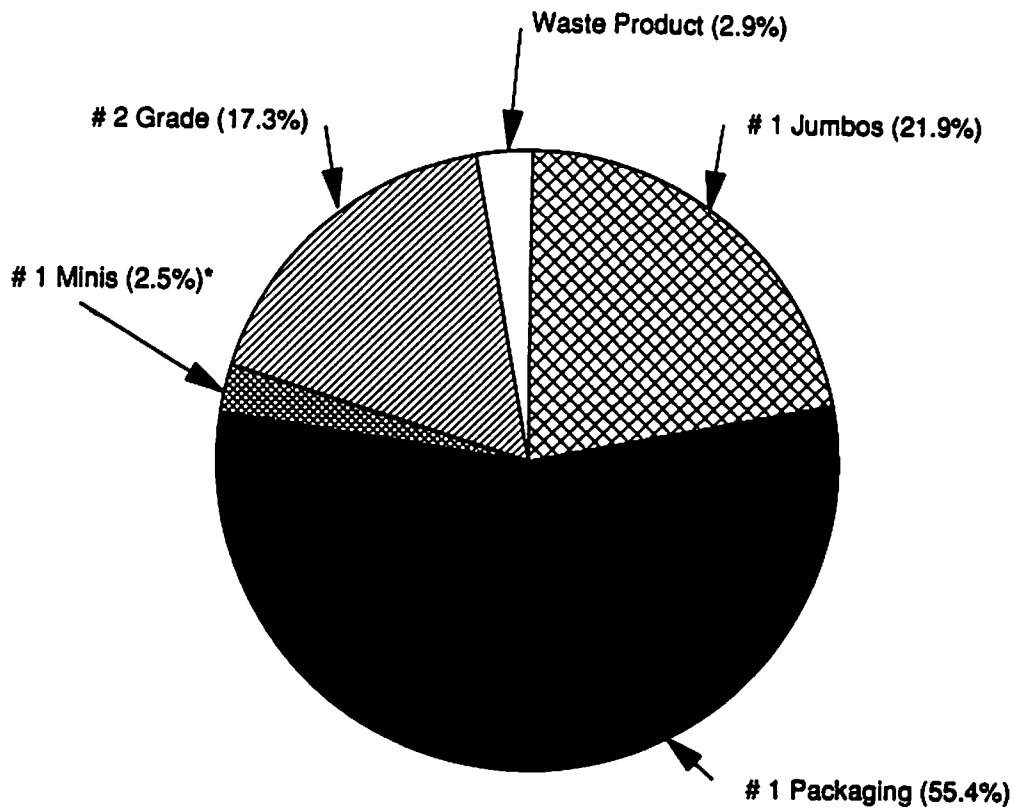

Figure 3. Carrot Grade and Packout Percentages From Case Study in Central Red River Valley, North Dakota, 1988

*Includes product harvested early with greentops.

TABLE 15. CARROT OPERATION COSTS FOR THE CENTRAL RED RIVER VALLEY CASE STUDY, 1988[a]

Variable, Fixed, and Total Costs	Total Costs	Cost Per Acre	Cost Per Master[b]
		$	
Variable Costs			
Growing Costs			
Seed (3 lbs @ $13.67/lb)	131	41	0.19
Cultural Operations			
Fall till	16	5	0.02
Planting	28	9	0.04
Cultivating			
1st	55	17	0.08
2nd	22	7	0.03
3rd	12	4	0.02
Handweeding			
1st	480	150	0.71
2nd	240	75	0.36
Interest on operating capital			
6 mo. @ 12%	59	18	0.09
Subtotal	1,043	326	1.55
Harvesting, Packaging, and Marketing Costs			
Mechanically harvest (75%)	689	215	1.02
Hand pick (25%)	600	188	0.89
Hauling to warehouse	160	50	0.24
Grading/packing	1,769	553	2.62
Packing materials	962	301	1.43
Warehouse utilities			
Water	150	47	0.22
Heat	120	38	0.18
Electric	200	63	0.30
Repairs/maintenance	400	125	0.59
Telephone/marketing	700	219	1.04
Delivery	2,150	672	3.19
Subtotal	7,900	2,471	11.72
Total Variable Costs	8,943	2,797	13.27
Fixed Costs			
Land rental	320	100	0.47
Warehouse rental	1,200	375	1.78
Fixed ownership charges			
Specialized production equipment	934	292	1.39
Other unspecialized equipment	376	118	0.56
Processing/packing equipment	667	208	0.99
Storage equipment	946	296	1.40
Office supplies, subscriptions	54	17	0.08
Vehicle insurance/taxes/licenses	100	31	0.15
Membership and professional fees	87	27	0.13
Total Fixed Costs	4,684	1,464	6.95
TOTAL VARIABLE AND FIXED COSTS	13,627	4,261	20.22

[a]Based on 3.2 acres and 674 masters of production.
[b]A master weighs 50 pounds.

