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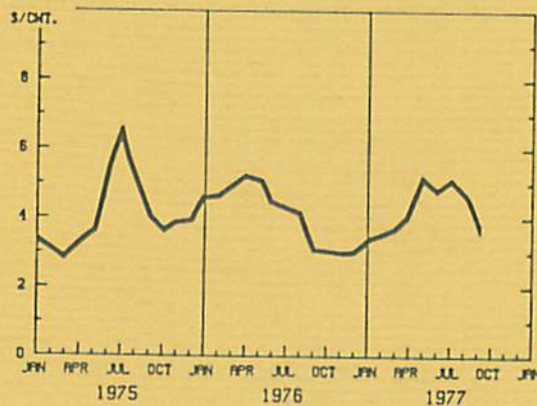
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POTATOES

- PRODUCTION
- PRICES
- STORAGE
- MARKETING
- CONSUMPTION

POTATOES : U.S. GROWER PRICES



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FOREWORD

Many were involved in the preparation of this report. The authors wish to acknowledge the contributions of the clerical and professional staff of the Department of Agricultural Economics. Special appreciation is extended to Dr. Donald E. Anderson, Dr. David W. Cobia, Dr. Jerome E. Johnson, Dr. Roger G. Johnson, Mr. Richard W. Reith, and Mr. LeRoy W. Schaffner for their comments and information.

Appreciation is also extended to personnel outside of the department--Dr. George L. Pratt, Department of Agricultural Engineering; Dr. Donald C. Nelson, Department of Horticulture; Mr. Stan Erickson, Market Specialist, Red River Valley Potato Growers Association; and a personal word of thanks to Mr. Robert C. Shephard, potato grower, Crystal, North Dakota.

Financial support for this study came from the North Dakota Agricultural Experiment Station.

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Highlights

Potatoes are grown in every state with Idaho ranking number one in production. The Red River Valley of the North is the third ranked production area.

The majority of the potato crop is harvested in the fall. However, some potatoes are harvested in the summer, winter, and spring months. In 1975, 86 percent of the total crop was harvested in the fall, and this constitutes the major source for both tablestock and processing needs.

Potatoes can be grown throughout North Dakota and Minnesota. The leading counties in order of production are Walsh, Grand Forks, Polk, Pembina, Marshall, and Clay.

Historically, prices received by farmers for potatoes have fluctuated greatly from year to year in response to changes in supply and demand and the fact that potatoes cannot be stored in an unprocessed form from one year to the next.

The volume of potatoes used for processing has grown rapidly during the past 20 years. This has occurred as a result of the increased demand for convenience foods and the expanding institutional market. Per capita consumption in the processed form increased from about six pounds in 1950 to about 67 pounds in 1975. Per capita consumption of all potatoes was about 122 pounds per person in 1975. Consumption of fresh potatoes decreased from 132 pounds per person in 1930 to 55 pounds in 1975.

Raising potatoes for processing as opposed to the fresh market entails added storage risks due to their higher temperature requirements. Chipstock, for example, must be stored at relatively high temperatures to maintain quality, but weight losses and susceptibility to rot organisms are more likely to occur at higher temperatures than lower temperatures.

Contracting and bargaining between growers and processors have become increasingly important in marketing potatoes. Processors in general typically contract for about 50 percent of their need. There are five independent producer bargaining associations--each located in a major potato production region. A number of conditions conducive to effective bargaining exist in the potato industry, but the effectiveness of bargaining is limited because of incomplete supply control and the independence of both growers and processors.

POTATOES:
PRODUCTION, PRICES, STORAGE, MARKETING, CONSUMPTION
by

Gordon W. Erlandson, Donald F. Scott, and Lyle C. Shephard*

North Dakota and Minnesota farmers harvested \$126 million worth of potatoes in 1975. Nationally, producing potatoes was a \$1.5 billion industry in that year. Over 32 percent of the total value of commercial vegetable production in the United States in 1975 was derived from the sale of potatoes. Potatoes are used more frequently than any other vegetable by United States' consumers. Nearly two-thirds of all households served potatoes at least twice a week in 1972. Potatoes make an important contribution to agricultural income in the United States and to the nation's food supply.

This report describes some aspects of the potato industry in the United States and summarizes statistics on potato production and marketing. Storage requirements for potatoes are reviewed. Special emphasis is given to potatoes grown for processing in the Red River Valley of the North.

Historical Background

Historically, potatoes have been consumed in a fresh, unprocessed form. Consumption of potatoes in this form has steadily decreased, but since the 1950's, this decline has been offset by an increase in the availability and popularity of potatoes in processed forms (see Table 1). As a consequence, the long-run trend in production has been upward due to new forms of processed products, as well as an increasing national population.

The volume of potatoes consumed by households on the farms where grown has fallen sharply. Data in Table 1 indicate that the consumption by that sector has fallen from over 29 million to less than one million hundredweight during the post World War II period. This indicates that fewer farmers are planting potatoes, even for their own use, and that as potato production is becoming more specialized, larger volumes are moving through commercial channels.

Foreign markets currently provide a small but expanding market for United States' potatoes. Several countries in Europe and the Orient are relaxing their import restrictions on potatoes. Exports are quite important

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TABLE 1. PRODUCTION AND UTILIZATION OF POTATOES, UNITED STATES, 1944-1976

Year	Total Production	Used for Food		Total Seed	Total Feed	Export	Loss, Shrinkage	Used on Farm Where Grown
		Fresh	Processed					
<i>000 cwt.</i>								
1944	230,356			28,033		1,258		29,115
1945	251,639			27,200		8,415		29,503
1946	292,389			22,572		7,860		28,811
1947	233,391			23,381		10,001		22,517
1948	269,937			21,206		2,872		20,641
1949	240,950			21,494		6,878		17,871
1950	259,112			17,444		3,082		17,440
1951	195,776			18,626		4,024		14,944
1952	211,095			21,409		2,620		13,045
1953	231,679			19,329		2,762		12,529
1954	219,547			19,826		4,274		12,722
1955	227,696			19,325		3,755		11,488
1956	245,792			20,187		3,153		9,312
1957	242,522	148,408	41,256	21,218	11,668	2,555	11,796	8,176
1958	266,897	148,868	52,494	20,165	22,834	3,063	15,257	7,279
1959	245,272	149,123	47,824	20,603	9,692	4,028	12,491	5,913
1960	257,104	149,199	59,150	22,310	8,257	2,307	12,850	5,310
1961	293,166	153,594	72,566	20,838	24,532	2,347	16,687	4,773
1962	264,810	149,710	65,977	20,084	11,253	3,359	13,627	3,955
1963	271,158	146,981	74,004	19,984	13,190	1,699	13,513	3,400
1964	241,076	129,513	69,429	21,589	7,458	1,617	10,334	2,776
1965	291,109	139,548	100,189	23,455	7,976	2,855	17,429	2,512
1966	307,242	134,571	106,558	24,343	11,380	2,247	28,188	2,202
1967	305,766	131,742	106,506	23,398	19,581	3,592	22,534	2,005
1968	295,401	126,087	113,151	24,479	10,951	2,569	18,965	1,768
1969	312,418	127,434	125,112	24,490	11,177	2,971	22,661	1,544
1970	325,752	129,809	136,574	24,257	9,860	2,928	23,849	1,403
1971	319,354	120,276	138,310	22,269	9,226	3,241	27,910	1,363
1972	295,955	111,354	133,719	23,520	6,107	4,430	19,968	1,287
1973	299,410	107,019	143,744	25,160	4,147	4,975	18,352	988
1974	342,060	124,094	154,810	23,517	5,375	4,545	32,394	907
1975	319,834	112,512	153,612	25,744	5,088	9,324	21,998	880
1976	357,357	122,907	174,667	25,484	7,252	a	26,195	852

^aNot available.

SOURCES: (1, 2).

in certain years. The 1975 drought in Europe, for example, contributed to the total export of over 13 million hundredweight of fresh potatoes in 1976.

Quantities used for seed do not vary importantly from year to year. Typically, from 11 to 14 percent of the national annual production is utilized as seed.

In years when production is high, prices typically are low, so livestock feed and dumping become alternative means for disposing of large volumes of potatoes.

Consumption

Per capita consumption of potatoes in all forms declined from 198 pounds to about 105 pounds on a fresh-weight equivalent between 1910 and 1950. During the 1950's, consumption stabilized and since then has increased. Per capita consumption increased from 108 to 115 pounds (fresh-weight equivalent) from 1960 to 1976 (Table 2).

There are a number of reasons for the reversal in per capita consumption of potatoes which reflect the development of processed products. The new products are popular with fast-food eating establishments whose numbers are growing as the number of meals eaten away from home increases. The popularity of processed items is also associated with higher consumer incomes which provide homemakers with financial ability to increase expenditures for convenience food products. Also, women have entered the labor force in increasing numbers, helping the demand for these products. Intensified promotional and merchandising efforts have also contributed to expanded sales.

The largest single use of potatoes is for the tablestock market. However, this market has been declining steadily over time (see Figure 1). Tablestock usage declined from 149 million hundredweight in 1960 to 123 million hundredweight in 1976. On a per capita basis, fresh potato consumption declined from 84 pounds to about 57 pounds over that period.¹

The quantity of potatoes processed for all food uses almost tripled from 1960 to 1976, increasing from 59 million hundredweight to 154 million hundredweight. Over that period per capita processed potato consumption increased from 24 to 67 pounds.² Such figures emphasize the increasing

¹Per capita consumption figures are for the period 1960 to 1975.

²Ibid.

TABLE 2. PRODUCTION AND PER CAPITA CONSUMPTION OF POTATOES, UNITED STATES, 1960-1976

Year	Production <i>million cwt.</i>	Per Capita Consumption						
		Total Fresh and Processed	Fresh	Total	Canned ^b	Frozen	Shoestrings and Chips ^a	Dehydrated
1960	257.1	108.4	83.8	24.6	1.5	6.6	11.6	4.9
1961	293.2	109.3	83.8	25.5	1.5	6.8	12.3	4.9
1962	264.8	107.3	78.4	28.9	1.6	9.4	13.1	4.8
1963	271.2	111.4	79.9	31.5	1.7	11.0	13.9	4.9
1964	241.1	111.0	74.6	36.4	1.7	14.6	14.8	5.3
1965	291.1	107.0	68.2	38.8	1.7	14.3	15.8	7.0
1966	307.2	116.8	72.4	44.4	1.7	17.3	16.7	8.7
1967	305.8	108.0	62.0	46.0	1.7	19.0	16.9	8.4
1968	295.4	115.2	65.9	49.3	1.9	21.2	17.1	9.1
1969	312.4	116.8	61.6	55.2	2.0	24.6	17.7	10.9
1970	325.8	117.6	58.4	59.2	2.0	27.7	17.7	11.8
1971	319.4	118.9	57.0	61.9	2.2	30.3	17.3	12.1
1972	296.0	119.2	57.2	62.0	2.1	30.6	17.0	12.3
1973	299.4	116.5	51.6	64.9	2.3	33.2	16.6	12.8
1974	342.1	113.8	47.9	65.9	2.3	33.0	16.1	14.5
1975 ^c	315.6	121.6	54.5	67.1	2.3	34.7	15.2	14.9
1976	357.4	115.0	^d	^d	^d	^d	^d	^d

^aFresh-weight basis.

^bIncludes potatoes canned in soups, stews, and other combinations.

^cPreliminary.

^dNot available.

SOURCES: (3:152; 4:16).

