Government of Canada
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Province of British Columbia

Ministry of Agriculture

University of British Columbia
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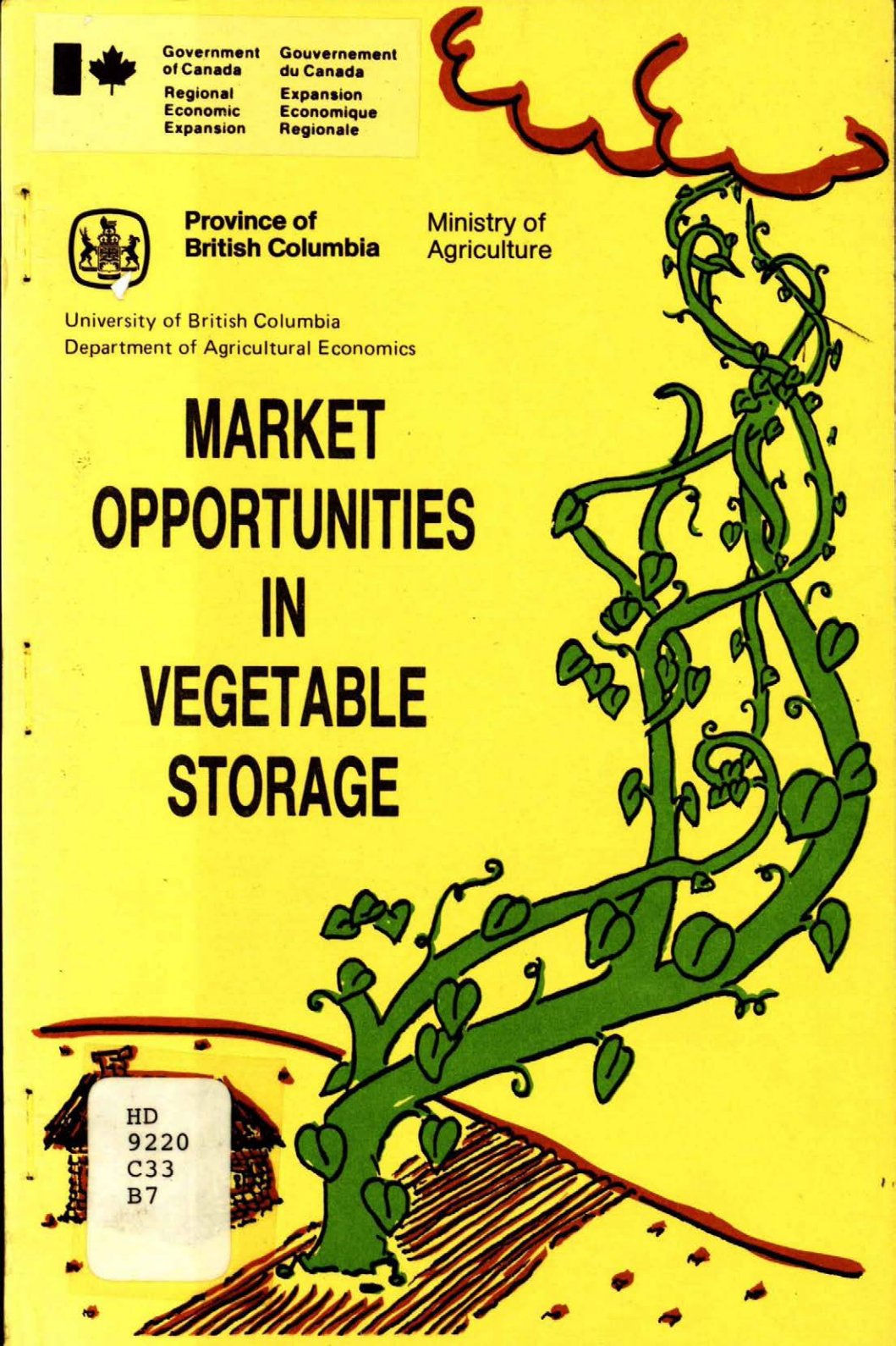
MARKET OPPORTUNITIES IN VEGETABLE STORAGE



MARKET OPPORTUNITIES IN VEGETABLE STORAGE

A REPORT BY THE MARKET OPPORTUNITY IDENTIFICATION PROJECT

A JOINT EFFORT OF

THE UNIVERSITY OF BRITISH COLUMBIA
DEPARTMENT OF AGRICULTURAL ECONOMICS

and

THE BRITISH COLUMBIA MINISTRY OF AGRICULTURE
MARKETING SERVICES BRANCH

and

GOVERNMENT OF CANADA REGIONAL ECONOMIC EXPANSION

GOUVERNEMENT DU CANADA EXPANSION ECONOMIQUE REGIONALE

February, 1980

Canadian Cataloguing in Publication Data

Market Opportunity Identification Project.
Market opportunities in vegetable storage.

"Tenth in a series of studies of market opportunities for B.C. agricultural products."
ISBN 0-7719-8409-X

1. Vegetables - British Columbia - Marketing. 2. Vegetables - British Columbia - Storage. I. British Columbia. Ministry of Agriculture. II. University of British Columbia. Dept. of Agricultural Economics. III. Title.

HD9220.C33B736 380.1'415 C80-092158-5

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PREFACE

This study is the tenth in a series of studies of market opportunities for B.C. agricultural products. The study was made possible through funding under the Federal-Provincial Agriculture and Rural Development Subsidiary Agreement (ARDSA). ARDSA is a joint program involving the Federal Department of Regional Economic Expansion (DREE) and the British Columbia Ministry of Agriculture.

The study was commissioned as the conclusion of a series of market opportunity studies on cabbage, carrots, onions, parsnips, and rutabagas, completed under this project during the summer of 1979. Those studies indicated substantial sales opportunities for B.C. product during the storage season. The objective of this study is to determine the economic feasibility of storage of the above named products.

It is our hope that this study will be useful to farmers, agrologists, processors, wholesalers and retailers. The work was done at the Department of Agricultural Economics of the University of British Columbia in full collaboration with the Marketing Services Branch of the B.C. Ministry of Agriculture. The project committee which provided overall guidance consisted of Mr. Don Rugg,[1] Mr. Jim Alcock[2], and Dr. George Winter[3], Director of Research. This report was researched and prepared by Mr. Dan Lutz of ABEC Ltd.[4] from an early draft by Mr. J. David Dyck now with the B.C. Ministry of Finance.

We are grateful to the many farmers, agrologists, and other industry members who have assisted by providing data, helpful comments and advice.

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SUMMARY/ABSTRACT

This market study for vegetable storage in British Columbia was undertaken to identify opportunities for industry growth. In the earlier individual commodity reports produced by this project, it was noted that substantial opportunities for increased sales of B.C. product were available through the use of storage.

An opportunity for about 1400 tons of onion storage and about 3000 tons of carrot and cabbage storage was identified. Storage construction and operating costs were estimated, and combined with price estimates to determine the profitability and risk associated with the storage of cabbage, carrots and onions.

With the production of quality product combined with an aggressive pricing policy, additional returns are available through the use of vegetable storage. Carrots show the greatest potential and the least risk, followed by onions with good returns but high risk, and then cabbage with lower returns and high risk.

It is emphasized that storage is a relatively high technology operation, requiring good management and yearly market evaluations. Providing that the storage operator can fill these requirements, then operation of a storage facility can be profitable.

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I. INTRODUCTION

For British Columbia to become more nearly self-sufficient in the production of cabbage, topped carrots, rutabagas, parsnips and yellow onions, additional storage facilities are required. This conclusion was reached in studies conducted by the Market Opportunities Project during the summer of 1979. Opportunities for displacing imports of these crops between mid-July and November are limited. Although some potential for import displacement exists in the early part of the harvest season, the greatest opportunities to displace imports lie in November through March. To access this market, storage facilities are required. The purpose of this report is to evaluate the economic feasibility of storage and sale of those vegetables in British Columbia.

II. STORAGE OPPORTUNITIES

General Requirements

The storage of vegetable products over long periods, while maintaining a high level of quality, requires careful control of temperature and humidity. Controlled temperature and humidity (CTH) storage has several advantages over conventional refrigeration systems. For example, relative humidity can be maintained in the 97-100 percent range, thereby greatly reducing product dehydration. More stable storage temperatures can also be achieved, as fluctuating temperatures cause both loss in product weight and condensation of moisture on the product. Thus, the quality of product stored for long periods in CTH storage can be considerably better than that of product stored in conventional refrigeration facilities.

The optimum storage conditions for cabbage, topped beets, topped carrots, rutabagas and parsnips is 0° C and 97-100 percent relative humidity. These crops can also be stored in close proximity without adverse effect. The optimum storage conditions for onions are 0° C and 65-70 percent relative humidity. Because dehydration is a much less serious problem with onions than with other crops, the advantages of CTH storage are reduced. Refrigerated (CT) storage is adequate for the storage of onions through at least March providing storage temperature does not fluctuate. Onions cannot be stored with other vegetable products due to moisture and flavour interactions.

Some methods of CTH storage can also be used to remove field heat from vegetables. One method is called pressure cooling and does not wet the product as happens in hydro-cooling. Pressure cooling involves forcing large volumes of cool air through the product, thereby rapidly reducing its temperature. The technique allows direct placement of vegetables into storage.

Imported Volumes Available for Displacement

There is a large potential for the displacement of cabbage, carrots, parsnips, beets, rutabagas and yellow onions imported from the U.S. to Western Canada between November and March by B.C. product sold from storage. The magnitude of these imports and their distribution over the November to March period has been determined (Table 1)*. On the basis of the individual market opportunity reports, topped beets can be eliminated from further consideration since opportunities for expanded sales have been shown to be small. Market opportunities for topped carrots, parsnips and rutabagas have been shown to exist only in British Columbia.

i. Cabbage

The potential for increased sales of B.C. cabbage in both B.C. and the Prairies is substantial. B.C. is annually about 30% self-sufficient in cabbage production, leaving at least 1,352 tons (90% certainty)** of cabbage to be imported (into the Vancouver market) between November and March. Virtually all of these imports could be displaced if adequate storage facilities were available. An additional 2,650 tons is imported into Alberta and Saskatchewan markets during this period (90% certainty). By far the bulk of these opportunities lie after Christmas.

Tariff protection (approximately $30 per ton) for Western Canadian cabbage growers extends for 34 weeks per year*** usually beginning about the

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*The procedure used to determine import displacements is given in Appendix A.

**See footnote on Table 1.

***The period during which the tariff is effective was increased from 30 to 34 weeks, effective October 1, 1979 (pending Parliamentary approval).

third week of June. Thus, sales from storage after mid-February are at a disadvantage because they receive no tariff protection.

Production of mid and late season cabbage in B.C. in 1978 totalled approximately 4,425 tons. Total displacement of the 1,352 tons of expected imports into Vancouver would require a 30% increase in production, or about 96 additional acres of cabbage (at yields of 14 tons per acre). If expected imports into Alberta and Saskatchewan were also totally displaced, production would have to rise 90% or about 284 acres (Table 1).

TABLE 1

B.C. PRODUCTION, EXPECTED IMPORTS & ADDITIONAL ACREAGE REQUIRED TO DISPLACE IMPORTS

(November to March, 1973-1979)

Commodity	1978 B. C. Production (tons)	Expected Imports By Provincial Markets (90%)* (tons)		Additional Acreage Required To Displace Imports (acres)	
		B.C.	Alta/Sask	B.C.	Alta/Sask
Cabbage	4,425	1,352	2,650	96[1]	189[1]
Yellow Onions	8,041	1,519[6]	2,343[6]	84[2,6]	130[2,6]
Carrots	7,377	2,689	-	207[3]	-
Rutabagas	2,614	99	-	10[4]	-
Parsnips	105	223	-	33[5]	-
TOTAL	22,562	5,882	4,993	430	319

1. 14 tons/acre yield
2. 18 tons/acre yield
3. 13 tons/acre yield
4. 10 tons/acre yield
5. 7 tons/acre yield
6. 25% of these market potentials are Jumbo and Spanish type onions which cannot readily be grown in B.C.

*This may be difficult to understand. Since sales volumes constantly fluctuate, one cannot say with 100% certainty that a particular sales volume will be attained in any market period. Statistical methods however, allow us to express an expected sales volume with less than 100% certainty. One way of interpreting this table is to say that, based on a brief historic record, we can calculate a fair bet about the future. The bet would be my $90 against your $10 that at least the level of sales shown could be attained. Clearly, I must be quite confident of the result to risk the loss of my $90 for the possible small gain of your $10.

Note: The careful reader may notice that the import displacement volumes indicated in this table are slightly different than volumes indicated in the individual commodity market opportunity reports. This is the result of using a slightly different statistical technique, and does not affect the validity of the conclusions.

Source: Derived from Agriculture Canada, Fruit and Vegetable Division, Annual Fresh Fruit & Vegetable Unload Reports, 1972-1979.

ii. Topped Carrots

Large opportunities exist for increased sales of B.C. topped carrots in this Province. About 30% of the fresh topped carrots annually consumed in the Province are grown here. This leaves at least 2,689 tons which can be expected (90% certainty) to be imported each year between November and March. Nearly all these imports could be displaced, provided B.C. quality can match the quality of available imports. The majority of the sales opportunity lies after Christmas. Tariff protection (about $10 per ton) extends into mid-March.

In 1978, B.C. growers produced 7,375 tons of topped carrots. Total displacement of the 2,689 tons of expected imports requires a 36% increase in production or 207 additional acres of topped carrots (at yields of 13 tons per acre).

Topped carrot production in B.C. has been concentrated in the Lower Mainland with Vancouver Island and the Okanagan also producing large amounts. In 1977, the respective shares were 78%, 17% and 4%. Total provincial production has been rising in recent years with Vancouver Island growers and Okanagan growers capturing a larger share at the expense of the Lower Mainland.

iii. Yellow Onions

Opportunities for increased sales of B.C. spring-seeded yellow onions in both B.C. and the Prairies are large. Annually B.C. is only about 40% self-sufficient in onion production. The potential for increased sales is particularly large for jumbo-sized onions. (See Yellow Onion Report.)

Between November and March, at least 1,519 tons (90% certainty) of yellow onions will be imported.

