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POTENTIAL FOR STORING CHIPPING POTATOES IN PENNSYLVANIA

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INTRODUCTION AND BACKGROUND

Potato chip manufacturing is an important part of Pennsylvania's food processing industry. It uses a major proportion of the potato crop in Pennsylvania and nearby states. It also uses fall-crop potatoes from as far away as the Red River Valley of North Dakota.

New, high-quality, professionally managed storages could reduce the "chipper's" cost of potatoes that are now purchased as needed during the winter and spring. Some of these late season potatoes come from distant sources. The addition of more storage capacity would be expected to expand the harvest-time potato market for Pennsylvania and other Northeastern growers if they produce "quality" potatoes acceptable for storing and chipping.

Consumption Patterns

Per capita potato consumption declined steadily from 155 pounds, fresh weight equivalent, in 1929 to approximately 120 pounds in 1970. Although per capita consumption has been relatively stable since 1970, the form in which potatoes have been purchased and consumed has changed substantially (Figure 1). The decline in per capita consumption of fresh potatoes, from 63.1 pounds in 1970 to 49.6 pounds in 1986, has been offset by the increased use of processed potato products which went from 58.5 to 74.7 pounds per person during the same period. Increased per capita use of processed potatoes results mainly from the consuming public's desire for more convenience, less time spent in food preparation, and other factors associated with a changing American lifestyle. Evidence of the change can be observed in the increase in food consumed away from home. The growth in production of frozen french fries is closely associated with the growth of the fast food industry.

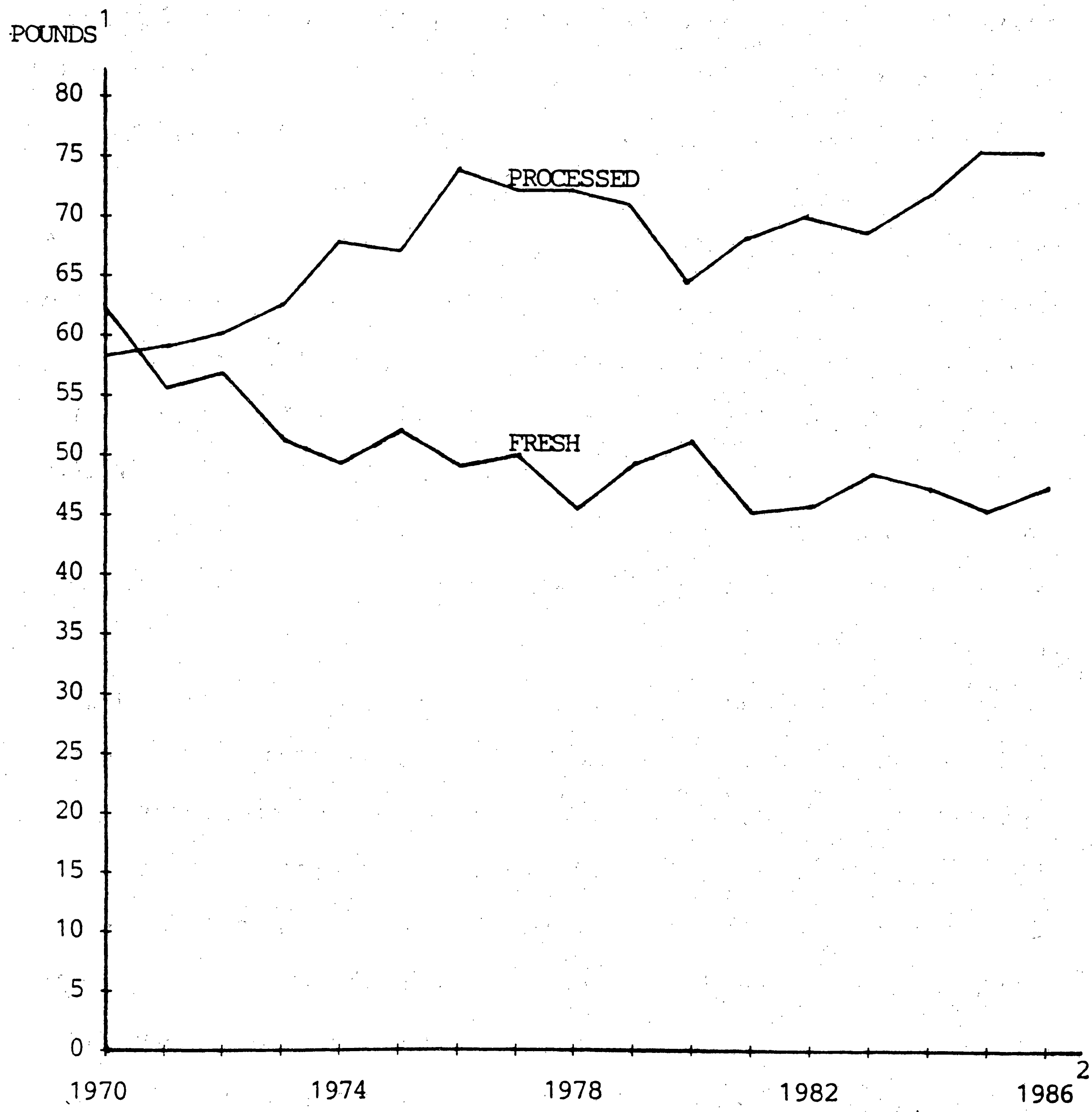


Figure 1: Per Capita Potato Consumption in the United States. (1970-86)

Source: Zepp, Glenn. 1987 Potato Facts. USDA Economic Research Service Commodity Economics Division.

[1] Fresh weight equivalent.

[2] Preliminary.

Per capita consumption of processed potatoes has risen from 1.9 pounds (fresh weight equivalent) in 1940 to a 1986 level of 74.7 pounds. Processors used about 50% of the total crop, or 61% of the portion used for food in 1986. Frozen products, which include french fries, have been the fastest growing use and now account for more than half of all potatoes processed. In 1942 potato chip manufacturers used about 42% of all the potatoes processed. That fell to 20% by 1976, largely due to the growth in frozen and dehydrated potato products, but has since increased to 23%. Since 1976 the quantity of potatoes utilized for chipping has increased substantially. Usage increased from 34.5 million cwt. in 1976 to 42.4 million cwt. in 1986 (Figure 2). Per capita consumption of potato chips increased from 15.8 pounds to 18.1 pounds per year during this period.

Potato chip consumption is relatively constant throughout the year, although consumption does increase around major holidays. Potato chip manufacturers must therefore produce chips for a year round market. Since the shelf life of potato chips is only four to six weeks, chip manufacturers must either store fall harvested potatoes to meet winter production needs or purchase from others during the storage season (late October through April). They can buy "new" potatoes once the southern crop is harvested in the spring. Typically, the price of fall crop chipping potatoes increases with the length of time in storage. Chippers' purchase prices for fall potatoes are lowest at harvest and gradually increase until peaking in late spring.

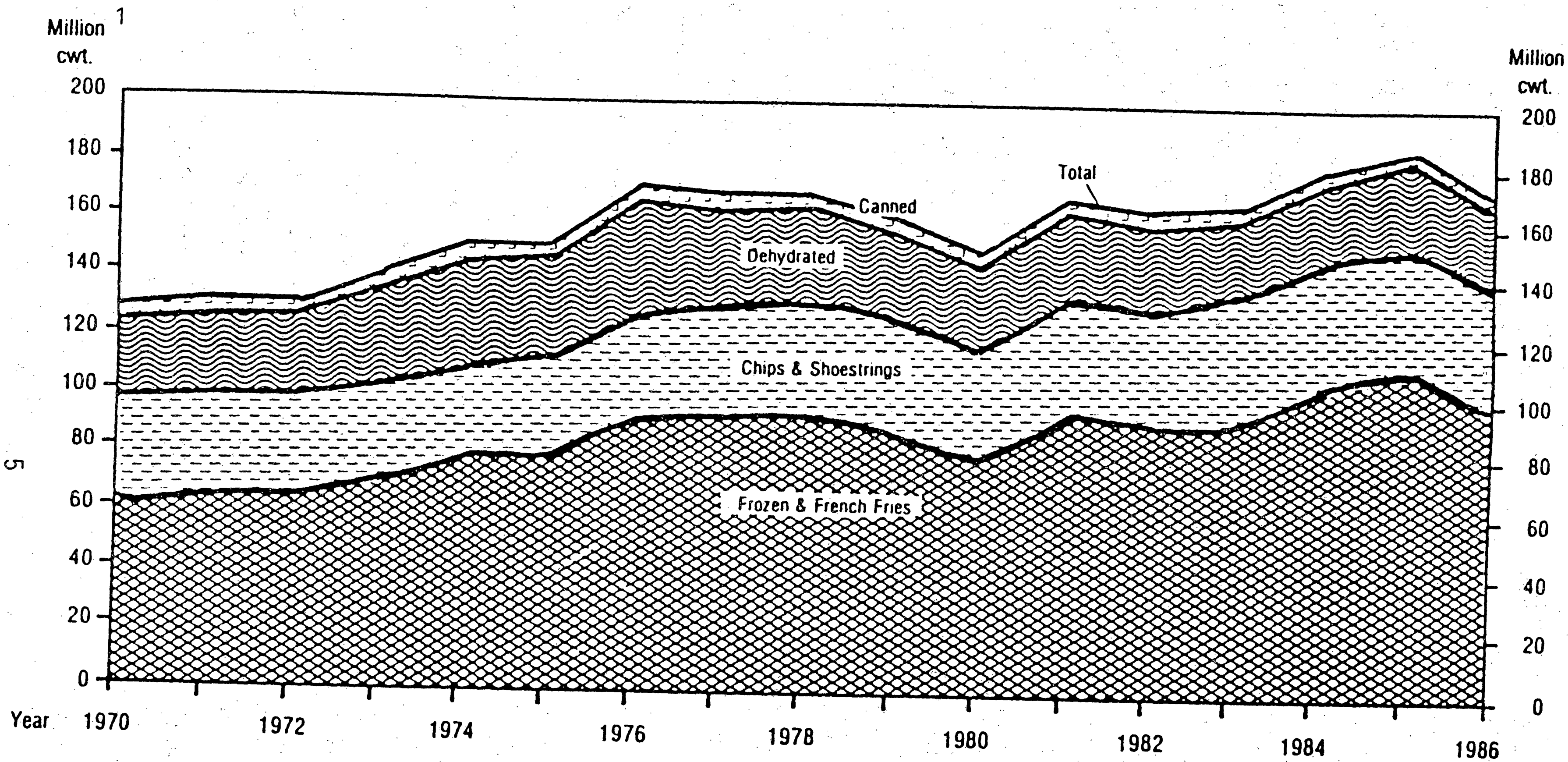


Figure 2: Potatoes Used for Processed Food Items

Source: National Potato Council's 1987 Potato Statistical Yearbook. 1987, Englewood, Colorado, page 38.

[1] Fresh weight equivalent.

Potato Production Patterns

The United States Department of Agriculture characterizes potato crops as winter, spring, summer, or fall according to time of harvest. The fall crop from Pennsylvania and other northern states is by far the largest. The smallest is the winter crop (mostly used for tablestock) which is confined to southern Florida and California. Potato production moves progressively northward during the spring and summer until the fall production areas are reached. The fall crop is the primary source of potatoes for "chipping" during the fall and winter months before harvest of the spring crop.

Over the years fall potato production has shifted from eastern to midwestern and western states. Still, potatoes continue to be an important Pennsylvania crop and Pennsylvania is an important source of supply for chip manufacturers in the state.

The chipping market has been an important outlet for Pennsylvania potato growers for many years. In 1958 Kriebel found that about half of the Pennsylvania crop (or 75% of that portion used for processing) was used by Pennsylvania chip manufacturers. The remaining 25% was used to produce canned and frozen products.

The importance of the chipping industry as a market for Pennsylvania potatoes is reflected in the varietal preferences of Pennsylvania potato growers (Table 1). In 1987, Norchip, the most popular variety of chipping potato, replaced Katahdin, a tablestock variety, as the most commonly planted. In terms of acres planted, Katahdin has been the most popular variety followed closely by Norchip. Katahdin represented 25.1% of planted acreage in 1986, but in 1987 it ranked fourth behind the chipping varieties Norchip, Atlantic, and Superior.

Table 1: Percentage of Potato Acreage Planted to Selected Varieties in Pennsylvania

Year	First Variety	%	Second Variety	%	Third Variety	%	Fourth Variety	%
1982	Katahdin	30.3	Norchip	29.4	Superior	13.2	Kennebec	10.2
1983	Katahdin	32.8	Norchip	31.2	Kennebec	9.0	Superior	6.7
1984	Katahdin	23.7	Norchip	21.9	Monona	13.6	Superior	10.4
1985	Katahdin	28.3	Norchip	18.1	Monona	12.1	Superior	12.0
1986	Katahdin	25.1	Norchip	21.2	Atlantic	14.6	Superior	10.2
1987[1]	Norchip	24.1	Atlantic	16.1	Superior	14.0	Katahdin	13.7

Sources: 1987 Potato Facts. USDA Economic Research Service.

[1] Preliminary data.

* Measured by the objective yield survey method and percentages do not add to 100 because only the top four varieties are reported.

The 1987 figures are preliminary, however, and a portion of this large shift in varietal preference may not exist if these figures are revised.

Objectives of the Study, Related Research and Procedures

The purpose of this project was to determine the economic feasibility of increasing the number of long-term storage facilities to store potatoes for the Pennsylvania chipping industry.

A great deal of storage research has been completed in midwestern and western states where facilities, sophisticated enough to maintain tuber quality and meet processor needs, already exist. These studies were reviewed and relevant parts incorporated in this analysis.

To conduct this analysis, it was necessary to determine: 1) the "landed cost" of procuring chipping potatoes, 2) how that cost varies seasonally, and 3) the quantity of potatoes used for chipping each month. "Landed cost" includes the price of potatoes as well as all other costs incurred in buying and transporting them to the chipping plant.

Knowledge of the technology necessary to maintain chipping quality and minimize storage losses, as well as information about chippers' current storage patterns and the origins of potatoes they use, was also necessary. This information was collected by surveying major Pennsylvania chipping firms.

The level of investment required to build and equip potato storages and the operating costs associated with them including losses of stored potatoes also had to be determined in order to compare the costs and benefits of storage. These costs were estimated using budgeting and economic engineering techniques.

If the economic gains achieved by purchasing chipping potatoes at lower harvest prices rather than as needed during the season, are enough greater than the costs of owning and operating long-term storages, then the construction of more such facilities would be profitable.

THE ECONOMIC MODEL

The demand for potato chips remains relatively constant throughout the year, while potato production occurs in each region but once a year. Therefore, potatoes must either be stored where chipped or imported from another region to meet processing needs between harvests. Since the value of potatoes generally increases with length of time in storage, new storage construction will occur only if that gain in value exceeds the costs of storage.

The costs associated with storage are those of providing and operating storage facilities. Operating costs are partly a function of how long potatoes are stored, and the quantity of product involved. Costs associated with the ownership of storage facilities and equipment include depreciation, interest on the investment, taxes, insurance on the physical facilities, and maintenance. The operating costs include taxes, expenses for labor, chemicals, utilities, and insurance on the facilities as well as on stored potatoes.

In addition to the costs of owning and operating a storage, weight losses and potato quality deterioration are costs of storing that must be considered. Some deterioration occurs even in the best storages. Weight loss and quality deterioration can be expressed in terms of changes in value (Figure 3).

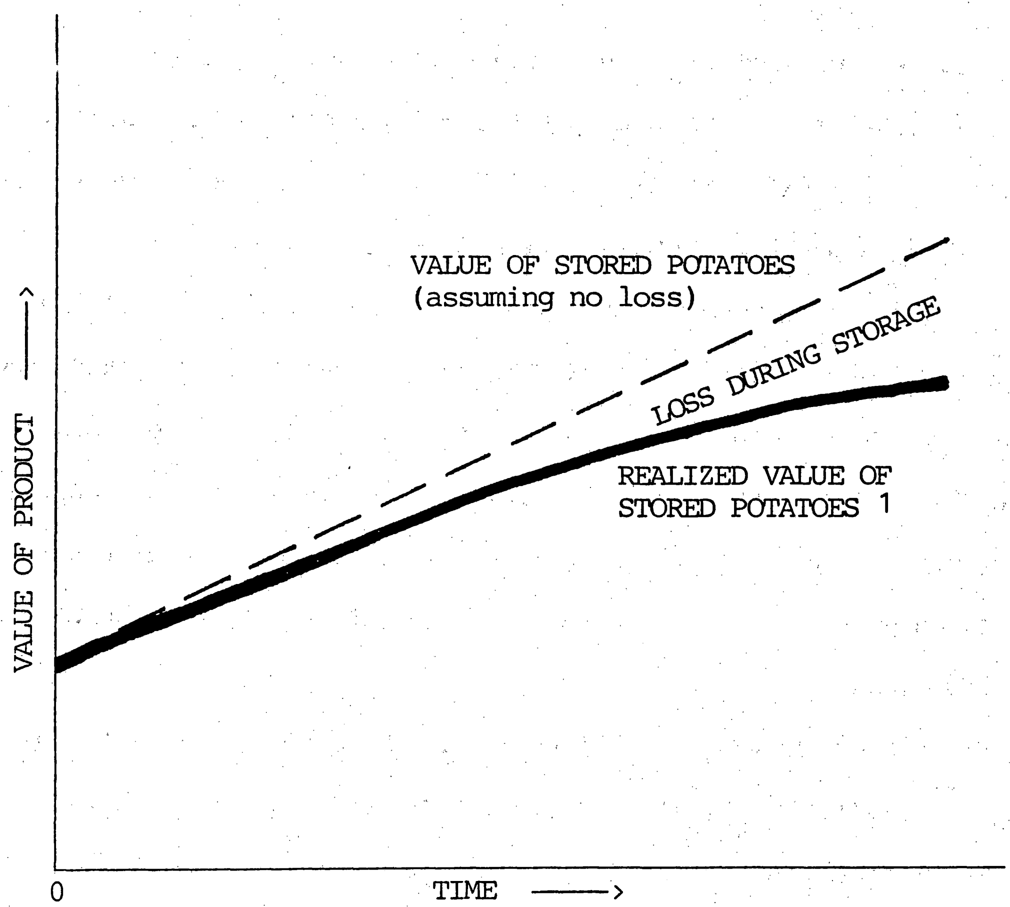


Figure 3: Expected Net Product Value Per Unit, by Time in Storage, Adjusted for Weight and Quality Losses

[1] Weight and quality losses reduce the quantity usable from each unit stored. Placing a hundredweight of potatoes in storage results in less than a hundredweight of usable potatoes coming out - although at a higher price. Netting these two factors out provides a realized value per unit of stored product.