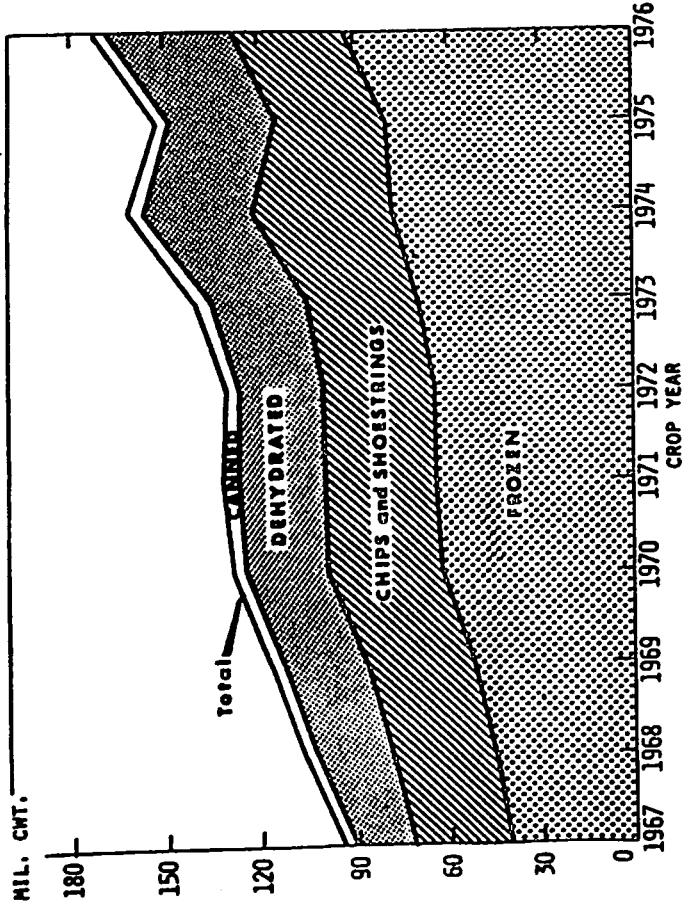


Figure 2. Potatoes Used for Processed Food Items, United States, 1967-1976

SOURCE: (2).

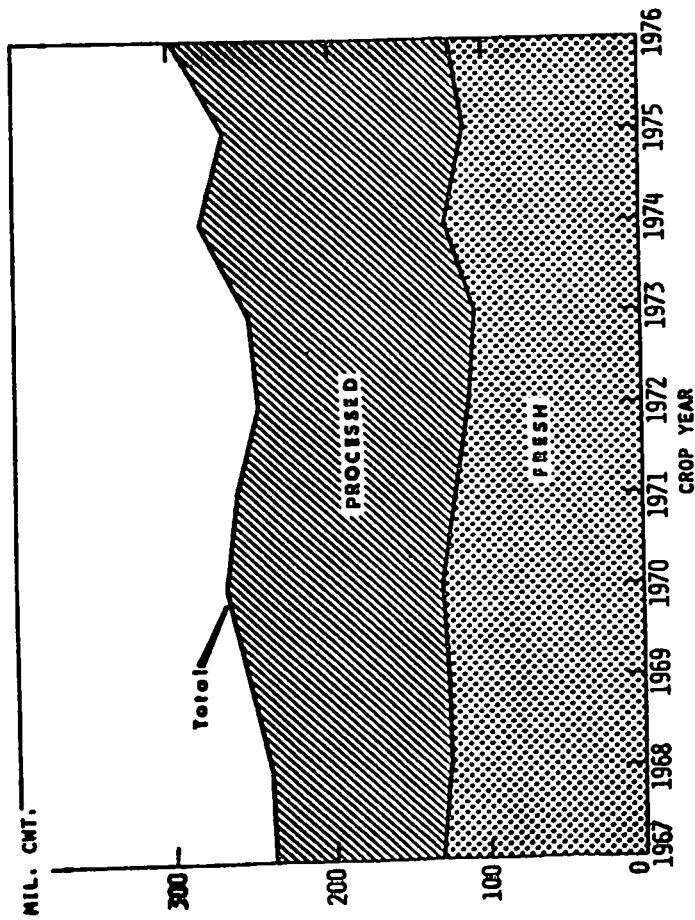


Figure 1. Potatoes Used for Food, Fresh, and Processed, United States, 1967-1976

SOURCE: (2).

importance of the processed market for potatoes and serve as an impressive example of the influence of modern food processing. According to Sullivan, "Potato processing has had the greatest absolute increase of the vegetable commodity groups since World War II" (5:4).

Processed potato products include chips and shoestrings, dehydrated products, frozen products, canned products, and starch and flour (see Figure 2). The most important processed potato category is the frozen product group. Frozen french fries comprise the greatest bulk within this group. Other products included in this group are hash browns, patties, and extruded products. On a fresh-weight equivalent basis, potatoes used for frozen products increased from 6 percent of total production (15 million cwt.) in 1960 to about 26 percent of total production (93 million cwt.) in 1976.

The volume of potatoes used for potato chips and shoestrings has increased slightly, increasing from 8 percent of total production (20 million cwt.) to about 10 percent (35 million cwt.) from 1960 to 1976.

The dehydrated category has exhibited dramatic growth within the processed potato categories. Dehydrated products--which include granules, flakes, flakelets, and sliced and diced potatoes--have received wide acceptance in the institutional market (5:16-17). The volume of potatoes used for dehydration increased from 4 percent of total production (10 million cwt.) in 1960 to about 11 percent of total production (40 million cwt.) in 1976.

Canned potatoes represent the oldest form of commercial processed potato manufacture (5:17). Use of potatoes for canned products has remained relatively stable, with approximately four million hundredweight of potatoes canned in 1976.

Potatoes are used more frequently than any other vegetable (6:32). In 1972, 62 percent of all United States' households were serving potatoes in some form at least twice a week while the corresponding figure for 1966 was 82 percent. Between 1966 and 1972 the percent of households serving fresh potatoes two or more times per week declined, but the percent of households serving processed potatoes increased (Table 3).

A consumer study for the National Potato Board indicated that consumers in metropolitan areas were eating more potatoes in 1975 than in 1973. In 1975, average fresh volume consumption was 15 percent higher than in 1973, while packaged potato serving frequency increased 22 percent (7).

TABLE 3. FREQUENCY OF FRESH AND PROCESSED POTATO USAGE BY HOUSEHOLDS, UNITED STATES, 1966 AND 1972

Frequency	1966		1972	
	Fresh	Processed	Fresh	Processed
	<i>percent of families</i>			
Two or More Times Per Week	82	27	77	33
Less Than Twice Per Week	18	73	23	67
Total	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>

SOURCE: (6:34).

Potato Exports

The export demand for potatoes and potato products in 1976 far exceeded normal periods, largely due to drought conditions in Europe. Typically, about 2 or 3 percent of the total production is exported, but this amount nearly tripled in 1976. Large shipments of fresh potatoes went to Europe from eastern and midwestern producing regions.

Canada remains a stable consumer of about 90 percent of the total fresh potato exports. The volume of processed products shipped to Canada is increasing. Table 4 presents the annual volumes shipped to importing countries.

New international developments include increased quantities of potatoes imported by Japan and other Far East nations. Most of this volume is in processed form, and the trend is increasing due in part to changing tastes for these products.

Foreign sales are important for the impact they have on domestic prices. A change of 1 percent in quantity is associated with an opposite price change of 3 percent.

Production

Potatoes are grown in every state in the Union. Idaho, well known for potatoes, is the leader in production. Washington has now taken over second place, while Oregon and Maine battle for third and fourth place, varying from year to year. North Dakota ranks sixth and Minnesota ninth, but when these two states are combined they rank third. Table 5 shows the leading states in production for selected years.

TABLE 4. UNITED STATES POTATO EXPORTS, BY COUNTRIES, 1969-1976
CALENDAR YEARS

Country	1969	1970	1971	1972	1973	1974	1975	1976
<i>Thousands of pounds</i>								
<u>Fresh</u>								
Canada	243,487	270,401	259,680	329,541	429,593	452,450	403,313	496,943
Mexico	6,202	31,563	22,273	14,792	16,640	30,351	17,944	23,352
Bahamas	3,299	3,532	3,532	3,975	5,581	5,794	5,425	4,920
Uruguay	8,482	110	--	--	--	--	0	5,418
Chile	--	--	0	11,129	0	0	24,251	23,810
Argentina	--	--	0	19,401	779	--	1,620	0
Japan	--	--	--	--	2,080	5,892	528	3
Australia	--	--	--	--	119	4,958	483	36
Panama	--	--	--	--	--	221	3,308	679
Bermuda	--	--	--	--	--	--	1,005	1,100
Barbados	--	--	--	--	--	--	799	4,184
Trinidad	--	--	--	--	--	--	0	14,940
North Antilles	--	--	--	--	--	--	545	3,521
Sweden	--	--	--	--	--	--	463	100,203
Norway	--	--	--	--	--	--	0	17,287
United Kingdom	--	--	--	--	--	--	0	1,986
Netherlands	--	--	--	--	--	--	0	116,129
Belgium	--	--	--	--	--	--	0	69,931
France	--	--	--	--	--	--	0	231,323
FR Germany	--	--	--	--	--	--	0	50,592
Portugal	--	--	--	--	--	--	0	86,248
Italy	--	--	--	--	--	--	0	44,273
Cyprus	--	--	--	--	--	--	2,037	0
Singapore	--	--	--	--	--	--	259	1,829
Hong Kong	--	--	--	--	--	--	1,025	2,193
Algeria	--	--	--	--	--	--	0	48,774
Others	7,730	5,143	2,949	4,936	7,107	7,297	2,014	11,800
TOTAL FRESH	269,200	310,749	288,434	383,774	461,899	506,963	465,019	1,361,474
<hr/>								
<u>Dehydrated</u>								
Canada	1,834	2,395	2,248	1,750	2,575	3,223	2,341	3,861
Sweden	5,056	5,548	3,518	1,102	535	504	26	--
Denmark	225	622	503	--	--	--	--	--
United Kingdom	797	209	635	--	--	1	2,088	19,656
Netherlands	0	267	0	--	--	--	16	1,952
West Germany	--	0	263	--	--	--	1	4,618
Japan	--	--	--	366	816	1,829	1,593	6,743
Australia	--	--	--	--	44	421	142	124
Barbados	--	--	--	--	--	--	66	7
France	--	--	--	--	--	--	0	5,839
Others	383	413	453	573	573	1,717	579	1,942
TOTAL DEHYDRATED	8,295	9,454	7,620	3,791	4,543	7,695	6,852	44,742
<hr/>								
<u>Flakes</u>								
Canada	612	969	1,885	1,727	2,403	3,139	1,947	2,485
Venezuela	55	--	--	--	386	18	--	--
Sweden	3,735	2,458	6,226	5,596	7,702	7,241	6,362	9,533
Denmark	410	389	853	930	913	1,393	694	1,358
United Kingdom	3,393	1,934	2,140	2,629	4,368	2,742	12,474	62,410
Netherlands	64	--	--	--	--	--	0	4,495
Spain	502	0	--	--	175	410	534	1,179
Ireland	0	224	--	--	--	--	557	1,650
Italy	33	285	--	--	--	--	--	--
Japan	--	--	--	796	2,926	3,400	4,264	13,449
Australia	--	--	--	--	37	1,005	591	634
Finland	--	--	--	--	--	0	966	1,068
France	--	--	--	--	--	--	0	22,187
FR Germany	--	--	--	--	--	--	0	32,814
Others	262	425	1,046	917	809	1,007	427	3,099
TOTAL FLAKES	9,066	6,684	12,150	12,595	19,719	20,355	28,816	156,361

TABLE 5. POTATO PRODUCTION IN LEADING STATES FOR SELECTED YEARS BETWEEN 1957 AND 1976

Year	Maine	New York	Wisconsin	MN-ND	Idaho	Oregon	Washington	Colorado	California
<i>000 cwt.</i>									
1957	37,812	17,552	6,021	17,912	37,374	9,222	9,970	10,857	31,150
1962	38,955	20,913	10,800	27,049	46,319	9,045	11,737	12,362	28,202
1967	37,604	17,764	13,251	27,668	63,900	13,252	22,090	11,608	33,331
1972	33,280	10,558	11,530	32,460	77,295	14,436	31,365	9,995	22,032
1976	27,440	13,510	15,370	29,995	88,455	28,913	55,800	11,207	24,044

Percentage of Total U.S. Production--Leading States									
1957	15.78	7.32	2.51	7.47	15.60	3.84	4.16	4.53	13.00
1962	14.60	7.84	4.04	10.14	17.36	3.39	4.40	4.63	10.57
1967	12.31	5.81	4.33	9.09	20.92	4.33	7.23	3.80	10.91
1972	11.24	3.56	3.89	10.96	26.11	4.87	10.59	3.37	7.44
1976	7.68	3.78	4.30	8.39	24.75	8.09	15.61	3.14	6.73

SOURCE: (2).