The bulk of these imports could be displaced provided the sizes and quality of B.C. production are those demanded. Alberta and Saskatchewan markets account for at least an additional 2,343 tons of imports (90% certainty) between November and March. Imports are spread fairly evenly through November-March with monthly potential only slightly higher after Christmas. Tariff protection (about $30 per ton) extends over the entire storage period*.

B.C. producers grew 8,040 tons of spring-seeded yellow onions in 1978. Displacing all of the 1,519 tons expected to be imported into B.C. between November and March requires a 19% increase in production or an additional 84 acres of onions (at yields of 18 tons per acre). If all imports into Alberta and Saskatchewan are also displaced, total production must increase by 48% or 214 acres.

Yellow onion consumers typically demand 5% small, 70% medium, 20% jumbo and 5% Spanish-type onions. Since in the past B.C. has had difficulty producing jumbo onions, and cannot produce Spanish onions, only small and medium yellow onions are available from B.C. producers. Therefore the B.C. import displacement potential is reduced to 1,139 tons and the Alberta/Saskatchewan potential is reduced to 1,757 tons. A total of 160 new production acres would fill that potential.

The location of onion production in B.C. has changed dramatically over the past ten years

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*Tariffs on onion imports are in effect for 46 weeks of the year (formerly only 44 weeks) effective October 1, 1979 (pending approval of Parliament). The 6 weeks when the tariff is not in effect falls in May and June.

even though total provincial production has been quite steady. Over this period, the Lower Mainland and Okanagan have exchanged shares, while Vancouver Island has obtained a slightly increased share. In 1977, the Lower Mainland's, Okanagan's and Vancouver Island's production shares were 74%, 20% and 6% respectively.

iv. Rutabagas

There is little potential for increased sales of B.C. rutabagas. In the last six years, an average of about 13% of B.C. consumption has been imported. Over the November to April period, only about 99 tons of rutabagas can be expected to be imported each year (90% certainty).

The bulk of these imports enter in the last half of the period. B.C. rutabaga growers receive no tariff protection.

In 1978, 2,615 tons of rutabagas were produced in B.C. Virtually all of the imports in the November to April period could be displaced but this would require only a 4% increase in production. Less than ten additional acres (at a yield of 10 tons per acre) would be required.

Rutabaga production is centred in the Lower Mainland with Vancouver Island and Okanagan growers also producing considerable volumes. Regional shares of provincial production have been quite stable in recent years, i.e. Lower Mainland, 65%; Vancouver Island, 18%; and the Okanagan, 12%.

v. Parsnips

Substantial opportunities exist for increased sales of B.C. parsnips. Over two-thirds of the parsnips consumed annually in B.C. are imported. In the November to April period alone, a minimum

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v. Parsnips

Substantial opportunities exist for increased sales of B.C. parsnips. Over two-thirds of the parsnips consumed annually in B.C. are imported. In the November to April period alone, a minimum

of 223 tons can be expected to be imported into B.C. (with 90% certainty). The imports are spread quite evenly over this period. Parsnips are imported free of duty.

B.C. growers produced 105 tons of parsnips in 1978. Most of the imports during November to April could be displaced, but producers have not shown interest in substantially increasing acreage (see Parsnips Report). If all imports were to be displaced, production would have to rise 212%. This would require an additional 32 acres (at a yield of 7 tons per acre).

Parsnip production in B.C. has been unsteady over the past ten years, primarily due to variability of production in the Lower Mainland. Vancouver Island and Okanagan production has been quite stable over this period.

Summary of Potential for Import Displacement

If conditions in the vegetable industry remain similar to those during 1973 to 1979, there is a 90% likelihood that 5,402 tons or more of the five vegetables (cabbage, yellow onions, rutabagas, carrots and parsnips) will be imported into Vancouver between November and March each year. At least another 4,407 tons of cabbage and yellow onions will be imported into major Alberta and Saskatchewan markets during this period.

These estimates are conservative for two reasons. Firstly, only imports unloaded in the five major urban centres are considered. Approximately one-third of imports go directly to smaller centres. Secondly, no allowance is made for market growth. However, a share of this potential market, particularly in the Prairies, may be displaced by Prairie producers.

Although it is unlikely that 100% of November to March Vancouver imports could be displaced by B.C.

product, displacement of all those imports would require an additional 409 acres of production. Total displacement of cabbage and yellow onion imports into Alberta and Saskatchewan markets in this period would require another 286 acres of production.

Storage Requirements

For various reasons, it is unlikely that 100% of imports could be displaced by B.C. product. Some imports of these vegetables come into Canadian markets as fillers, topping off semi-trailer loads of other vegetables. Displacement of imports under these circumstances is difficult since the normal rules of competition do not apply. Similarly, B.C.'s chances of becoming totally self-sufficient in fresh topped carrots between November and March is hampered by quality problems. Difficulty in producing the sizes demanded is a problem hindering self-sufficiency in onions. A lack of producer interest in the production of parsnips prevents B.C. from becoming self-sufficient in that vegetable.

Given that 100% displacement of expected imports into the B.C., Alberta and Saskatchewan markets between November and March is unlikely to be attained, storage requirements will be lower than would otherwise be the case. The level of import displacement of each commodity is clearly difficult to estimate. For the moment it will be convenient to assume that 75% of imports into B.C. could be displaced and that one-third of imports into Alberta and Saskatchewan can be displaced by B.C. product. Displacing these levels of imports would require about 1,400 tons of refrigerated storage for yellow onions, and about 4,000 tons of CTH storage for cabbage, carrots, parsnips and rutabagas. In 1979, two storage facilities for cabbage were built by growers in Delta. One is an 800 ton "Filacell" unit, the other is a 150 ton refrigerated unit. These units reduce the storage shortfall for cabbage, carrots, rutabagas and parsnips to about 3,000 tons.

III. COSTS OF STORAGE

Review of General Requirements

The ideal storage conditions for onions are 0-5° C and 60-70% relative humidity. The ideal storage conditions for cabbage, carrots, rutabagas and parsnips are 0-1° C and 97-100% relative humidity. (Because parsnips and rutabagas represent only 8% of total storage opportunities, and because of their similarity to carrots they will be dropped from detailed discussion.)

i. Cabbage

Cabbage going into storage must be handled with great care to prevent product damage and to ensure that no damaged or rotten product is stored. The sooner that field heat is removed from the product, the better will be the storage results. Under ideal temperature and humidity, cabbage can be stored for 26 to 34 weeks (six to eight months). Culling losses on a monthly basis would probably be 2%, 4%, 7%, 12%, 18% and 25% in the sixth month. Dessication occurs at a rate of about 1% per month.

ii. Carrots

Carrots should be clean going into storage. Cleaning at the time of storage not only removes dirt and bacteria thus improving storage life, but reduces staining. It is unsatisfactory to clean later on as carrots stain easily and readily show skin damage. Because a pre-wash is important, hydro-cooling and a chlorine bubble-wash as a surface sterilant can easily be incorporated to further improve the condition of carrots going into storage. A rough cull of 20 to 30 percent is typical before storage. Dessication rates for carrots are about 1/2% per

month, with culling rates about the same as for cabbage. Carrots have been stored for 30 to 40 weeks (seven to ten months) with 25% cull rates.

Carrots and cabbage can be stored in tote bins. When product is stored in tote bins, capacity is about 120 tons per 1,000 square feet (given an 18 foot ceiling) after making allowance for aisles. If the facility can be tightly packed (no allowance for aisles) then capacity increases by about 10% to 130 tons per 1,000 square feet. Tote bins have a capacity of about 800 pounds each, so if aisles are left, 300 tote bins are required per 1,000 square feet. If no allowance is made for aisles, then 330 tote bins are required per 1,000 square feet. On average, with good care, tote bins can be expected to last eight to ten years. Forklifts are required to handle the tote bins and also are assured to last eight to ten years.

iii. Onions

Onions should ideally be rapidly brought to 0° C after curing. If they are to be stored longer than three months then a sprout inhibitor should be applied. Bulk storage is probably most economical as long as adequate forced air circulation is provided through the pile. Storage is possible for six to eight months to a 25% cull loss. Dessication rates are slight, and culling rates out of storage, by month, under ideal conditions would probably be 2% the first month, then 4%, 7%, 12%, 18% and 25% in the sixth month. Note that storage losses increase rapidly as the storage term lengthens. Growers indicate that 150 tons can be stored per 1,000 square feet with a depth of 15 feet. An elevator and a front end loader are required for moving the product in and out of storage.

Storage Construction Costs

The use of controlled temperature and humidity for vegetable storage requires sophisticated technology.

Location, climate, building structure, building size and building shape are a few of the factors influencing the cost of the complete storage unit. Each individual unit would have a different cost structure.

To obtain some estimates of capital costs of storage, local building contractors and storage equipment suppliers were approached. In providing cost estimates, these contractors and suppliers repeatedly emphasized that their estimates were approximate. Cost estimates were obtained for various building sizes. These structures would have 4 inch concrete floors, insulated panels on a steel frame, and have 18 to 24 foot ceilings. Various types of CTH and CT equipment were then added to these buildings. No major maintenance costs would be expected on the building or equipment during the first twenty years.

i. Cabbage Storage

Four sizes of cabbage storage were costed: 4,000, 6,000, 12,000 and 20,000 square feet. Capacities would be 500 tons, 800 tons, 1,400 tons and 2,400 tons respectively. No allowance for aisles was made in the two smaller units. Insulation factors of R18 for the walls and R25 for the roof were specified. Ranging from smallest to largest, the cost of the bare building would be $94,000 ($23.50 per square foot), $129,000 ($21.30 per square foot), $255,600 ($21.30 per square foot) and $406,000 ($20.30 per square foot). "Filacell" equipment costs, again ranging from the smallest to the largest units would be $55,000, $57,000, $68,000 and $91,000. This includes a pressure cooling capacity of 25 tons per day for the 4,000 and 6,000 square foot facilities, and a pressure cooling capacity in the 12,000 and 20,000 square foot units able to handle 50 tons per day. These cooling capacities suggest that it would take between 20 and 48 days to load the storage unit, depending upon the size of the unit. Staggered harvesting times would be required.

Tote bins for the storage of 500, 800, 1,400 and 2,400 tons will cost about $50,000, $75,000, $135,000 and $228,000 respectively (330 bins per 1,000 square feet for the two smaller units and 300 bins per 1,000 square feet for the two larger units valued at about $38 each). One forklift each would be required for the two small units, and two forklifts each would be required for the two larger units. Forklifts cost about $21,000 each. Total costs for the 500, 800, 1,400 and 2,400 ton cabbage facilities will therefore be approximately $220,000, $282,000, $470,000 and $767,000 respectively. If pressure cooling facilities are not included, then total costs will be about $209,000, $270,000, $456,000 and $749,000 respectively. Electric power costs would be about $100 per 1,000 square feet per month regardless of size. (See Table 2.)

ii. Carrot Storage

Carrots in storage require temperatures near 0° C and relative humidities near 97%. Carrots are completely compatible with cabbage. Since carrots need to be washed prior to storage, and can be cooled in the wash, pressure cooling facilities should not be required. We are therefore concerned with the costs of the basic building, the "Filacell" equipment, and the tote bins and forklifts.

Costs were estimated for units to contain 500, 800, 1,400 and 2,000 tons. These are exactly the same units as were estimated for cabbage storage, excluding the need for pressure cooling. Total costs for carrot storage can be taken from the cabbage costs, and ranging from the smallest to the largest units would be about $209,000, $270,600, $456,400 and $748,800. Electric power costs would be about $100 per 1,000 square feet per month regardless of unit size. (See Table 2.)

iii. Onion Storage

Onions can be bulk stored to a depth of 15 feet. This removes the need for tote bins and forklifts, but requires a ventilation system to ensure adequate air circulation through the pile. For equipment, an elevator and front-end loader are minor cost items, probably already owned by growers. For refrigeration equipment, temperature must be maintained near 0° C and relative humidities near 65%. This can be attained with a standard refrigeration unit combined with a condenser to remove moisture. Insulation requirements were reduced to R8 in the walls and R15 in the ceiling.

The cost of a 4,000 square foot building would be about $88,000 ($22.00 per square foot). A 6,000 square foot building would cost about $120,000 ($20.00 per square foot). Refrigeration equipment would be about $12,000 and $15,000 respectively. Total costs therefore, would be $100,000 for the 4,000 square foot unit, and $135,000 for the 6,000 square foot unit. Capacities for the two structures would be 600 and 900 tons respectively, and electric power costs would be about $100 per 1,000 square feet per month for both structures. (See Table 2.)

Comparing Construction Costs

The construction costs listed in the previous section are summarized in Table 2. Land costs were not included but will be discussed later in this chapter. About one acre of non-arable land would be required, which can range in value from $3,000 to $200,000 per acre.

To estimate annual operating costs based on Table 2, the following assumptions were made:

1. The building and cooling equipment will require a 25% down payment, which has an opportunity cost @ 11-1/2% over twenty years.

2. The building and cooling equipment can be 75% debt financed over twenty years @ 14% interest.

3. The forklifts and tote bins shall require a 25% down payment with an opportunity cost @ 13% over seven years.

4. The forklifts and tote bins can be 75% debt financed over seven years @ 16% interest.

5. Power costs will be about $100 per 1,000 square feet per month and the buildings will operate for about six months.

6. The salvage value of the assets at the end of their useful lives will be a percentage of their original cost: 50% and twenty years for the building, 25% and twenty years for the refrigeration equipment, 5% and seven years for the tote bins, and 25% and seven years for the forklifts.

Annual costs resulting from the construction and operation of the storage facilities specified in Table 2 are calculated and presented in Tables 3a, 3b and 3c.

TABLE 2

CAPITAL COSTS OF STORAGE WAREHOUSES

	500 Ton[1] Facility	800 Ton[2] Facility	1,400 Ton Facility	2,400 Ton Facility
Land	?	?	?	?
Basic Shell, R18, R25	94,000	129,000	225,000	406,000
Basic Shell R8, R15	88,000	120,000	-	-
Refrigeration Equipment	12,000	15,000	-	-
Filacell Equipment	44,000	45,600	54,400	72,800
Pressure-Cool Equipment	11,000	11,400	13,600	18,200
Tote Bins[3]	50,000	75,000	135,000	228,000
Forklifts[3]	21,000	21,000	42,000	42,000
Total Storage Investment:				
Cabbage	220,000	282,000	470,000	767,000
Carrots	209,000	270,600	456,400	748,800
Onions	100,000	135,000	-	-

1. 600 tons for bulk-stored onions.