See Bressler, R. G., and King, R. A. Markets, Prices, and Interregional Trade, Raleigh, North Carolina. John Wiley and Sons, Inc., 1978, pages 205-6 for further discussion.

SURVEY OF THE PENNSYLVANIA POTATO CHIP INDUSTRY

Introduction

A survey designed to collect data describing current storage facilities, practices, purchasing patterns, and raw product costs was conducted in the fall and winter of 1987-88. Sixteen large Pennsylvania chipping firms participated and provided data. Fifteen of the participating firms were found to have accounted for 78% of all the potatoes used for chips in the Eastern region (Delaware, Maryland, New Jersey, New York, Pennsylvania, Virginia, and the District of Columbia) during the 1986-87 crop year. Nationally, they accounted for about 18% of the potatoes used for chips that year. While there are a number of smaller chip manufacturers in the state, no attempt was made to collect data from them.

Raw product price data were collected for each of the past five crop years. In addition, information about current storage facilities and management practices was collected.

Fifteen potato chipping firms provided information as complete as their records would allow, for the past five years. The sixteenth firm provided general information but did not provide raw product cost and quantity information.

Terms and Variables

The variables used in the study and special terms pertaining to the topic are listed and defined in Table 2.

Table 2: Variables and Terminology Glossary

Raw product:	Potatoes to be used in the production of chips.
Raw product cost:	'Landed cost' of raw product at the plant: includes price of potatoes purchased, transportation costs, and other procurement costs such as brokerage fees or commissions.
Contract cost:	Cost of potatoes contracted in advance, usually with brokers or cooperatives. (Prices may be established up to a year in advance.)
Open market cost:	Cost of potato purchases other than by contract; (usually from brokers or cooperatives) used to meet additional production needs not met by contract purchases.
Monthly weighted average raw product cost for single firm:	Average monthly costs of raw product for individual firms; contract and open market costs/cwt. are weighted according to the percentage of raw product obtained by contracting and by the percentage purchased on the open market.
Monthly weighted average industry raw product cost:	Monthly individual firm raw product costs/cwt. (above) are weighted by the proportion of the industry's raw product used by that firm and an average calculated, which is then 'industry's average cost/cwt.'
Crop year:	August through July; based on the beginning of local harvest in late summer.
Purchase (production) regions:	Pennsylvania - Three arbitrary marketing areas were defined with industry guidance, dividing the state into western (1), central (2), and eastern (3) regions.
	Pennsylvania and Vicinity - Pennsylvania, New York, and Ohio
	Midwest - North Dakota, Michigan, and Minnesota.
	Early South - Florida and North Carolina.
	Intermediate - Virginia, New Jersey, Delaware, and Maryland.
Cultivar:	Variety of potato.
Reconditioning:	Increasing storage temperature to about 60°F for several weeks to encourage the conversion of reducing sugars which accumulated during storage, back to starch. Presence of reducing sugars in raw sliced potatoes tends to darken the chip when frying.

Regional Chip Industry Summary

The Eastern Region (defined by the United States Department of Agriculture as Delaware, Maryland, the District of Columbia, New Jersey, Pennsylvania, Virginia, and New York) had 33 potato chip plants in 1987, or 20% of the nation's total. In 1986-87, these 33 chipping plants processed the equivalent of 56% of the region's potato production. Nationally, only 11.7% of the total crop was utilized for chips (Table 3).

The responding Pennsylvania chip manufacturers accounted for 78% of the total raw product used for chipping in the Eastern Region. This high percentage of total utilization is due to the fact that Eastern chippers are concentrated in Pennsylvania and that several very large firms were among those cooperating. Those not surveyed were generally quite small. The average size of respondent firms (as measured by potato usage) was approximately 65% larger than the average for the 33 firms in the region. The average firm in the survey used approximately 500,000 cwt. of potatoes during the 1986-87 crop year compared to a regional average of 300,000 cwt.

Due to incomplete records of chipping firms for the earlier years, Pennsylvania chipping potato utilization data collected from responding firms may not accurately reflect the trend in potato usage. The 7,766,000 cwt. of potatoes used by responding firms in 1986-87 is accurate, but usage for the 1984-85 and 1985-86 crop years must be viewed as less certain since it is based on estimates.

Table 3: National, Regional, and Pennsylvania Potato Production and Chipping Industry Utilization (Crop years 1984-85 through 1986-87)

	1984-85[1]	1985-86[1]	1986-87[1]
UNITED STATES			
Potato Production (1,000 cwts.)	362,612	407,100	361,511
Chip Utilization (1,000 cwts.)	42,574	42,300	42,400
Percent of Crop	11.7	10.4	11.7
EASTERN REGION[2]			
Potato Production (1,000 cwts.)	20,296	23,869	17,579
Chip Utilization (1,000 cwts.)	9,424	9,416	9,885
Percent of Crop[5]	46.4	39.4	56.2
PENNSYLVANIA RESPONDENTS			
Potato Production (1,000 cwts.)	5,160	5,720	5,160
Chip Utilization (1,000 cwts.)	6,653[3]	6,794[3]	7,766[4]
Percent of Crop[5]	128.9[3]	118.8[3]	150.5[4]
Percent of Regional Chip Utilization	70[3]	72[3]	78[4]

Sources: Zepp, Ibid. National Potato Council's 1987 Potato Statistical Yearbook, Ibid. Survey data, 1987.

[1] Crop year basis - August through July.

[2] Delaware, Maryland, New Jersey, New York, Pennsylvania, Virginia, and the District of Columbia.

[3] From survey data of 9 responding firms augmented with estimates based on 1986-87 usage for those firms whose records were incomplete for earlier years.

[4] Calculated using survey data.

[5] Does not imply the potatoes were actually produced in the region or in Pennsylvania, but does indicate the importance or potential importance of the chipping industry to growers in the east.

Description of Storage Facilities

The average age of potato storage facilities now in use by survey respondents is seventeen years, but some are over forty years old. The average firm's storage capacity is 97,500 cwt., which is equivalent to 7.4 weeks of an average respondent's processing usage. However, as in most industries, storage capacities vary widely from firm to firm. Storage capacity among firms surveyed varied from a minimum of 2,000 cwt., or one week's processing needs for that firm, to a maximum of 320,000 cwt., or 22.5 week's production needs for another. Table 4 summarizes sizes and characteristics of chipper storage facilities now in use by respondents.

Chipping Potato Characteristics and Varietal Preferences

Chip color was the characteristic that buyers ranked most important when purchasing potatoes. It had an average ranking of 1.125 on a scale which ranged from 1 for most important to 7 for least important or not considered (Table 5). Specific gravity, which affects the yield of chips, was the second most important with an average ranking of 2.375. United States grade, cultivar, size uniformity, and the presence or absence of defects, are characteristics which are considered, but were deemed to be less important than color or specific gravity.

Each of these characteristics are considered when purchasing chipping potatoes but the relationship of each to prices paid for potatoes is often indirect. In general, potatoes are accepted or rejected on the basis of contract specifications, and the contract price is paid for accepted potatoes. Although premiums are not paid for higher

Table 4: Description of Storage Facilities Operated by Sixteen Responding Potato Chip Manufacturers. (Pennsylvania, Fall 1987)

	Average	Range
Age of Storage Facility (Years)[1]	17	1-43
Average Storage Capacity (Cwt.)	97,500	2,000-320,000
Weeks of Processing From Storage	7.4	1-22.5

Storage Characteristic	Number of Firms	Percentage of Firms
Owned by Firm	15	93.75
Rented	1	6.25
Bulk[2]	3	18.75
Bin[2]	1	6.25
Crates[2]	14	87.50
Heated	16	100.00
Refrigerated	6	36.50
Ventilated	16	100.00
Controlled Humidity	8	50.00
Computer Controlled[3]	1	6.25
Thermostat Controlled[3]	12	75.00
Manually Controlled[3]	8	50.00

Source: Survey data, 1987.

[1] Years since it was built or last remodeled.

[2] Some firms store in both bulk and crates

[3] Some firms have more than one type of atmosphere control.

Table 5: Importance of Chipping Potato Characteristics as Ranked by Sixteen Chip Manufacturers. (Pennsylvania, Fall 1987)[1]

Characteristic	Percent of Respondents[1] Ranking Characteristic by Level of Importance[2]: Major (1)	Major (2)	Moderate (3,4,5,6)	Nome (7)	Average[3] Rank
Color	87.5%	12.5%	0	0	1.125
Specific Gravity	12.5%	50.0%	37.5%	0	2.375
U.S. Grade	6.25%	6.25%	37.5%	50.0%	4.813
Uniform Size	0	6.25%	56.25%	37.5%	5.063
Defects	6.25%	12.5%	25.0%	56.25%	5.375
Cultivar	0	6.25%	31.25%	62.5%	5.938

Source: Survey data, 1987.

[1] Respondents were asked to rank a list of characteristics from 1 to 7 with 1 being the most important characteristic and 7 the least important or not even considered.

[2] The column under (1) represents the percentage of respondents that ranked each characteristic the most important. Column percentages do not add to 100 because some respondents gave the same rank to more than one characteristic, but row percentages do add to 100.

[3] Average rank was calculated by dividing the total of numerical ranks of all respondents by the number of respondents. The lower the average rank, the more important that characteristic is to respondent chip manufacturers. An average rank of 1.0 would mean that all respondents ranking that characteristic ranked it the most important.

than contract-specified quality, occasionally potatoes of lesser quality are accepted when higher quality potatoes are not available. Presumably open market prices are more directly related to the availability of potato supplies than to the levels of the characteristics associated with chipping quality.

Norchip is the variety of chipping potato preferred for storage (Table 6). Respondents gave it an average ranking of 1.125 (on a scale from 1 for most used to 8 for never used). The high ranking is due to its color and specific gravity characteristics. Respondents believe Norchip provides the best available combination of these important characteristics. Monona is the second most desirable variety with an average ranking of 3.50. Generally, varieties other than those ranked in the top two or three are not stored, but purchased only to meet immediate production needs, and then only when the preferred varieties are not available.

Purchasing Patterns

Although respondent firms use about 50% more potatoes than are produced in Pennsylvania, less than half of Pennsylvania-grown potatoes are used for chips. Within Pennsylvania, the Central and Western Regions are the major supply areas (Table 7).

Pennsylvania chip manufacturers purchase potatoes from several areas, and the source varies with the time of year (Figure 4). Pennsylvania and Vicinity (Pennsylvania, New York, and Ohio) and the Midwest Region (North Dakota, Michigan, and Minnesota) supply Pennsylvania chip manufacturers with raw product from the beginning of harvest of the fall crop in late summer until the Early South (Florida

Table 6: Stored Chipping Potato Variety Preferences as Indicated by Respondent Chip Manufacturers. (Pennsylvania, Fall 1987)

	Percent of Respondents Ranking Characteristic by Level of Importance[1]				
Variety	Most Used (1)	Most Used (2)	Sometimes Used (3,4,5,6)	Never Used (7)	Average[2] Rank
Norchip	93.75%	0	6.25%	0	1.125
Monona	6.25%	62.5%	6.25%	25.0%	3.50
#657	0	6.25%	31.25%	62.5%	6.188
Atlantic	0	6.25%	18.75%	75.0%	6.75
Kennebec	0	12.5%	6.25%	81.75%	6.938
#945	0	0	12.5%	87.5%	7.50
Superior	0	0	6.25%	93.75%	7.813

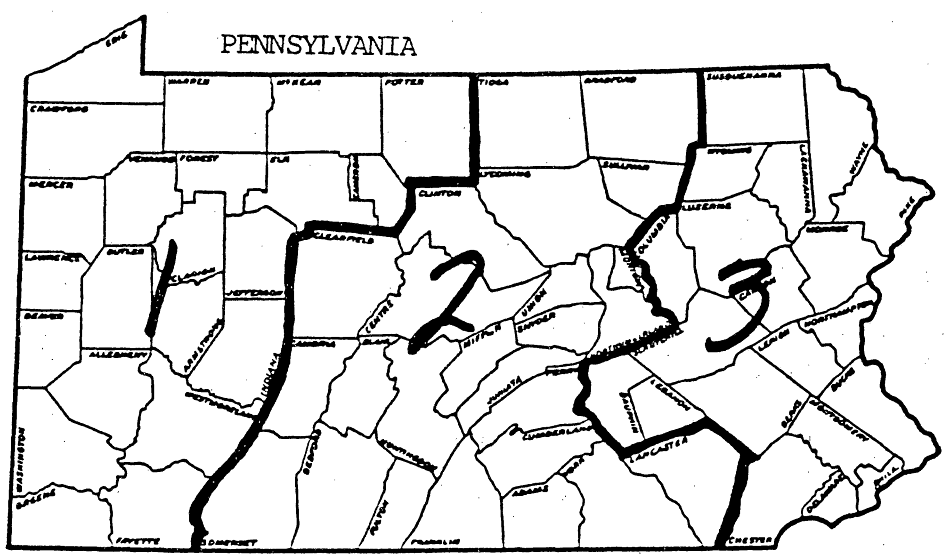
Source: Survey data, 1987.

[1] Ranked from 1 for the preferred variety of stored chipping potato to 8 for never used.

[2] Average rank was calculated by dividing the sum of numberical rankings (by the 16 respondents) for each variety by the number of respondents. The lower the average rank, the greater the preference for that variety of stored potato. An average rank of 1.0 would mean that all respondents ranked that variety as their number one choice.

Table 7: Percentage of Monthly Purchases for Fifteen Pennsylvania Chip Manufacturers from Three Pennsylvania Regions and Other Supply States. (1986-87 crop year)

	PA1	PA2	PA3	NY	OH	ND	MN	MI	FL	NC	VA	NJ	DE	MD	TOTAL
Aug.	15.1	54.7	-	12.7	-	-	-	-	-	-	12.7	4.8	-	-	100
Sept.	19.0	35.0	-	36.5	-	9.5	-	-	-	-	-	-	-	-	100
Oct.	9.5	27.0	-	47.9	-	15.6	-	-	-	-	-	-	-	-	100
Nov.	21.7	20.5	-	19.7	-	36.8	1.3	-	-	-	-	-	-	-	100
Dec.	21.0	18.7	-	22.4	-	36.7	1.3	-	-	-	-	-	-	-	100
Jan.	9.3	16.4	5.2	22.5	7.1	39.5	-	-	-	-	-	-	-	-	100
Feb.	12.7	14.1	6.5	19.2	9.0	38.5	-	-	-	-	-	-	-	-	100
Mar.	4.9	13.5	7.1	13.2	10.1	51.2	-	-	-	-	-	-	-	-	100
Apr.	3.6	8.8	9.3	14.4	-	52.0	-	-	11.9	-	-	-	-	-	100
May	-	-	-	-	-	-	-	-	100	-	-	-	-	-	100
June	-	-	-	-	-	-	-	-	47.3	48.6	4.1	-	-	-	100
July	-	12.5	-	-	-	-	-	-	-	31.1	33.1	14.2	8.3	0.8	100
Annual totals															
1,000 cwt.	552.7	1062.7	343.9	1062.5	466.6	1483.0	17.6	4.6	1401.8	729.6	363.7	209.5	55.4	13.3	5,363.2
%	7.3	14.5	2.8	13.6	2.5	23.0	0.1	-	18.9	9.4	5.0	1.9	1.0	0.1	100
	Pennsylvania and vicinity 2,179.2 cwt. 40.6 %					Midwest 1,241.3 cwt. 23.1 %			Early South 1,519.3 cwt. 28.3 %		Intermediate 423.4 cwt. 8.0 %				100



Source: Survey data, 1987.