Potatoes are not all harvested at the same time. Production is separated into four seasonal groups--winter, spring, summer, and fall.³ For convenience a state is identified by the time of harvest; North Dakota is listed as a "fall state," for example. The major portion of United States potato production is produced by fall states, accounting for about 86 percent of total production in 1976. Winter, spring, and summer states accounted for approximately 1, 7, and 6 percent of total production, respectively. Table 6 presents production and yields by states and by seasonal groups for 1972 through 1976.

Dramatic changes have been occurring in potato production. Acres harvested have been declining while yield has been increasing. There has been a noticeable decline in winter, spring, and summer production and an increase in fall states' production (Table 6). In addition, shifts in production have occurred within the fall states. For example, production in Maine and New York has decreased substantially while states such as Idaho, Oregon, and Washington have greatly increased their production (Tables 5 and 6). Production costs and location of market are key factors in determining each state's relative position.

Potatoes can be grown throughout North Dakota and Minnesota. However, commercial production is heavily concentrated in the counties in the northern part of the Red River Valley (see Figure 3). The three leading counties in North Dakota (Walsh, Grand Forks, and Pembina) accounted for 89 percent of the state's total production in 1975. Three Red River Valley counties in Minnesota (Polk, Clay, and Marshall) produced 45 percent of the state's production in 1975.

North Dakota and Minnesota farms with sales of \$2,500 and over that produced potatoes in 1974 numbered 775 and 920, respectively (see Table 7). About 52 percent of the potato growers in North Dakota harvested 50 acres or more of potatoes in 1974. This figure corresponds with 40 percent for Minnesota for the same year. About 9 percent of the farms harvested 500 acres or more of potatoes in North Dakota and about 4 percent of the Minnesota growers harvested that many acres of potatoes in 1974.

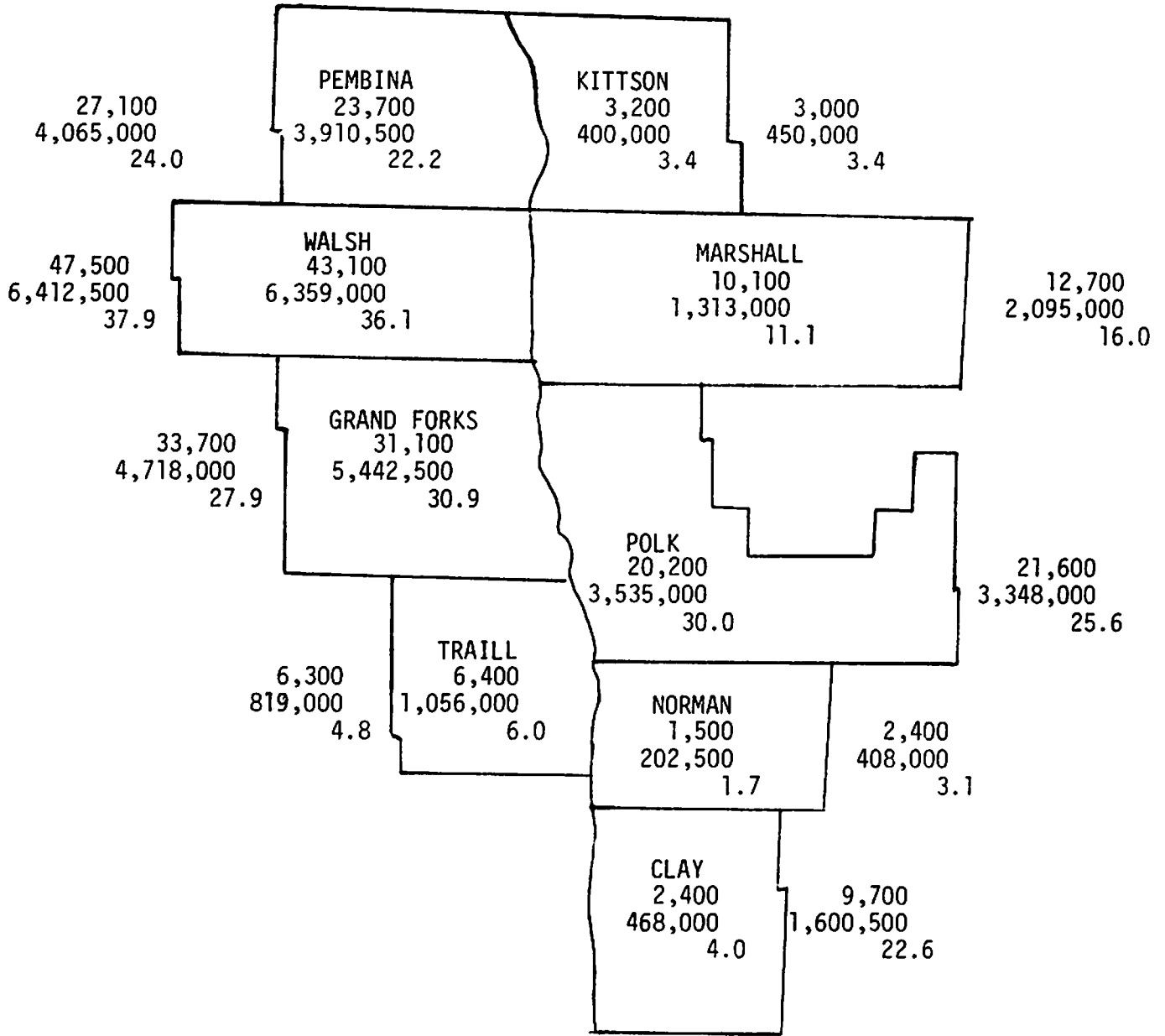
³The usual time of harvest for each season is: winter--January through March; spring--April through June; summer--July through September; fall--October through December.

TABLE 6. ACREAGE-YIELD-PRODUCTION OF IRISH POTATOES, UNITED STATES, 1972-1976

Seasonal Groups and States	Acreage Harvested					Yield Per Acre					Production				
	1972	1973	1974	1975	1976	1972	1973	1974	1975	1976	1972	1973	1974	1975	1976
Winter:															
California	5.7	4.9	4.4	4.9	5.2	170	220	265	215	270	969	1,078	1,166	1,054	1,144
Florida	9.7	9.1	9.3	9.4	9.2	140	195	190	195	200	1,358	1,775	1,767	1,833	1,840
TOTAL	15.4	14.0	13.7	14.3	14.4	151	204	214	202	207	2,327	2,853	2,933	2,887	2,984
Spring:															
Alabama	9.0	11.0	12.5	10.6	11.5	155	118	145	130	140	1,395	1,298	1,813	1,378	1,616
Arizona ^a	8.0	9.9	8.6	6.2	6.8	300	260	245	245	270	2,400	2,079	2,245	1,519	1,836
Arkansas	1.4					65									
California	31.2	34.7	35.5	27.6	34.2	355	325	385	380	395	11,076	11,278	13,658	10,488	13,509
Florida-Hastings	21.1	19.0	18.8	16.2	19.3	142	160	175	195	210	2,399	3,420	3,990	3,159	4,053
Other	1.8	2.1	2.8	1.9	2.5	75	83	90	90	75	252	315	426	382	400
Louisiana	2.7	2.3	2.8	2.6	2.6	140	170	135	160	160	1,700	1,910	2,520	1,920	1,950
Mississippi	2.0	2.0	2.0	1.9	2.0	85	85	95	90	95	1,606	1,624	1,410	1,920	1,885
North Carolina	11.0	11.2	13.0	12.0	13.0	146	145	150	160	145	822	838	962	625	1,101
Texas	7.6	6.7	7.4	5.5	7.1	108	125	130	150	155	21,011	21,213	24,294	19,994	24,779
TOTAL	95.8	98.9	103.4	84.5	99.0	219	214	243	237	250					
Summer:															
Alabama	8.0	8.0	10.5	9.0	8.2	130	125	145	150	145	1,040	1,000	1,523	1,350	1,189
California	7.3	9.2	9.9	8.4	6.1	354	370	350	320	360	2,584	3,040	3,465	3,108	2,916
Colorado	7.6	6.5	6.8	7.2	7.5	235	220	275	263	260	2,030	1,430	1,872	1,950	1,782
Delaware	6.5	6.8	6.8	5.7	5.8	190	195	225	155	200	1,235	1,325	1,530	941	1,160
Illinois	2.0	1.8	1.6	2.0	2.7	200	155	155	180	190	1,000	1,270	1,248	380	513
Indiana	1.1	1.0	1.0	.8	1.2	150	130	150	180	185	135	130	209	184	222
Iowa ^a	3.1	2.6	3.1	3.1	2.9	220	175	200	200	185	682	453	660	420	537
Kentucky ^a	1.0					95					95				
Maryland	2.1	2.0	2.0	1.8	1.8	167	160	147	170	170	150	320	294	306	396
Michigan	8.8	8.0	8.4	7.4	7.6	200	140	190	190	170	1,760	1,120	1,596	1,476	1,292
Minnesota	7.2	7.4	8.5	8.1	8.0	250	250	260	260	250	1,800	1,850	2,125	2,105	2,000
Missouri	6					110					66				
Nebraska	2.5	2.4	2.6	2.5	2.2	170	150	160	160	160	425	408	390	400	312
New Jersey	10.8	9.0	9.0	7.0	7.6	195	185	220	195	250	2,106	1,721	2,330	1,365	1,976
New Mexico	3.2	2.3	4.2	3.5	3.2	235	260	200	202	180	860	832	840	700	576
North Carolina	3.1	3.0	4.2	4.0	4.0	178	210	135	120	135	397	360	608	480	540
Ohio	2.7	2.8	2.9	2.9	2.9	170	150	180	165	200	459	420	479	479	580
Tennessee	3.9	2.8	2.9	2.9	2.9	99	80	90	85	95	371	336	336	425	447
Texas	8.0	5.0	6.0	6.0	6.0	249	220	220	250	245	2,360	2,940	2,244	2,150	2,312
Virginia	14.3	12.0	10.2	8.6	9.6	165	165	142	122	122	4,131	3,255	4,030	2,400	3,506
West Virginia	3.7	3.6	4.2	3.7	3.6	141	105	77	96	78	1,369	1,456	1,323	2,400	2,274
TOTAL	130.9	125.1	133.3	115.7	120.1	70	182	191	181	189	23,776	21,478	25,178	20,898	22,688
Fall:															
California	23.5	20.5	20.7	19.0	18.5	315	305	310	335	350	7,403	6,253	6,324	6,385	6,435
Colorado	31.0	30.5	34.0	32.5	36.3	255	270	260	265	255	7,995	8,235	8,633	8,613	9,427
Connecticut	2.9	2.6	2.6	2.4	1.9	219	220	230	230	260	699	623	598	552	484
Ideho-10 St Counties	27.0	26.0	26.0	33.0	35.0	335	325	315	325	325	9,045	11,520	11,505	10,395	11,315
Other Counties	273.0	287.0	301.0	289.0	328.0	250	235	230	230	255	63,250	67,445	68,540	66,470	77,053
Indiana	5.4	5.5	5.3	6.0	6.0	225	220	240	240	245	1,415	1,238	1,440	1,440	1,530
Maine	128.0	137.0	140.0	122.0	112.0	260	210	260	220	245	33,280	28,770	36,490	26,840	27,450
Massachusetts	3.7	3.7	4.0	3.5	3.2	160	160	200	205	220	592	750	800	718	764
Michigan	31.5	32.0	34.0	29.0	34.0	250	235	165	170	245	7,875	7,520	8,330	6,670	6,670
Minnesota	78.0	82.0	85.0	57.0	67.0	160	160	150	170	165	13,260	13,120	15,370	9,690	11,055
Montana	7.5	7.0	7.0	7.6	8.4	220	215	230	230	215	1,450	1,462	1,750	1,748	1,806
Nebraska	4.4	4.4	4.4	5.0	4.9	220	230	245	245	240	968	1,012	1,152	1,225	1,274
Nevada															
New Hampshire	.8	.6	.7	.4	.4	220	170	205	230	260	136	102	144	92	104
New York-Long Island	27.0	25.0	27.0	23.1	23.4	207	215	210	260	310	5,585	5,375	6,150	6,058	7,400
Upstate	25.5	29.0	26.8	24.0	24.9	195	230	260	255	245	4,973	6,670	4,470	6,170	6,101
North Dakota	120.0	132.0	135.0	110.0	121.0	145	145	170	160	140	17,490	17,140	22,950	17,850	16,319
Ohio	9.5	9.0	9.5	9.2	9.8	214	200	220	220	255	2,043	1,807	1,995	2,004	2,070
Oregon-Walheur County	12.0	13.4	12.8	10.2	11.0	339	310	305	310	370	3,960	4,975	3,904	3,570	4,070
Other Counties	28.7	28.4	37.2	45.3	54.6	365	395	365	460	455	10,476	10,334	13,578	20,438	24,383
Pennsylvania	30.0	30.0	32.0	29.0	4.2	185	185	235	235	252	5,000	6,390	7,360	6,815	7,107
Rhode Island	4.2	4.2	4.4	4.2	4.4	125	135	70	115	65	738	770	371	598	745
South Dakota	5.9	5.7	5.3	5.2	5.2	235	235	275	260	240	1,011	1,060	1,481	1,508	1,245
Utah	4.3	5.0	6.3	3.8	5.2	235	220	235	230	205	209	230	150	212	205
Vermont	1.1	1.0	1.0	.9	1.0	190	150	220	230	270	709	1,060	1,260	1,260	905
Washington	8.0	8.0	98.0	105.0	124.0	418	430	460	460	460	31,345	35,260	41,160	48,300	55,307
Wisconsin	45.5	47.0	50.0	49.5	51.0	253	259	300	290	290	11,570	11,570	14,600	14,450	15,317
Wyoming	5.6	6.1	6.5	6.8	6.3	235	249	249	270	270	1,316	1,175	1,528	1,632	1,701
TOTAL	1,011.7	1,006.6	1,140.4	1,047.3	1,140.9	246	238	253	264	269	248,641	253,866	287,710	276,055	306,966
United States	1,253.8	1,304.6	1,330.8	1,261.8	1,374.4	236	230	246	253	260	295,955	299,410	340,116	319,834	357,357