2. 900 tons for bulk-stored onions.

3. Tote bins can be leased for about $6.75 per year each over seven years with a zero residual. A forklift lease under the same terms would cost about $5,250 per year. Forklift rental rates are about $700 per month.

Source: Approximate estimates provided by local builders and contractors.

TABLE 3a

ANNUAL COST OF CABBAGE STORAGE FACILITIES

Cost Item	500 Ton Facility	800 Ton Facility	1,400 Ton Facility	2,400 Ton Facility
Total Investment	$220,000	$282,000	$470,000	$767,000
Down Payment Required (25%)	55,000	70,500	117,500	191,750
Building and Equipment				
- 25% equity financing over 20 years @ 11½%	4,831	6,031	9,500	16,116
- 75% debt financing over 20 years @ 14%	16,872	21,062	33,179	56,280
Forklifts and Totebins				
- 25% equity financing over 7 years at 13%	4,013	5,427	10,005	15,262
- 75% debt financing over 7 years at 16%	13,185	17,828	32,870	50,141
Salvage Value of Assets Per Year	4,125	5,224	8,939	14,417
Annual Power Costs*	2,400	3,600	7,200	12,000
Total Costs				
- total/year	37,176	48,724	83,815	135,382
- total/ton/year	74.35	60.90	59.87	56.41
Cash Costs				
- total/year	32,457	42,490	73,249	118,421
- total/ton/year	64.91	53.11	52.32	49.34

*Estimated at $100/1,000 sq.ft./month for six months' operation.

TABLE 3b

ANNUAL COST OF CARROT STORAGE FACILITIES

Cost Item	500 Ton Facility	800 Ton Facility	1,400 Ton Facility	2,400 Ton Facility
Total Investment	$209,000	$270,600	$456,400	$748,800
Down Payment Required (25%)	52,250	67,650	114,100	187,200
Building and Equipment				
- 25% equity financing over 20 years @ 11½%	4,475	5,662	9,060	15,526
- 75% debt financing over 20 years @ 14%	15,627	19,772	31,639	54,219
Forklifts and Totebins				
- 25% equity financing over 7 years at 13%	4,013	5,427	10,005	15,262
- 75% debt financing over 7 years at 16%	13,185	17,828	32,870	50,141
Salvage Value of Assets Per Year	2,987	5,081	8,769	14,189
Annual Power Costs*	2,400	3,600	7,200	12,000
Total Costs				
- total/year	36,713	47,208	82,005	132,959
- total/ton/year	73.43	59.01	58.58	55.40
Cash Costs				
- total/year	31,212	41,200	71,709	116,360
- total/ton/year	62.42	51.50	51.22	48.48

*Estimated at $100/1,000 sq.ft./month for six months' operation.

TABLE 3c

ANNUAL COST OF ONION STORAGE FACILITIES

Cost Item	600 Ton Facility	900 Ton Facility
Total Investment	$100,000	$135,000
Down Payment Required (25%)	25,000	33,750
Building and Equipment		
- 25% equity financing over 20 years @ 11¼%	3,240	4,380
- 75% debt financing over 20 years @ 14%	11,320	15,290
Forklifts and Totebins		
- 25% equity financing over 7 years at 13%	0	0
- 75% debt financing over 7 years at 16%	0	0
Salvage Value of Assets Per Year	2,350	3,190
Annual Power Costs*	2,400	3,600
Total Costs		
- total/year	14,610	20,080
- total/ton/year	24.35	22.31
Cash Costs		
- total/year	13,720	18,890
- total/ton/year	22.86	20.98

*Estimated at $100/1,000 sq.ft./month for six months' operation.

i. Cabbage

Annual costs were calculated for four sizes of cabbage storage: 500 ton, 800 ton, 1,400 ton and 2,400 ton. Assuming purchase of all assets, the total capital expenditure for these units would be $220,000, $282,000, $470,000 and $767,000 respectively. The down payments required were assumed to be 25% of the total capital costs, or about $55,000, $70,500, $117,500 and $191,750. The total costs per year (including interest on the down payment investment and an annual salvage value allowance) would be $37,176, $48,724, $83,815 and $135,382 from the smallest to the largest units. Cash costs per ton however (excluding interest on investment on the down payment and no annual salvage value allowance) were $64.91, $53.11, $52.32 and $49.34. Economies of size can be noticed as one moves to larger storage units. Probably a reasonable average value for the annual capital cash cost of cabbage storage is $52 per ton. (See Table 3a.)

ii. Carrots

Similar to cabbage, carrot storage capital costs were calculated for 500 ton, 800 ton, 1,400 ton and 2,400 ton storage units. From smallest to largest, the total capital expenditure would be $209,000, $270,600, $456,400 and $748,800. Down payment requirements at 25% of the capital investment would be $52,250, $67,650, $114,100 and $187,200. Cash costs per ton however (excluding interest on investment on the down payment and an annual salvage value allowance) would be $62.42, $51.50, $51.22 and $48.48. As with cabbage, economies of size exist as one moves to larger storage units. Probably a reasonable average value for the annual capital cash cost is $51 per ton. (See Table 3b.)

iia. In-Ground Storage of Carrots

This technique is currently being researched by the Agriculture Canada Agassiz Research Station and is based on practises in Europe. The crop is late-seeded to mature about the 1st of November. At that time the rows are covered with six inches of loose straw and covered with plastic. Baby carrots in excellent condition were harvested on February 6, 1980, with results on larger carrots still to come. The cost of plastic, which would run at least $500 per acre and the cost of straw which would run about $2,000 per acre (a total cost of about $190 per ton of product) makes this method prohibitively expensive. A more economical covering will have to be found before 'in-ground' storage becomes viable.

iii. Onions

Two sizes of bulk storage for onions were costed: 600 ton and 900 ton. The total capital investment would be $100,000 and $135,000 respectively. Down payment levels at 25% determine a requirement for $25,000 and $33,750 up front. The total annual cost of these units (including interest on investment on the down payment, and an annual salvage value allowance) would be $14,610 for the 600 ton unit and $20,080 for the 900 ton unit. Annual cash costs per ton however (excluding interest on investment on the down payment and taking no annual salvage value allowance) would be $22.86 and $20.98 for the 600 and 900 ton units respectively. Again, economies of size are evident in moving to larger storage units. Probably a reasonable average annual cash cost per ton would be about $21.50 per ton. (See Table 3c.)

Product Handling Costs

Once costs are estimated for the empty structure, consideration must be given to the costs of product handling. Table 4 summarizes these costs for cabbage, carrots and onions. Parsnips and rutabagas would incur approximately the same cost as carrots.

i. Cabbage

Under usual marketing procedures, cabbage are trimmed and packed in cartons in the field for delivery to the B.C. Coast Vegetable Co-op (BCCVC). According to grower experience, costs for that work are about the same as the cost of preparing cabbage for storage (trimming, an initial cull and placing the cabbage into tote bins). After storage, but prior to sending the product to the BCCVC, the cabbage must be re-trimmed and placed into cartons.

In 1980, growers reported post-storage trimming and packing costs of between $40 and $100 per ton, with cull rates of 25% and greater. If cull rates of less than 25% can be attained, then $50 per ton becomes a reasonable estimate of the cost of post-storage trimming. (The lower the cull rate over the storage life of the product, then the lower should be the post-storage trimming costs.) The additional charges accruing to stored cabbage will be $4 per ton for movement of the tote bins from field into storage, $2 per ton for movement of the tote bins out of storage (based on a rate of ten tons per forklift per hour), and $50 per ton for post-storage trimming and culling to total $56 per ton. (See Table 4.)

An alternative to post-storage trimming and culling being conducted by the growers would be to send the cabbage directly to a central trimming line. To estimate these costs, it shall be

TABLE 4

ESTIMATED HANDLING COSTS OF STORED PRODUCT

($/ton)

Cost Item	Commodity		
	Cabbage	Carrots	Onions
Field to Cull Area	N/A/C*	N/A/C*	N/A/C*
Pre-Storage Cull	N/A/C*	27	5.60**
Haul to Storage	2	2	3
Into Storage	2	2	
Out of Storage	2	2	2
Post Storage Cull	50	N/A/C*	N/A/C*
To BCCVC	N/A/C*	N/A/C*	N/A/C*
Final Cull and Pack	N/A/C*	N/A/C*	N/A/C*
Total Storage Handling	56***	33	10.60

*N/A/C: No additional cost associated with storage.

**Includes sprout inhibitor application.

***An estimated $18 saving could be accomplished if final culling and packing were done on a central line (see text). Depending upon the location of the central grading line and the storage facilities, additional product transportation costs may be incurred.

Source:

1. B.C. Ministry of Agriculture, Farm Economics Branch, Producers' Consensus of Costs and Returns Series.

2. Estimates from growers and other industry members.

assumed that cabbage trimming and culling is similar to cauliflower trimming and culling. The Cloverdale Lettuce Co-op operates a cauliflower trimming and cello-rapping line which under full operation incurs costs of about $ .80 per 12 cauliflower heads (one carton). About half of that cost is incurred in trimming and culling, and about half in chlorinating and cello-wrapping the cauliflower. Therefore, if cabbage can be trimmed and culled at least as fast as cauliflower, costs will be about $ .40 per 12 cabbage heads, or about $ .80 per carton (assuming an average weight of 2 pounds per head of cabbage). Costs per ton for central trimming and culling and packing of the cabbage will therefore be about $32 per ton. This is $18 per ton less than the grower expense of about $50 per ton.

ii. Carrots

Carrots are normally brought directly to the BCCVC at harvest where handling, washing, grading and sales occur. The 1979 season charges for these services will be increased by $10 per ton during the 1980 season due to unionization of the BCCVC. For example, $17 per ton was charged by the BCCVC for the washing, grading and handling of the carrots in 1979; this cost will increase to $27 per ton in 1980. Carrots destined for storage must undergo a pre-wash and cull, which requires that this $27 per ton charge be incurred as well as $4 per ton for movement into storage, and $2 per ton for movement out of storage to total $33 per ton in additional handling costs from product storage.

iii. Onions

Additional costs for storage of onions begins with the application of a sprout inhibitor in the field. B.C. Ministry of Agriculture cost

estimates place this cost at $11 per acre, or on a yield of 18 tons, about $ .60 per ton (applied with last insecticide application). Bulk storage and handling, according to grower experience, costs about $5 per ton for an initial cull, $3 per ton for movement into storage and $2 per ton for movement out of storage. Total handling costs for storage onions are therefore about $10.60 per ton.

Total Storage Costs Before Land Costs

Total storage costs are of course the sum of amortized capital costs and annual handling costs. For cabbage, an estimated total annual cash cost would be about $108 per ton. Carrot storage would cost about $84 per ton. Onion storage would be about $32 per ton.

The Cost of Land

About one acre of non-arable land would be required for each storage facility. If this land is located on the farm, its value could be as low as $3,000 per acre. If this land is located in an industrial area, its value could be as high as $200,000 per acre.

A reasonable proxy for land costs that would include both opportunity cost (interest on investment) and out-of-pocket costs requires assuming a 14% interest rate on a 25 year term. Under these conditions the annual land cost will range from $440 to almost $30,000 per year. For the 500 ton storage unit this could range from $1 to $60 per ton. For the 2400 ton storage unit the land cost could range from $ .20 to $12.50 per ton. Clearly the storage unit should be placed on low valued land in order to reduce total costs.

IV. PAYING FOR STORAGE

The cost of storage must be recovered from the market. Traditionally, product prices for cabbage, carrots and onions have been higher in the storage season than during the regular production season.

Historic Prices

Weekly wholesale and FOB prices for cabbage, carrots and medium yellow onions on the Vancouver market were obtained for 1973 to 1979. Seasonal averages of weekly high and low wholesale prices are presented in Table 5. Wholesale prices for cabbage, carrots and yellow onions have typically increased by 50% during the period January to March over prices during September to November. Also, the further one moves into the storage season, the greater the increase in price. However, January to March prices showed greater fluctuation than September to November prices, implying a higher level of price risk during the storage period*.

To obtain a price meaningful to growers, an attempt was made to subtract the wholesaler markup from the wholesale prices. On average, for cabbage, carrots and yellow onions, wholesale margins were $2 per 50 pounds during the September-November period. During January through February, the wholesale margin increased to at least $3 per 50 pounds for cabbage and carrots, and for onions to $2.50 per 50 pounds (within data limits; see Table 6 and Appendix B). By subtracting the wholesale margin, one arrives at the FOB price, or the price that growers receive before costs incurred by the B.C. Coast Vegetable Co-op. Hence to determine FOB prices from wholesale prices requires subtracting the appropriate wholesale margin in Table 6 from the appropriate wholesale price in Table 5.

*See Appendix B for the data indicating fluctuation of prices.

TABLE 5

AVERAGE WHOLESALE PRICES OF CABBAGE, CARROTS AND ONIONS ON THE VANCOUVER MARKET

1973-1979[1]
December 31, 1979 Dollars Per 50 Pounds

Market Period (weeks)	Green Cabbage	Topped Carrots	Medium Yellow Onions
	By Market Period		
September-November (36-48)	7.94	7.62	7.23
December (49-52)	8.29	9.12	7.56
January-March (1-13)	12.05	11.83	9.77
	By Month		
September (36-39)	8.20	7.91	7.89
October (40-43)	7.89	7.28	7.11
November (44-48)	7.75	7.65	6.80
December (49-52)	8.29	9.12	7.21
January (1-5)	10.60	11.34	8.67
February (6-9)	12.66	12.41	9.57
March (10-13)	13.27	11.86	11.35

1. The average of weekly high and low wholesale price quotations inflated to 1979 dollars and then averaged over the seven years 1973 to 1979.

Source: Agriculture Canada, Marketing Services Division, Food Production and Marketing Branch, Fresh Fruit and Vegetable and Honey Crop and Market Report, (Weekly), 1973-79.