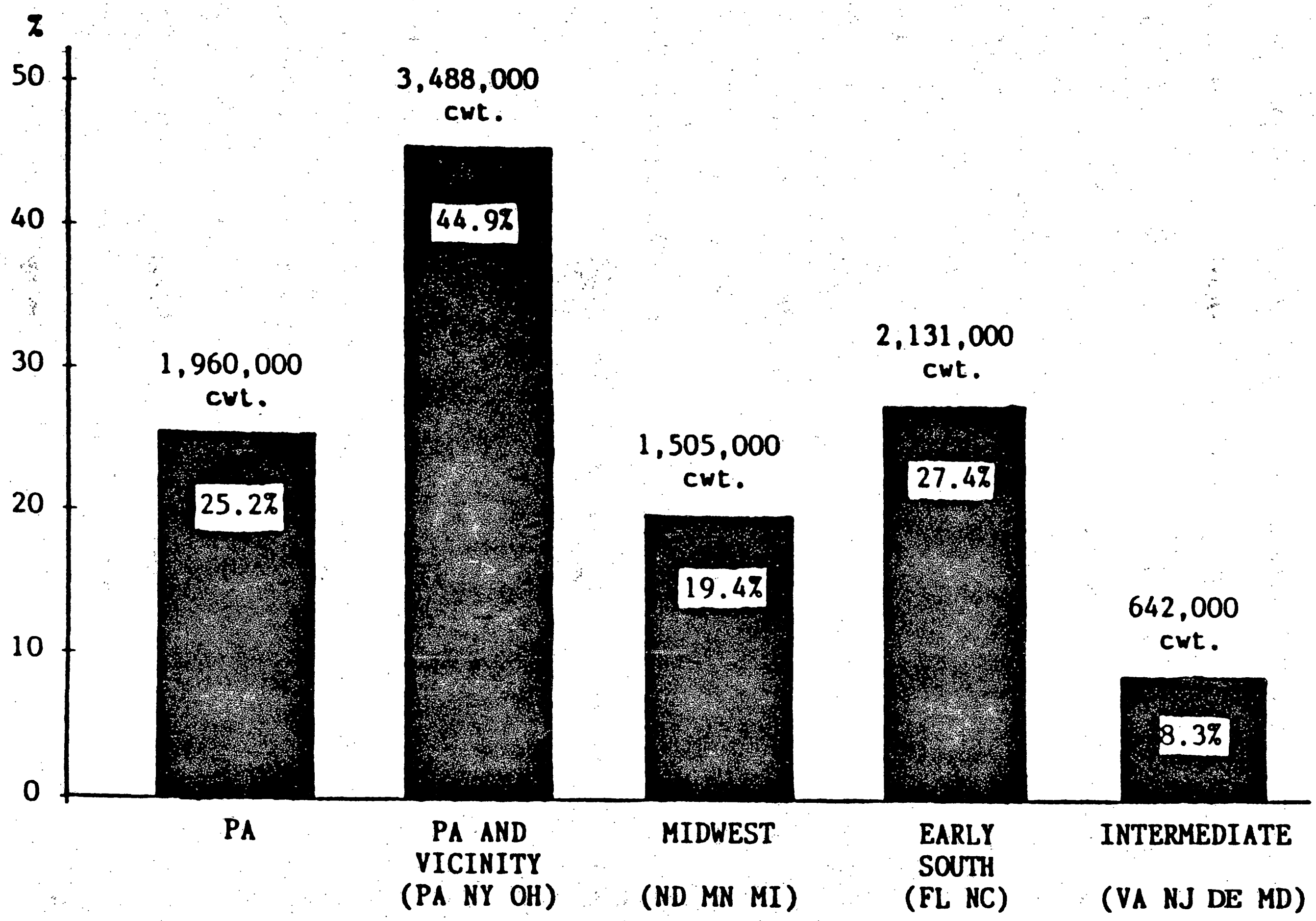


Figure 4: Percentage of Annual Raw Product Purchases by Supply Region for Fifteen Responding Pennsylvania Potato Chip Manufacturers. (1986-87 crop year)

Source: Survey data, 1987.

and North Carolina) harvest begins in late spring. The Intermediate Region (Virginia, New Jersey, Delaware, and Maryland) supplies chipping potatoes during the summer before the fall crop is harvested. On a crop year basis, in 1986-87 the Pennsylvania and Vicinity group supplied nearly 41% of responding Pennsylvania chip manufacturers' production needs; the Midwest Region supplied about 23%; the Early South just over 28%; and the Intermediate Region 8%. These purchasing patterns remained fairly stable over the five year period.

Contracting is the most common method of obtaining chipping potatoes. Among survey respondents, an average of 77.4% of potato purchases for fall and winter chipping were made by contracting with growers, brokers, or cooperatives. The remaining 22.6% of potato supplies were purchased on the open market in 1986-87. The level of contracting increased to 89.1% for spring and summer potato requirements.

Most of the potatoes used by Pennsylvania chip manufacturers during August come from Pennsylvania (Figure 5). Pennsylvania is also a major supply source during the fall. However, the percentage of Pennsylvania chip manufacturers' raw product requirements that are supplied by in-state growers declines through the storage season while the percentage supplied by other regions increases. The harvest seasons in New York and Ohio generally coincide with Pennsylvania's, and purchases from these states are of comparable cost because of their proximity. Since the cost of transportation is largely a function of distance, transportation costs from New York or Ohio may be comparable to in-state costs for Pennsylvania manufacturers not located near Pennsylvania's growing areas.

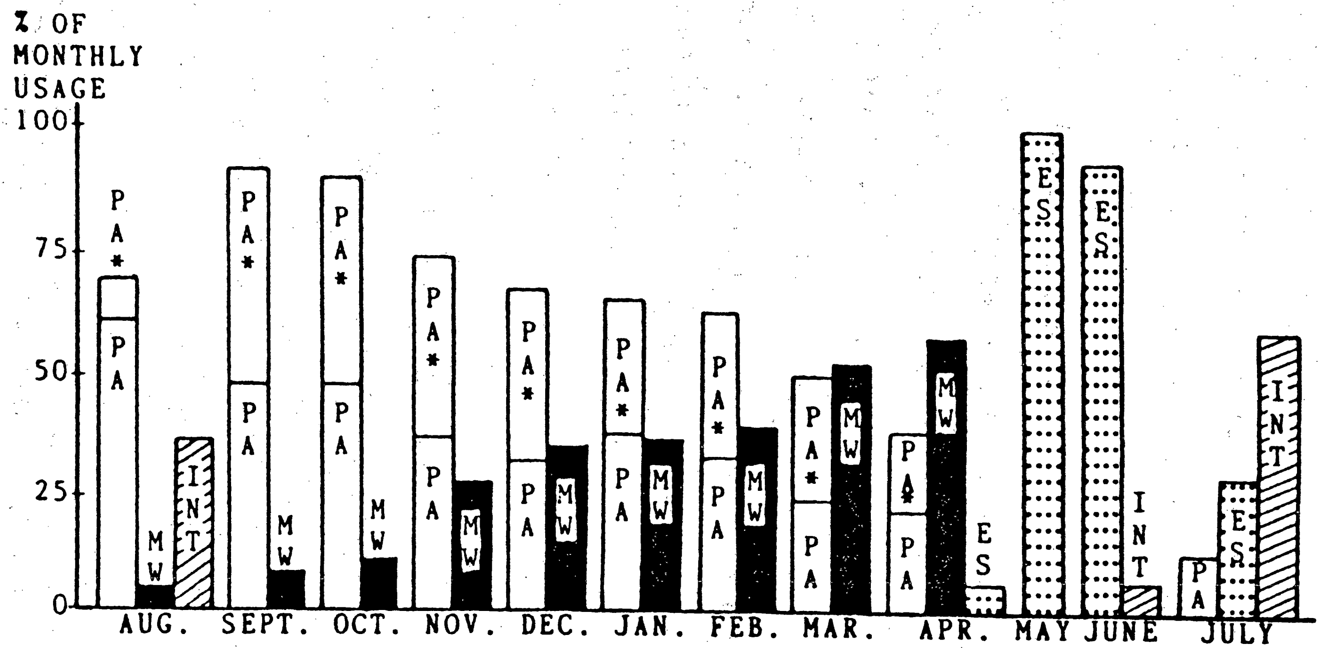


Figure 5: Seasonal Chipping Potato Supply Sources for Fifteen Responding Pennsylvania Potato Chip Manufacturers. (1986-87 crop year)

Source: Survey data, 1987.

KEY

- PA: Pennsylvania
- PA*: Pennsylvania and vicinity (PA OH NY)
- MW: Midwest (ND MN MI)
- ES: Early South (FL NC)
- INT: Intermediate (VA NJ DE MD)

Furthermore, in the interview process some chip manufacturers expressed the opinion that stored potatoes from New York are of higher quality due to superior storages and better harvesting practices. These cost and perceived quality factors may help explain the importance of New York and Ohio potatoes to Pennsylvania chip manufacturers. The percentage of stored chipping potatoes purchased from New York and Ohio late in the storage season is quite large.

The Red River Valley of North Dakota, a major potato producing region, supplied nearly all of the potatoes imported by Pennsylvania chip manufacturers from the Midwest Region in 1986-87 (Table 7). Michigan and Minnesota provided less than 1.5% of Pennsylvania chip manufacturers' purchases from the Midwest Region. Transportation costs incurred in shipping potatoes to Pennsylvania generally exceed the prices paid for Red River Valley potatoes. Higher transportation costs are about offset however, when comparing North Dakota potato costs to those of local potatoes, by the substantially lower prices of Red River Valley potatoes.[1]

Survey respondents indicated that favorable growing conditions and better handling practices in the Red River Valley result in a tuber with higher specific gravity that is better suited for long-term storage. Chippers believe they experience lower storage losses from tuber defects or mechanical damage incurred during harvest with North Dakota potatoes.

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1 Although North Dakota potato prices vary with the size of the harvest, they are consistently below the cost of transportation to Pennsylvania chippers. The landed cost of potatoes at the chipping plant is comparable whether the potatoes are produced in Pennsylvania or the Red River Valley.

This may partially explain their expressed preference for Red River Valley potatoes during the late storage season.

May marks the end of the storage season for fall-crop potatoes. Chippers shift to spring production regions for supplies. Potatoes can be stored longer, but chip quality declines with tuber quality which deteriorates with time in storage. Weight and quality characteristics such as color, flavor, and texture all decline during storage even in the best facilities. Therefore, once the spring crop is available in volume, Florida potatoes become more price competitive and are preferred.

In recent years, Florida has supplied all of the raw product used by these fifteen Pennsylvania chip manufacturers in May and approximately 50% of their needs in June. The potatoes grown in the Early South and Intermediate Regions are not well-suited for storage and are manufactured into chips soon after harvest. Potatoes are generally purchased from states in the Intermediate Region from June through August, to meet production needs until the early fall harvest begins.

Current Storage Patterns

Some chip manufacturers have sufficient storage capacity to meet their production requirements for several months and thus fill their storages at favorable harvest prices. Others with limited storage capacity, meet raw product needs by purchasing from Pennsylvania sources, those in other northeastern states, or the Red River Valley on an as-needed basis. Chip manufacturers generally have storage capacity for at least one week's processing needs to insure against possible transportation delays associated with unpredictable winter weather. Typically storages are filled at harvest and the potatoes are held for use beginning in early winter. All stocks are depleted by late April or early May, and any storage after that time during the spring and summer is of very short duration. The sixteen Pennsylvania chippers hold fall crop potatoes in storages an average of 3.75 months. An average of the longest periods of time these chippers have held potatoes in storage is 5.75 months.

Storage Losses

Survey respondents report average losses of 4.9% during the time that potatoes are held in storage. That is the weight loss, from shrink or spoilage, as a percentage of the weight of tubers placed in storage. It includes those tubers unacceptable for chipping when they're removed from the storage facility. Losses for individual firms vary from a reported 0 up to 15%. Generally firms without losses purchase on an as-needed basis or store only for very short periods. Firms that store in bulk have higher losses than those using crates, and firms without refrigeration or controlled humidity have higher losses than those with refrigeration and controlled humidity.

Soft rot is ranked as the most important cause of losses in chip manufacturer's storages with an average ranking of 3.125 (on a scale from 1 for most important cause of damage to 8 for not a problem) (Table 8). Shrink (weight loss) follows closely with an average ranking of 3.438 and bruise is third with an average ranking of 4.438. Sprouting, dry rot, black spot, and pressure bruising are preventable storage problems and do not cause significant losses among respondents. The only firms experiencing substantial pressure bruise losses are those who store in bulk, and these losses usually occur late in the storage season.

Table 8: Relative Importance of Causes of Storage Losses as Perceived by Sixteen Respondent Chip Manufacturers. (Pennsylvania, Fall 1987)

	Perceived Importance of causes of Loss[1]				
Cause of Loss	Major (1 or 2)	Moderate (3,4,5)	Minor (6 or 7)	Nome (8)	Average[2] Rank
Soft Rot	50.0%	31.25%	0	18.75%	3.125
Shrink	62.5%	6.25%	6.25%	25.0%	3.438
Bruise	37.5%	37.5%	0	25.0%	4.438
Dry Rot	6.25%	25.0%	6.25%	62.5%	6.375
Sprouting	12.25%	18.75%	6.25%	62.5%	6.438
Pressure Bruise	6.25%	31.25%	6.25%	56.25%	6.438
Black Spot	0	12.5%	18.75%	68.75%	7.063

Source: Survey data, 1987.

[1] Ranked from 1 for the most important cause of loss to 8 for least important or not a problem.

[2] Average rank was calculated by dividing the total of numberical ranks of all respondents by the number of respondents. The lower the average rank, the more important that characteristic is to respondent chip manufacturers. An average rank of 1.0 would mean that all respondents ranking that characteristic ranked it the most important.

According to survey respondents, better handling practices (reducing mechanical damage) by growers during harvest and by shippers during transport, improved storage facilities, and the appropriate use of chemicals are the most important ways of reducing storage losses.

Raw Product Costs

The cost/cwt. of raw product is the landed cost of potatoes at the plant. This cost includes transportation and other procurement costs such as brokerage fees or commissions. The weighted average cost of monthly purchases was calculated for each firm using the prices and quantities purchased under contract and on the open market each month. A weighted average industry raw product cost was also calculated for each month. Each firm's monthly raw product costs were weighted according to its proportion of total raw product used by all respondents. For example, a firm using 10% of the potatoes used by all respondents during a month would have their raw product cost weighted twice as heavily as that of a firm accounting for 5%.

The five-year industry average cost (Table 9) was calculated for the five-year period from the monthly weighted averages of industry costs to compensate for year to year potato production and price fluctuations. The failure of the 1987 Florida spring crop illustrates the impact such an event can have on chipping potato prices.

Landed raw product costs of firms using potatoes from their own long-term storages were excluded when calculating monthly industry costs. This was done to more accurately reflect the potential gains associated with storage. Inclusion of the three firms that currently operate long-term storages for much of their winter and spring raw product needs would

Table 9: Weighted Average Landed Raw Product Costs by Month. (Pennsylvania, 1982-83 to 1986-87)[1]

	1982-83	1983-84	1984-85	1985-86	1986-87	Average
August	5.93	7.11	6.73	5.99	5.92	6.34
September	5.99	6.91	6.95	6.34	6.20	6.48
October	6.29	7.19	6.68	6.78	6.48	6.68
November	6.60	7.73	7.37	6.95	7.11	7.16
December	6.79	8.01	7.66	7.44	7.53	7.49
January	7.47	8.33	8.16	7.79	8.00	7.95
February	7.89	8.77	8.45	7.90	8.24	8.25
March	7.69	9.10	9.13	8.36	8.69	8.59
April	8.61	9.63	9.31	8.79	9.46	9.16
May	8.45	8.18	8.32	8.27	11.80	9.00
June	8.05	7.84	7.63	7.72	11.28	8.50
July	7.68	8.22	6.54	6.96	7.93	7.47

Source: Survey data, 1987.

[1] Does not include three firms that had been purchasing at harvest and storing during the storage season.