^aEstimate discontinued after 1972.
1972 first year estimate.

SOURCE: (2).



Top Number: Harvested Potato Acres
 Middle Number: Production in Hundredweight
 Lower Number: Percent of Total Production in the State

Numbers outside of counties are those for 1976. Growers suffered a 23,000 acre flood loss in 1975.

Figure 3. Number of Potato Acres, Total Production, and Percent of Total Production in the Major Potato Producing Counties in the Red River Valley, 1975 and 1976

SOURCES: (10,11).

TABLE 7. NUMBER OF FARMS WITH SALES OF \$2,500 AND OVER ACCORDING TO ACRES OF POTATOES HARVESTED PER FARM, NORTH DAKOTA AND MINNESOTA, 1974

Acres of Potatoes Harvested Per Farm	North Dakota	Minnesota
	<i>number of farms</i>	
0.1 to 0.9	233	294
1.0 to 4.9	64	111
5.0 to 14.9	23	49
15.0 to 24.9	11	35
25.0 to 49.9	43	60
50.0 to 99.9	68	87
100.0 to 249.9	133	165
250.0 to 499.9	128	81
500.0 and Over	72	38
Total	775	920

SOURCE: (9:1-24).

A number of trends may be noted among commercial producers of potatoes. Farms producing potatoes are getting fewer in number, harvesting more acres per farm, and becoming more specialized in potato production (Table 8). Production has expanded more than the increase in acres would suggest because of higher yields, increasing from less than 11 million hundredweight in both North Dakota and Minnesota in 1964, to over 17 million hundredweight in Minnesota and almost 21 million hundredweight in North Dakota in 1974. The fluctuation in the value of the crop points out a dilemma facing potato producers. In North Dakota, for example, the value of the crop declined from \$38 million to \$21 million between 1964 and 1969, and increased to nearly \$66 million in 1974. The same trends may be detected nationally, with farms getting fewer and larger, total output expanding, and price movements that cause returns to fluctuate excessively.

Producer Prices

Historically, potato prices have fluctuated widely from year to year. Sometimes prices stay low for extended periods. These two types of price behavior combine to cause concern for producers, processors, and consumers alike.

Average potato prices received by North Dakota farmers never exceeded \$2 per hundredweight during the decade of the 1960's, with the exception of the 1964-1965 marketing season. The 1964-1965 season was unusual, in that

TABLE 8. POTATO PRODUCTION, NUMBER OF FARMS REPORTING, ACRES HARVESTED, QUANTITY HARVESTED, VALUE OF CROP, UNITED STATES, NORTH DAKOTA, MINNESOTA, 1964, 1969, 1974^a

Item	United States			North Dakota			Minnesota		
	1964	1969	1974	1964	1969	1974	1964	1969	1974
Farms Reporting	155,769	55,455	^b	5,354	1,929	775	5,735	2,015	920
Acres Harvested	1,151,505	1,260,898	1,390,800 ^c	95,819	112,274	131,614	92,465	77,490	105,023
Acres Per Farm	7.4	22.7	^b	17.9	58.2	169.8	16.1	38.5	114.2
Quantity Harvested ^d	219,105	273,664	342,060 ^c	10,634	16,398	20,927	10,917	12,615	17,163
Yield (cwt./acre)	190 ^c	221 ^c	246 ^c	108 ^c	145 ^c	170 ^c	110 ^c	150 ^c	180 ^c
Value of Crop (\$000)	750,799	545,973	1,371,661 ^e	38,283	21,317	65,921	39,301	19,427	52,347

^aUnless otherwise noted, the data are for farms with sales of \$2,500 or more.

^bNot available.

^cReflects total production of all farms.

^dQuantity in thousands of hundredweights.

^eEstimated by taking yearly average price times quantity harvested.

SOURCES: (2, 9).

the seasonal average price was \$3.55, well above the prices received by farmers for several preceding and following years (Table 9). Even in that year of higher than average prices, early potatoes sold in September and October for \$1.75 and \$1.40, respectively.

A second concern, in addition to the general low price level, is the price variability producers encounter. For example, producers in North Dakota received \$.85 in May, 1972, and \$6.95 in March, 1974. Figure 4 illustrates some of the fluctuations in potato prices received by North Dakota farmers. This figure also relates prices to production in the state. However, the price-production relationship is not clearly seen since prices are influenced by national production, not just regional production. Actually, price variation is greater than Figure 4 reveals because some of the variation is disguised since only a single monthly average price is charted on the graph. The ups and downs do not appear as sharp as they are in reality when all of the short-term fluctuations are included. Another factor that tends to reduce the fluctuations in Figure 4 is the role played by producer contracts. For example, during the 1973-1974 marketing season, price per hundredweight exceeded \$9 at one point but due to locked-in prices with producer contracts, the reported average was less than that.

Price variability at the farm level can also be attributed to the nature of the demand for potatoes. The demand for potatoes is quite stable and the quantity of potatoes demanded changes very little regardless of price. A small change in supply, therefore, causes a relatively large change in the price of potatoes in the opposite direction.

Marketing Channels and Patterns⁴

The 1950's mark a transition stage in marketing potatoes. The fresh potato market had historically been the single major outlet. Potato chippers had used small amounts, while cull potatoes were processed into starch and flour. The shift since the 1950's to an increased percentage of the potato crop being processed has broadened the spectrum of possible marketing channels for potato producers as shown in Figure 5. This is

⁴The material presented here on marketing channels draws heavily on: Harrison, Kelly M., Stephen O. Sparks, and Michel M. Fabre, The Michigan Potato Industry: A Market Analysis, Agricultural Economics Report No. 294, Department of Agricultural Economics, Michigan State University, East Lansing, April, 1976.

TABLE 9. AVERAGE PRICES RECEIVED BY NORTH DAKOTA FARMERS FOR POTATOES, BY MONTHS, PER HUNDREDWEIGHT, 1961-1977^a

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Season Average
<i>dollars per cwt.</i>													
1961	1.30	1.20	1.15	1.40	1.25	--	--	--	1.10	1.15	1.05	1.05	.99
1962	.90	.85	.90	1.00	1.10	--	--	--	1.15	.95	.95	.90	.98
1963	1.00	1.05	1.05	.90	.75	--	--	--	1.15	.90	1.00	.90	1.08
1964	.90	.95	1.20	1.30	1.60	--	--	--	1.75	1.40	2.85	3.75	3.55
1965	4.65	4.70	4.45	4.50	5.50	--	--	--	1.55	1.45	1.40	1.35	1.40
1966	1.40	1.35	1.45	1.40	1.30	--	--	--	1.65	1.10	1.45	1.45	1.60
1967	2.00	2.00	1.80	1.60	.90	--	--	--	1.60	1.25	1.35	1.15	1.34
1968	1.25	1.35	1.15	1.55	2.40	--	--	--	1.30	1.15	1.30	1.25	1.34
1969	1.25	1.40	1.60	1.55	.90	--	--	--	1.30	1.15	1.45	1.50	1.61
1970	1.55	1.75	1.95	1.95	2.55	--	--	--	1.35	1.50	1.60	1.80	1.67
1971	1.50	1.90	1.85	1.60	1.65	--	--	--	1.25	1.20	1.20	1.40	1.23
1972	1.20	1.30	1.25	1.20	.85	.85	--	1.85	1.85	1.70	2.25	2.50	2.75
1973	3.00	3.15	3.30	3.35	3.90	4.50	--	--	2.10	2.20	3.10	4.00	4.60
1974	4.25	5.85	6.95	6.75	5.85	6.80	--	3.40	3.35	3.15	3.25	3.15	3.15
1975	3.35	3.35	3.80	2.45	1.80	2.00	--	--	2.75	3.25	3.85	3.95	4.20
1976	4.00	4.80	5.15	4.80	4.45	--	--	--	2.60	2.60	2.60	2.65	2.65
1977	2.80	3.70	4.00	4.40									

^aNo prices are reported during summer months.

SOURCE: (12).