TABLE 6

AVERAGE DOMESTIC FOB TO WHOLESALE PRICE MARKUP ON CABBAGE, CARROTS AND ONIONS ON THE VANCOUVER MARKET

1973-1979[1]
$/50 LBS

Market Period (weeks)	Green Cabbage	Topped Carrots	Medium Yellow Onions
	By Market Period		
September-November (36-48)	2.09	2.07	2.18[2]
December (49-52)	2.28	3.19	2.65
January-February (1-9)	3.15	4.33	Not Available
	By Month		
September (36-39)	2.22	2.14	Not Available
October (40-43)	2.14	1.88	2.18[2]
November (44-48)	1.95	2.17	
December (49-52)	2.28	3.19	2.65
January (1-5)	3.03	4.38	2.57
February (6-9)	3.48	4.20	Not Available
March (10-13)	No Data Available		

1. Average of high and low wholesale and FOB price quotations inflated to 1979 dollars, and averaged over the years 1973 to 1979.

2. October and November only.

Source: Derived from Agriculture Canada, Marketing Services Division, Food Production and Marketing Branch, Fresh Fruit and Vegetable and Honey Crop and Market Report, (Weekly), 1973-79.

Wholesaler margins were calculated as the average difference between the weekly average wholesale price of all product on the market and the weekly average FOB price of domestic product on the market. It is not clear why the wholesale margin on domestic product increases at the end of the regular season. One possibility is reduced wholesaler competition in selling that product during the early winter. Another possibility is that wholesalers take a larger margin on imported product as compared to domestic product, perhaps because of increased order costs (imported product sales dominate the market in January and February). A further possibility could be that the wholesale margin remains constant as the FOB cost of imported product increases. A final possibility is that the quality of B.C. product declines relative to the quality of imported product, and hence commands a lower price. If any or all of these conditions occur, then the wholesale price will rise relative to the domestic FOB price. This means that increased supplies of good quality domestic product, combined with an aggressive pricing policy by the BCCVC, may be able to capture additional returns for growers. Those additional returns should certainly be no lower than regular season returns (when B.C. product dominates the market), and may be as high as the increase in the wholesale markup: $1.00/50lbs for cabbage, $2.00/50lbs for carrots and $ .50/50lbs for onions.

Accounting for Price Risk

Using averages of several past years to try to predict future prices carries the implicit assumption that past market conditions will continue. Another way of stating this is to say that in the past seven years, price variations due to overproduction, crop failure, etc., have occurred to provide a group of price data that reflects with appropriate frequency all likely future events. We will therefore use that historic price data to estimate prices as well as price risk in the near future. This is much better than basing investment decisions solely on last year's prices, or

even on an average of past prices. An excellent example involves cabbage prices in January and February of 1980. Tables 5 and 6 suggest an average FOB price of approximately $305 per ton for January, and $365 per ton for February. Actual FOB prices through the B.C. Coast Vegetable Co-op have been about $220 per ton. Decisions based on average price strength thus fail to reflect variability of the outcome.

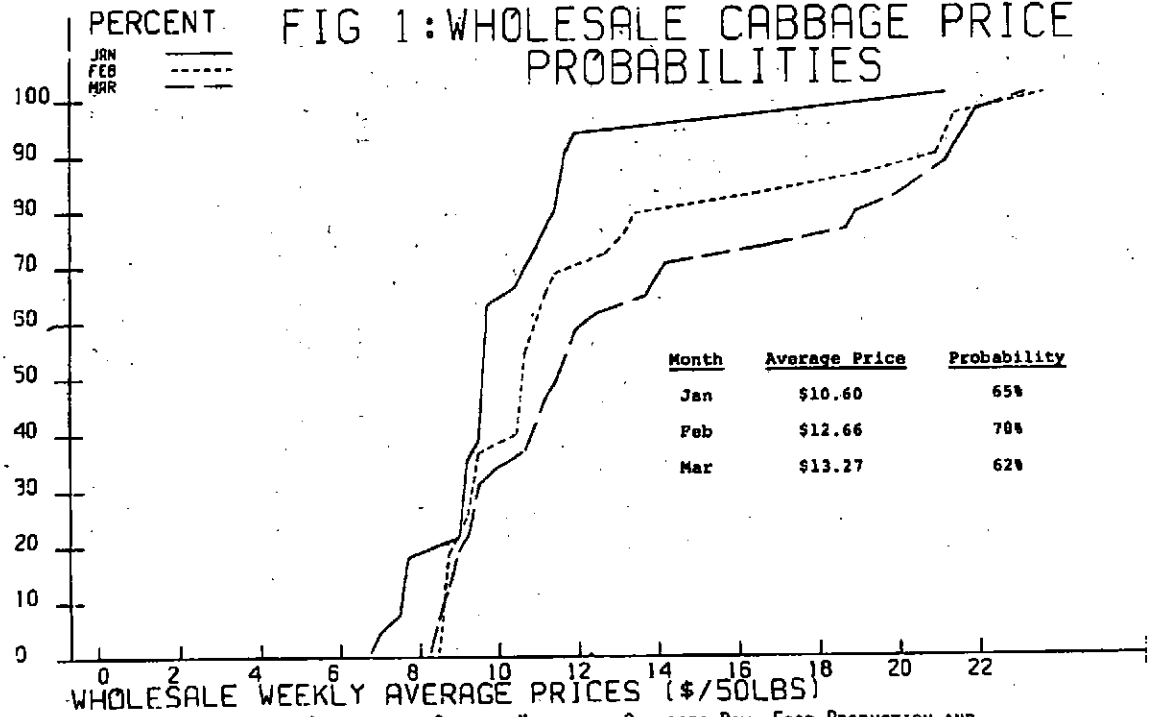
To improve the price prediction available from average prices, price probability distributions were constructed. Figures 1, 2 and 3 show the likelihood of prices below a specified level for cabbage, carrots and yellow onions respectively, by month during January to March. Each figure also shows the average price for each month. In the case of February cabbage, the average price is $12.66 per carton wholesale and that price corresponds to about a 78% probability that prices will be less than $12.66 per carton. This means that during the last seven years, 78% of the time wholesale prices for cabbage in February were less than $12.66 per carton, but after accounting for how often each price occurred, $12.66 per carton is the expected average price. The value of Figures 1, 2 and 3 is that an individual can look at his overall financial position and decide whether or not he can afford to take the risks indicated. If the decision is made to proceed with storage construction, then contingency plans may be needed for the event of low prices, (e.g. a reliable line of credit).

In the case of current February cabbage prices of $220 per ton FOB (equivalent to about $8.50 per 50 pounds wholesale), Figure 1 shows a probability of almost zero for the occurrence of a price that low. The conclusion is that cabbage prices in 1980 are among the lowest of the last seven years.

Competing Levels of Production

When one is considering an investment such as storage construction, past prices can provide part of the

FIG 1: WHOLESALE CABBAGE PRICE PROBABILITIES



Month	Average Price	Probability
Jan	$10.60	65%
Feb	$12.66	70%
Mar	$13.27	62%

SOURCE: DERIVED FROM AGRICULTURE CANADA, MARKETING SERVICES DIV. FOOD PRODUCTION AND MARKETING BRANCH, FRESH FRUIT AND VEGETABLE AND HONEY CROP AND MARKET REPORTS WEEKLY, 1973-1980.

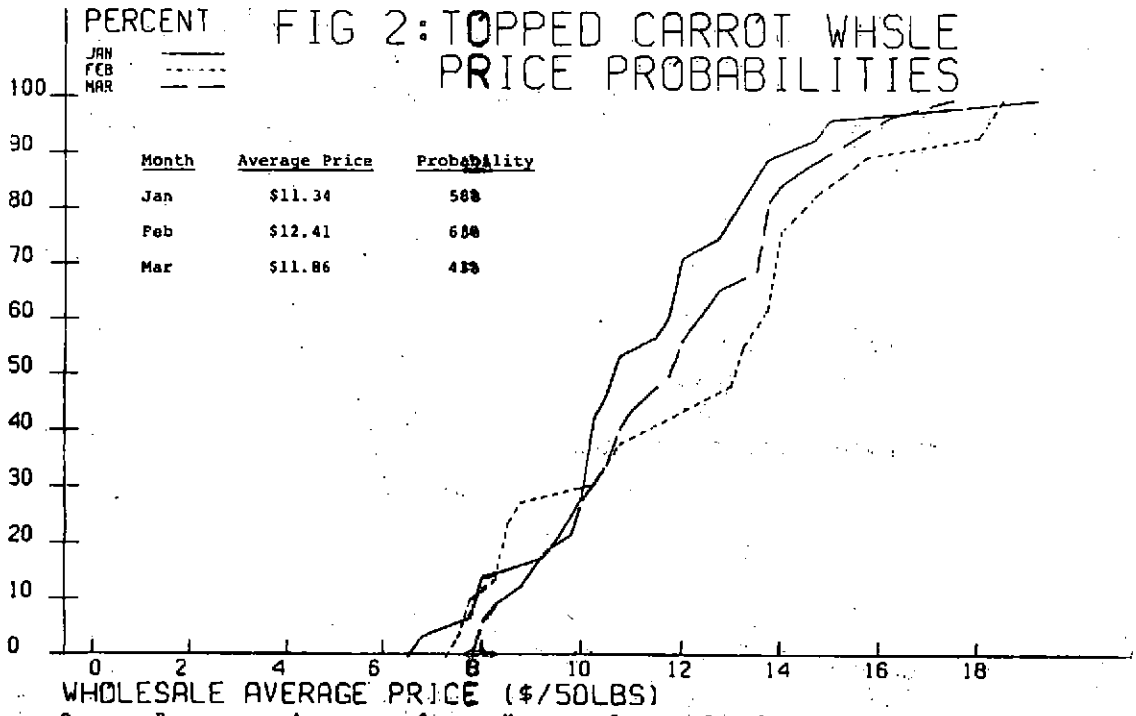


FIG 2: TOPPED CARROT WHSLE PRICE PROBABILITIES

Month	Average Price	Probability
Jan	$11.34	58%
Feb	$12.41	68%
Mar	$11.86	43%

SOURCE: DERIVED FROM AGRICULTURE CANADA, MARKETING SERVICES DIV. FOOD PRODUCTION AND MARKETING BRANCH, FRESH FRUIT AND VEGETABLE AND HONEY CROP AND MARKET REPORTS WEEKLY, 1973-1980.

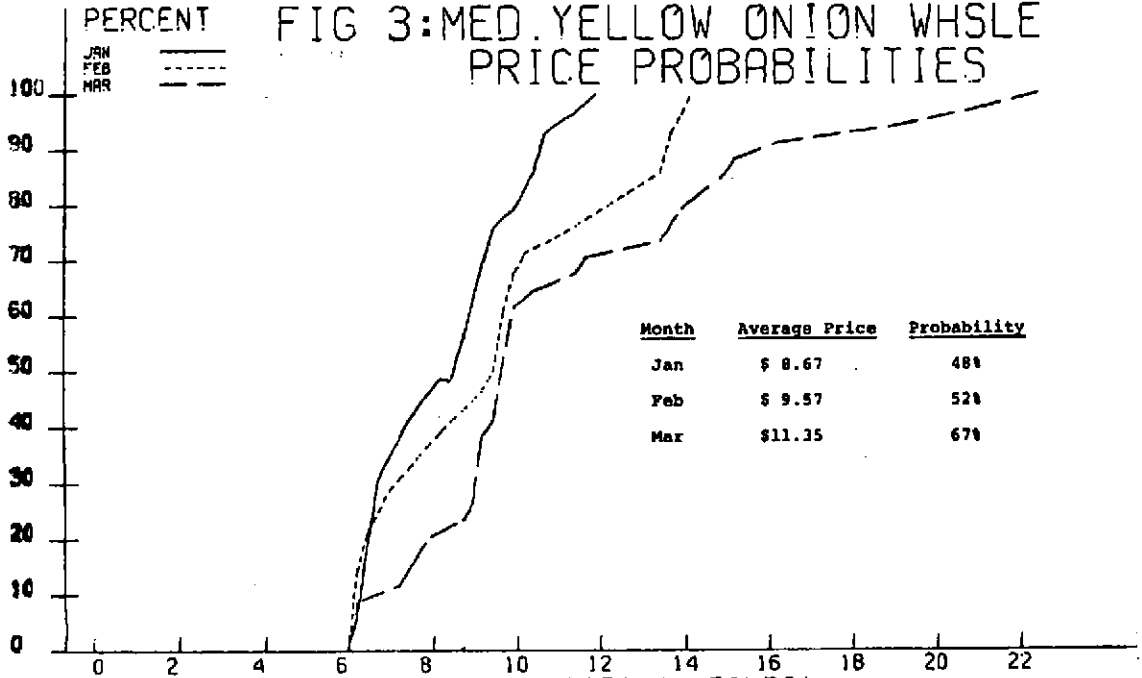


FIG 3: MED. YELLOW ONION WHSLE PRICE PROBABILITIES

Month	Average Price	Probability
Jan	$ 8.67	48%
Feb	$ 9.57	52%
Mar	$11.35	67%

SOURCE: DERIVED FROM AGRICULTURE CANADA, MARKETING SERVICES DIV. FOOD PRODUCTION AND MARKETING BRANCH, FRESH FRUIT AND VEGETABLE AND HONEY CROP AND MARKET REPORTS WEEKLY, 1973-1980.

analysis needed for estimating future returns. One should also, however, look at the levels of production and trends in production in the competing areas of supply. Tables 7a, 7b and 7c show the levels of planting and production by season from 1974 to 1979 by major U.S. competitor for cabbage, carrots and onions respectively.

For cabbage, one can see that Texas and California have increased their planted acres and production of winter cabbage. Notice that Texas only managed to harvest about 40% of its 1979 winter cabbage crop. The low cabbage prices of 1980 are probably due to successful harvesting of a large 1980 crop. (See Table 7a.)

Winter carrot production in California has remained almost constant over the last six years. Texas growers however, have been increasing acreage by about 10% per year since 1977. Whatever affected the 1979 Texas cabbage crop (presumably adverse weather) also reduced the carrot crop that year by about 35%. (See Table 7b.)

The acreage of summer non-storage onions in Texas and Washington has increased by 10% and 30% respectively during 1974 to 1979. In 1978 and 1979, despite increased acreage, Texas onion production declined. Washington maintained yields on summer non-storage onions, and also increased production of summer onions for storage. The production of storage onions in Washington increased 35% between 1978 and 1979. (See Table 7c.)