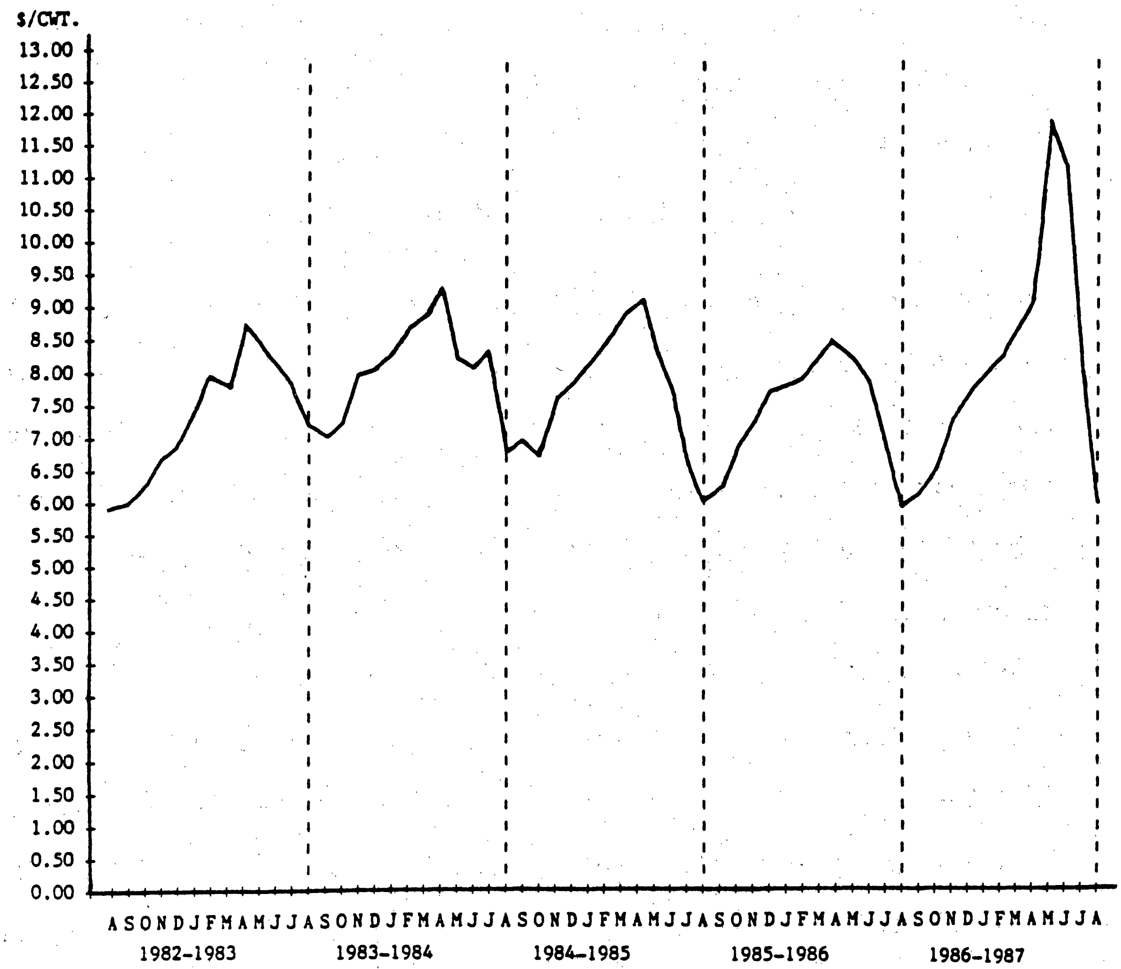
The price gain during storage (storage incentive) can be calculated by subtracting the average of the September and October landed cost when potatoes would be placed in storage, from the landed cost in the month removed from storage. In this analysis we used the 5 year average. For example the price gain for storing till March would be

$$\$8.59/\text{cwt.} - \frac{(6.48/\text{cwt.} + 6.68/\text{cwt.})}{2} = \$8.59 - \$6.58 \text{ or } \$2.01/\text{cwt.}$$

distort the measure of economic gains from storage. Their raw product costs were reported as landed prices at the time of purchase during the fall, and did not reflect increases in value associated with time in storage. Thus they had to be excluded in calculating a monthly industry weighted average cost per cwt.

The figures for the 1986-87 crop year are probably the most reliable since chipper data was most complete for that year. Although the data for earlier years do not include all firms due to incomplete respondent records, industry average costs exhibit the same seasonal behavior patterns each year (Figure 6). The cost at harvest varies from year to year, but the monthly pattern of variation is very consistent. The lowest cost occurs at the beginning of fall harvest in August and the highest cost at the end of the storage season in April. This increase in value of stored potatoes between harvest and later usage from storage provides the economic incentive to invest in new storage facilities. Costs of chipping potatoes sometimes vary from the norm. They did in the spring of 1987 when costs continued to rise in May and June due to Florida's crop failure which substantially reduced available supplies that year. However, that year's May and June costs would not directly affect the storage incentives for fall harvested potatoes because chippers would not normally be using stored potatoes in May. However, anticipation of these higher prices (by storage owners with knowledge of the impending shortage) may have increased April and earlier month's costs if stored potatoes intended for April use were held until May.

Over the five year period, the landed cost of potatoes used by responding Pennsylvania chippers increased an average of $2.58/cwt.



<u>Figure 6</u>: 'Landed Cost' of Chipping Potatoes in Pennsylvania, Including Transportation and Brokerage Fees. (Crop years 1982-83 to 1986-87)

Source: Survey data, 1987.

between the average raw product costs at harvest (Sept.-Oct.) and those of April the following year. This so-called "storage incentive" ranged from \$2.23 cwt. for the 1985-86 crop year to \$3.12/cwt. for 1986-87. Incentives for storing for shorter periods of time can also be calculated from Table 9. For example, in 1982-83, the incentive to store for use in February 1983 would have been:

$$\$7.89/\text{cwt.} - \left(\frac{5.99 + 6.29}{2}\right) \text{ or } \$1.75/\text{cwt.}$$

The usefulness of this table in calculating "storage incentives" will become more apparent later when those monthly "landed costs" of potatoes are used to evaluate storage strategies. Once the economic incentives for building storages are known, the amount of capital required to build such facilities and the costs of owning and operating them must be determined. Those costs are necessary to determine the expected profitability associated with storage ownership.

An economic-engineering approach was used to determine the level of investment that would be required to build modern facilities which would be used for storing late season chipping potatoes. Lists of materials and items of equipment were developed and the required numbers of each item, that would be required were determined. Total investment was determined by multiplying the number of units by the unit price of each. These were summed and the labor costs for installation or assembly were added.

ASSUMED MANAGEMENT PRACTICES, AND ESTIMATES OF INVESTMENT OUTLAY AND OPERATING EXPENSES ASSOCIATED WITH LONG TERM CHIPPING POTATO STORAGES

Advances in storage technology and management practices have enabled storage owners to reduce shrink losses and quality deterioration. The equipment necessary to maintain a proper storage environment is relatively inexpensive compared to the capital outlay for the storage itself or to the value of potatoes placed in storage.

The investment required for construction of storage facilities and the associated operating costs were estimated. Recommended management practices were assumed and are discussed where relevant.

Storage Design

A storage facility should maintain quality and minimize losses during storage. Those factors affecting potato quality through deterioration and weight loss during storage were kept in mind when designing storages and preventative measures incorporated.

A modular design was chosen to enable one to evaluate the profitability of different sized storages. Flexibility could be achieved by adding modules. The modular approach allows chipping firms to examine the outlays required, together with the associated costs and returns which are most relevant to individual potato useage requirements.

The envisioned basic storage structure is a wood-frame, metal-clad building with a concrete floor and incorporates features that are generally recommended for potato storage facilities (Table 10). Each unit (module) measures 48' by 84' by 16' and has a capacity of 12,000

Table 10: Potato Storage Structural Design Considerations

1.	Adequate structural design to withstand the internal vertical and lateral forces (only with bulk storages) imposed by the potatoes, and external forces imposed by wind and snow loads.
2.	Adequate insulation protected by a good vapor barrier to control heat transfer through walls and ceilings, so that proper conditions of temperature and humidity can be maintained. Exterior ventilation for walls and ceilings to allow escape of moisture which escapes the vapor barrier.
3.	An efficient layout for handling potatoes in and out of storage and any other functions that the facility serves.
4.	A ventilation system that will allow accurate and controlled air movement into the building and through the stored potatoes to control temperature and humidity as required.

Source: Hallee, N. D., and Hunter, J. Potato Storage Design and Management. University of Maine at Orono, Cooperative Extension Service, Bulletin N. 656, 1984.

cwt. (Figure 7). This size and configuration was chosen because it provides the greatest amount of storage capacity per investment dollar, and the unit would be compatible with the constraints imposed by environmental system capacities. In addition it is an appropriate size for potato reconditioning.[2]

In each of the envisioned modules potatoes would be stored in 1,200 crates, each holding 1,000 pounds. The crates would be stacked five high in twelve rows and each row would be twenty stacks long. Four inches would be allowed between rows of crates to permit visual inspection. A flashlight could be used to look between the rows for fluid leakage. Twelve inches would be allowed between crates and walls to minimize condensation on the potatoes. Each module would have an aisle approximately ten feet wide to permit movement of crates by forklift. The aisle could be used to increase storage capacity by approximately 10%. However, the crates in the aisle would have to be used first and could complicate the removal of crates of diseased or deteriorating potatoes, particularly when two or more of these modular storages are constructed with common walls. The doors are placed on the side of the building rather than the end to permit easy access to each unit when the facility is made up of four or more modules.

Potatoes for processing are generally stored in crates or pallet boxes rather than in bulk due to the greater ease of handling and to reduce losses. This premise is supported by survey results in which

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2 Potatoes should be processed into chips within a period of two to four weeks after reconditioning. Thus, the capacity of the individual storage unit should not exceed one month's production needs.

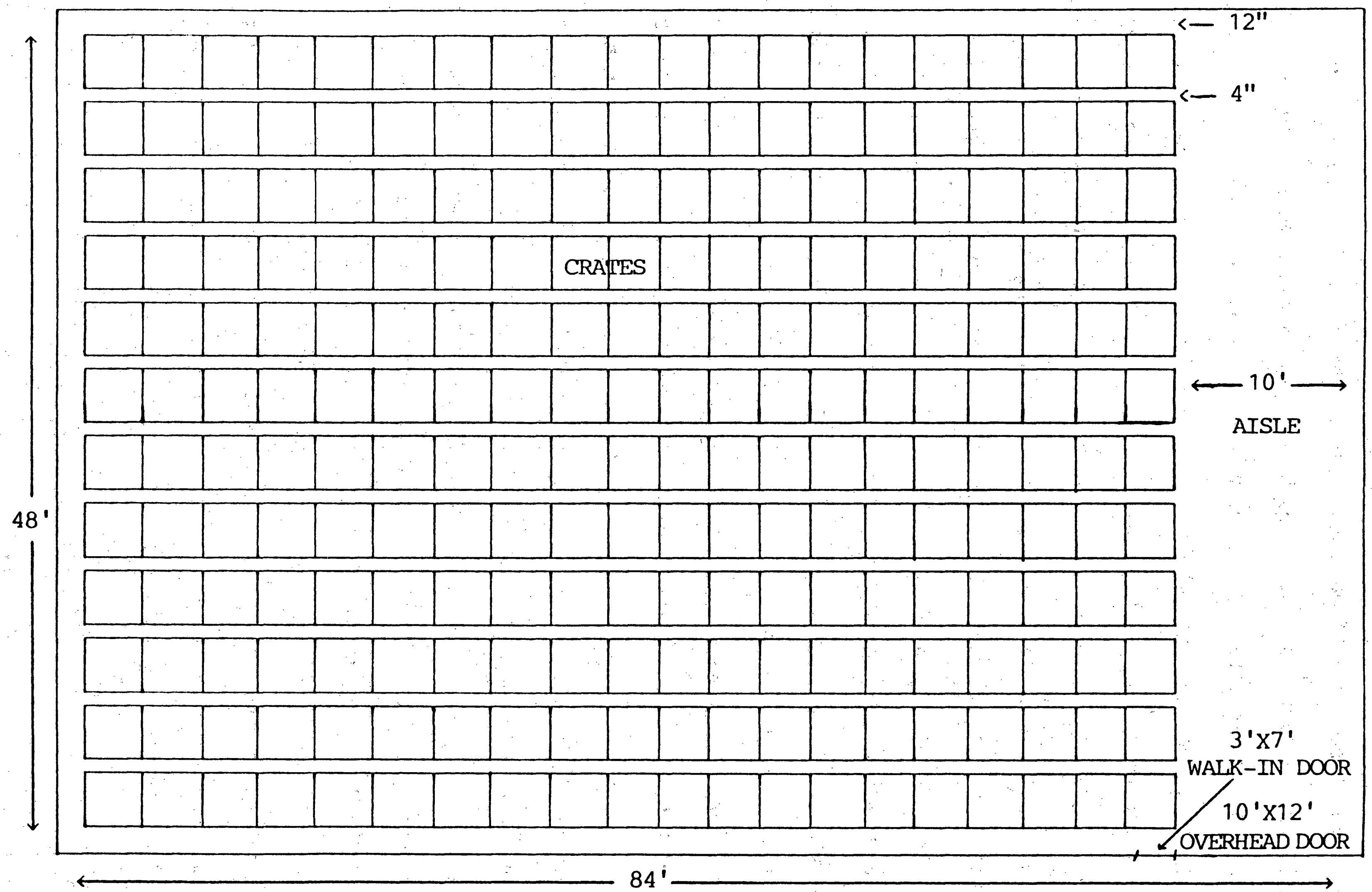

Figure 7: Storage Unit Module Design

average losses of 3.2% were reported by the respondents using crate storage compared to an average loss of 10.3% reported by firms with bulk storage. The greater losses in bulk storage may be caused by bruising of tubers during handling, the bruising of tubers at the bottom of the stack from the weight of potatoes above, as well as from the lack of control over quality changes consistant with various forms of deterioration. With crates or pallet boxes, damage from handling is reduced since the crates are moved rather than the potatoes themselves. The pressure on tubers stored in crates is limited to the weight of potatoes within the crate rather than the entire stack, and losses from damaged or diseased tubers can be contained within the crate rather than having the problem spread through the entire pile.

The additional investment required for crates and the larger area required to store a given quantity of potatoes are partially offset by lower losses and lower construction costs for walls that are then not required to bear the lateral pressure of a pile of bulk potatoes. Thus crate storage was chosen despite the higher initial outlay.

Growing and harvesting conditions are among the many factors beyond the control of the chipping firm storage operator that affect the storability of potatoes. However, management practices and the environment maintained within a storage facility are also important to tuber quality and affect storage losses. Proper temperature, humidity, and ventilation are essential for quality maintenance and minimization of losses and they are controllable by the storage operator.

The Storage Environment

The ventilation, heat, refrigeration, and humidification systems were chosen so that they would have enough capacity to meet requirements for the entire storage facility when it is completely filled (Table 11). Each 12,000 cwt. module as envisioned could operate independently. Thus equipment capacities, designs, and costs incorporated in the estimates were intended to enable many different levels of operation among the modules in a multi-module facility.

The ventilation system must provide adequate airflow through the potatoes to regulate temperature and humidity. The ventilating system can be used to distribute warm or cool air and moisture in conjunction with the heating, refrigerating, and humidifying systems. To satisfy all of these needs, the ventilating system must have an air flow capacity of 0.6 cu. ft. per minute for each hundredweight of potatoes to be stored.

While a high ventilation rate is necessary to remove "field heat" and excess moisture from the tuber when potatoes are first placed in storage, continuous high ventilation rates throughout the storage period result in higher weight losses. Sparks et al. (1968) found that ventilation on an intermittent basis resulted in less weight loss than continuous ventilation at the same flow rate.[3] Regardless of relative humidity, continuous fan operation resulted in a 1.6% greater weight loss than intermittent ventilation with the same flow rate.

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3 Intermittent ventilation describes a system in which tubers are supplied with air only as often and for as long as necessary to maintain a uniform temperature and humidity, in contrast to continuous ventilation where fans operate 24 hours a day.

Table 11: Ventilation, Refrigeration, Heat, and Humidification Systems Specifications and Total Investment ($/cwt.) in those Systems for Potato Storage Facilities

Storage Capacity (cwt.)		Refrigeration (BTU/hr.)		Ventilation (CFM)		Heat (BTU/hr.)		Humidity (Gal/hr.)		Investment In $/cwt.[5]
Design	Maximum[1]	Required[2]	Actual[3]	Required	Actual	Required	Actual[4]	Required	Actual	
12,000	13,200	95,040	109,000	7,920	8,400	18,000	85,000	48	50	0.882
24,000	26,400	190,080	212,000	15,840	20,200	36,000	85,000	96	100	0.697
36,000	39,600	285,120	330,000	23,760	30,000	54,000	85,000	144	150	0.661
48,000	52,800	380,160	421,000	31,680	40,400	72,000	85,000	192	200	0.714
72,000	79,200	570,240	658,000	47,520	48,600	108,000	125,000	288	300	0.778
96,000	104,600	760,320	767,000	63,360	68,800	144,000	150,000	384	400	0.741
120,000	132,000	950,400	988,000	79,200	78,800	180,000	200,000	480	500	0.656

[1] Maximum capacity of the storage facility if aisle is utilized.

[2] Capacity of environment control systems to satisfy maximum capacity requirements.