SOURCE: Case Study, Central Red River Valley, North Dakota, 1988.

TABLE 16. CARROT PACKOUT AND PRICE RECEIVED FOR CENTRAL RED RIVER VALLEY CASE STUDY, 1988

Description	Packout	Value	Average Price/master	Weight	Average Price/lb.
	Masters	—$—	—$—	—lbs—	—$—
#1 Packaging	481	7,156	14.88	23,088	0.31
#1 Bulk Jumbo	191	2,654	13.90	9,525	0.28
#1 Mini-carrot	55	657	11.95	1,105	0.60
#2 Bulk	151	379	2.51	7,525	0.05
Culls and waste	25	0	0.00	1,245	0.00
Total	903	10,846	12.01	42,488	0.26

SOURCE: Case study, 3.2 Acres in Central Red River Valley, North Dakota, 1988

Total harvesting costs of mechanical harvesting, handpicking, and hauling the product to the warehouse were $2 per cwt. This high cost is due to the small scale of the operation, which required weekly digging for only a few carrots, and harvester misses, which required handpicking 25 percent of the product.

Grading, packaging, and packaging materials were $3.75 per master. This high rate is due to the physical constraints of the simplistic washing and packaging line that required much labor. Warehouse utilities were $.90 per bale, which was high due to the low volume of product in the warehouse.

Telephone/marketing and delivery were $4 per cwt. This rate is high, because product volumes are low and the product often was marketed and delivered directly to local retail markets, bypassing wholesale houses that might have taken regular large volumes at lower per-unit prices.

Based on field experiments, the production and marketing of sweet carrots in North Dakota appears feasible but would require a larger-scale operation to be profitable. One of the most serious constraints in producing carrots in North Dakota is spring seedling emergence, which can be solved best by early spring planting, irrigating, or applying an anti-crust substance to the row's surface.

Marketing sweet short carrots as a packaged product may be unacceptable. Although flavor is excellent, clientele still may prefer the customary long carrot. The future of producing carrots for packaging seems to hinge upon market acceptance of a short but sweet carrot.

The expanded model for this study is based on an Agricultural Economics Department of Michigan State University study. Entitled "Costs of Producing Carrots" the study covered fixed and variable costs associated with a commercial sized carrot farm and profitability of carrots under alternative yield and price assumptions.

The same methodology from the Michigan study was used to develop a commercial carrot operation for North Dakota. Carrots were selected because the case study and a horticultural crop survey indicated North Dakota had favorable conditions to successfully produce carrots (Dufner et al. 1990). Although North Dakota does not have a commercial carrot operation, this model presents the opportunities available to individuals could use this model to start an operation specializing in carrot production.

The following assumptions were made for this model: 1) the farm would consist of 300 acres with 250 tillable acres, 2) 100 acres would be planted to carrots 3) the remaining 150 acres would be used for grain or other vegetable crops, 4) carrots would be irrigated to help alleviate the emergence problem, and 5) wells would be available to provide sufficient water to irrigate the carrots.

Cost Return Analysis

Both fixed and variable costs of growing 100 acres of carrots were taken from the Michigan study. Price and yield to determine gross receipts came from the case study presented in this paper. Various prices and yields are presented to illustrate how losses/returns vary with changes in price and yield.

Fixed Costs

Fixed costs do not vary with the acres planted or yield of the crop (once committed to the production of the crop). They include such items as depreciation, interest, repairs and maintenance, land rental, and insurance. Interest on investment was the largest fixed cost at $208 per acre (Table 17). Depreciation on machinery and equipment amounted $177 per acre, a considerable portion of fixed costs.

Variable Costs

Variable costs, those that change with production of the crop, include seed, fertilizer, the chemicals used for the crop, labor, and other costs. The variable costs incurred in a typical carrot operation were $2,079 (Table 17). The variable inputs are presented on a per acre basis for both the amount used and cost. Variable growing costs were for a third of total variable costs. Seed and machinery repair were the two major variable growing costs. Variable harvesting and marketing costs came to $1,319 per acre with over 90 percent used for packing.

Total Costs and Net Returns

Gross receipts, variable and fixed costs, and net returns for both a per acre and per master basis were provided (Table 17). The carrot operation was profitable at a yield of 350 masters per acre and a price of $7 per master (Table 17), assumed to be a possible yield and price with the conditions presented in the case study. The price received for carrots can vary depending on the targeted market and regional location of markets and on whether the farmer uses irrigation. The price used for computing gross receipts in Table 17 was not for organically grown carrots. the price of carrots would be more if organically grown.