Increased acreages and production of winter vegetables in the U.S. supply areas are likely to result in lower prices both in the U.S. and Canada during the winter months of 1980 and in subsequent years. Further, there is renewed interest in completion of the Columbia Irrigation Project in Washington where 300,000 additional acres could be in production by the year 2000. These observations on production levels and increasing U.S. acreages add uncertainty to price projections.

TABLE 7a

FRESH MARKET AND PROCESSING CABBAGE BY COMPETING AREA OF PRODUCTION, 1974-79

	Winter			Spring			Summer			Fall		
	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt
California												
1974	3,700	3,700	814	3,000	3,000	630	1,500	1,500	383	1,700	1,700	374
1975	2,600	2,600	533	3,300	3,300	693	1,600	1,600	400	1,700	1,700	425
1976	2,400	2,400	504	2,300	2,300	460	1,500	1,500	360	1,800	1,800	432
1977	2,200	2,200	517	2,300	2,300	518	1,400	1,400	371	1,600	1,600	432
1978	2,300	2,300	518	2,000	2,000	440	1,800	1,800	405	1,700	1,700	391
1979	2,900	2,900	667	2,200	2,200	517	1,500	1,500	360	1,700	1,700	417
Texas												
1974	11,500	9,500	1,710	3,700	3,600	846				5,200	4,800	1,032
1975	9,000	8,700	1,392	3,100	3,000	690				5,700	5,400	1,026
1976	10,500	10,000	1,800	4,000	3,600	774				6,000	5,500	1,045
1977	6,500	6,200	1,736	3,300	3,200	992				5,900	5,500	1,100
1978	9,600	9,500	2,660	4,600	4,400	1,320				7,100	6,200	961
1979	11,100	4,300	1,011	4,300	4,100	1,148				5,800	5,500	990
Washington												
1974							1,200	1,100	264			
1975							1,400	1,300	293			
1976							1,100	1,100	250			
1977							770	740	140			
1978							880	780	157			
1979							950	850	162			

Source: U.S. Department of Agriculture, Crop Reporting Board, Statistical Reporting Service, Vegetables Annual Summary, Acreage, Yield, Production and Value, 1976-79.

TABLE 7b

FRESH MARKET AND PROCESSING CARROTS BY COMPETING AREA OF PRODUCTION, 1974-79

	Winter			Spring			Summer			Fall		
	Acres Planted	Acres Harvested	Production '000 cwt	Acres Planted	Acres Harvested	Production '000 cwt	Acres Planted	Acres Harvested	Production '000 cwt	Acres Planted	Acres Harvested	Production '000 cwt
California												
1974	10,900	10,900	3,449	10,200	10,200	3,477	6,400	6,400	2,272	6,800	6,800	3,308
1975	8,500	8,500	2,267	10,000	10,000	2,880	7,200	7,200	2,628	7,400	7,400	2,111
1976	9,700	9,300	2,575	10,900	10,500	3,125	6,300	6,300	1,890	7,500	7,500	2,510
1977	8,100	8,100	2,247	10,600	10,600	2,651	6,800	6,800	2,346	7,500	7,500	2,090
1978	7,900	7,900	2,160	9,900	9,900	2,591	6,700	6,700	1,642	8,100	8,100	2,143
1979	8,400	8,400	2,316	12,100	12,100	3,201	7,000	7,000	2,310	9,500	9,500	2,490
Texas												
1974	12,000	10,600	1,537	5,500	5,100	765	900	900	189	3,000	2,700	414
1975	9,500	9,000	1,350	3,900	3,600	612	900	800	216	4,500	4,200	654
1976	11,500	10,500	1,575	5,700	5,300	636	750	700	126	3,800	3,600	520
1977	8,800	8,000	1,120	3,400	3,200	592	1,100	800	100	2,300	2,200	341
1978	9,600	9,200	1,794	5,000	4,700	611	700	500	90	4,100	3,400	612
1979	10,000	9,000	1,170	5,200	2,700	338	900	600	60	4,200	3,800	608
Washington												
1974							1,100	1,000	390	2,400	2,300	1,070
1975							700	600	192	2,100	2,000	930
1976							750	650	228	2,900	2,800	1,246
1977							1,100	1,000	435	4,200	4,000	1,900
1978							1,100	1,000	420	3,700	3,500	1,400
1979							1,100	800	308	3,800	3,700	1,610

Source: U.S. Department of Agriculture, Crop Reporting Board, Statistical Reporting Service, Vegetables Annual Summary, Acreage, Yield, Production and Value, 1976-79.

TABLE 7c

FRESH MARKET AND PROCESSING ONIONS
BY COMPETING AREA OF PRODUCTION, 1974-79

	Spring			Summer					
				Non-Storage			Storage		
	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt	Acres Planted	Acres Harv-ested	Produc-tion '000 cwt
Calif.									
1974	5,400	5,400	1,809						
1975	4,600	4,600	1,587						
1976	6,400	5,900	1,652			Primarily			
1977	5,700	5,700	1,967			Processing			
1978	5,400	5,300	1,590						
1979	5,600	5,600	1,904						
Texas									
1974	21,500	21,000	3,570	6,300	6,100	1,586			
1975	18,000	17,000	2,975	5,600	5,200	1,404			
1976	25,000	24,000	4,800	7,000	5,600	1,980			
1977	17,800	16,900	2,789	6,900	6,800	1,870			
1978	25,800	22,300	3,345	8,100	7,700	1,502			
1979	24,500	21,900	3,504	8,200	7,600	1,482			
Wash.									
1974				600	500	200	1,700	1,600	640
1975				550	500	190	1,600	1,500	600
1976				600	550	209	1,900	1,800	720
1977				650	600	204	2,800	2,700	1,107
1978				850	800	304	3,200	3,100	1,178
1979				800	750	278	4,000	3,900	1,599
Oregon									
1974							7,700	7,500	3,576
1975							7,700	7,600	3,567
1976							8,200	8,000	4,341
1977							9,200	8,700	4,287
1978							9,600	9,300	4,187
1979							9,600	9,500	4,776

Source: U.S. Department of Agriculture, Crop Reporting Board, Statistical Reporting Service, Vegetables Annual Summary, Acreage, Yield, Production and Value, 1976-79.

Transportation, Exchange Rates and Tariffs

Due to rising fuel costs, transportation rates across the continent are rapidly increasing. Diesel fuel is currently in the neighborhood of $1 per gallon. Reefer trucks fully loaded attain no more than 5 miles per gallon. Fuel costs are therefore approximately $60 to bring a truckload lot of produce from Washington, about $350 from California and about $700 from Texas. Since trucks normally carry about 21 tons, the fuel cost from Washington is about $3 per ton, from California about $16 per ton, and from Texas about $32 per ton. Some sources have predicted a 50% increase in fuel costs during the summer of 1980. If fuel costs do increase by 50%, then the transportation factor could increase price protection to $5 per ton on product coming from Washington, to $25 per ton on product coming from California, and to $50 per ton on product coming from Texas.

The possibility of increased fuel costs offering increased price protection assumes that no major changes will occur in the current transportation system. Currently however, the U.S. Congress appointed, "Rural Transportation Advisory Task Force" is recommending the following:

- Incentives to encourage States to increase truckload limits to 80,000 pounds and length limits to 65 feet on interstate and other major highways, and incentives to States trying to resolve varying State regulations;

- That the Secretary of Agriculture be given authority to develop and regulate standard contracts of haul for trucking fresh fruits and vegetables;

- Incentives for improvement of railroad rolling stock and improvement of branch lines.

If these recommendations are implemented, B.C.'s transportation protection will probably be reduced.

In recent years, exchange on the Canadian dollar has offered about 15% protection against imported product. Investors in storage should be aware that the current level of protection provided by the Canadian dollar may change substantially. The average prices and price risks indicated earlier in this section already include the exchange rate effect of the past seven years. Not until 1977 did the Canadian dollar provide any significant price protection. From 1973 to 1977, the U.S. and Canadian dollars were always within 3% of each other.

Current tariff rates on produce entering Canada from the U.S. are about $30 per ton of cabbage, $10 per ton of carrots and $30 per ton of onions. Cabbage tariffs end in mid-February, carrot tariffs in mid-March, while onion tariffs apply over the entire storage period. The effects of these tariffs were included in the price analysis. An alternative tariff system based on past price averages has been proposed but has received little grower support. The proposed alternative tariff would be flexible. If local prices dropped to less than 85% of the last three years' average, or to less than 90% of the last five years' average, a tariff would automatically come into effect to make up the difference. The advantage of this type of tariff scheme is that growers would have a solid floor price on which to make planning decisions.

To summarize, transportation fuel costs, current exchange rates, and current tariffs offer the following approximate levels of price protection dependent upon product origin, time of sale, and the level of the Canadian dollar:

	Cabbage	Carrots	Onions
Estimates of Fuel Cost Protection	$16-50/ton	$16-50/ton	$3-50/ton
Tariff Protection	$0-30/ton	$0-10/ton	$30/ton
Current Exchange Rate Protection	$30/ton	$30/ton	$30/ton
TOTAL	$46-110/ton	$46-90/ton	$63-110/ton

Operating at the Margin

So far we have treated storage construction as a "one shot" investment separate from other parts of the farm. It may be, however that for some growers the construction of storage can increase total returns by using "slack" resources or by reducing the average cost of production.

For example, suppose a grower currently producing 20 acres of cabbage (14 tons per acre) at a cost of $170 per ton could expand to 30 acres and reduce costs to $160 per ton. A small storage facility to handle the extra 140 tons of production could be built, and the result would be that even before considering the costs and returns from stored cabbage, the grower has earned (saved) $10 per ton on his existing 20 acres of production. Although benefits such as this will be unique to individual operations, storage construction

may have benefits beyond the costs and returns from the storage facility alone.

Grower Experiences

In 1979, two cabbage storage warehouses were built in the Delta area for storage of the 1979 crop. One is an 800 ton wood frame "Filacell" unit, the other a 150 ton wood frame refrigerated unit. Both began storing Houston-Evergreen cabbage on November 1, 1979. To mid-February, 1980, both growers were experiencing cull losses of 25% and greater. Because considerable trimming is required, colour quality is low. It is widely considered that cull rates of 25% represent the break even point in vegetable storage. The primary reasons for these high levels of losses were reported to be the initial quality of the stored product, system overloading, and trouble with compressors, thermostats and defrosting equipment. One grower declares that if he knew then what he knows now, the storage would not have been built. Due to high Texas cabbage production, local cabbage prices have been depressed to about $220 per ton FOB. The combination of high storage losses with unexpectedly low prices has threatened the viability of these storage projects. On the other hand, a Vancouver Island grower who has been storing cabbage for several years indicated that the storage operation had been profitable.

Off-Season Utilization of Storage

Storage facilities built primarily to store cabbage, carrots and yellow onions will only be filled to capacity for a short period toward the end of harvest each year. From mid-December until late September, some capacity should be available for storage of other products. Use of the facility in the off-season to store other product spreads the fixed costs, thereby reducing the cost of storing the vegetables.

On the basis of the revenue generated by off-season storage of other products, in another CTH facility in

the Lower Mainland, annual revenue of about $1.20 per square foot might be expected. This appears to be a conservative projection. Operating costs over the six months the facility would otherwise be shut down, April through September, would probably be about $ .60 per square foot. This leaves a profit of $ .60 per square foot from off-season utilization, reducing annual charges which have to be paid from vegetable storage profits. If 120 tons of vegetables can be stored per 1,000 square feet, the cost of vegetable storage could be reduced by about $5 per ton through off-season utilization.

Government Assistance for Storage Construction

Two government programs exist which may be able to provide financial assistance: the Federal government's Fruit and Vegetable Storage Construction Financial Assistance (FVSCFA) Program and the Agriculture and Rural Development Subsidiary Agreement (ARDSA).

The FVSCFA program, begun in 1973, provides assistance to build qualifying structures of one-third of the total cost of construction to a maximum payment of $500,000. Handling and grading equipment, design costs, land costs, etc., can be included in the total costs. To qualify for assistance, a minimum of three partners must be involved, none of which can own more than 40% of the structure. Unfortunately, the future of this program is in doubt. It may be terminated before assistance can be obtained.

Even if the FVSCFA program is terminated, construction assistance for qualifying structures may be available from ARDSA. ARDSA, a development agreement jointly funded by the Federal and B.C. governments, will continue at least until July 31, 1982. ARDSA provides only enough funds so that viable projects which would otherwise not be undertaken will proceed. ARDSA funds up to 25% of the eligible costs of new qualifying projects, to a maximum of $750,000. Eligible costs include plant and equipment costs, but not land

costs. Tote bins and fork lifts qualify. Additional assistance is available if new jobs are created up to a maximum of $5,000 per man year equivalent. To qualify for assistance, no one producer can use more than 25% of the facility for storage of his own crop. Generally, at least four or five producers must be involved in an assisted project.

Both programs are clearly designed to favour assistance to storage projects of a co-operative nature, either in the form of a marketing co-operative or a group of producers. Storage projects owned by one or two producers qualify only if a large share of capacity is used to store product of third parties. For further information on these programs contact the B.C. Ministry of Agriculture.

V. PROFITABILITY OF VEGETABLE STORAGE

Estimates have been made of both the capital and operating costs of storages. Cost of production estimates were reviewed in the individual commodity reports. These data, combined with projected prices and other market considerations can now be used to estimate the profitability of vegetable storage. Throughout the following price analysis it is assumed that stored product will be able to match the quality of imported product and hence command an equivalent price.

Cabbage

i. Breaking Even on Price

The total cost of cabbage production according to recent studies lies between $78 and $170 per ton. Wholesale market prices for local product have traditionally averaged $7.94 per 50 pounds ($318 per ton). Four estimates of annual storage cash costs per ton based on capacities of 500 tons, 800 tons, 1,400 tons and 2,400 tons have been made at $64.91, $53.11, $52.32 and $49.34 respectively. Earlier, $52 per ton was selected as a reasonable average among those holding cost estimates. Handling costs for stored cabbage were estimated at $56 per ton if done on farms, or $38 per ton if done through a central line. On-farm handling will be considered the most prevalent and most likely to occur in the immediate future. The conclusion available from this information is that stored cabbage must earn a margin of $56 + $52 = $108 per ton in order to be at least as profitable as regular season cabbage production.

Normal cull losses for November cabbage coming from storage in January, February and March have been estimated to be 7%, 12% and 18% respectively.