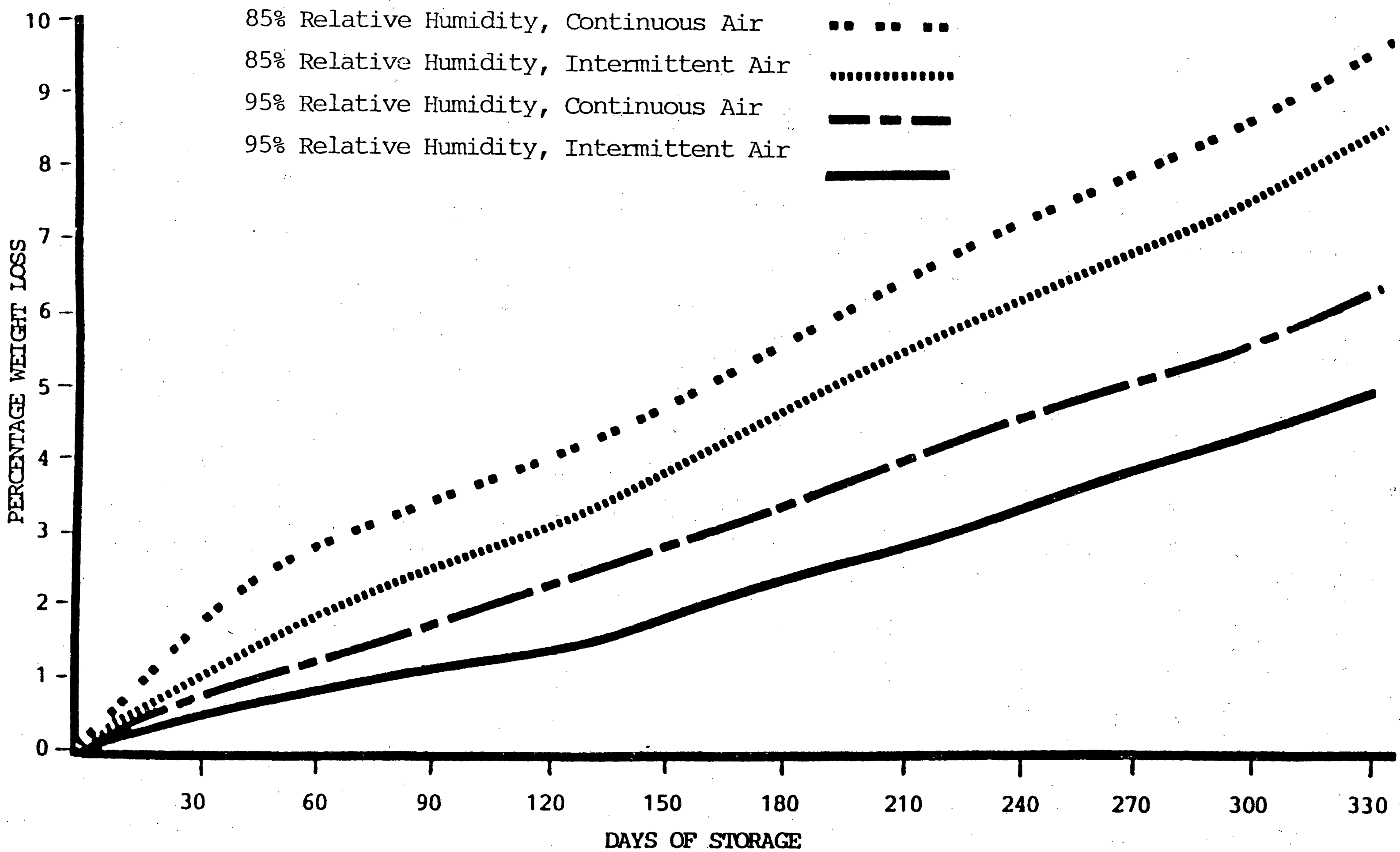
[3] Actual capacity of the environment control system; exceeds requirements due to available sizes.

[4] An oil-fired furnace with an 85,000 BTU capacity is the smallest practical size available.

[5] Investment required for storage environment control system in $/cwt. (design capacity); lumpy nature of investment per cwt. is due to the excess capacity of some systems.

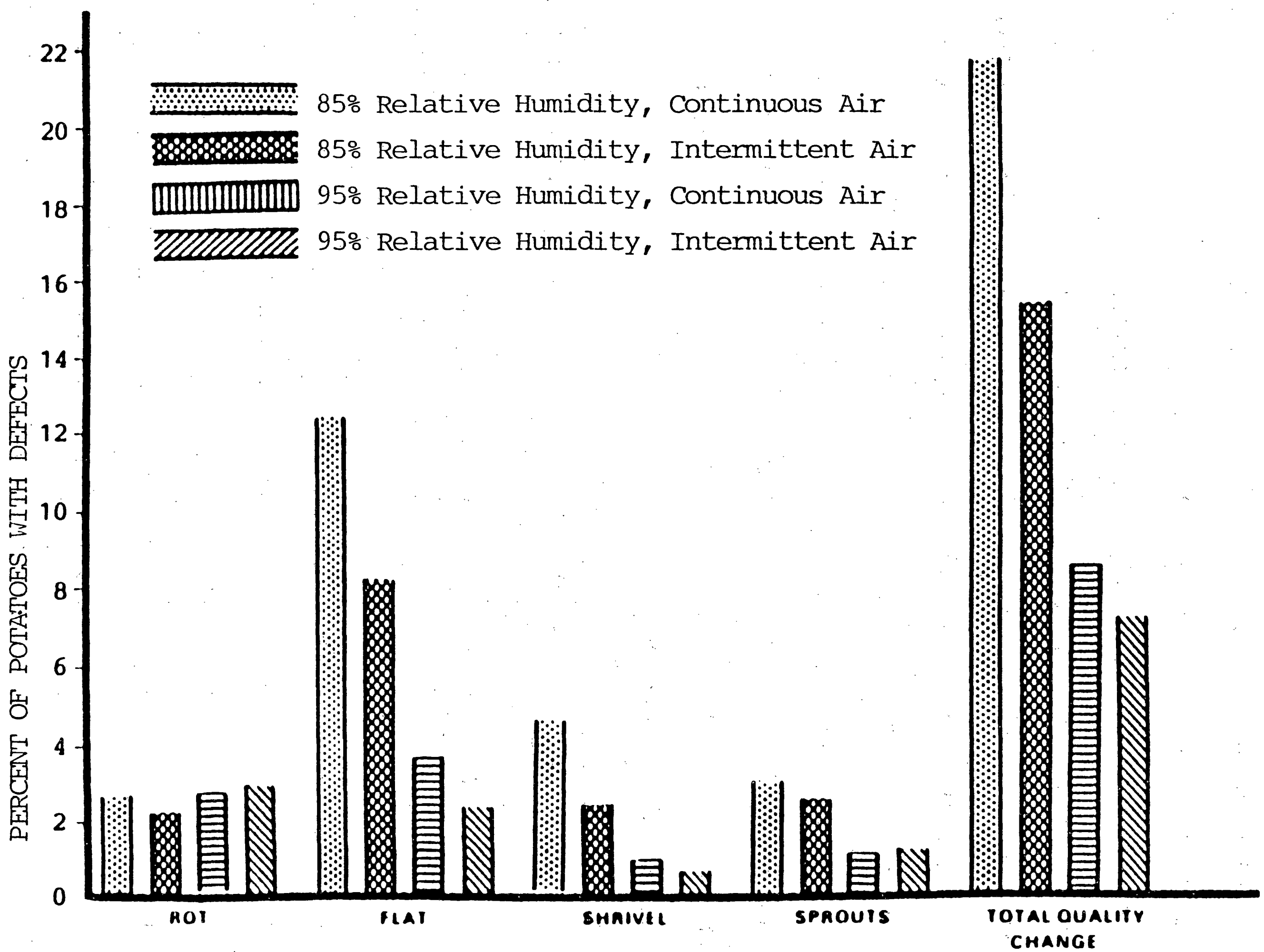
Control of relative humidity within the storage is essential for minimizing weight loss and healing wounds occuring during harvest and transport. Sparks et al. (1963) determined the importance of the air's relative humidity and its effect on weight loss during storage. The effects of ventilation method (continuous and intermittent) and humidity on weight loss are shown in Figure 8. Weight losses were considerably lower with intermittent ventilation using air of 95% relative humidity than with alternative storage environments. A 3.7% weight loss resulted after 270 days in storage with intermittent ventilation of 95% relative humidity air, compared to a 5.0% loss for potatoes receiving continuous ventilation with air of 95% relative humidity. Ventilation with air of 85% relative humidity resulted in weight losses of 6.8% if the ventilation was intermittent, and 8.0% if it was continuous.

The quality of stored potatoes must be considered in addition to weight losses. Quality of raw product is affected by both storage management decisions (such as the application of chemicals) and environmental factors. Sparks and Summers (1974) defined tubers as having grade defects if they contained rot, were shriveled, or had poor appearance due to sprouting or flattening. Intermittent ventilation with air of 95% relative humidity resulted in significantly less quality deterioration than alternate storage environments (Figure 9). The sum of all quality changes (including rot, sprouts, flat or shriveled tubers) under continuous ventilation with air of 85% relative humidity resulted in defects in 22.0% of the potatoes after 330 days in storage, compared to 7.0% for those receiving intermittent ventilation with air of 95% relative humidity.



<u>Figure 8</u>: Potato Weight Losses Over 330 Days as Influenced by Ventilation and Humidity

Source: Sparks, W. C., and Summers, L. V. Potato Weight Losses, Quality Changes and Cost Relationships During Storage. Idaho State University Agricultural Experiment Station Bulletin No. 535, 1974.



<u>Figure 9</u>: Potato Quality Changes After 330 Days as Influenced by Ventilation and Humidity

Source: Sparks and Summers, Ibid.

To minimize both weight losses and quality deterioration, the storage's environmental control system envisioned for this analysis, was designed to provide intermittent ventilation with air of 95% relative humidity.

Maintaining a storage temperature of not less than 50°F is important since temperatures that are too low, or which fluctuate too widely, contribute to the accumulation of reducing sugars and result in dark colored chips. Potatoes cannot be stored for extended periods at high temperatures either. Since outside air temperatures vary considerably during the storage period, both a heating and a cooling system are necessary.

Supplemental heat may be required in potato storages even though potatoes are living organisms and produce heat as they respire. That alone may not be enough. A well-insulated storage will require supplemental heating if:

1. The storage is filled to less than 50% of capacity during prolonged cold periods (-10°F or lower for periods of 4 to 5 days) or if:

2. Reconditioning is required (usually at 60°F) as it is for chipping potatoes stored at 50°F or if:

3. Humidity becomes too high and condensation occurs.

An oil furnace providing 1.5 BTU/cwt./hr. would be sufficient for any supplemental heating required for the envisioned storage.

Refrigeration is sometimes necessary to remove the field heat from potatoes when they are first placed in storage and to cool the ventilating air when outside temperatures exceed the 50°F storage temperature. Late fall temperatures that can reach 70-80°F would reduce the lifespan of potatoes in unrefrigerated storages. Refrigeration may be unnecessary in years without extended warm periods (a 4 to 5 day period when the minimum outside temperature exceeds 50°F). Cooling may not be required if potatoes are harvested at or below 50°F. However, harvesting or handling of potatoes when pulp temperatures are below 45°F should be avoided if at all possible. Harvesting or handling at low temperatures increases bruising.

The unpredictability of weather during the storage period and the frequent need to cool newly harvested potatoes as well as occasional warm weather late in the storage season requires a refrigerating unit to be incorporated in long-term storage facilities. A refrigerating unit with a cooling capacity of 7.2 BTU/cwt./hr. would be adequate to maintain stored tuber quality and reduce losses from unseasonably warm temperatures in most parts of Pennsylvania, most years. Refrigeration would be used most often during the two-week curing, or cooling, period at harvest and occasionally in the spring when outside temperature can be quite high.

Insulation is closely related to heating and cooling requirements and is one of the most important considerations in storage design because of its impact on operating costs. Insulation requirements depend on minimum outdoor temperatures during the storage period (Table 12). A minimum sustained temperature of -10°F was assumed in determining the insulation requirements of the envisioned storage.

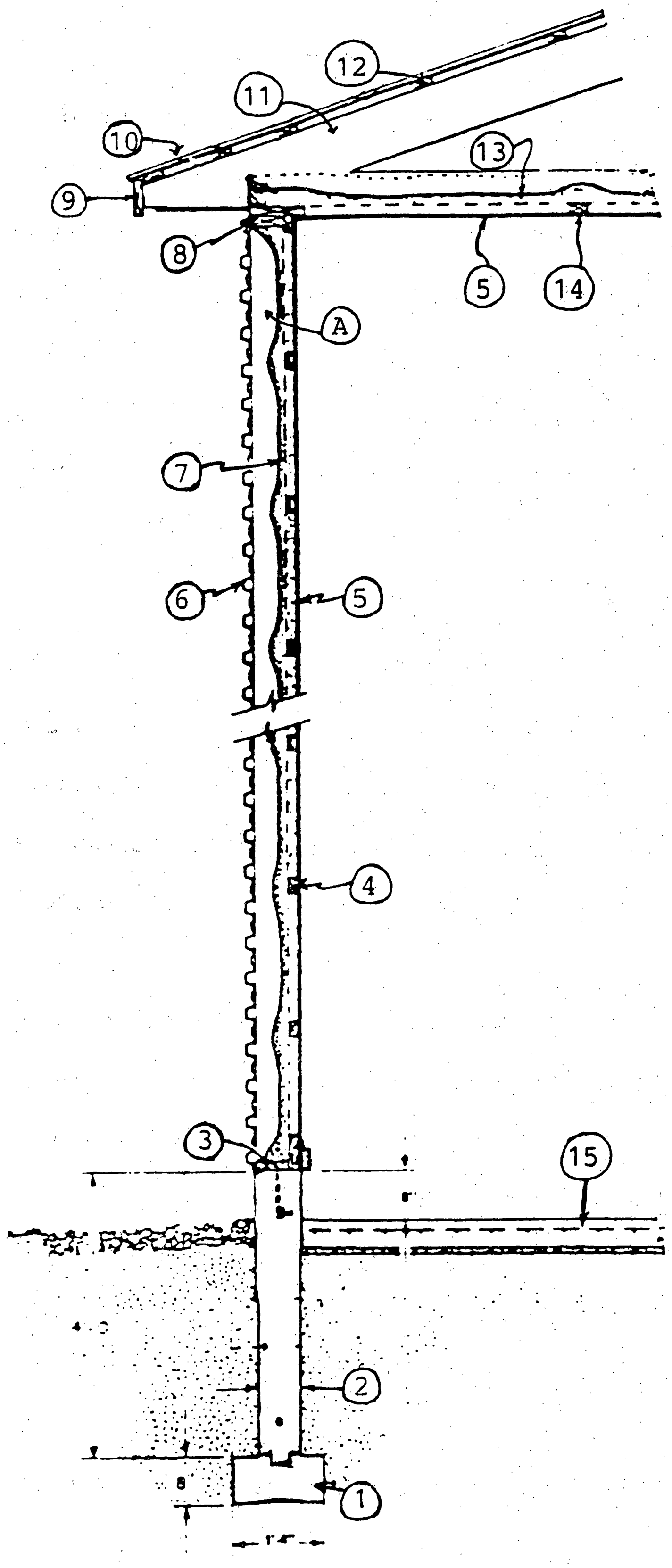
Design and material specifications for the storage building are shown in detail in Figure 10. The construction would remain the same for each additional module except that R-13 insulation would be used for interior walls (those separating two storage modules) in multiple unit

Table 12: Recommended Insulation Resistance Values (R) for Air-Cooled Potato Storages. (50°F, 95% RH)

Outside Minimum Temperatures (°F)[1]	Recommended R Values	
	Walls	Ceiling
10	17	22
0	21	28
-10	25	34
-20	30	40
-30	35	46

Source: Hallee and Hunter, Ibid.

[1] Minimum temperature sustained for a period of 4 to 5 days.



A. Studs 36" on center 2"x8"x16', #2 Douglas fir

1. Concrete footing, 8"x16", 4'-0" below ground
2. Concrete foundation wall, 10"x4', 2 #6 rebars continuous
3. 2"x8" pressure treated sill
4. 2"x4" interior strapping, 2'-0" o.c.
5. ½"select sheathing plywood
6. 26 gauge metal siding applied horizontally
7. R-26 insulation, vapor barrier toward outside
8. Top sill 2"x8", top plate 2"x12"
9. 2"x8" facia
10. 26 gauge metal roofing
11. roof truss
12. 2"x4" purlins
13. R-35 insulation, vapor barrier toward outside
14. 2"x4" ceiling strapping, 4'-0" o.c.
15. 5" concrete floor

Figure 10: Building Specifications

facilities rather than the R-26 insulation required for exterior walls. A multiple unit facility would generally have a flat roof rather than the pitched roof of the single unit. The flat roof's higher cost for trusses plus the additional siding required (due to the three foot depth of the flat truss) is about offset by the reduction in labor and roofing materials, resulting from the smaller roof area (Appendix A, page 93). Since the cost differential between the two is negligible, construction outlay estimates were calculated assuming all roofs to be pitched, whether for single or multiple units.

Estimated Outlays for Storage Facilities

The outlays required to build and equip 1,2,3,4,6,8, and 10 module storages were calculated and these calculations can be found in Appendix B. A summary of the investment levels and the outlay per sq. ft. and per cwt. both for designed and maximum capacity (aisles used) is presented in Table 13.

Construction materials and labor prices obtained from a variety of sources (Appendix A) were used to estimate the investment required for various sized storage facilities (Appendix B). To simplify analysis, the construction site was assumed to be level and free of obstructions, requiring only minimal excavation. Concrete and lumber prices were provided by State College, Pennsylvania suppliers and insulation prices (materials and labor) were obtained from a State College, Pennsylvania contractor. Refrigeration and ventilation equipment prices were quoted by several suppliers of such equipment. Most labor costs are from Dodge Construction Manuals, and are adjusted for locality. Plumbing and electrical service outlays were calculated as a percentage of

Table 13: Investment Outlay Required for the Construction and Equipping of Storages. (Central Pennsylvania, 1988)

Number of Units	Capacity (cwt.) Design	Maximum	Initial Investment	$/Ft^2	$/cwt. Design	Maximum
1	12,000	13,200	$63,378	15.72	5.28	4.80
2	24,000	26,400	$112,405	13.95	4.69	4.26
3	36,000	39,600	$166,402	13.76	4.62	4.20
4	48,000	52,800	$220,411	13.67	4.59	4.17
6	72,000	79,200	$324,995	13.43	4.51	4.10
8	96,000	105,600	$421,857	13.08	4.39	3.99
10	120,000	132,000	$511,609	12.69	4.26	3.88

Source: Computations, Appendix B.

construction costs based on Dodge Construction Manual figures for a refrigerated warehouse. General overhead includes additional expenses not previously counted, such as permits, licenses, insurance during construction, and other miscellaneous expenses.