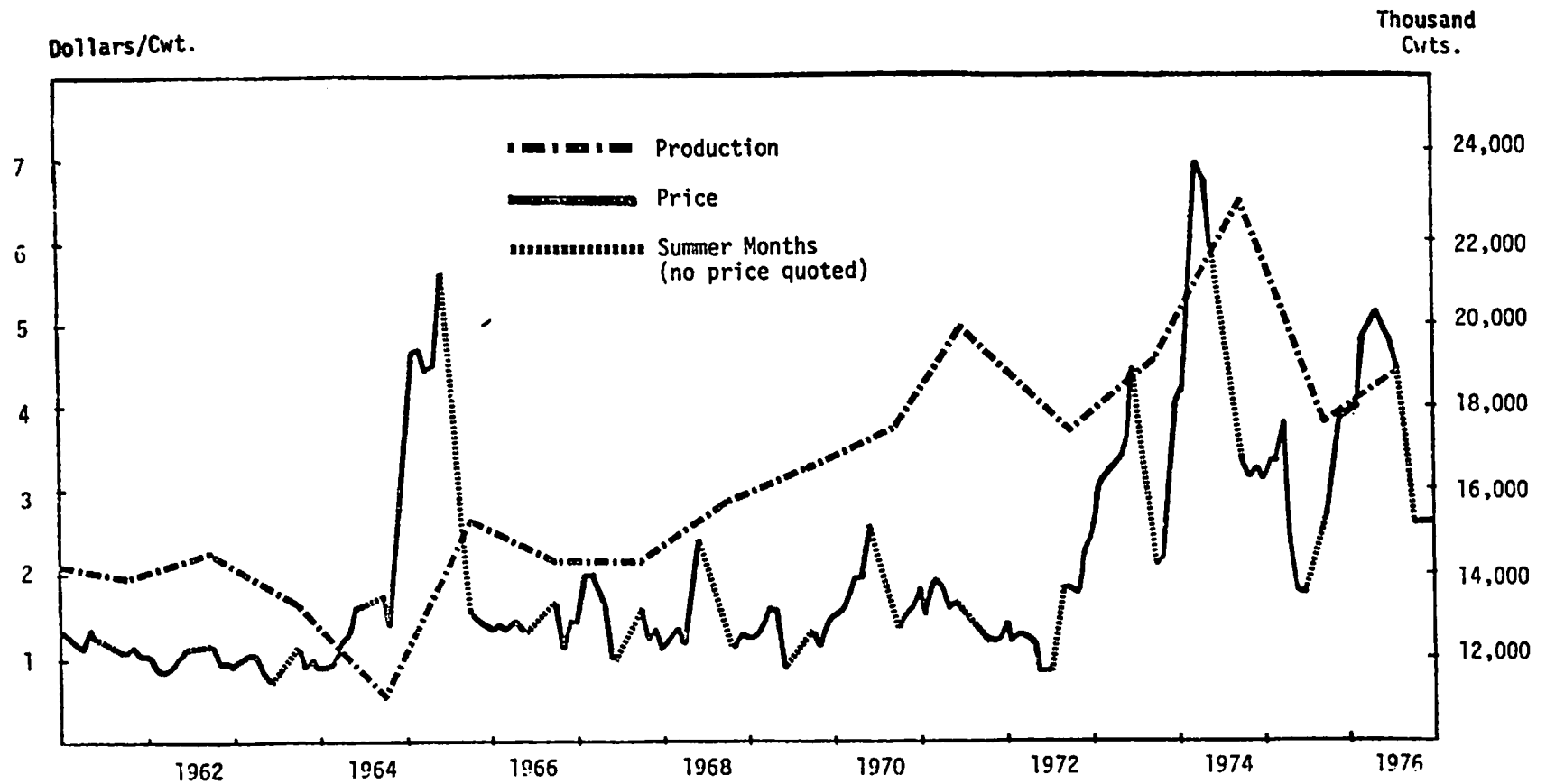


Figure 4. Potato Production and Prices Received by Farmers, North Dakota, 1961-1976

SOURCE: (10).

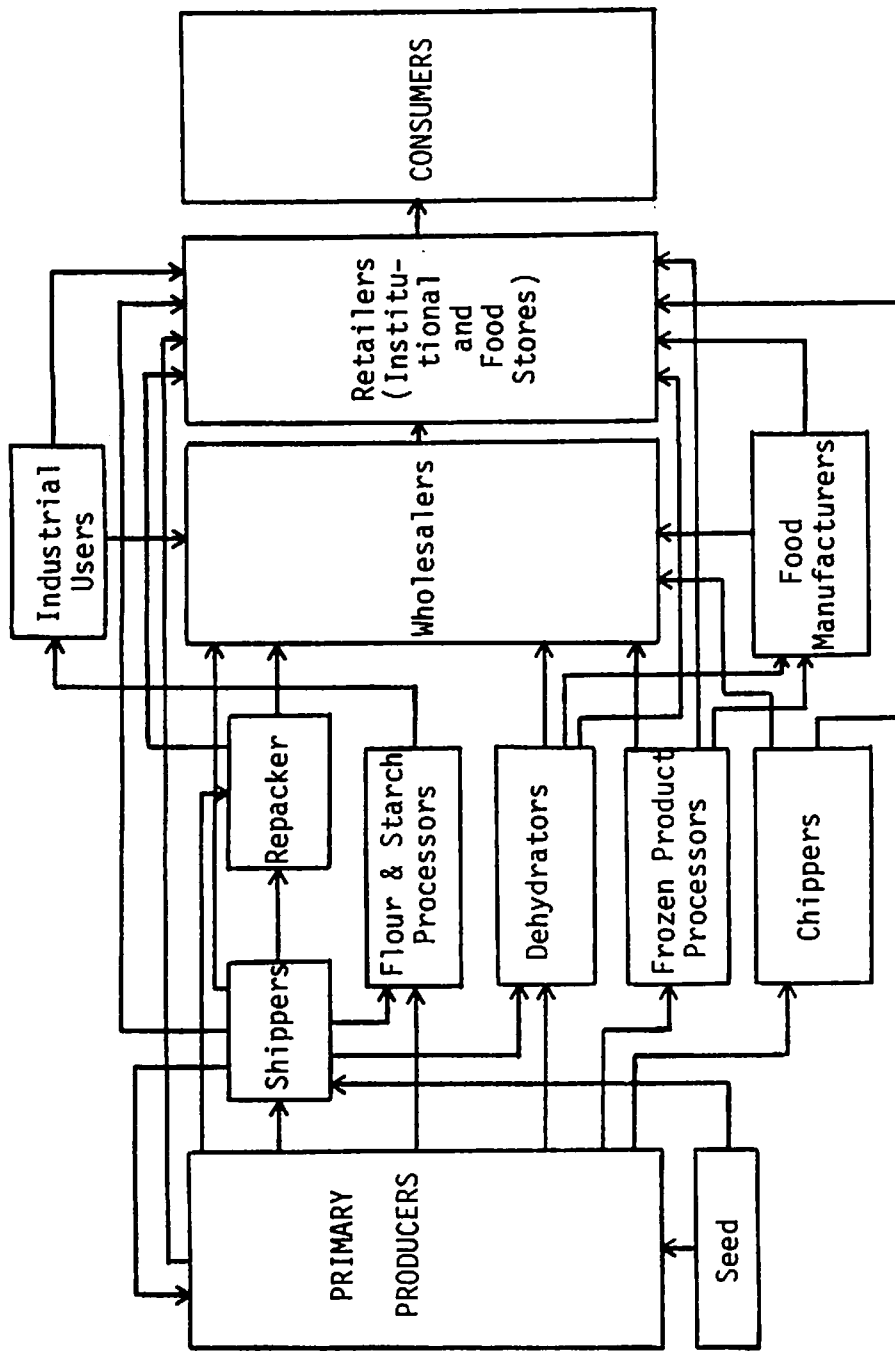


Figure 5. Major Marketing Channels for Potatoes and Potato Products

SOURCE: Adapted from 6:14.

especially the situation in the northwestern portion of the United States, where many of the various types of potato processors have located.

Potatoes produced for processing are either taken directly from the field to the processing plant or stored by the farmer for later delivery. Most potatoes used for processing in the Valley are stored and then shipped to the processing plants. Tablestock potatoes are either stored by the grower or delivered directly from the field to the market. Growers raising potatoes for the fresh market may wash, grade, package, and ship potatoes directly to the retailers or deliver them to shippers who perform these services. A few growers or shippers deliver sorted and graded potatoes to repackers in metropolitan areas where they are packaged for sale to wholesalers, retailers, or institutional food establishments.

Fresh potatoes may move through marketing channels via a wide range of alternatives. They may move from producer to shipper, from producer to repacker, or from producer to retailer. Shippers, in turn, may ship fresh potatoes to repackers or retailers, while repackers may ship to wholesalers or retailers. Fresh potatoes are also provided by processors who select potatoes they receive that meet market standards and market them in the fresh market. It is unlikely that processors supply a very large quantity to the fresh market.

As potato growers have become more specialized, they have taken on some functions that were once performed by others. Potato growers are taking over the function of the shipper and are shipping sorted potatoes to repackers.

A large portion of dehydrated potato products goes to wholesalers and retailers. These movements may be facilitated by food brokers who represent different companies. Dehydrated products are also shipped to food manufacturers for use in other food products.

Frozen potato products go to wholesalers, retailers, and food manufacturers. Frequently, food brokers are involved in the distribution of frozen products. A relatively large proportion of the frozen pack goes to the institutional market and to private label supermarket sales.

Potato chips move from chippers to wholesalers and retailers. About 30 percent of the chip products go to the retail institutional market. Potato chippers are located near major consuming areas, and rely primarily on their own distribution system. Most chippers have established routes which originate either at the plant or a regional warehouse and cover a radius of about 200 miles.

Dehydrator, Freezer, and Chip Plants

Dehydrator and freezer plants are mostly located in major fall crop production areas of Maine, the Red River Valley, and the western tri-state area of Idaho, Washington, and Oregon. Dehydrator plants produce dehydrated potato products, such as flakes and granules and freezer plants produce frozen products, such as french fries and potato tots. Some freezer plants also have facilities for producing potato flakes and other dehydrated products, but this would not be considered a major line. On the basis of information published by the U.S.D.A. and information obtained from industry sources, it is estimated there are 33 dehydrator plants and 33 freezer plants in the United States (Figure 6).⁵ The largest concentration of processors occurs in the western tri-state area which accounts for 21 dehydrators and 18 freezers.



Figure 6. Location of Dehydrator and Freezer Facilities in the United States, 1977

SOURCES: (13:10; 14).

⁵The number of plants in operation varies from year-to-year as a result of the supply and demand situation in the industry and the fact that some plants are relatively small and may be unable to operate on a continuous basis for financial reasons.

Chip plants are located in virtually every state. There were 224 chip plants in operation in 1976 with the largest concentration occurring in the eastern part of the United States.

Disposition of Potato Crop

The disposition of potatoes varies across producing regions. Most of the winter states' production moves to the fresh market. Spring production flows to the fresh market and to chippers. Summer production moves to the fresh market and chippers and also is used for processing--allowing processors in some areas to utilize their facilities for extended periods.

Disposition of fall production varies among states. Over 70 percent of the production in the western tri-state area of Idaho, Washington, and Oregon (and as much as 85 percent of Washington's production) is used for processing--primarily for frozen and dehydrated products. About 45 percent of Maine's production is used for processing, 45 percent for table-stock, and 10 percent for seed.

It has been estimated that 30 percent of the production in the Red River Valley is used for chips, 13 percent for frozen products, and 7 percent for dehydrated potato products. The fresh market accounts for about one-third of the crop, and seed the remaining 17 percent (15:23).

Shipments of Potatoes From North Dakota and Minnesota

Potatoes grown in North Dakota and Minnesota are shipped to many parts of the United States. Table 9 gives a breakdown of shipments (unloads) of fresh potatoes from the two states in 1975 to selected cities as reported by the U.S.D.A. The unload data are not all inclusive since potatoes are shipped to cities that are not included in the unload reports. In addition, the unloads represent raw potatoes which may be used for fresh consumption or processed uses.

The shipments to the ten cities given in Table 10 represent about 87 percent of the region's reported shipments, although shipments of potatoes from North Dakota-Minnesota are reported for almost all 41 cities. Minneapolis, Chicago, and St. Louis account for about 52 percent of the shipments of potatoes from North Dakota-Minnesota.

The unload data also serve to emphasize the importance of storing potatoes. Potatoes are shipped during each time period, and while some of

TABLE 10. POTATO UNLOADS IN SELECTED CITIES FROM NORTH DAKOTA AND MINNESOTA AND OTHER PRODUCING STATES, 1975 (IN CARLOT EQUIVALENTS-- 600 CWT.)