Dessication losses occur at a rate of about 1% per month. Total losses out of storage for January, February and March will therefore be about 10%, 16% and 23% respectively. These losses must be included in the storage margin. Hence, January cabbage will require a minimum margin of $108 plus 10%, or about $119 per ton. February cabbage will require $125 per ton and March cabbage $133 per ton. These storage margins must be converted to wholesale prices per 50 pounds to be used with Figure 1. To accomplish this we add the storage margins to the regular season wholesale price of $7.94 per 50 pounds. The result is that a wholesale price of about $10.92 per 50 pounds is required for January, $11.07 for February and $11.27 for March in order to maintain returns at levels comparable to the regular season.

Figure 1 shows a 72% probability of not receiving a wholesale price of at least $10.92 per carton for January, a 58% probability of not receiving a price of at least $11.07 per carton for February, and a 48% probability of not receiving a wholesale price of at least $11.27 per carton for March. The average expected prices per carton by month from Figure 1 however, were $10.60, $12.66 and $13.27 respectively. Hence we can say that the following profitabilities exist for storage cabbage.

January Cabbage Market: On average, growers will lose $0.32 per 50 pounds ($13 per ton) relative to regular season returns on storage cabbage sold in January. Further, 72% of the time, the wholesale price will be below the estimated storage breakeven whole price of $10.92 per 50 pounds. Only 28% of the time will wholesale prices be greater than $10.92 per 50 pounds.

February Cabbage Market: On average, growers will gain $1.59 per 50 pounds ($64 per ton) on

storage cabbage sold in February, relative to returns available in the regular season. Unfortunately, 58% of the time, the wholesale price will be below the estimated storage breakeven wholesale price of $11.07 per 50 pounds. Only 42% of the time will wholesale prices be greater than $11.07 per 50 pounds.

March Cabbage Market: On average, growers will gain an additional $2.00 per 50 pounds ($80 per ton) over regular season returns, on storage cabbage sold in March. Nevertheless, 48% of the time, the wholesale price will be below the estimated storage breakeven wholesale price of $11.27 per 50 pounds. Wholesale prices will be greater than $11.27 per 50 pounds 52% of the time.

ii. Other Considerations

a. Operating at the Margin

Some farmers may be able to accept lower returns on stored cabbage than they obtain on regular season cabbage. The sale of stored cabbage may have a lesser per unit return, but may increase total returns. Further, increased acreage may lower the average cost of production, hence increasing regular season returns. The increase in regular season returns can then be taken as profit, or can be applied to stored cabbage losses, if any. These factors will of course be unique to individual farms and the cost structures of those farms.

b. Production Trends

Cabbage production has been increasing in Texas and California — our primary competitors during the January to March period. One supposes that those production increases

are due to high cabbage prices in the past and/or improved markets. A look at cabbage prices in California from 1969 to 1979 showed that high prices were occurring with slightly greater frequency in the period 1976 to 1979, but that those high prices were within the same range as prices during 1969 to 1975 (with the exception of the first quarter of 1977 when an exceptionally high price occurred). One must conclude that although higher prices are a factor influencing increased production of cabbage in Texas and California, price is not the only reason for expansion in Texas and California. For a detailed site-specific storage analysis, prices in competing areas must be analysed in great detail. Further, contact should be made with those areas to determine general expectations. These wider analyses have not been done in this study, but should be completed as proposals for building storage approach a final decision.

c. Wholesale Margin

It was shown earlier that in the past, wholesalers have increased their margins on average from about $2.00 per 50 pounds during the regular season to about $3.00 per 50 pounds on domestic product sales during January and February. It may be that an increased volume of quality cabbage from storage can capture that higher margin. If that is not the case, then the wholesale price required on storage cabbage to maintain the same profit margin to growers as during the regular season would be increased by the increased wholesale margin ($1.00 per 50 pounds) to $11.92 per 50 pounds for January, $12.09 per 50 pounds for February, and $12.27 per 50 pounds for March. This would decrease the average expected profits

(above regular season returns) for January, February and March to -$53 per ton, $23 per ton and $40 per ton respectively. The reader can refer to Figure 1 to see that the level of price risk increases as well.

Carrots

i. Breaking Even on Price

According to recent studies, the total cost of carrot production lies between $67 and $139 per ton. Traditionally, during the regular season, the wholesale price of topped carrots has been about $7.62 per 50 pounds ($305 per ton). Four estimates of storage cash costs based on capacities of 500 tons, 800 tons, 1,400 tons and 2,400 tons were made at $62.42 per ton, $51.50 per ton, $51.22 per ton and $48.48 per ton respectively. A reasonable average cash cost of $51.00 per ton was selected between those capacities. Handling costs for stored carrots were estimated to be $33 per ton. A margin of $51 + $33 = $84 per ton ($2.10 per 50 pounds) is therefore required for stored carrots to be at least as profitable as regular season carrot production.

Cull losses on November carrots coming from storage in January, February and March were estimated to be 7%, 12% and 18% respectively. Dessication occurs at a rate of about 1/2% per month. Therefore the total storage losses for January, February and March will be about 8%, 14-1/2% and 21% respectively. Adding these losses to the storage costs of $2.10 per 50 pounds provides a cost of $2.27 per 50 pounds for January, $2.40 per 50 pounds for February and $2.54 per 50 pounds for March. By adding the storage margins to the regular season price we arrive at values of $9.89 per 50 pounds for January, $10.02 per 50 pounds for February and $10.16 per 50 pounds for March. These values are the wholesale

prices required to ensure that grower returns during the storage season will be no less than grower returns during the regular season.

Average wholesale prices for carrots in January, February and March have been $11.34 per 50 pounds, $12.41 per 50 pounds and $11.86 per 50 pounds respectively. Figure 2 shows that there is a 30% chance that prices will not be as high as the storage breakeven point of $9.89 for January, a 30% chance that prices will not be as high as the storage breakeven point of $10.02 for February and a 30% chance that prices will not be as high as the storage breakeven point of $10.16 for March. This leads us to the following conclusions on the profitability of carrot storage.

January Carrot Market: On average, growers would gain $1.45 per 50 pounds ($58 per ton) as compared to regular season returns on storage carrots sold in January. Further, growers can expect wholesale prices to be below the storage breakeven point 30% of the time.

February Carrot Market: On average, growers would gain $2.39 per 50 pounds ($96 per ton) as compared to regular season returns on storage carrots sold in February. However, growers can expect wholesale prices to be below the storage breakeven point 30% of the time.

March Carrot Market: On average, growers would gain $1.70 per 50 pounds ($68 per ton) as compared to regular season returns on storage carrots sold in March. Further, growers can expect that price will be below the breakeven point 30% of the time.

ii. Other Considerations

a. Operating at the Margin

As was discussed for cabbage, carrot growers

may be able to reduce their average costs of production by increasing acreage. Similarly a large enough margin may exist that although returns would be lower on stored cabbage as compared to regular season cabbage, total returns may increase. These factors would of course be unique to individual farms.

b. Production Trends

A review of winter carrot production trends shows little change in California production but a gradual increase in Texas production during 1977 to 1979. This suggests that more volumes may be coming on the market. Production forecasts for those States should be examined, but this has not been done in the present study.

c. Wholesale Margin

Similar to cabbage, wholesalers have historically increased their margin on winter season domestic carrots. That increase in margin has been about $2 per 50 pounds. If increased volumes of quality domestic carrots cannot capture that increased margin, then the profitability of carrot storage is reduced. Profitability decreases by $2 per 50 pounds, which means that January carrots would provide returns of -$22 per ton, February carrots +$16 per ton and March carrots -$12 per ton relative to regular season returns.

Onions

i. Breaking Even on Price

Studies on the total cost of production of onions have ranged between $74 and $139 per ton. Normal

season wholesale prices for medium yellow onions have averaged $7.25 per 50 pounds ($290 per ton) in recent years. Onion storage handling costs were estimated at $10.60 per ton, with storage holding costs estimated at $22.86 for a 600 ton unit, and $20.98 per ton for a 900 ton unit. An average of $21.50 per ton was selected as being reasonable for storage holding costs. Stored onions must therefore earn a margin of $10.60 + $21.50 = $32.10 per ton in order to be at least as profitable as regular season production. The figure of $32.10 per ton is equivalent to about $ .80 per 50 pounds.

Cull losses on onions stored to January, February and March were estimated to be 7%, 12% and 18% respectively. Dessication rates are not a concern with onions. If we add these cull losses to the total storage costs of $ .80 per 50 pounds, then margins of $ .86, $ .90 and $ .94 per 50 pounds are required for January, February and March respectively. Adding these monthly margins to the average regular season price of $7.25 per 50 pounds determines the storage breakeven prices for January, February and March. Those storage breakeven prices are $8.11, $8.15 and $8.19 per 50 pounds respectively.

Figure 3 shows us that there is a 48% probability of price not being that high for January, a 39% probability of price not being that high for February and a 22% probability of price not being that high in March. The expected average prices for January, February and March were however, $8.67, $9.57 and $11.35 respectively. These data lead us to the following conclusions:

January Onion Market: On average, the sale of onions from storage in January would provide grower returns $ .56 per 50 pounds ($22/ton) greater than regular season returns. The storage breakeven wholesale price required was $8.11

per 50 pounds while the average wholesale price was $8.67 per 50 pounds. However, 48% of the time, the wholesale price would be below $8.11 per 50 pounds.

February Onion Market: On average, the sale of onions from storage in February would increase grower returns by $1.42 per 50 pounds ($57 per ton) above grower returns during the regular season. Further, growers can expect the wholesale price to be below the storage breakeven point 39% of the time.

March Onion Market: On average, the sale of storage onions in March would increase grower returns by $3.16 per 50 pounds ($126 per ton) above grower returns during the regular season. Further, growers can expect that 22% of the time the wholesale price would be below the storage breakeven point.

ii. Other Considerations

a. Operating at the Margin

Similar to cabbage and carrots, average costs of production may be reduced, and/or total returns may be increased through operating a storage unit. The difference between the average wholesale regular season price of $290 per ton and the costs of production of $74 to $139 per ton imply this may be the case for a majority of growers.

b. Production Trends

Washington State production trends show considerably increased production of yellow onions for storage in the 1979 season. On the Vancouver market that increased production reduced prices dramatically in 1979. One can safely assume that increased production in Washington will continue to have

potential to reduce prices on the Vancouver market. A detailed analysis of production in Washington State is required. Such an analysis has not been done in this report.

c. Wholesale Margin

Table 6 showed that wholesalers have historically increased their margin on onions by about $ .50 per 50 pounds during the winter season. If increased domestic onion volumes cannot capture that additional markup, then grower profit from storage would decrease by $20 per ton in January, February and March.

VI. SUMMARY AND CONCLUSIONS

This study attempted to present a feasibility analysis of vegetable storage facilities. Sales volumes and storage costs were estimated and combined with an analysis of expected future prices.

A total of 1,400 tons of onion storage and 3,000 tons of cabbage and carrot storage were determined as a realistic initial target for B.C. The construction of facilities beyond those levels might begin to oversupply the market and reduce price.

Storage construction costs, holding costs and handling costs were estimated for cabbage and carrots in tote bins, and for onions in bulk storage. The cabbage and carrots would have humidified and temperature controlled storage, while onions would have temperature control with a lesser amount of humidity control. Costs of storage were estimated to be $108 per ton for cabbage, $84 per ton for carrots, and about $32 per ton for onions.

To the average regular season wholesale price was added the cost of storage and the effect of storage losses. The result was a breakeven wholesale value required to maintain stored product returns at levels equal to returns available during the regular season. Average wholesale prices and price risk were then estimated for cabbage, carrots and onions for the months of January, February and March. Expected profit and risk of loss are shown in Table 8.

To this point the construction of storage facilities appears to be a solid proposition. Carrots show the greatest potential and also the lowest risk. Onions show the next best level of average returns, but risk is high. Cabbage shows the lowest level of average returns, and the greatest risk.

At this point one must look at other market forces which will affect product prices or costs of storage.

TABLE 8

EXPECTED PROFIT AND RISK OF LOSS

Month	Cabbage		Carrots		Onions	
	Expected Profit[1]	Risk of Loss[2]	Expected Profit[1]	Risk of Loss[2]	Expected Profit[1]	Risk of Loss[2]
	$/ton	%	$/ton	%	$/ton	%
January	-13	72	+58	30	+22	48
February	+64	42	+96	30	+57	39
March	+80	48	+68	30	+126	22

1. Average expected profit to growers above returns available during the regular season assuming B.C. product quality can match that of imported product and hence command an equivalent price.

2. Frequency with which product price was below the breakeven point during the last seven years.

In the U.S. the production of cabbage, carrots and onions has been increasing. Expectations for U.S. production in 1980 and beyond were not determined in this study, and would require specific and detailed study of the major production areas in the United States. Whether increased production will be consumed in the U.S., or aimed at western Canadian markets, is open to debate. A review of published statistics indicated that cabbage production has increased in Texas. Current low cabbage prices may halt or reverse that increase. Carrot production has been increasing in Texas at about 10% per year since 1977, while prices have remained relatively constant. Onion production has increased dramatically in Washington and has had a strong effect on B.C. prices. Since the analysis of prices includes the effects of these past changes in U.S. production levels, there are two remaining possibilities:

- That the current changes in production in the U.S. are part of a continuing cycle which is adequately reflected in the analysis of prices. If this is the case, then our estimates of expected future prices will remain valid.

- That the current trends in production in the U.S. are part of a structural change to increased production. If this is the case, then the expected profitability of storage in B.C. will be reduced, especially for cabbage and onions.

The effect of transportation costs, tariffs and exchange rates are also important when competing with U.S. product. In transportation, B.C. growers can expect some additional price protection if fuel costs rise. Over the longer term there is a possibility of larger loads being permitted on U.S. highways which may decrease the transportation cost protection. Current tariffs on cabbage, carrots and onions range from $10 to $30 per ton for the storage period. Those

effects were included in the price analysis. The possibility for a new Canadian tariff structure exists that could remove much of the price risk currently existing throughout the marketing period. Finally, the value of the Canadian dollar relative to the U.S. dollar can change at any time. Past exchange rate values were included in the price analysis. Future changes in exchange rates may alter the profitability of vegetable storage.