Economies of size are gained with larger storage facilities, mostly because interior walls are less expensive than exterior walls and one wall serves two adjoining modules. The investment required for a single storage unit is $5.28/cwt. ($63,378/12,000 cwt.) and decreases with each added unit to $4.26/cwt. ($511,609/120,000 cwt.) for a ten-unit facility (Table 13). Additional, but smaller and smaller economies could be realized with even larger facilities.

The accuracy of the construction estimates was confirmed by a bid from a Bellefonte, Pennsylvania building contractor for a single storage unit (basic structure excluding specialty equipment). The calculated estimate was only 0.1% or $43 greater than the bid of $40,000.

The land area occupied by a single unit (12,000 cwt.) storage facility is approximately one-tenth of an acre. Some additional land around the building would be necessary for drainage, room for trucks to maneuver when filling the storage, etc. Real estate values vary greatly with location. To simplify this analysis, it was assumed that sufficient land for the storage would have been previously owned by the firm building it. When considering an investment in a long-term chipping potato storage building, the investor should include the cost of land and site preparation costs as part of the storage facility investment.

Crates, although not part of the structure, are a part of the investment necessary for the storage operation (Table 14). The 1,200 hardwood crates required for each unit currently cost about $20.00 each.

All construction cost estimates are for the State College, Pennsylvania area during the spring of 1988. The actual investment required may vary somewhat by location.

Estimated Operating Expenses

Annual operating expenses must be estimated before annual net gains from storage can be calculated (Annual storage incentive minus annual operating costs equals net storage gain.) It is this net gain per year which must be compared to the level of investment indicated in Table 14. Operating costs include real estate taxes, insurance, maintenance, labor, utilities and chemicals used to treat storage potatoes.

Property taxes vary with location. Real estate tax estimates were based on the average tax rates for areas where chipping plants are currently located. The average annual effective tax rate is 0.254% of the market value of a structure. It is assumed market values would be equal to the cost of construction and that taxes would be paid in equal quarterly amounts (0.0635%). Property taxes for the land on which the building would be situated were not included in this financial analysis since the land was assumed to be previously owned and taxed. Taxes on that land would be included if additional land would be purchased for the purpose of building a storage facility.

Insurance premiums vary greatly among locations and insurance companies. In State College, fire and liability ($300,000 liability

Table 14: Total Investment Required for Potato Storages of Various Capacities Including Building, Equipment, and Crates. (Central Pennsylvania, 1988)[1]

	Dollars			
Number of Modules	Initial Investment[2] in Bldg. and Equip.	Initial Investment[3] in Crates	Total Investment	Total Inv./cwt.
1	63,378	24,000	87,378	7.28
2	112,405	48,000	160,405	6.69
3	166,402	72,000	238,402	6.62
4	220,411	96,000	316,411	6.59
6	324,995	144,000	468,995	6.51
8	421,857	192,000	613,857	6.39
10	511,609	240,000	751,609	6.26

[1] This is the total new outlay, assuming the land for the storage site is already owned. If it isn't, land purchase costs would be added to determine the level of the new investment.

[2] Source: Table 13, page

[3] Calculated - 1,200 crates per module at $20.00/crate equals $24,000/module.

limits) rates in 1988 were 0.8% of the market value of the structure.[4] Contents of the building could be insured at the same rate, based on market values. For example, potatoes could be valued at their purchase price at the time they were placed in storage. Premiums were assumed to be paid quarterly. Insurance costs were estimated so that those levels of insurance would cover the building and the maximum quantity of potatoes in storage during a quarter. It was assumed premiums would be paid at the beginning of each quarter. Thus the September payment provides coverage for October, November, and December. Calculation of insurance premiums for the maximum inventory at 0.2% of their value at the beginning of the quarter, results in some excess coverage during the period when potatoes are removed from storage since inventory is reduced during those three months.

Maintenance of the structure, the crates, and equipment is necessary to protect the initial investment and keep the facility in satisfactory condition. It was assumed that most annual maintenance expenditures would occur in July, when the facilities would be empty, prior to the upcoming storage season. Annual maintenance expenses were calculated at 0.5% of the initial outlay for the building and equipment and 2% of the

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4 State Farm Insurance. See Appendix A, page 97.

initial outlay for crates.[5] Crates require more maintenance as a result of moving and handling.

Labor expense includes only the labor required to move potatoes into and out of storage. It represents the additional labor above that required if potatoes were going directly to processing upon arrival at the plant. Some labor is required to unload potatoes from trucks and place them in crates (held in a receiving area until processed) regardless of whether or not they go into storage. Thus, labor expenses cover only the additional labor required to place potatoes in and remove them from storage.

The $0.025/cwt. labor charge is based on an assumed $12.00/hour labor cost for a forklift operator who would move an average of 25 cwt. every three minutes (Appendix A, page 93). The same charge applies to potatoes as they are taken out of storage. The $0.025/cwt. expense is considered constant for all sizes of storages, despite differences in distance traveled, because travel time differences are small when compared to the fixed time required to pick up and place the crates at each end of the trip.

The quantities of fuel oil and electricity for heating, cooling, and ventilating were calculated for each unit, taking into account average monthly temperatures in Central Pennsylvania and the resulting

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5 Maintenance rate of 0.5% each year was recommended by Paul Patterson from the University of Idaho based on his research. New storages and equipment would require less maintenance and older ones more. In this analysis we are assuming a 20 year life for the facilities and thus higher building maintenance costs which might occur after that time are not reflected in these cost estimates.

heat losses or gains through the walls and ceilings of each building and the heat produced by potatoes during respiration. An oil-fired furnace was selected for heating despite a slightly greater investment outlay than for an electric furnace. The savings from lower operating expenses as a result of using oil rather than electricity would equal the higher investment outlay for the furnace in less than one year. Electricity would be required for refrigeration, ventilation, and lighting.

Monthly utility expenses would vary with the quantity of potatoes in storage. Monthly utility expenses (Table 15 and 16) were calculated using prices of $0.60/gallon for no. 2 fuel oil and $.06/kilowatt hour for electricity.[6] For multiple units it was assumed that equal volumes of potatoes would be placed in storage in September and October. Thus, the utility expenses in September are for a storage half filled. The October utility expenses are calculated for a full storage and reflect the higher cost of cooling those potatoes placed in storage during October plus the cost of maintaining temperatures on those potatoes placed in storage and cooled down during September. Total monthly utility expenses decrease as the individual units are emptied, since only units containing potatoes are heated or cooled and ventilated. The full monthly charge is assessed for any unit containing potatoes, whether full or not. A $10 electrical service fee is included for any month when the storage is empty and assumes only minimal power usage.

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6 The price for No. 2 fuel oil was quoted by Martin Oil in State College, Pennsylvania during the fall of 1987. The electrical rate was quoted by Pennsylvania Power and Light and was for industrial users in the spring of 1988.

Table 15: Utility Expenses for Cooling, Heating, and Ventilating by Size and Months of Storage.[1]

	Number of Units									
	1	2	3	4	5	6	7	8	9	10
	Dollars[1]									
	Cooling (Electricity)[2]									
Sept.	94	179	264	347	429	511	593	675	757	839
Oct.	19	36	54	71	88	104	121	137	154	170
	Heating (Fuel Oil)[3]									
Nov.	21	34	48	61	73	85	97	109	121	133
Dec.	51	85	119	151	181	210	240	269	299	328
Jan.	59	98	138	175	210	244	279	313	348	382
Feb.	51	85	119	151	181	210	240	269	299	328
Mar.	32	53	75	95	114	132	151	169	188	206
Apr.	5	8	11	14	17	20	23	26	29	32
	Ventilating (Electricity)[2]									
Sept.	79	158	237	316	395	474	553	632	711	790
Oct.	62	123	123	185	308	369	431	492	554	615
Nov.	39	78	117	156	195	234	273	312	251	390
Dec.	41	82	123	164	205	246	287	328	369	410
Jan.	41	82	123	164	205	246	287	328	369	410
Feb.	37	74	111	148	185	222	259	296	333	370
Mar.	41	82	123	164	205	246	287	328	369	410
Apr.	40	80	120	160	200	240	280	320	360	400

[1] All utility expenses are based on the average monthly temperatures for Harrisburg, Pennsylvania (September, 65°F; October, 53°F; November, 42°F; December, 31°F; January, 28°F; February 29°F; March, 38°F; April, 48°F).

[2] Cooling and ventilating costs are based on $0.06/KW; the price was quoted by Pennsylvania Power and Light for industrial users in the spring of 1988.

[3] Heating costs are based on $0.60/gal. for No. 2 fuel oil; the price was quoted by Martin Oil Company in the fall of 1987.

Table 16: Total Monthly Utility Expenses ($) by Size of Storage

	Number of Units									
	1	2	3	4	5	6	7	8	9	10
	Dollars									
Aug.	10	10	10	10	10	10	10	10	10	10
Sept.	173	337	501	663	824	985	1146	1307	1468	1629
Oct.	81	159	177	256	396	473	552	629	708	785
Nov.	60	112	165	217	268	319	370	421	472	523
Dec.	92	167	242	307	386	456	527	597	668	738
Jan.	100	180	261	339	415	490	566	641	717	792
Feb.	88	159	230	299	366	432	499	565	632	698
Mar.	73	135	195	259	319	378	438	497	557	616
Apr.	45	88	131	174	217	260	303	346	389	432
May	10	10	10	10	10	10	10	10	10	10
June	10	10	10	10	10	10	10	10	10	10
July	10	10	10	10	10	10	10	10	10	10

Source: Summation by month of expenses listed in Table 15 when potatoes are in storage plus an assumed ten dollar per month electrical fee when the storage is empty (assuming nominal usage).

* This table is the estimated total utility expense by month for heating or refrigerating and ventilating.

Application of the chemicals Mertect and CIPC are necessary to maintain quality and reduce losses. Mertect is a liquid applied in diluted form to potatoes entering storage to reduce the incidence of rot. One gallon of Mertect, currently selling for $94.00, will treat approximately 6,100 cwt. at a cost of $0.015/cwt. Although the process is mostly mechanical, $0.005/cwt. has been included to cover labor. CIPC sprout inhibitor is applied as a gas through the ventilating system. It is used on potatoes that are to be held in storage past December. Potatoes used from storage before or during December are not treated because sprouting isn't a problem that early in the season. Application during November, for those potatoes stored for usage in later months is usually contracted. The cost is about $0.08/cwt for materials and labor. A list of the monthly operating expenses for a single unit (12,000 cwt.) storage in which potatoes are placed in storage in September and removed for processing in April is presented in Table 17. Tables similar to Table 19 (page 67), summarizing monthly expenses (outflows) and gains (inflows) incurred by larger units and those utilizing different storage patterns are found in Appendix C.

Potato Losses During Storage

Weight and quality losses are not typically included as an operating expense. Nevertheless they are a cost of storing potatoes. Such losses can have a significant impact on the profitability of storage operations. Some loss will occur, despite the quality of the environmental systems and management practices employed to minimize them. The percentage of stored potatoes which are lost varies with time in storage. This loss

Table 17: Estimated Monthly Operating Expenses for a Single Storage Module (12,000 cwt.) in Which Potatoes are Stored in September and Removed for Processing in April.[1]

	Taxes[2]	Insurance[3]	Mertect[4]	CIPC[5]	Labor[6]	Utilities[7]	Maintenance[8]
	dollars						
Aug.						10	
Sept.	40	285	240		300	173	
Oct.						81	
Nov.				960		60	
Dec.	40	285				92	
Jan.						100	
Feb.						88	
Mar.	40	285				73	
Apr.					300	45	
May						10	
June	40	127				10	
July						10	797

Note: All values are rounded to the nearest dollar.

[1] A single unit holding 12,000 cwt. of potatoes all of which are assumed used in April. Timing and level of expense varies with the month in which potatoes are used.

[2] Taxes are based on the market value (cost in this case) of the structure at an annual rate of 0.254%, or 0.0635%/quarter.

[3] Insurance is paid quarterly at 0.2% of the market value (cost in this case) of the structure and 0.2% on the value of potatoes (at purchase cost) in storage during that quarter.

[4] Mertect materials and labor - $0.02/cwt. Applied when placed in storage.

[5] Contracted CIPC application to inhibit sprouts - $0.08/cwt. Applied in November but used only on potatoes to be stored after December.

[6] $0.025/cwt. for labor when placed in storage and again when removed from storage.

[7] Utilities vary with utilization pattern because empty units are not heated, cooled, or ventilated, but a $10/month charge is assessed even when the storage is empty.

[8] Maintenance is based on 0.5% of structure cost plus 2.0% of crate cost and is assumed to occur in July.

must be accounted for since it reduces the quantity of usable potatoes taken from storage and therefore the net gains from storage. The dollar value of weight and quality losses is calculated by multiplying the percentage of loss (for the month taken out of storage) by the landed cost of potatoes for that month (Table 18).

Table 18: Cost of Quality and Weight Losses by Time in Storage

Days In Storage	Percent Loss[1]	Cost ($/cwt.)[2]	$ Value of Loss/cwt.[3]
30 (Oct.)[4]	0.88	6.68	0.059
60 (Nov.)	1.50	7.16	0.107
90 (Dec.)	2.04	7.49	0.153
120 (Jan.)	2.64	7.95	0.210
150 (Feb.)	3.54	8.25	0.292
180 (Mar.)	4.56	8.59	0.392
210 (Apr.)	5.56	9.16	0.509

Source of weight and quality loss percentages: Sparks and Summers, Bulletin 535

[1] Total weight and quality losses.

[2] Five year average landed cost of potatoes by month purchased: provided by responding chippers (crop years 1982-83 through 1986-87, Table 9).

[3] Percentage loss multiplied by landed cost per cwt. of potatoes for that month. Thus a dollar loss per cwt. of potatoes placed in storage.

[4] Assumes potatoes are put into storage during September and October so that by the end of October most will have been stored an average of 30 days.

ANALYZING INVESTMENTS IN CHIPPING POTATO STORAGE FACILITIES

Investment decisions are among the most important that businesses make. Large expenditures for land, buildings, equipment, and other assets have a great impact on the future operations, flexibility, and earnings of the firm. Thus, careful consideration of investments, starting with objective information and utilizing sound evaluation procedures, is imperative.

While investment decisions are critical to the success of a business, they are also among the most difficult to make. Most investments involve large immediate capital outlays, from which future cash inflows are expected to result. One difficulty associated with investment decisions is that knowledge about the future is not available. At best these decisions are based upon carefully thought out estimates. Once estimates of costs and benefits associated with an investment are made and the amount of the outlay for the investment determined the problem of comparing the initial outlay for an investment with its future returns net of future costs remains.

A brief discussion of cash flows, as opposed to accounting costs and returns, and the time value of money are a necessary first step. That discussion is followed by descriptions of two methods useful in evaluating capital investments. The two are <u>the payback period</u> and <u>the discounted internal rate of return</u> method. Each uses the investment outlays, operating costs, and benefits previously developed.

Cash Flows

Only those cash costs and cash inflows associated directly with a new investment should be included. Cash costs or cash inflows that do not change are irrelevant. Costs that will be incurred and cash inflows that would be achieved without making the investment are not affected. Thus they are irrelevant.

Cash costs rather than total economic or accounting costs are used in analyzing investments. Depreciation, for example, is a non-cash cost. It's purpose is to allocate a portion of the initial investment in an asset to each year of its useful life. This accounting procedure spreads the outlay for a new investment over its active life and avoids assigning very high costs to the period when the investment is made and correspondingly lower costs in succeeding years. To do otherwise would distort levels of profit from year to year due to over or under charging of expenses. However, a business making an investment has to make the cash outlay at the beginning before any benefits are realized. The business is interested in the cash outlay and the future cash inflows associated with the new investment. Of course the business expects net cash inflows to exceed the initial cash outlay for the investment and to provide it with some profits. Depreciation on the financial statement is simply a charge against a period's income and as such, reduces the firm's income tax obligation but does not otherwise affect cash flows. Depreciation shields cash inflows from taxes assuming that the firm would otherwise have taxable income and thus it may reduce the cash outflows for taxes. This analysis is being performed without making a provision for income taxes; on a before-tax basis. Depreciation and other non-cash costs are thus not included as expenses in this analysis.

Interest paid, although a true cash cost, is also excluded from the cash flows used in evaluating capital investments. The reason for excluding interest paid on borrowed money is that in discounting cash flows for an (IRR) analysis, the interest on borrowed money together with the returns expected on a business's other sources of capital are combined and used as a benchmark or cutoff level to determine an acceptable rate of return for investment. Inclusion of the interest expenses in estimating cash outflows would result in a type of double counting. It would reduce the level of net cash inflows associated with the investment and distort the value of benefits. Finally using these distorted figures to calculate the IRR associated with an investment would provide an incorrect rate of return on it.