Producing State	Months Shipments Received				Total ND-MN Unloads	Percent of ND-MN Unloads
	Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.		
Minneapolis						
ND-MN	581	676	443	1,045	2,745	21.7
Percent of Shipments Received	71.3	54.5	55.5	84.2		
ID	130	162	31	95		
Percent of Shipments Received	16.0	13.1	3.9	7.7		
Chicago						
ND-MN	983	404	297	823	2,507	19.8
Percent of Shipments Received	49.4	24.2	15.7	40.6		
WI	478	210	643	674		
Percent of Shipments Received	24.0	13.1	34.0	33.3		
St. Louis						
ND-MN	495	295	85	406	1,291	10.2
Percent of Shipments Received	63.5	40.0	12.3	54.7		
WI	121	26	197	92		
Percent of Shipments Received	15.5	3.5	28.5	12.4		
Kansas City						
ND-MN	322	189	152	240	1,003	7.9
Percent of Shipments Received	74.9	38.3	39.0	71.1		
WA	2	9	39	65		
Percent of Shipments Received	0.5	1.8	10.0	13.6		
Dallas						
ND-MN	307	112	13	209	643	5.1
Percent of Shipments Received	29.4	10.2	0.9	16.7		
Tx	7	284	737	54		
Percent of Shipments Received	0.7	25.9	53.7	4.3		
Atlanta						
ND-MN	221	64	82	199	566	4.5
Percent of Shipments Received	26.3	5.9	7.2	20.4		
WI	179	54	275	232		
Percent of Shipments Received	21.3	5.0	24.1	23.8		
Oklahoma City						
ND-MN	174	143	62	163	542	4.3
Percent of Shipments Received	27.9	25.5	11.9	24.2		
CO	387	289	112	497		
Percent of Shipments Received	62.1	52.0	21.5	62.2		
Cincinnati						
ND-MN	168	77	67	138	450	3.6
Percent of Shipments Received	22.9	9.6	9.4	20.1		
ID	142	153	50	139		
Percent of Shipments Received	19.4	19.1	7.0	20.2		
Memphis						
ND-MN	180	89	11	149	429	3.4
Percent of Shipments Received	60.7	33.2	4.2	57.3		
WI	26	5	54	48		
Percent of Shipments Received	9.3	1.9	20.6	18.5		
Louisville						
ND-MN	217	26	10	154	407	3.2
Percent of Shipments Received	31.2	3.5	1.4	19.5		
WI	306	110	177	173		
Percent of Shipments Received	42.1	14.8	24.6	21.9		

SOURCE: [16].

the reported shipments represent early potatoes (summer production), about 93 percent of the potato production in North Dakota and Minnesota in 1975 was fall production.

Potato unloads are reported by rail and truck. In 1975, about 65 percent of all unloads from North Dakota-Minnesota were shipped by truck and 35 percent by rail. Shipments by mode of transportation from the region to major unload points are presented in Table 11. The reliance on truck rather than rail, even to distant points, can be explained in part because trucks are faster and also potato outshipments provide backhaul opportunities for truckers making fresh fruit deliveries from the south.

TABLE 11. POTATO UNLOADS IN SELECTED CITIES FROM NORTH DAKOTA AND MINNESOTA BY MODE OF TRANSPORTATION, 1975 (IN CARLOT EQUIVALENTS--600 CWT.)

Unload Point	Mode of Transportation			
	Truck		Rail	
	<i>number</i>	<i>percent</i>	<i>number</i>	<i>percent</i>
Minneapolis	2,686	98.0	59	2.0
Chicago	693	28.0	1,814	72.0
St. Louis	310	76.0	981	24.0
Kansas City	758	76.0	245	24.0
Dallas	474	74.0	169	26.0
Atlanta	364	64.0	202	36.0
Oklahoma City	366	68.0	176	32.0
Cincinnati	345	77.0	105	23.0
Memphis	303	71.0	126	29.0
Louisville	362	89.0	45	11.0

SOURCE: (16).

The General Storage Situation

The quantity of potatoes used for processing has increased dramatically in the past few years. Potatoes used for this purpose need to be stored under special conditions. Storage is of particular concern in the Red River Valley where a substantial portion of the crop is sold to potato chippers. Potatoes used for chipping must meet rigid quality standards. The grower stands to suffer a loss if potatoes sold from storage do not meet those high standards. He may have to sell the potatoes to starch processors, dehydrators, or for feed. In any case, he may not cover all of his costs. Or, he may not be able to sell the potatoes at all, in which case none of his production or storage costs are covered.

The trend in storage in the Valley has been toward large, centralized units with capacities ranging up to 400,000 hundredweight of potatoes. All of the new storage units are built above ground, and about 95 percent have capacities from 15,000 to 200,000 hundredweight. About 95 percent of the new units are located off the farm and near a railroad. This type of centralized storage may be owned individually by one large producer or cooperatively by several, and is often managed by one individual. The large storage capacity and consolidated management reduces the number of sources that a packing or processing plant must use to secure a long-term supply, and helps to reduce the variability of the raw product received from each source. This is important as buyers become more concerned about the need for uniform quality of the raw product. Packing plants are usually located adjacent to a large bulk potato storage facility to minimize transportation of the raw material and provide a large inventory to use as a basis in accepting orders. Processing plants have limited storage facilities on site to smooth out the flow of raw product to their production lines, but the bulk of the required raw product is shipped to the plant as it is needed (17:1).

A large percentage of storage facilities in the Valley have been altered in the past few years because of the increased use of potatoes grown for processing. The change in end use requires higher storage temperatures and has increased the problems in storage design and management. Potatoes stored for processing must be held at higher temperatures which not only presents problems in storage design but creates an atmosphere which encourages bacteria development that contributes to susceptibility to disease and breakdown of the tuber. This will be discussed in greater detail later.

There has also been a trend to a longer storage season in recent years. Large amounts of potatoes have been contracted to be stored and delivered in April, seven months after harvest (Table 12).

There are different reasons for extending the storage season in the Red River Valley. Processing plants operating during early fall acquire potatoes grown near their plants and rely on distant areas like the Valley for supplies later in the season. Because of this, producers in the Valley delay the starting date of their shipments until after the small, local production areas have marketed their crop. These smaller areas are often in warmer climates where potatoes are harder to store.

TABLE 12. TOTAL STOCKS OF FALL POTATOES HELD BY GROWERS AND LOCAL DEALERS IN NORTH DAKOTA, MINNESOTA, AND OTHER FALL STATES, CROP OF 1975 AND 1976

Time Period	North Dakota		Minnesota		Other Fall States	
	1975	1976	1975	1976	1975	1976
<i>000 cwt.</i>						
Production	17,600	16,940	9,690	11,055	248,765	278,911
December 1	12,800	11,500	8,000	9,000	160,130	181,335
January 1	10,400	9,400	6,400	7,400	136,120	157,845
February 1	7,900	7,300	5,400	5,700	112,060	130,855
March 1	5,400	5,100	3,700	4,000	90,005	105,025
April 1	2,500	2,600	1,900	2,100	62,800	77,165

SOURCE: (2).

Storage Requirements

The potato is not dormant in storage, but is a living organism. It has the ability to manufacture new skin, if bruised, and to protect itself from rot organisms. The potato respire, losing moisture, which results in weight loss. Therefore, ideal storage conditions require the correct temperature, humidity, and air movements to minimize the losses due to disease and shrink. Potatoes held for processing have additional requirements as discussed on the following pages.

Temperature

Temperature control is an important factor for the potato in storage. The potato will not actually freeze until it reaches a temperature of about 20° F. However, chilling injury and discoloration can be encountered at temperatures as high as 34° F., if maintained long enough. Sawyer reports that at temperatures below the 35° to 36° F. range, the carbohydrates in the potato change to a form which gives a sweet flavor that is undesirable to some consumers (18).

Recommended storage temperatures are highest for processing potatoes. Recommendations are 38-40° F. for seed and tablestock; 43-50° F. for potatoes to be processed into french fries and flakes; and 50-55° F. for chipstock. Most varieties accumulate sugars that affect deep fat frying operations at temperatures under 50° F., and tend to lose these sugars at temperatures above 55° F. These figures will vary somewhat, depending on the variety, location, and season (17:3).

A high reducing sugar content in potato chips causes chips to retain more oil during frying. This gives chips a darker color which is undesirable in quality potato chips. Potatoes stored below 50° F. can be reconditioned by holding them for a period of time at temperatures around 60° F. The reducing sugars turn back to starches during reconditioning but the quality of reconditioned potatoes is seldom as good as the quality of potatoes which have been stored at temperatures constantly over 50° F. (19).

Figure 7 shows the results of a Michigan study of reconditioning potatoes stored at various temperatures. The potatoes stored at temperatures below 50° F. have distinctly lower quality.

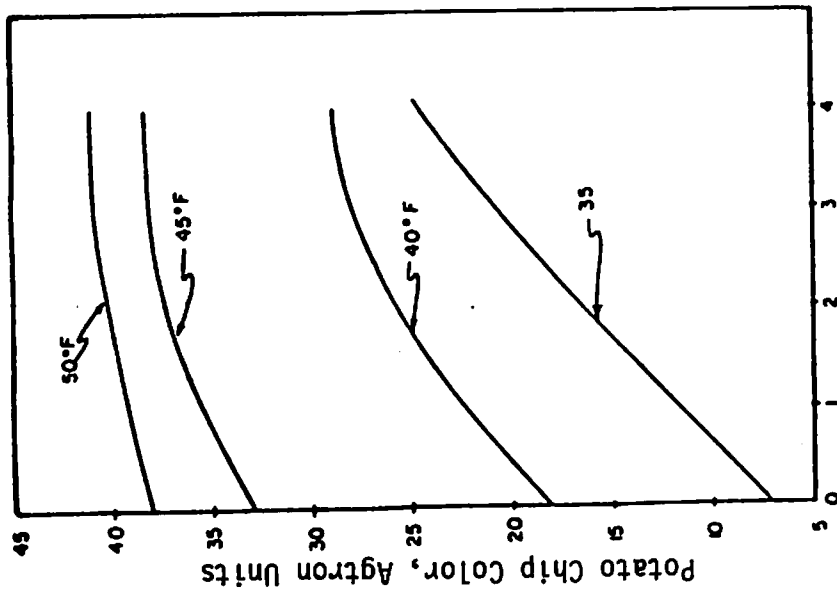
Figure 8 presents some results on potato chip color of Kennebec potatoes stored at 50°, 40°, and 35° F. and at 95 percent relative humidity. Only those stored at 50° yielded satisfactory potato chips. Potatoes stored at 40° F. did not come up to the 30 Agtron reading which is the minimum color desirable for potato chips (Agtron reading--a measurement of potato chip color). There is a marked increase in the speed of multiplication of rot organisms as the temperature is increased above 40° F. Respiration rises sharply, and transpiration potential is increased.

Increasing potato temperatures 15° F. roughly doubles the rate of respiration and consequent heat generation (17:3). In addition, the higher the temperature, the greater the potential weight loss. Figure 9 illustrates the weight loss of Monona potatoes at three different temperatures and at 95 percent relative humidity. Potatoes held at 45° F. for 200 days had an accumulated weight loss of over 10 percent.

Humidity

Tubers are approximately 78 percent water by weight. A continual tension exists to transpire which increases with low relative humidity. The potato loses weight as it loses water. The extended storage season in the Valley requires close control of relative humidity, preferably maintaining 90 to 95 percent at all times in order to minimize the weight loss accompanying shrinkage (21:49).

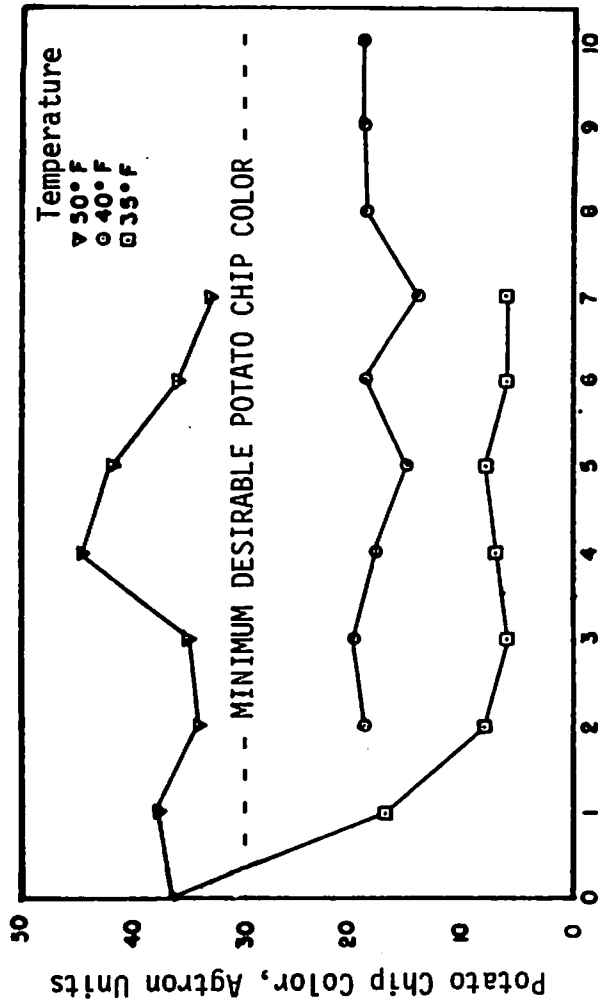
Maintaining high humidity to hold shrinkage to a minimum creates an environment favorable for storage rot organisms. This is especially true when combined with the high temperatures required for potatoes used in processing. The balance is very delicate between optimum storage conditions and conditions which induce the growth of microorganisms and physiological changes in the potato-reducing quality. Any condensed water is a potential



Reconditioning Time, Weeks

Figure 7. Influence of Reconditioning Time at 60° F. and 95 Percent Relative Humidity on Chip Color From Kennebec Potatoes Stored for an Extended Period of Time at Four Temperatures and 95 Percent Relative Humidity

SOURCE: (20:432).