Wholesale margins may play a large role in determining the feasibility of storage. It was noted that for unknown reasons, wholesalers have in the past increased their margins on B.C. products sold in the winter season relative to imported product sold in the winter season. For cabbage the increased margin was about $1.00 per 50 pounds ($40 per ton), for carrots about $2.00 per 50 pounds ($80 per ton) and for onions about $ .50 per 50 pounds ($20 per ton). It may well be that an increased volume of quality domestic product could capture these increased markups. If those increased markups cannot be captured by B.C. product from storage, then the profitability of storage decreases, and the level of risk increases. Onions then show the greatest profitability and least risk, followed by cabbage and then carrots. The capture of the margin relies upon an aggressive pricing policy by the BCCVC and the production of high quality product.

Finally profitability may change depending upon how the individual manages his costs. The storage costs estimates developed in this study are approximate. Individual operators may be able to earn more or less than shown through unique circumstances involving their cost of production, debt load, interest rates obtained, unused land, off-season uses, government assistance, etc. On the same line, this study has not included the cost of a hydro-cooler for carrots going into storage. It was assumed that hydro-cooling could be inexpensively included in the carrot washing system. Also, optional costs such as building and product insurance have not been included. Finally,

profitability is expressed as expected price minus cash costs. No allowance was made for a return to equity and salvage of depreciated assets. The individual can include these as he wishes, or simply calculate the profit as a return to management and capital.

All possible storage technologies have not been considered. For example, two growers on Vancouver Island are bulk-storing carrots. Although capacity is reduced by about 30%, cash costs are reduced by about $20 per ton. Some breakage and damage occurs in bulk handling, but this loss was not considered excessive by the growers. The $20 per ton cost saving (due primarily to not needing tote bins or forklifts) can either be taken as profit, applied against price risk, or can be applied to cull rates. Carrot cull rates for January, February and March could increase to about 38%, 44% and 51% respectively before bulk storage would be as costly as storage in tote bins.

Another technology is the use of "jacketed storage". In jacketed storage the room is cooled by air circulating through a jacket or envelope surrounding the room. Since the circulating air does not come into contact with air in the storage area, humidity, temperature and air flow in the storage room are not directly dependent on the refrigeration equipment or external heat flowing into the room. Advantages of this system are that storage conditions are more readily maintained than in conventional storage. Higher humidities are also possible because there is no air exchange. Research has indicated that because of these factors, product is maintained in better quality than in other storage systems. Building costs increase by about 15% in jacketed storage, but some savings may be available in equipment costs and operating costs.

The final consideration is the location and type of management of the storage facility. Current government assistance programs favor the co-operative

storage facility. Centralization of storage would facilitate bulk washing and grading, and should provide a more uniform product than would be available from a number of smaller facilities with varying levels of management and quality control. Larger facilities also have reduced holding costs per ton. A larger facility could make better use of forklifts and other equipment, and also be more able to search out off-season storage contracts or use the storage for other vegetables during the regular season. On the other hand, the private operator should have the opportunity to capture the additional returns from storage construction. There would be less risk of total crop loss in numerous smaller storages and several small facilities are less vulnerable to strikes and/or lockouts. The individual would also have some latitude in harvest scheduling vs. deliveries for sale. The large downpayments required to build a storage facility, and the level of price risk are equal for both the central and the private storage facility.

Individuals considering construction of a specific storage warehouse, in a specific location, with specific crop requirements and a specific financial situation should complete the type of analysis developed in this paper. It is likely that particular costs of production, yields, management, etc. can make storing vegetables a highly profitable venture. Such features as examination of prices and production levels (particularly in the U.S.A.) should be on-going each year to estimate expected profits and losses for following years. For example, a storage facility that holds cabbage one year could be used for carrots or onions the next year depending upon the market outlook.

To conclude, a large sales potential exists for B.C. stored vegetables. There is also potential to increase returns. However, expected margins may not be large and there is some risk of loss. Because of the expected profitability but relatively high variability

of returns, a case might be made for government involvement to spread the risk. Individuals planning the construction of a vegetable storage should recognize the variability of returns. They should have secure capital resources and be able to withstand one or two years of losses. Over the longer term, a well managed privately owned vegetable storage warehouse can be profitable.

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APPENDIX A

CALCULATING MARKET SALES OPPORTUNITIES

Source: Derived from Agriculture Canada, Production and Marketing Branch, Marketing Services Division, Annual Unload Report: Fresh Fruits and Vegetables on 12 Canadian Markets, 1973-79.

TABLE A1

SUMMARY OF POSSIBILITIES FOR NOVEMBER-MARCH
U.S. IMPORT DISPLACEMENT BY PRODUCT AND MARKET
AT 90% CERTAINTY
(tons)

Market	Cabbage	Topped Carrots	Yellow Onions	Rutabagas	Parsnips	Total
Vancouver	1,352	2,689	1,519	99	223	5,882
Calgary	788	0	858	0	0	1,646
Edmonton	1,033	0	960	0	0	1,993
Regina	413	0	266	0	0	679
Saskatoon	416	0	259	0	0	675
Prairies Subtotal	2,650	0	2,343	0	0	4,993
Total	4,002	2,689	3,862	99	223	10,875

TABLE A2

MINIMUM IMPORTS (90% CONFIDENCE)
(tons)

VANCOUVER

	Cabbage	Topped Carrots	Yellow Onions	Rutabagas	Parsnips[1]	Total
November	1	44	225	18	32	320
December	70	410	271	12	33	796
January	248	673	331	33	29	1,314
February	454	754	293	36	47	1,584
March	615	809	400	0	45	1,869
Total	1,388	2,690	1,520	99	186	5,883

1. An additional 39 tons of parsnips could be stored and sold in April.

TABLE A3

MINIMUM IMPORTS (90% CONFIDENCE)
(tons)

CALGARY

	Cabbage	Yellow Onions	Total
November	25	139	164
December	138	150	288
January	182	189	371
February	209	170	379
March	235	211	446
Total	789	859	1,648

TABLE A4

MINIMUM IMPORTS (90% CONFIDENCE)
(tons)

EDMONTON

	Cabbage	Yellow Onions	Total
November	12	170	182
December	113	176	289
January	252	204	456
February	289	180	469
March	368	232	600
Total	1,034	962	1,996

TABLE A5

MINIMUM IMPORTS (90% CONFIDENCE)
(tons)

SASKATOON

	Cabbage	Yellow Onions	Total
November	25	50	75
December	88	41	129
January	87	69	156
February	97	49	146
March	120	52	172
Total	317	261	578

TABLE A6

MINIMUM IMPORTS (90% CONFIDENCE)
(tons)

REGINA

	Cabbage	Yellow Onions	Total
November	16	41	57
December	56	39	95
January	100	60	160
February	106	61	167
March	136	66	202
Total	414	267	681

Procedure for Determining Monthly Storage Requirements

In order to determine monthly storage requirements for each crop in each market, the following procedure was used. The period over which each crop could be stored successfully and still compete on quality with fresh imports was taken from the individual commodity reports. Harvest of these crops in most years has to be completed by mid to late November, at the latest, in the Lower Mainland. The storage period is thus from November through March or April, depending upon the crop.

Annual monthly imports during the storage period were collected by market (Ag. Canada, Unload Reports) for the years 1973 through 1979. Using standard statistical procedures, the minimum level of imports which could be expected with 90% confidence was determined. This minimum level of expected imports was made the target level for annual import displacement over the storage period. Because of greater variability within months across years, than within the storage periods within years, the sum of the minimum monthly level of imports over the storage period was always somewhat less than the minimum level of imports determined for the storage period as a whole. Hence, the monthly levels determined were adjusted upward by the factor

$$\left(\frac{\text{Minimum Expected Imports During November-March}}{\Sigma \text{ Minimum Expected Imports by Month}} \right)$$

to obtain the level for the storage period on a monthly basis.

EXAMPLE: VANCOUVER YELLOW ONIONS

	Historical Monthly Imports ('000 lbs.)							90% Confidence Lower Bound	Adjusted 90% Confidence Lower Bound
	72-73	73-74	74-75	75-76	76-77	77-78	78-79		
Nov.	516	320	626	453	317	1,097	1,246	- 380)	449
Dec.	677	594	747	220	542	604	817	- 459)	542
Jan.	666	875	626	365	609	1,004	1,135	- 560) 2,571	662
Feb.	406	327	749	629	1,569	921	1,036	- 495)	585
Mar.	307	1,137	495	1,132	2,384	2,207	1,116	- 677)	800
Total	2,572	3,253	3,234	2,799	5,421	5,834	5,350	- 3,038	

$$\text{Adjustment Factor} = \frac{3,038}{2,571} = 1.18$$

APPENDIX B

VEGETABLE PRICES AND PRICE VARIATIONS

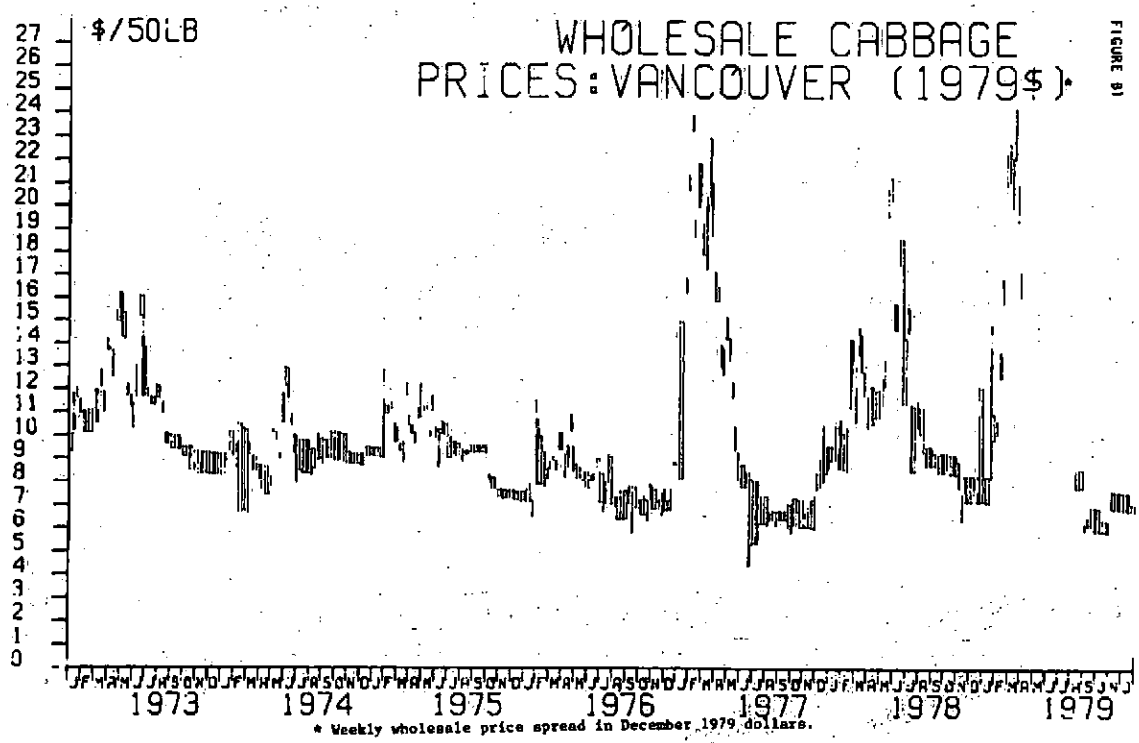
Source: Derived from Agriculture Canada, Marketing Services Division, Food Production and Marketing Branch, Fresh Fruit and Vegetable and Honey Crop and Market Report, (Weekly), 1973-79.

TABLE B1
WHOLESALE PRICE STATISTICS
VANCOUVER MARKET, BY MARKET PERIOD 1973-1979 ($/50 LBS)

Market Period	Green Cabbage				Topped Carrots				Medium Yellow Onions			
(Weeks)	Aver.	S.D.	N	C.V.	Aver.	S.D.	N	C.V.	Aver.	S.D.	N	C.V.
Sep-Nov (36-48)	7.94	1.14	91	.14	7.62	1.28	91	.17	7.23	1.63	91	.23
Dec (49-52)	8.29	0.93	28	.11	9.12	2.18	28	.24	7.21	1.20	28	.17
Jan-Mar (1-13)	12.05	4.30	91	.36	11.83	2.90	91	.25	9.77	3.23	91	.33
Sep (36-39)	8.20	1.37	28	.17	7.91	1.69	28	.21	7.89	2.59	28	.33
Oct (40-43)	7.89	1.21	28	.15	7.28	0.98	28	.13	7.11	0.77	28	.11
Nov (44-48)	7.75	0.84	35	.11	7.65	1.05	35	.14	6.80	0.84	35	.12
Dec (49-52)	8.29	0.93	28	.11	9.12	2.18	28	.24	7.21	1.20	28	.17
Jan (1-5)	10.60	3.41	35	.32	11.34	2.73	35	.24	8.67	1.88	35	.22
Feb (6-9)	12.66	4.59	28	.36	12.41	3.31	28	.27	9.57	2.82	28	.29
Mar (10-13)	13.27	4.59	28	.35	11.86	2.65	28	.22	11.35	4.25	28	.37

TABLE B2
DOMESTIC FOB TO WHOLESALE AVERAGE MARK-UP
VANCOUVER MARKET 1973-1979 ($/50 LBS)

Market Period	Green Cabbage				Topped Carrots				Medium Yellow Onions			
(Weeks)	Aver.	S.D.	N	C.V.	Aver.	S.D.	N	C.V.	Aver.	S.D.	N	C.V.
Sep-Nov (36-48)	2.09	0.39	78	.19	2.07	0.58	75	.28				
Dec (49-52)	2.28	0.79	24	.35	3.19	1.06	14	.33	(Not Available)			
Jan-Mar (1-13)	3.15	1.06	27	.34	4.33	0.78	7	.18				
Sep (36-39)	2.22	0.50	24	.23	2.14	0.70	24	.33	(Not Available)			
Oct (40-43)	2.14	0.34	24	.16	1.88	0.20	24	.11				
Nov (44-48)	1.95	0.26	30	.13	2.17	0.65	30	.30	2.18	0.41	54	.19
Dec (49-52)	2.28	0.79	24	.35	3.19	1.06	14	.33	2.65	0.72	24	.27
Jan (1-5)	3.03	1.16	20	.38	4.38	0.95	5	.22	2.57	0.72	20	.28
Feb (6-9)	3.48	0.66	7	.19	4.20	0.01	2	.00	(Not Available)			
Mar (10-13)	(No Data Available)								(Not Available)			


$/50LB
WHOLESALE CABBAGE
PRICES: VANCOUVER (1979$)*
FIGURE 61
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1973
1974
1975
1976
1977
1978
1979
* Weekly wholesale price spread in December 1979 dollars.