Only cash inflows resulting directly from the investment should be included. Since many operating costs (cash outflows) and cash inflows resulting from use of the new investment occur at the same time during the year, it is easier to net them out. If cash inflows in such periods are greater than outflows of cash, net cash inflows are positive. If inflows are less than outflows, net cash inflows will be negative.

Capital outlays for an investment are a special kind of cash outflow. They occur at the beginning of the venture and represent the capital placed at risk if the investment is made. Operating costs and returns during future periods are different. They occur throughout an asset's (investment's) lifetime. As discussed earlier, only incremental cash flows (those directly associated with the investment) are used in investment analysis.

Some cash outflows such as most taxes, insurance, chemicals, utilities associated directly with the storage and for purchase of potatoes to place in storage are clearly a result of the investment in a storage facility since they would not otherwise be incurred. However, the labor expenses associated with storage investments are harder to identify. Only the labor required because of the storage operation should be included in cash flows. Some labor is necessary for unloading and handling of potatoes going into production. If the potatoes are being placed in or removed from storage at the plant a little more labor is required. Labor expenses associated with normal production should not be included in the cash outflows associated with this new increment of business (storing).

Inflows are gained by using potatoes from storage. Since this takes place within the firm no actual cash changes hands but the value of potatoes used from storage, since they are higher than landed values, can be viewed as cash savings for the business and thus are treated like cash inflows. The inflows attributable to storage are the potato values at the time of removal from storage. They are calculated by multiplying the quantity of potatoes used in a particular month by the average landed cost of potatoes that month, after an adjustment for weight and quality losses. Losses reduce cash inflows by an amount equal to the percentage of loss incurred by the time the potatoes are used, multiplied by their average landed cost during that month (Table 18, page 61). We have followed this method in Table 19 and in Appendix C.

Cash outflows are subtracted from cash inflows each month to determine the net gains attributable to storage. Monthly net cash flows result (Table 19). Monthly net cash flows are summed to provide the annual net cash flows for various storage sizes and usage patterns. Other cash flow tables for smaller storages and other usage scenarios can be found in Appendix C.

Time Value of Money

The concept of a "time value of money" can be employed to fairly and equitably compare cash flows that do not occur at the same instant in time. Use of this concept recognizes the fact that a dollar received immediately is more valuable than a dollar received sometime in the future. The same concept can be applied to payments or cash outflows. A dollar paid out immediately is worth more to the recipient (of higher cost to the party disbursing it) than a dollar paid sometime in the future. The timing of cash flows can greatly affect the profitability of an investment since the major cash outflow (the investment outlay) takes place immediately, while the benefits accrue over many future periods. A dollar of cash inflow obtained several years in the future is of much less value than the dollar now used to make the investment. One reason that a dollar received immediately is more valuable than one received a year from now is because the dollar in hand can be used to make other new investments and gain the benefits associated with them. This point is perhaps best illustrated by example. A dollar available now, could be invested and earn a return. If the dollar were deposited in an interest bearing account at a bank, the interest earned would be the return on the investment. The sooner it is deposited, the greater the amount of

Table 19: Monthly Cash Flows of 120,000 cwt. Storage for Usage in December - April. (24,000 cwt. per month)

	OUTFLOWS								INFLOWS		Net
	Taxes	Insurance	Mertect	CIPC	Labor	Util.	Maint.	Potatoes	Potatoes	Loss[3]	Cash Flows[2]
	dollars[1]								dollars[1]		dollars[1]
Aug.						10					- 10
Sept.	325	2602	1200		1500	824		388800			-395251
Oct.			1200		1500	785		400800			-404285
Nov.				7680		523					- 8203
Dec.	325	2287			600	738			179760	-3667	172143
Jan.					600	641			190800	-5037	184522
Feb.					600	432			198000	-7009	189959
Mar.	325	1339			600	259			206160	-9401	194236
Apr.					600	88			219840	-12223	206929
May						10					- 10
June	325	1023				10					- 1358
July						10	7358				- 7368

Estimated Annual Net Cash Inflow $ 131304

[1] All values are rounded to the nearest dollar.

[2] All outflows and losses are negative and all inflows are positive. Negative values in the net cash flows column indicate net cash outflows for that month.

[3] Loss calculations in this column will not be exactly equal to the result one would get by mulitplying the value of loss/cwt. from Table 18 by 24,000 cwt. because of rounding the value of loss/cwt. to the nearest tenth of a cent.

interest that would be accumulated by a specified future time. If 6% interest could be earned on the dollar, it would have a value of $1.06 at the end of a year. However, a dollar received a year from now would be worth only one dollar. Thus, a dollar received a year from now is only worth $1.00/1.06, or 94.33 cents now if it could have been invested at 6%. Investing 94.33 cents at 6% would provide a dollar a year from now. Using the same method, a dollar to be received in two years is worth 89 cents now (if it could be invested at 6% annually), and on and on.

Since a dollar received at some future time is worth less than one received now, the timing of cash inflows and outflows is important. Most investments require a large capital outlay at the outset and their benefits take the form of a future stream of net cash inflows which will presumably make the investment profitable. Those future inflows must be discounted to their present or current values before they can be compared with the initial investment outlay. They then reflect the "time value of money" and allow an objective comparison of the cash inflows and outflows associated with alternative investments.

This procedure allows the investor to determine which potential investment alternatives are best and provides a standard means of comparing competing investments. The discounted values of such cash flows are referred to as their present values. Profitability is a question yet to be answered.

The Payback Period

The payback period is one of the simplest and most commonly used methods of analyzing business investments. The payback period determines the time necessary to recover the initial outlay for an investment from the expected net cash inflows associated with it. Annual net cash gains are calculated by subtracting annual cash operating expenses from the estimated cash benefits expected each year. Dividing the initial outlay by the annual net gain tells us how long it would take the investment to generate enough cash to cover the initial outlay. For example, in Table 19 on page 67, it was shown that expected annual net cash inflows, from a ten-module storage from which potatoes would be used in equal amounts each month from December through April, would be $131,304. The outlay for building, equipment and crates for a ten-module facility would be $751,609 (Table 14, page 52). The payback period would be $751,609/$131,304, or 5.72 years.

Businessmen generally establish a maximum acceptable payback period for each type of investment and reject all potential investments with longer paybacks. Investment proposals with shorter paybacks tend to be given higher rankings and more active consideration. The payback period analysis can be used to rank investment alternatives, but it has serious weaknesses that can lead to incorrect rankings of investments and may encourage unsound decisions.

One major limitation of the payback method is that it ignores profits earned after the initial investment has been recovered. Two investments with equal initial outlays and equal annual net cash inflows would have the same payback periods. Presumably they would both produce cash inflows beyond the end of the payback period. But if one investment has a longer life than the other and is expected to provide earnings over its entire life, it would obviously be a better investment even though both have equal payback periods. The payback method is not a measure of profitability. It only considers how quickly an investment outlay will be recovered.

Another weakness of payback analysis is that it does not consider the timing of cash inflows and outflows. It ignores the fact that a dollar in hand today is more valuable than a dollar received sometime in the future. While payback analysis has some serious limitations, it may be useful in screening out obviously undesirable investments such as those with a payback period as long or longer than the expected useful life of the investment. There are discounted cash flow methods of evaluating investments that, though having some shortcomings themselves, do incorporate the time value of money. One of these, the discounted internal rate of return approach, will be addressed next and then applied to selected potato storage investment alternatives.

Discounted Internal Rate of Return Analysis (IRR)

The discounted internal rate of return approach to analyzing potential investments also utilizes expected net cash inflows and investment outlays to evaluate investments. It determines the return on an investment over its lifetime. The discounted internal rate of return (IRR) is that rate, which when used to discount future annual net cash inflows, will make their cumulative present values equal to the initial outlay for the investment. For instance, if the net cash inflows for a

120,000 cwt. storage of $131,304/year for 20 years[7] are discounted by a rate of 16.7%, their cumulative present values will just equal the $751,609 outlay for the building, equipment, and crates. Thus the investor in effect would get the initial outlay back, plus a 16.7% before tax return on the investment for 20 years.

A method utilizing the payback period may be employed to find an approximate internal rate of return on the investment.[8] First one should calculate the payback period for the investment and then in Appendix D find a close approximation to that period in column #1 and read the corresponding discounted internal rate of return (IRR) on that line in column #2. One should remember that these rates of return will only be accurate if investment outlays, storage incentives, and operating costs are also accurate and can be expected to continue for 20 years.

After determining the IRR associated with an investment, the decision maker decides whether that particular investment and the gains associated with it provide an adequate before-tax return to cover the firm's cost of borrowed and equity capital after adjusting them for taxes. If the IRR is higher than the firm's cost of capital (a

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7 An expected 20 year life is used for this analysis and is based on manufacturers estimates of lengths of life for various pieces of equipment, and the expected life of the crates. While the building would quite likely last much longer, it is not at all certain that the chip market and current seasonal chipping potato prices will continue. A few additional years of expected net cash inflows would increase the IRR a bit, but not much.

8 The methodology used to determine the discounted internal rate of return is too complicated to present here. Those interested can find further information in Aplin, Casler, and Francis, Grid, Inc., 1977.

combination of borrowed money costs and the costs of capital provided by the owners), after tax considerations, it would be considered a good but not necessarily the best investment alternative for the firm. An investment with a higher IRR would presumably be better. By the same token, an investment with an IRR lower than the cost of capital probably would not be undertaken.

The internal rate of return analysis provides results in the form of yields, with which most businessmen are familiar. Selected levels of storage sizes employing alternative potato utilization patterns were evaluated using the internal rate of return method.

Results of the Internal Rate of Return Analysis

Discounted internal rates of return could be determined for many different sized storages (for example 1 to 10 modules) and for different utilization patterns for the stored potatoes. Three selected sizes with selected utilization patterns were evaluated using the internal rate of return method. The sizes were 12,000 cwt. (1 module), 72,000 cwt. (6 modules), and 120,000 cwt. (10 modules) storages. These sizes were believed to be representative of those that chippers might be interested in building if they were to construct new storages. Storage-use scenarios ranging from using the entire inventory in a particular month to spreading the utilization of stored potatoes over a six month period were evaluated. Rates of return (IRR), representing the expected level of return on the investment over its twenty-year life, were calculated using estimated capital outflows and annual net cash inflows and are presented in Table 20. The rate of return for one size of storage may be compared to the rate of return for a different size. For example, the

Table 20: Internal Rates of Return for Selected Sizes of Storages Employing Various Utilization Patterns

	Monthly Utilization (cwt.)						
	November	December	January	February	March	April	IRR[1]
12,000 cwt.	12,000	-	-	-	-	-	< 0.0
Storage	-	12,000	-	-	-	-	3.5%
Capacity	-	-	12,000	-	-	-	9.3%
	-	-	-	12,000	-	-	12.8%
	-	-	-	-	12,000	-	16.5%
	-	-	-	-	-	12,000	22.9%
72,000 cwt.	72,000	-	-	-	-	-	< 0.0
Storage	-	72,000	-	-	-	-	5.3%
Capacity	-	-	72,000	-	-	-	11.4%
	-	-	-	72,000	-	-	15.2%
	-	-	-	-	72,000	-	19.2%
	-	-	-	-	-	72,000	26.0%
	12,000	12,000	12,000	12,000	12,000	12,000	13.4%
	-	14,400	14,400	14,400	14,400	14,400	15.5%
	-	-	18,000	18,000	18,000	18,000	18.2%
	-	-	-	24,000	24,000	24,000	19.8%
	-	-	-	-	36,000	36,000	22.8%
120,000 cwt.	120,000	-	-	-	-	-	< 0.0
Storage	-	120,000	-	-	-	-	5.9%
Capacity	-	-	120,000	-	-	-	12.2%
	-	-	-	120,000	-	-	16.0%
	-	-	-	-	120,000	-	20.1%
	-	-	-	-	-	120,000	27.0%
	20,000	20,000	20,000	20,000	20,000	20,000	14.2%
	12,000	12,000	24,000	24,000	24,000	24,000	16.2%
	-	24,000	24,000	24,000	24,000	24,000	16.7%
	-	-	30,000	30,000	30,000	30,000	19.1%
	-	-	-	40,000	40,000	40,000	21.3%
	-	-	-	-	60,000	60,000	23.8%

[1] IRR is calculated on net cash inflows discounted annually and rounded to the nearest tenth of a %.

IRR for a 12,000 cwt. storage the contents of which would all be used in January would provide a 9.3% return, while using all of the potatoes in a 72,000 cwt. storage in that month would provide a 11.4% return on investment. In addition, one can compare rates of return for different utilization patterns within each size category or the same use patterns between different sized storages. Rates of return increase throughout the storage season as the storage incentive increases. Building facilities to store potatoes to be used in November would not be a profitable investment since rates of return are negative for all sizes of storage facilities.

Storage for use in December or January may also be unattractive because of the relatively low rates of return. Storing potatoes for December usage would provide between a 3.1% (12,000 cwt. storage) and 5.9% return on investment (120,000 cwt. storage). Similarly storage of 72,000 cwt. of potatoes for January use would provide an 11.4% return, and there would be a 12.5% return on storage of 120,000 cwt. However, storing 12,000 cwt. for use in January would generate less than a 10% return. Rates of return were significantly higher for investments in storages for February through April usage regardless of size.

The internal rate of return on the investment in storages in which potatoes are stored for usage in the later months is high and can compensate for low rates of return in earlier months. For instance, if one wanted to construct storage facilities to provide 20,000 cwt. of potatoes each month from November through April one could still obtain a 14.2% return on the investment. This practice would reduce the rate of return for the entire investment, compared to storing for February, March, and April only, but might still be a desirable investment for several reasons to be discussed later.

Computations and Considerations for the Individual Firm

Individual firms can analyze their own storage needs and options using the techniques employed in this study. This may be done by using the construction and operating cost estimates presented earlier, or by replacing some or all of them with construction outlay and operating cost estimates for a particular location by inserting local costs where relevant. Table 19 (page 67) can be used as a guide in developing cash flow estimates.

Storage Gain Estimates

The first step would be to calculate the average price (including transportation and other procurement costs) of contract and open market purchases each month from harvest time until the end of the storage season. Among our respondents, the storage incentive varied widely. Some experience much greater and others much lower storage incentives than the industry average used in this analysis. This monthly average "landed cost" can be used to determine the storage incentive by subtracting the landed cost of potatoes at the time they would be placed in storage from the landed cost of potatoes in those months when they would be removed and chipped.

The purchase of potatoes to place in storage results in large cash outflows. Gains result from using stored potatoes in months when the average landed price of potatoes is greater than when the potatoes were placed in storage. These inflows are calculated by multiplying the quantity of potatoes used from storage during a particular month by the firms landed cost that month. From this amount, the value of weight and quality losses incurred during storage are subtracted. The dollar value of those losses is calculated by multiplying the quantity of potatoes placed in storage and then used in a particular month by the average landed cost (for that month), and multiplying this figure by the expected percentage of loss for that month found in Table 18 (page 61).

Cash Outflows

The first and largest cash outflow is for construction of the facility and purchase of crates. The estimates developed earlier (Table 14, page 52) may be used, or an independent construction estimate may be obtained from a local contractor. In this study adequate land for the storage facility was assumed to be owned by the potential investor and the outlay for it was not included. The outlay for land should be included in the initial outlay if it must be purchased especially for this investment.

Operating expenses vary with location and with storage utilization patterns, but estimates developed during this study may be used. Cash flows similar to those in Table 19 (page 67) or in Appendix C can be used or adjusted for local conditions.

Only those real estate or property taxes associated with the storage facility should be included unless land was purchased especially for its site. The appropriate tax payments for the area should be calculated and included at the times they would be paid.

Insurance rates may also vary with location and insurance company. Insurance premiums applicable for a particular area and company should be included for the months they would be paid. The total insurance expense will vary with the time that potatoes are held in storage. Potatoes in storage are insured at the original purchase price. Total coverage needed, and the corresponding premiums decrease as potatoes are removed from storage.

Mertect is applied to all potatoes when put into storage, at a cost of \$0.02/cwt. CIPC is applied in November, but only to those potatoes to be used after December. CIPC is usually custom applied through the ventilating system at a rate of \$0.08/cwt for materials and labor.

Expenses for labor should include only the labor required for operation of the storage. At the time the potatoes are put into storage, a labor charge for the time spent in filling and transporting crates would be incurred. Labor would also be required to remove the potatoes from storage. The actual labor expenses incurred will also depend on wage levels and fringe benefits paid by the firm. One should include only the labor expenses incurred as a result of the new storage operation, and exclude employee time spent in other ways such as that used to process potatoes.

Monthly utility costs can be estimated from the figures for the appropriate number of units (Table 15, page 56). These costs were calculated and based on prices of \$0.60/gal. for No. 2 fuel oil and \$0.06/Kilowatt-hour. They can easily be adjusted for different prices by first finding the ratio of the price which would be paid by the firm to the price used here. Those expenses can then be approximated by multiplying that ratio by the costs found in the tables. For example, if electricity costs were actually $0.04/KWH, instead of $0.06/KWH the cost at the lower price could be calculated by dividing 0.04 by 0.06 (0.667) and multiplying that coefficient by the cost in Table 15 for the appropriate number of storage units and month.

Annual maintenance costs can be calculated by multiplying the structure and equipment estimates as developed for an individual firm by 0.5% and the crate value by 2.0%.