TABLE 17. ESTIMATED PER ACRE AND PER MASTER COSTS AND RETURNS FOR CARROT PRODUCTION CENTRAL RED RIVER VALLEY, NORTH DAKOTA, 1988[a]

Item	Per Acre	Per Master
	$	
Gross Receipts - 350 msts. reg.	2,450.00	7.00
- 100 msts. jumbos	400.00	4.00
Total Gross Receipts	2,850.00	6.33
Variable Costs		
Growing		
- Seed	111.00	0.25
- Fertilizer	43.00	0.10
- Lime, micronutrients	30.00	0.07
- Fungicide	44.80	0.10
- Insecticides	38.00	0.08
- Herbicides	86.80	0.19
- Nematicides	90.00	0.20
- Cultural labor	75.68	0.17
- Fuel, oil	67.00	0.15
- Machinery repair	102.00	0.23
- Machine hire	2.50	0.01
- Utilities	18.00	0.04
- Miscellaneous (travel, etc.)	15.00	0.03
- Interest on operating capital	36.18	0.08
Subtotal	759.96	1.69
Harvest and Marketing		
- Labor	39.60	0.09
- Packing	1,215.00	2.70
- Transportation	60.00	0.13
- Promotion	4.50	0.01
Subtotal	1,319.10	2.93
TOTAL VARIABLE COSTS	2,079.06	4.62
Fixed Costs		
- Depreciation	177.08	0.39
- Interest on investment	208.22	0.46
- Repairs and Maintenance	7.46	0.02
- Rent	84.00	0.19
- Insurance	12.20	0.03
TOTAL FIXED COSTS	488.96	1.09
TOTAL VARIABLE AND FIXED COSTS	2,568.02	5.71
Net return (loss)	281.98	0.62

[a]The typical farm in this study consists of 300 acres total, with 250 acres of tillable land of which 100 acres is in carrot production.

Net returns per acre for various prices and yields were used to represent both organically and non-organically grown carrots (Table 18). Organically grown carrots generally command a higher price in the marketplace. Net returns (Table 18) were determined using the following assumptions: 1) variable costs expended to prepare the land and to grow carrots would not vary with yield, 2) harvesting, packaging, and promotion costs would vary directly with yield. Active vegetable producers should compute their costs of operation using cost and yield estimates pertaining to their enterprise.

TABLE 18. NET INCOME (LOSS) PER ACRE AT VARIOUS PRICES AND YIELDS, CENTRAL RED RIVER VALLEY, NORTH DAKOTA, 1988[a]

	Average Price Received/Master (dollars)				
	Non-Organic		Organic		
Yield	5	7	9	11	13
(Masters Sold/Acre)	$/acre				
150	(938)	(638)	(338)	(38)	(262)
250	(731)	(231)	269	769	1,269
350	(524)	176	876	1,576	2,276
450	(317)	583	1,483	2,383	3,283

[a]Jumbo's not included.

Summary and Conclusions

The potential for competitive commercial production of carrots in North Dakota was examined in this study. Total and seasonal U.S. production and foreign trade statistics, market shares, seasonal prices, monthly shipments and returns to storage were presented. Carrots were into fresh and processed. Regional market share (production) and population along with per capita consumption were used to determine regional demand. North Dakota lies in a net import region, which would suggest the potential exists for North Dakota to produce carrots. North Dakota's advantage (disadvantage) in transportation costs versus other competing regions were determined for the Fargo, Minneapolis, Chicago, New York, Atlanta, and Sioux Falls markets.

North Dakota carrots have a transportation advantage over California for all the destination markets studied. A transportation advantage also exists for North Dakota carrots over Michigan and Minnesota carrots for the Fargo market and over Michigan for the Minneapolis and Sioux Falls markets.

North Dakota's competitiveness in any market is determined by production and transportation costs relative to production and transportation costs for other originating regions. However, since production costs for each region were not available, competitiveness comparisons were unobtainable.

A case study of a small vegetable production/marketing operation was analyzed. A vegetable operation was started in the central Red River Valley in 1987 and continued in 1988. Production in 1987 concentrated on carrots while 1988 production shifted to primarily onions. Results of the operation, including machinery, operational problems, production, sales, variable and fixed costs, packout, prices, and net return data were analyzed.

An expanded model was developed from case study data using the methodology of a study from Michigan State University. The expanded model evaluated economic feasibility of a commercial-sized operation producing carrots. Assumptions used in the expanded model included a 300 acre farm with 250 tillable acres (100 acres planted to carrots). Carrot acreage was irrigated. Carrot yields were estimated at 350 masters per acre and priced at $7 per master (based on case study data).

Carrots were estimated to have positive net returns. Carrot production in the central Red River Valley of North Dakota was estimated to have per acre fixed and variable costs of $489 and $2,079, respectively. Gross carrot receipts were estimated at $2,850 per acre and net returns at $282 per acre. Various price and yield scenarios presented provide information on net profit or loss per acre. Under the assumed cost structure, carrots were profitable at a yield of 250 masters per acre and a price of $9 per master.

Feasibility studies estimate costs and returns using generally acceptable assumptions available from trade sources. However, an individual producer's costs and/or returns may vary significantly from assumptions used in this report. Therefore, each producer considering vegetable production and marketing should analyze the specific costs and returns that are inherent to their operation.

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