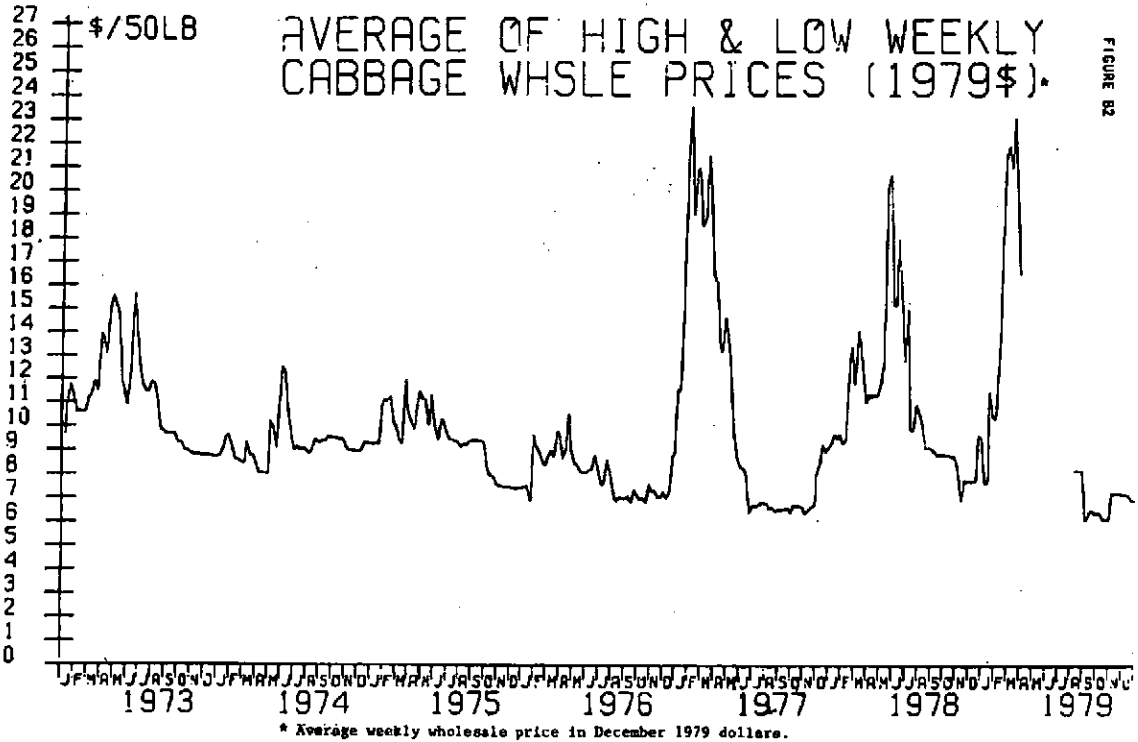
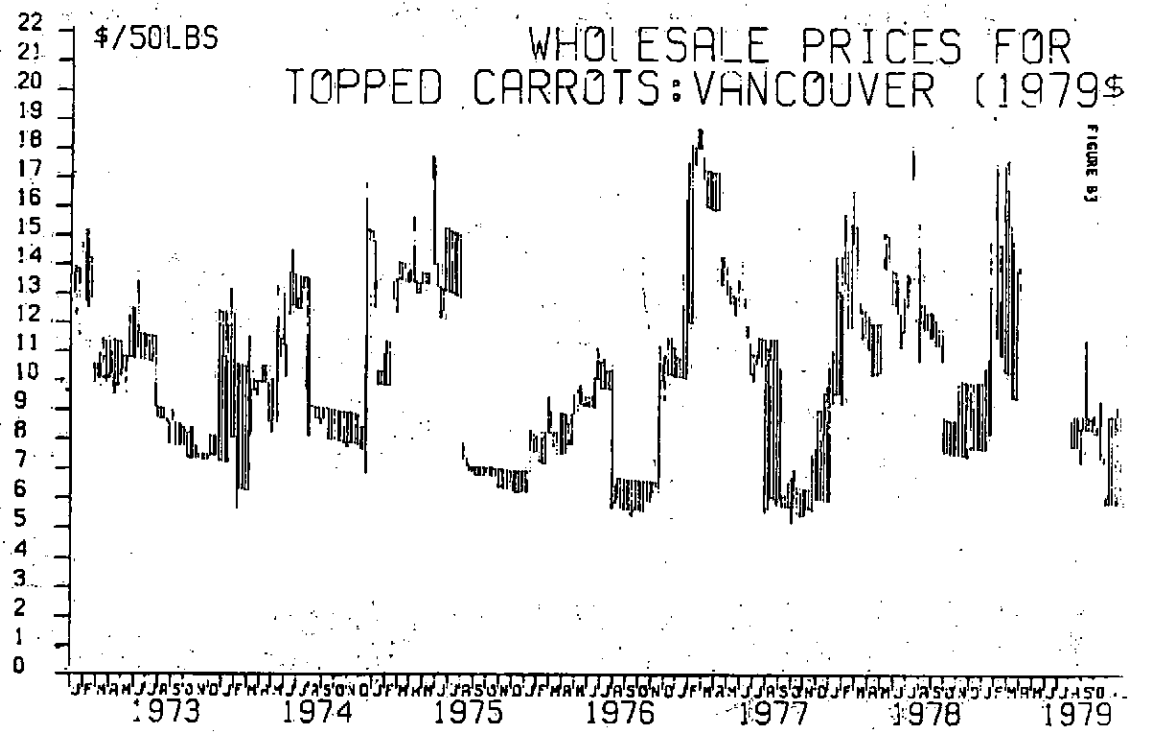


FIGURE 82

* Average weekly wholesale price in December 1979 dollars.



*, Weekly wholesale price spread in December 1979 dollars.

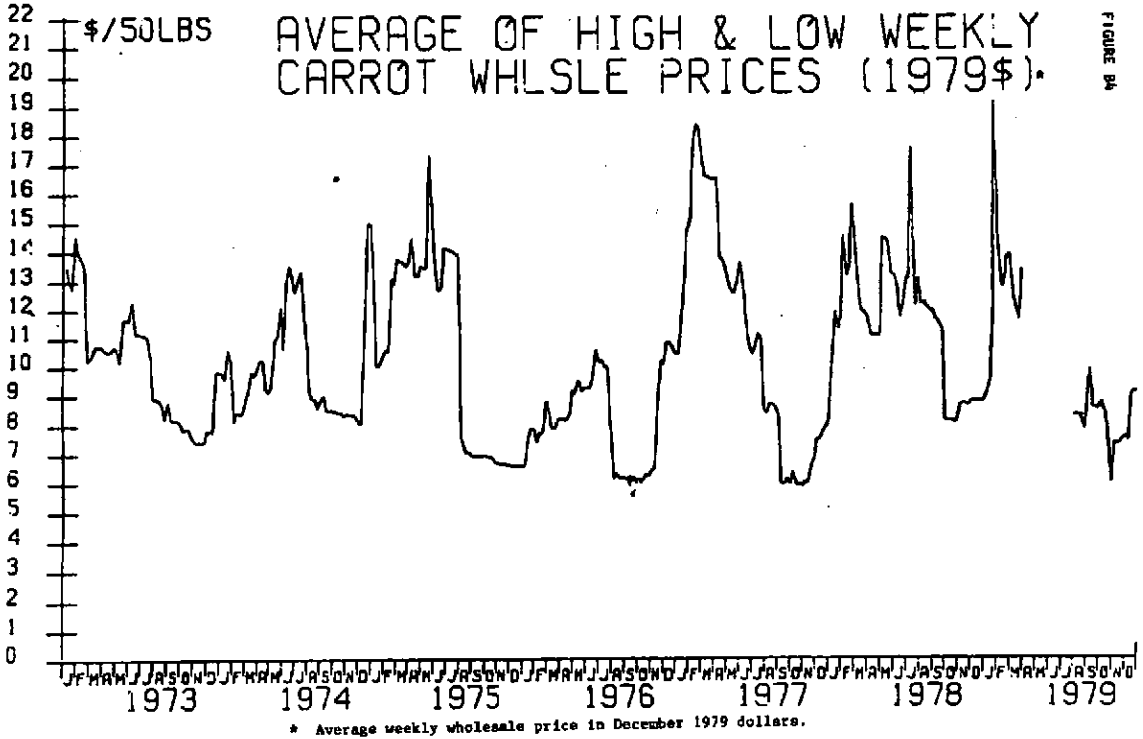
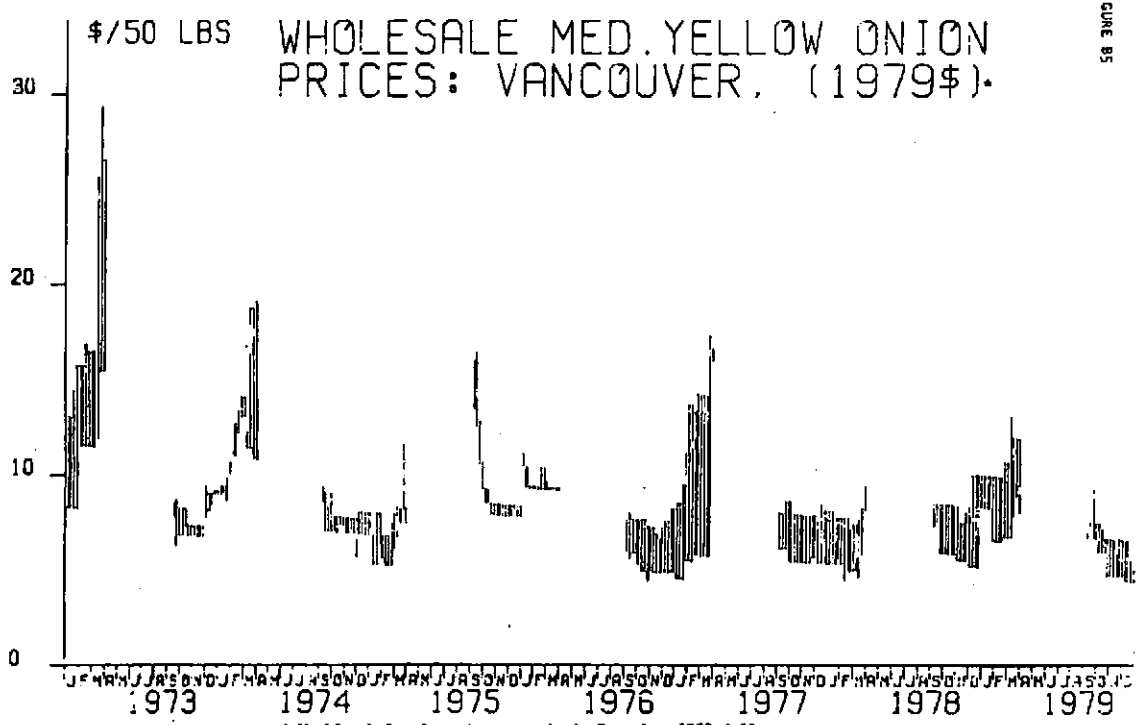


FIGURE 84

* Average weekly wholesale price in December 1979 dollars.

FIGURE 55



* Weekly wholesale price spreads in December 1979 dollars.

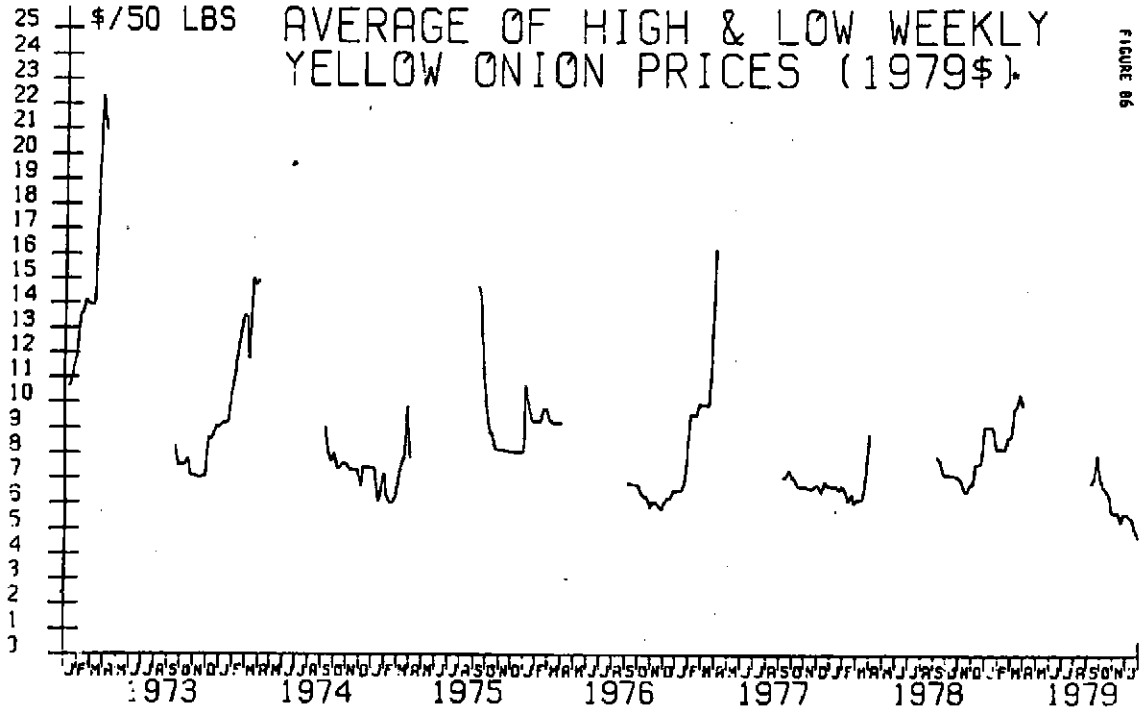


FIGURE 86

* Average weekly wholesale prices in December 1979 dollars.

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