Length of Storage, Months

Figure 8. Influence of Storage Temperature on Potato Chip Color From Kennebec Potatoes Stored at 95 Percent Relative Humidity

SOURCE: (20:431).

hazard leading to loss of potatoes in storage. There is some indication that humidity conditions which leave the surface of the potato wet for a prolonged period are detrimental to good color of certain types of processed potatoes.

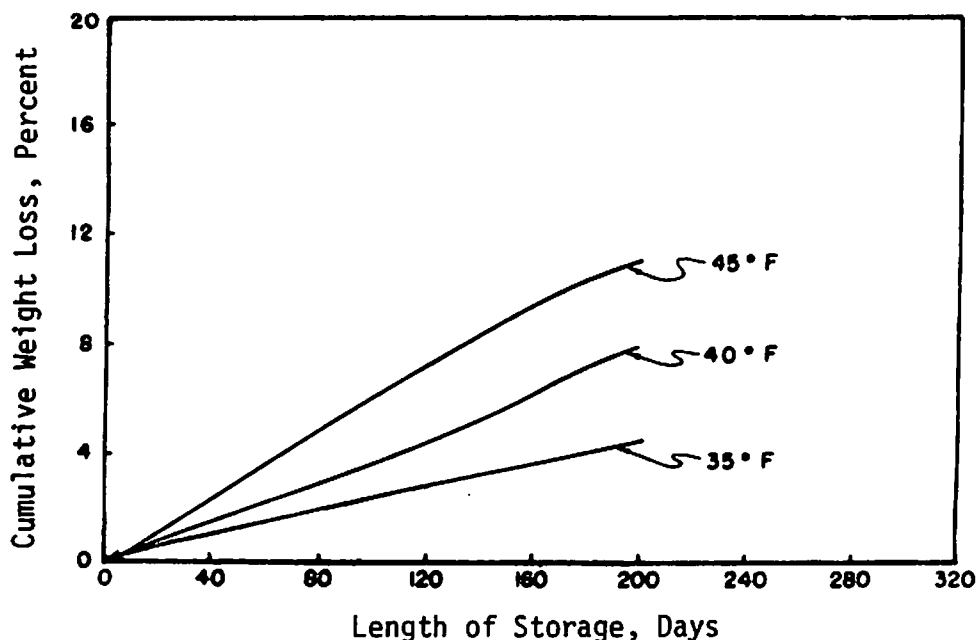


Figure 9. Influence of Three Different Storage Temperatures and 95 Percent Relative Humidity on Weight Loss of Monona Potatoes

SOURCE: (20:415).

Ventilation

The conditions that must be met in potato storage are quite specific and a good ventilation system is required. A storage facility must include adequate fan capacity, duct sizes, and controls. The storage must be well insulated, contain a vapor barrier, and have a reliable heat supply. The structure must be sound.

Storage Management

Ideal storage facilities and environment will not compensate for poor production and harvesting practices. Often these practices leave a potato susceptible to rot organisms and moisture loss once it is in storage, and a high percentage of the problems in storage are normally brought in from the field. A good air distribution system is of little value in a pile of potatoes containing a lot of dirt. Undersized, unsalable potatoes and trash should not go into storage.

Curing potatoes is important. Curing involves toughening and thickening of skin. "Ripe" skin helps to reduce moisture loss and is a defense against disease. Curing is best obtained by holding temperatures at 60° to 65° F. for seven to ten days with high humidity and good ventilation. Temperatures should be reduced to the low 50's and a longer curing period used if rot threatens. It is recommended to cool potatoes rapidly to the desired holding temperature once curing is over, taking into consideration the basic temperature-humidity pattern best suited for the particular area.

Producer-Processor Contracts

Contracts have become increasingly important in marketing potatoes, especially between growers and processors. The potato producer faces a high degree of risk and uncertainty and many feel that contracts help to reduce the adverse effects of these variables on the producer. The contract may be desirable to both the grower and the processor or retailer. The grower knows exactly what price he is going to receive and the processor or retailer knows he has a specified supply unless there is a complete crop failure.

The use of contracts between growers and processors varies from year to year, depending on the supply and demand conditions. The amount contracted can vary from 30 to 75 percent of processor requirements in any given year. Processors in general typically contract for about 50 percent of their need, purchase about 45 percent of their supply in the open market, and grow about 5 percent (13:13).

Only a small percentage of the potatoes going to the fresh market is contracted at the present time. Recently, dehydrators of potatoes have been making greater use of contracts. They are now contracting directly with the grower for about half of the raw potatoes needed for processing.

Processors manufacturing frozen potato products make even greater use of contracts for raw potatoes. Currently, over 50 percent of all potatoes processed into frozen products are obtained via contracts. Potato chippers use grower contracts less frequently than do other processors; however, the use of contracts in the chipping area is increasing. Many potato chippers are relatively small and do not use large quantities of raw potatoes, thus finding it easy to obtain needed supplies without extensive use of contracts. On the other hand, Frito-Lay, the largest national potato chip producer, uses detailed grower contracts to procure a high percentage of its chipstock (6:15-16).

Basis of a Contract⁶

A contract is merely an agreement by a seller to sell and a buyer to buy a given good or service for an agreed upon price, and often times, an agreed upon delivery date and terms of trade. Some contractual agreements are actually completed over the telephone. This usually works only where the two parties know and respect each other and if the time is short and the terms are relatively simple.

Each potato firm is usually involved with many different growers and a written agreement is important. Verbal agreements often lead to difficulties when open market prices differ greatly from contract prices. A written general contract usually contains the following provisions:

1. Parties to the contract.
2. Date of the contract.
3. Quantity of product contracted.
4. Specifications (variety, grade, etc.).
5. Price per unit.
6. Terms of payments.
7. The point and method of delivery.
8. Time of delivery.
9. Storage agreements, if applicable.

Types of Contracts

Two types of preseason contracts are used by growers and processors: the harvest contract and the storage contract. The storage contract is used most often in the Red River Valley because processors prefer to receive Valley potatoes at intervals throughout the season.

The Harvest Contract

The harvest contract requires delivery of potatoes to either the processing plant itself or to some specified storage that is controlled by the processor. A grower operating under this type of contract has no responsibility for storing potatoes. His potatoes are graded upon delivery from the field. Harvest contracts are popular with farmers who want to cover expenses in the fall or who do not own adequate storage. They are also important to farmers who have obsolete storage facilities.

⁶The following sections pertaining to basis, types, and benefits of contracts are outlined by Sargent, Robert L., Potato Marketing--Processor Contracts, Current Information Series No. 258, Cooperative Extension Service, University of Idaho, Moscow, December, 1974.

The Storage Contract

The storage contract requires that the farmer store potatoes for specified periods of time. The contract provides for additional payments to growers above the base price according to the length of time the potatoes are stored. The premiums are increased on a weekly, biweekly, or monthly basis. Storage payments serve the dual purpose of extending the period over which potatoes will be delivered to the processor, and compensating the grower for additional risk and investment associated with providing storage.

Benefits of Contracts

Benefits can accrue to both processors and growers as a result of contracting. Some of the benefits accruing to both parties are discussed below.

Processor Benefits

A Known Price:

Contracting eliminates price uncertainty for the processor. He is not subject to price fluctuations often found in the open market when covered by a contract. This enables him to know a portion of the cost of the raw product in advance.

A Known Supply:

Processors contract for different portions of their raw product needs. By contracting, processors obtain the raw material when it is needed, except in the case of a complete crop failure. The portion of raw material requirements that are not contracted are obtained by the processor in the open market where a more favorable (lower) price than the contract price might be obtained. This hinges closely on the size of the crop in a given year. With a known supply of potatoes contracted, a processor can establish production schedules and estimate other input requirements. In addition, the processor is able to more effectively coordinate his overall marketing efforts.

Desired Quality Known:

Contracts make it possible for the processor to specify the type and quality of potatoes needed to yield the finished product desired. Contract specification related to quality of the raw product provides the processor with a degree of control over the production practices of growers.

Grower Benefits

An Assured Outlet:

Perhaps one of the greatest advantages of a contract to a grower is that it assures him of a market for that portion of his production which is covered by the contract. It enables him to focus his attention on production practices that will provide high yields and meet quality requirements.

A Known Price:

A contract establishes a base price for potatoes which eliminates some of the uncertainty associated with price fluctuations that a grower faces. This offers him an advantage from the standpoint of being able to plan his production schedule for potatoes and other crops. Contracts are also helpful in determining storage requirements once the crop is harvested.

Access to Credit:

A contract acts as a form of collateral for growers. Credit agencies are generally more willing to grant needed credit for operating expenditures if growers can show that a market is assured at a known price for at least a portion of their production. This gives credit agencies a clearer concept of the financial operating requirements of growers and possible receipts; with the potential receipts, there is additional assurance that loans will be repaid.

Desired Quality Known:

The grower knows the grade of potatoes he has to produce when quality specifications are contained in the contract. The price he receives will be discounted to reflect the lower quality of his potatoes if these specifications are not met. Quality specifications enable the producer to take advantage of the various incentives that may be included in a contract.

Storage:

Contracts contain clauses to reimburse the grower for the risk of storing potatoes. Processors are now operating their plants ten months or more per year and since they do not have the facilities to store potatoes over that length of time, they need a supply of raw product arriving at the plant throughout the operating period. For this reason, growers must store potatoes for considerable periods of time. Clauses are included in storage contracts which reimburse the producer for the added risk of storing the crop for extended periods.

Disadvantages of Contracts

The advantages of contracts listed above may work to the disadvantage of growers under certain circumstances. For example, a grower will not benefit from an increase in the market price, at least not on the portion of the crop covered by the contract. Also, if the contract does not include an "Act of God" clause, the grower is still responsible for delivery of the contracted amount even in the case of a crop failure caused by weather or other natural occurrences.

Grower Attitude Toward Contracts

Contracts affect growers in different ways. Growers throughout the Valley have various attitudes with respect to contracting their potatoes for market. Their feelings could probably be classified in four categories.

1. Some feel contracts are essential to provide security.
2. Some feel that if they contract one year they should do so every year because the year they may decide not to contract, the market price may deteriorate severely.
3. Other growers like to contract just enough potatoes to cover their expenses and gamble with the remainder of their crop on the open market.
4. Some growers would rather not contract and take their chances on the open market, hoping for the "big" price.

Bargaining Between Growers and Processors

Contracts have been used by growers and processors since World War II. There was no formal bargaining between chippers and growers until 1973. Bargaining with freezers and dehydrators started in Idaho in 1956, and by 1958, there were four regional bargaining groups organized in that state. Although these groups bargained with some success, their powers were limited and this led to the incorporation in 1966 of a statewide organization-- The Potato Growers of Idaho. Organization of bargaining associations in other production areas followed the developments in Idaho. However, it was not until 1973 that contracts were signed by growers with practically all of the freezers and dehydrators in the United States.

There were five independent producer bargaining associations operating as of July, 1974--one each in Idaho, Washington, Oregon, Maine, and the Red

River Valley. There is no coordinated exchange of information between groups although informal exchanges have increased in recent years.

Each bargaining organization is structured differently, but there are similarities between them. A base contract is negotiated with each processor by a negotiating team representing the bargaining association. The association has no formal control over supply and processors are free to select growers who will be offered contracts. The base contract represents a starting point in negotiations between processors and individual growers. Growers agree that they will not accept lower terms than those specified in the base contract but they are free to individually negotiate for better terms with processors. Processors also view the price established in the base contract as a minimum price in negotiating with individual growers (13:13-14).

Increased Emphasis on Bargaining

Bargaining has become an important factor in marketing potatoes. The impetus for bargaining has come from growers just as it has in other agricultural sectors, such as fluid milk and other processing fruits and vegetables. Bargaining is viewed as a process through which income gains may accrue to growers. The potential sources of such gains include the profit margins of processors, higher prices to consumers, and/or increased efficiency in marketing products. Whether such gains actually accrue to growers depends on the strength of the association and certain economic factors over which it has little or no control. The strength of the bargaining association depends on the proportion of total production it controls and the number of growers it represents, its disciplinary power over members, the willingness of members to bear the costs of withholding actions, the ability of the association to assure processors a stable supply of product that meets processor specifications, and the recognition by processors of the association's ability to inflict economic losses on processors.

Bargaining associations exert control mainly on the supply side of the market. Their control over the demand side of the market is much more limited. Actions taken by an association which result in higher consumer prices may cause consumers to reduce purchases and to look for substitutes. The result will ultimately be a reduction in sales, and depending on the extent of substitution, lower overall prices which will eventually be reflected in lower prices at the farm level. In such a case the income

gain may be short-lived and farmers may eventually be worse off. In another situation, a "pure" income gain for the grower from bargaining will not result if the distribution of risk has been altered. Bargaining may result in the grower taking on additional responsibilities with added risks. For example, a bargaining agreement may contain specifications for certain cultural practices or it may specify delivery dates so that the grower must arrange storage for his product. The grower is compensated for the additional risks but this should not be viewed as a "pure" income gain for the grower from bargaining--rather he is simply being compensated for performing duties that were once the responsibility of the processor.

Conditions Conducive to Bargaining

A number of conditions conducive to effective bargaining exist in the potato industry. These include: the importance of contracting, the demand by processors and other intermediate marketers for a stable supply of potatoes that meets their specifications, concentrations of power at certain stages in the market system, geographic concentration of supply, increased grower specialization, instability in production, storability of potatoes, and alternative markets for potatoes.

Contracting

Growth in bargaining for many agricultural commodities has paralleled the increased use of contracts--particularly when contracting becomes an important price determining mechanism. Initial efforts involving contracts tend to favor the contractor. He usually has access to more information than an individual farmer--both with respect to market supply and demand and his marketing and production costs. With this information the contractor is in an advantageous position in contract negotiations. Farmers in turn look for ways to improve their bargaining position and a bargaining association may be the best alternative. This has been the case in the potato industry where processors contract with growers to assure themselves a portion of their raw product requirements. The increasing importance of processed potato products has created more emphasis on contracting as a price determining mechanism and with it the feeling on the part of growers that they must bargain collectively to insure equity and stability in their relationship with processors.

Stable Supply--Quality Requirements

Processors and other intermediate marketers of agricultural commodities are increasingly requiring reliable supplies of raw products. Quality of raw product at time of delivery is also an important factor. Potato processors require a reliable supply of potatoes that meet certain quality standards depending on the end use. Continued growth in the processing industry will place added emphasis on these requirements in the future. High investment costs in plant and equipment, the need to plan production schedules, product differentiation, and competition are factors leading to these requirements. Recognition of these requirements by farmers provides some impetus for bargaining since they control the supply of raw product. On the other hand, processors may be willing to relinquish some of their profits to farmers in return for an assurance of a stable supply of high quality raw product and additional services. In fact, processors may be giving up little or nothing if efficiencies in production and marketing of end products occur so that the absolute value of margins change very little.

Processor Concentration

Concentration within a market channel means that a small number of firms at some stage in the system buy and/or sell a relatively large proportion of raw and/or finished product. These firms may be in a position to exert disproportionate influence on other participants in the system resulting in economic gains to themselves. The economic gains may come at the expense of other marketers or consumers or both. This imbalance of power has been an important factor in the creation of producer bargaining associations in agriculture as farmers have sought a mechanism through which they can exert countervailing power.

There is a rather high degree of concentration of dehydrators and freezers of potato products--both geographically (see Figure 6, p. 20) and in terms of ownership of processing facilities. The geographic concentration of processors in the major producing areas creates incentives for growers to bargain collectively with processors. It is also an advantage to growers since processors must generally rely on local supplies for their raw product requirements. If prices for comparable raw product are about equal industry-wide, then processors in one region cannot compete with processors in other regions if they have to obtain their raw product in one region and pay the cost of shipping it to a plant in another region. The

bargaining power of growers in this instance is limited, however, because excessive price demands by growers could force processors to look elsewhere for their supply of raw product; or where a firm operates more than one plant it might shut a plant down and increase production in plants in other areas. About two-thirds of the dehydrators and freezer plants in the United States are owned by 22 companies. One-third of the plants are owned by five companies (13:11). Most of the total annual supply of potato chips is produced by fewer than 90 processors. In the Red River Valley, for example, if a farmer who raises potatoes for processing does not sell his product to one of the following--Old Dutch, Frito Lay, Guys Foods, Fairmont, Sunshine, Mid-American, Bordens, Pillsbury, Simplot, King of Spuds, or International--he may not find an outlet for his potatoes. The four main buyers of chipping potatoes are Old Dutch, Frito Lay, Guys Foods, and Fairmont (14).

Geographic Concentration of Supply

Geographic concentration of supply is conducive to bargaining because it is easier to coordinate the activities of producers within a small area and it is also easier to maintain control over supply--an important factor in the success of bargaining efforts. Where supply is concentrated geographically and farmers coordinate their marketing efforts, the alternative sources of supply of raw product to processors and other intermediate marketers is limited and the bargaining association gains strength in negotiations.

Potato production is concentrated geographically in the United States. The western tri-state area of Idaho, Oregon, and Washington accounted for about 48 percent; North Dakota-Minnesota about 8 percent; and Maine about 8 percent of total potato production in the United States in 1976. The five producer bargaining associations are located in these areas.

Increasing Specialization in Production

The trend toward specialization in farming and increased investment in land and equipment increases the concern farmers have for marketing their product at a price that assures an adequate return on investment and return for their labor. While specialization allows for efficiencies in production which may be reflected in farm income, it also makes farmers more vulnerable to weather and forces originating in the marketplace. Bargaining may offer farmers an opportunity to secure outlets for their product and to negotiate for a price which provides an adequate return on their investment and for their labor.

Specialization also serves as a barrier that restricts the number of producers growing certain crops. Investment in special equipment that cannot be used in producing other crops precludes some producers from growing specialty crops and it forces others who do not make the commitment of resources out of the industry. This limits the number of producers. making it easier to maintain control over supply and giving strength to a bargaining association.

The trend toward fewer but larger farms growing potatoes (see p. 13) is an indication of the increasing specialization in farms growing potatoes. In addition, investment in new storages (see p. 24), irrigation equipment, and other machinery must be viewed as a long-run commitment by farmers for which an adequate return must be realized.

Instability in Production

Production of some agricultural commodities is characterized by recurring waves of overproduction. The result is unstable prices and farm income. Bargaining associations have been suggested as one method of stabilizing production. The effectiveness of such an action, however, depends on the ability of such groups to control supply.

Potato production in the United States is quite variable. Production in 1971 and 1975 was the same, but for each of the three intervening years it averaged about 6.5 percent below or above production in those two years. Potato prices, especially at the farm level, fluctuate much more than the change in production would suggest because of the nature of the demand for potatoes. Growers have looked for ways to remove some of the instability in production. The result has been the implementation of market orders in some parts of the country and increasing emphasis by bargaining associations to make growers aware of the importance of supply control as it relates to prices.

Storability of Potatoes

The effectiveness of bargaining depends on supply control. The more control a bargaining association has over supply, the more effective it will be in negotiating with processors and other intermediate marketers. Potatoes are considered quite perishable, but the degree of perishability is less for potatoes than for some other commodities. Potato growers have facilities to store their product so they are not under pressure to sell their crop as soon as they would if their product were more perishable. This enhances

the individual grower's ability and that of an association in bargaining with processors. It would be wrong to infer, however, that processors are completely at the mercy of growers or bargaining associations because most processors have storage facilities which assure them of a partial supply of raw product. In addition, processors traditionally do not contract for all of their raw product requirements and none of the bargaining associations control the total supply of potatoes in their respective growing areas. Nevertheless, the fact that potatoes can be stored and most of the storage is owned by growers enhances the bargaining position of potato growers.

Alternative Markets

Alternative market outlets offer advantages to sellers in marketing their product. In agriculture, such a situation allows farmers to divert a portion of their supply to markets where the most favorable prices and terms of trade can be obtained or to attempt to bolster prices in certain markets by diverting supplies from markets where prices are low, relative to other markets. In effect, the more market outlets or uses of the raw product there are, the more favorable is the bargaining position of growers and the more conducive such a situation is to the creation of a bargaining association. The bargaining strength is limited somewhat since there are usually limits to how much of the raw product can be diverted to alternative markets.

Potatoes have multiple uses that offer a number of potential market outlets for growers. However, there are a number of factors that serve to limit this potential source of bargaining strength of growers. First, the demand for potato products limits the quantity of potatoes that can be used for any one use. Second, there are differences in raw product quality requirements depending on end use that serve to restrict potential markets to growers. And third, location of markets in relation to production areas may make it uneconomical to ship potatoes to certain markets. The fact remains, however, that alternative market outlets for potatoes have been conducive to bargaining in the potato industry.

Effectiveness of Bargaining

The conditions necessary to bargain effectively were outlined above. Although the effectiveness of the present system of bargaining in the potato industry is difficult to assess in absolute terms, some observations can be made.

The number of growers represented by each association varies as does the acreage and volume of processed potatoes shipped in each production area. For example, the Agricultural Bargaining Council in Presque Isle, Maine, represented 50 percent of the producers in Maine in 1974 and about 42 percent of the potatoes used for processing in Maine. In the same year, the Red River Valley Potato Growers Association represented 70 percent of the growers in North Dakota and Minnesota and 70 percent of the potato acreage in those two states (13:12). While some associations appear to represent a relatively large number of growers and volume of potatoes, growers have continued to maintain a sense of individual independence as evidenced by the fact that they ultimately negotiate directly with processors.

There have been instances where contracts have not been signed by all processors in certain regions. In addition, there have been situations where individual growers have not been offered contracts or where processors have been unable to obtain individual grower contracts.

Growers and processors are both content to "play the market" to some extent. Growers do not normally contract all of their production nor do processors contract for all their raw product requirements. In each instance there is some incentive to rely on the open market to sell (buy) at least a portion of the crop.

Growers have demonstrated on several occasions the cohesiveness required in bargaining associations. In 1969, potato growers in Idaho rejected contract proposals of a major processor that were considered undesirable and failed to reach a contract agreement with that firm (22:18). In 1973, growers in the Red River Valley took advantage of a small crop to bargain effectively with processors. The result was higher prices to growers in that year.

The use of group action in the potato industry has had effects on both growers and processors. Processors have lost some of the market power they once possessed. They have relinquished some of their control over the term of trade as growers have become more unified. However, processors have some assurance of a supply of a quality raw product unless there is a crop failure. This reduces the threat of shutdown to processors caused by insufficient supplies of potatoes.

Growers have a better understanding of the factors affecting their welfare and the fact that there may be advantages in joining with other participants in the market system in the pursuit of mutually beneficial

objectives. Increasingly, contracts require processors to pay for quality differentials. Because of this, grower efforts to improve quality have been rewarded.

Concluding Remarks

Potato production is increasing in the Red River Valley. The number of growers is becoming smaller, but the remaining commercial growers are becoming more specialized and increasing their acreage of potatoes. With specialization comes added investment. One of the problems facing the industry has been wide price swings which cause erratic income patterns. Commercial growers have difficulty coping with these price gyrations. Another problem is the additional risk associated with extended storage. Moreover, growers lack market strength, since they sell to processors who tend to be concentrated and are able to exert market power. Growers have sought to overcome this limitation through participation in the Red River Valley Potato Growers Association.

Strides have been made in recent years through the producer association, market contracts, and limited use of integration that are mutually beneficial to all market participants with the desire that the expanded use of such management tools will contribute toward market stabilization.

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