Return on Investment

Once annual cash inflows and outflows have been determined, annual net cash inflows can be calculated. The initial outlay for the building and crates (and possibly land) should be divided by the annual net cash inflow to determine the payback period.

Table 21 provides a worksheet that individual firms might use to analyze an investment in a long-term potato storage using those costs and benefits that would apply to their firm.

After completing calculations on the worksheet, the discounted internal rate of return (IRR) on the investment with an assumed life of twenty years, can be approximated by locating the payback period in column #1 of Appendix D nearest the one calculated on the worksheet and then finding the corresponding number in column #2. This number in column #2 is the approximate discounted internal rate of return on the investment which is assumed to last twenty years with constant net cash inflows over that period.

If one assumes the investment and cash flow benefits associated with it will last for a shorter period of time but still provide the same

Table 21: Individual Firm Worksheet

Use numbers from Appendix B and C, or those which more accurately represent those you would experience, as suggested on pages 75-78.

Annual Cash Inflows	
Market value (landed cost) of potatoes taken from storage	$ ______
Less cost of potatoes placed in storage	- ______
Less cost of loss See page 76	- ______
Equals: Value gains from storage	$ ______
Annual Operating Costs	
Real estate or property taxes on new investment	$ ______
Insurance on building, crates, and equipment as well as on raw product for the year	______
Mertect application (experience figures or $0.02/cwt.)	______
Labor (only costs for that additional labor required because of storage)	______
Utilities (Table 15 and 16, page 56 & 57, or make adjustments as explained on pages 77 & 78 if prices for electricity or fuel oil are different form those in this analysis)	______
Building, equipment, and crate maintenance (experience estimate or calculated as on page 78)	______
Equals: total annual cash expenses	$ ______
Annual Net Cash Inflows = Gains from storage (top) minus total annual cash operating expenses (above)	______
Payback Period = Firm's estimate (or that from Table 14), of the total outlay (storage building, crates, and equipment) divided by annual net cash inflows (above)	
$\frac{\text{Total Outlay}}{\text{Annual Net Cash Inflows}}$ = Payback Period (in years)	______

annual net cash inflows as were used when assuming a twenty year life, the rate of return will be lower. If the life expectancy is greater than twenty years, the discounted internal rate of return will be higher, but not much. The present value of returns after twenty years is not very great. For example, the present value of a dollar received fifteen years from now is only 31.5¢, if a discount rate of 10% is used, and one received twenty years from now would be worth only 14.9¢ now. By the 25th year, a dollar received would have a present value (discounted at a 10% annual rate) of only 9.2¢. Thus returns beyond twenty years are not very significant especially at reasonable rates of return.

Implications

This study assumes that storages would be located adjacent to chipping plants and quite likely would be owned by the chip manufacturers themselves.[9] The large capital investment required, economies associated with construction of larger storages, and the perceived reluctance on the part of growers to accept risks associated with storage, make at-plant storage the more likely alternative. However, individual farmers, farmers in conjunction with others, cooperatives, or brokers could invest in facilities for long-term chipping potato storages. For storers other than those who are also chippers, some costs and returns may vary from

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9 For the calculation of annual labor expenses the storage was assumed to be at the chipping plant with a forklift available for moving potatoes. It was also assumed that adequate land for storage construction was available and that property taxes on it as an undeveloped property were not a relevant cash outflow since they would be incurred whether or not a storage was placed on that land.

those in this analysis. However, the analytical framework and most of the numbers could also be applied to those alternatives. In general, storages should provide similar returns regardless of ownership.

The financial resources necessary for constructing and operating storage facilities may be too great for small growers. However, joint ventures involving grower groups, or growers in conjunction with brokers or chippers would enable sharing of costs, risks, and benefits associated with long-term chipping potato storage.

One scenario might include use of existing grower storages for late fall and early winter storage. These facilities, already in place, would need to at least recover variable costs from the value gains of potatoes in storage and could be successfully used (without excessive potato losses) for early season storage. Chip manufacturers, growers collectively, or some combination of chippers and growers could build modern storages to meet chipper production needs for the latter part of the storage season. This would allow each party to capture a portion of the storage benefits while avoiding redundant capital investment, avoiding some of the risk of product loss in grower storages, and in addition reduce congestion at the chipping plant during the harvest season.

The viability of this scenario would depend upon grower-chipper relations, the degree of cooperation between them, and how benefits might be distributed. Growers storing for early season use would need to receive higher prices than at harvest. They would incur relatively small weight and quality losses since the greatest losses occur later in the storage season. Chip manufacturers would be assured of a raw product supply and could avoid the capital outlays for building greater capacity storages at the plant.

Storage Risks

If chip manufacturers assume all storage ownership and operating responsibilities, they are in effect fixing their own raw product costs throughout the storage season. They will accept the associated risks only if anticipated raw product costs would likely be higher without the storages than with them. By assuming all storage functions, the chip manufacturer would relieve the grower of both the risks and the benefits of storage.

Adverse price movements may be the greatest risk associated with storage of chipping potatoes. Storage operators can, to a large degree, control weight and quality losses with well-constructed and equipped storage facilities, especially when properly managed. No single grower or storage owner is large enough to influence market prices. Prices can go up or down during the storage season for any number of reasons and the storage incentive could vary substantially from the one calculated in this analysis. For example, a much greater quantity of chipper stored potatoes could result in a smaller than anticipated market price increase from harvest-time to spring usage. If such an unforeseen event were to occur the gain from storing potatoes might not cover the annual cash costs of storage.

Until 1981, storage owners could partially protect themselves from adverse price movements by hedging on the futures market. A major default destroyed trader confidence. Since then, the market has remained inactive.

Large unforeseen spoilage and weight losses can occur in storages. These losses generally result from the storing of marginal-quality potatoes rather than from inadequate storage facilities or the employment of improper management practices.

Another longer-term risk associated with additional investment in chipping potato storages is the possibility of a change in the market for potato chips. Potato snacks, made from dehydrated potato flakes, were introduced some time ago, but have not gained the share of the chip market that their promoters envisioned. However, recent product developments in this area have resulted in new types of snack foods made from dehydrated potato stock. These snacks have not been on the market long enough to determine their impact on the market for conventional chips. The need for and profitability of long-term chipping potato storages would be greatly reduced if consumer preferences for these or other new snack foods reduces the size of the potato chip market.

A consideration important to Pennsylvania growers is that chip manufacturers may choose to purchase and store potatoes grown in other areas if they invest in additional high-quality storages. Survey respondents indicated a preference for potatoes with quality characteristics not often found in local potatoes. Therefore, chipping firms or other storage operators might purchase and store potatoes grown in other areas rather than those from Pennsylvania. Several respondents did state, however, that increased storage capacity might increase their use of local potatoes.

SUMMARY AND CONCLUSIONS

The economic feasibility of expanding Pennsylvania's storage facilities for chipping potatoes was addressed in this study. Pennsylvania chip manufacturers rely on fall-crop potatoes to meet processing needs from the end of harvest in late October until the beginning of the spring crop in May. A state-wide survey of major Pennsylvania chip manufacturers provided the necessary empirical data for this analysis. Information descriptive of current storage facilities and practices, as well as purchasing patterns, and seasonal raw product costs was collected. Monthly raw product costs were used to determine the potential returns from storing fall harvested potatoes.

Survey data were analyzed and the benefits of long-term storage estimated. New storages were envisioned and design specifications developed which would maintain quality and minimize losses. The dollar outlays required to construct such storage facilities were estimated using economic-engineering procedures.

Annual net cash inflows were calculated by subtracting budgeted cash operating expenses from expected gains in the form of reduced raw product costs as a result of storing. The resulting annual net cash inflows were assumed to remain constant each year for twenty years (the investments' assumed economic life). These annual net cash inflows were compared to the initial outlay for the investment and a payback period determined.

Investments in potato storages were evaluated using the internal-rate-of-return method of evaluating investments. The higher the discounted internal rate of return, the better the investment. Most storage sizes and storage scenarios provided positive returns. Whether those who might invest in such facilities find these levels of return sufficient to assume the risks described earlier cannot be determined. Each firm will make that judgement.

The discounted internal rates of return, regardless of storage size, increase with the length of time that potatoes are held in storage after the fall harvest. The rates of return on storages used for storing potatoes to chip during late fall and early winter were so low they would probably not justify new investment. Rates of return were significantly higher for storage of potatoes to be used in February, March, and April. Storages for use during the entire season from November through April provided a lower rate of return on the investment than storage used only for the later months.

Building facilities to store potatoes for chip production during the February thru April period may be attractive investments, judging by the discounted internal rates of return associated with them. Investment in the larger storage facilities to store potatoes for January use would provide a return of 11 or 12% before taxes. Building a high-technology storage facility as described on pages 34-38 for November and December chipping potatoes would provide much lower internal rates of return. Even with the largest facilities, which generally provide the highest returns, the storing of potatoes for use in November would provide a negative return. Storage of 120,000 cwt. of potatoes for December use would provide a 5.9% before tax return.

The internal rate of return on storages for potatoes stored until late winter and early spring is high enough to compensate for the low rates of return in earlier months. A 14.2% before-tax return on investment could be achieved if storage facilities were constructed and used to provide 20,000 cwt. of potatoes per month from November through April. Although this would result in a lower internal rate of return than storage for February, March, and April only, it still might be an acceptable return for some investors and for other reasons might be a desirable practice.

Even though storage for November or December chipping needs doesn't seem particularly attractive, when measured by return on investment, some storage benefits cannot be easily measured. The convenience of having raw product on-site rather than depending on well-timed deliveries would avoid unforeseen delays that might result from bad weather and furthermore would allow chipping firms to have more control over the quality of their raw product. Those who wish to store for late fall and early winter (Nov.-Dec.) use may believe the convenience and control factors sufficiently important to offset the lower internal rates of return.

Limitations

The first and most apparent potential limitation of this study is that its results pertain only to Pennsylvania. The results cannot be directly applied outside Pennsylvania since marketing conditions and storage incentives may vary greatly from one area to another. However, the analysis herein can be used as a framework for analysis in other areas (see worksheet on page 79).

Raw product costs utilized in this study are the average raw product costs of all survey respondents. Individual firms have different raw product costs and hence different storage incentives, possibly resulting from differences in size, location, or purchasing patterns. The 1986-87 storage incentive for potatoes purchased at harvest and brought out of storage and used in April, varied from $1.98/cwt. for one respondent to $4.84/cwt. for another. Other storage seasons reflect similar differences. Therefore, raw product costs and the incentive to store should be examined by each firm considering investment in long-term storage facilities. Some may find storage a less attractive investment than the "average" analysis indicates, while others may find it more profitable.

This analysis assumed that conditions experienced recently will continue over the life of the investment. Changes in tastes and preferences, technology, varieties, and other things could make the recent past a poor indicator of the future. Although this uncertainty is unavoidable, it makes the results tentative.

This study depends on the accuracy of information provided by survey respondents. Accuracy of the collected data was not perceived to be a major problem, although exact substantiation is impossible.

One point that has not been addressed is the effect that any increased capacity for storing late-season chipping potatoes in Pennsylvania might have on the market and, as a consequence, on local and national incentives to store. Substantial investment in storage facilities by Pennsylvania chip manufacturers or others could reduce the storage incentives, and as a result the rates of return on storage investments. Presumably, when compared to the current pattern, chipping potato prices would increase in the fall if larger quantities were purchased for storage, and decrease in the spring because raw product needs could be met from at-plant storages instead of purchasing from others. How big an impact such an event might have on market prices throughout the season is unknown.

Seasonal price changes that deviate from the current norm for Pennsylvania-grown potatoes that might result from increased storage capacity should be rather small since the Pennsylvania price for chipping potatoes is influenced largely by prices paid for out-of-state potatoes, Out of state areas provide the biggest volume of winter and early spring potatoes. Pennsylvania chipper purchases from North Dakota, which is the largest out of state supplier of chipping potatoes, account for only about 7% of North Dakota's crop. Therefore, chipping potato prices in other states should not be greatly affected by increased Pennsylvania storage capacity since purchases from North Dakota and other such areas account for only a small portion of the production in those areas.

Implications for Further Research

Several topics beyond the scope of this study may merit further investigation. A study similar to this one analyzing on-farm bulk storage of potatoes for chipping might be beneficial. Investigating the economic potential of new, grower-owned storages would provide more precise information about the costs associated with bulk storages on farms and the expected rates of return on such investments.

A similar investigation of seasonal price variations and utilization patterns of table stock potatoes would provide empirical data that would be useful in determining storage needs and storage incentives for that segment of the industry. The storage design and investment outlays that were developed for this project should be applicable to storages for fresh-market potatoes.

Efforts aimed at improving existing potato varieties and developing new chipping varieties better suited for long-term storage that can be produced in Pennsylvania are currently underway. Continued research in this area may provide improved varieties which, together with better grower harvesting and handling practices, may increase the demand for Pennsylvania produced potatoes by long-term storage operators.

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Appendix A
SOURCES OF STORAGE SPECIFICATIONS AND PRICES

EXCAVATION

100 cubic yards (yds^3) per unit - pile and backfill

$5.00/$yd^3$ - 1986 Dodge Construction Manual[1]

CONCRETE

6-bag mix - $49.00/$yd^3$ - Telephone quote from Sheesley Supply (3/24/88) and Centre Concrete (3/25/88).

Steel (#6 rebar) - $0.30/ft. - Telephone quote from Sheesley Supply (3/24/88) and Centre Concrete (3/25/88).

Labor - Footing and foundation labor is based on 1987 Dodge Assemblies Cost Data as a percentage of materials (based on labor costs of $16.90/hr.).

The labor for the footing and foundation for a single unit is calculated as follows:

Materials	
Footing	$ 441
Foundation wall	$1617
Steel	$ 238
	$2296 x 89% = $2044

The labor for the concrete floor (including: concrete work, reinforcing mesh, finish and cure, porus fill, and fine grading) is calculated on the basis of $1.41 per square foot ($ft^2$) from 1987 Dodge Assemblies Cost Data.

CARPENTRY

Material specifications from PSU and USDA Refrigerated Fruit and Vegetable Pallet Storage Plan #6389.

Lumber prices - Lezzer Building Supply (3/8/88).

48' roof trusses (4-12 pitch) - $87.00 each - Telephone quote from Lezzer Building Supply (3/19/88).

48' flat roof trusses - $104.45 each - Telephone quote from Hommer Lumber Company (4/4/88).

[1] All Dodge Construction and Assembly figures are adjusted for location. The given cost factor is multiplied by 90% (the average adjustment for all Pennsylvania locations excluding metropolitan areas).

Labor - Carpentry labor is based on 1987 Dodge Assemblies Cost Data as a percentage of materials (based on labor costs of $22.40 per hour) except for studs, sheathing, and trusses that are addressed specifically.

The labor for carpentry for a single unit is calculated as follows:

Studs - $0.387 per board foot (21.33 board feet per 2" x 8" x16' stud)

88 studs (21.33)($0.387) = $726

Sheathing for walls and ceiling - $0.30/ft^2

Trusses - $44.00/48' truss (pitched or flat)

Other materials	
Sill	$ 169
Topsill	$ 96
Toplate	$ 144
Interior strapping	$ 373
Ceiling Strapping	$ 204
Purlins	$ 474
Facia	$ 62
	$1522 x 75% = $1142

ROOFING

Galvanized corrugated steel (26 gauge) - $0.42/ft^2 - Telephone quote from Lezzer Building Supply (3/19/88).

Labor for roofing and siding is based on an amount equal to the material cost - 1987 Dodge Assemblies Cost Data.

Labor for roof caps ($100.00/unit) is based on a rate of $1.00/ft with an allowance for sizing because roof caps are in 10 ft lengths.

1¼" standing seam roofing - $0.65/ft^2 - Telephone quote from Fabral (Lancaster, PA - 4/5/88).

Labor for flat roof and 1¼" standing seam roof - $0.08/ft^2 - Telephone quote from Fabral (4/5/88).

DIFFERENCE IN COST FOR FLAT ROOF VERSUS PITCHED ROOF PER 12,000 cwt. STORAGE UNIT:

Flat trusses	(22)($104.45)	= $2298	
$1\frac{1}{4}$" standing seam roofing (materials and labor)	(4032 ft^2)($0.73)	= $2944	
additional siding (materials and labor)	(3 ft. x 264 ft.)($0.84)	= $ 666	$5908
Pitched trusses	(22)($87.00)	= $1914	
Galvanized corrugated roof (materials and labor)	(4684 ft^2)($0.84)	= $3893	$5807
	additional cost of flat roof		$ 101

INSULATION

Specifications from: Hallee, N. D., and Hunter, J. Potato Storage Design and Management, University of Maine at Orono, Cooperative Extension Service, Bulletin No. 656, 1984. Based on a minimum sustained air temperature (4 to 5 days) of -10°F.

Exterior walls (R-26, 1" urethane board and blown-in fiberglass) - $0.86/$ft^2$.

Interior walls (R-13, rolled fiberglass) - $0.32/$ft^2$.

Ceiling (R-35, blown-in fiberglass) - $0.45/$ft^2$.

Prices are for total materials and labor - Telephone quote from Benneyfield and Farrell (State College, PA - 3/28/88).

DOORS

Materials and labor - 1987 Dodge Assemblies Cost Data. Labor is based on a percentage of materials as shown below.

	Materials	Labor
Roll-up overhead (10' x 12')	$825 x 86.7% =	$715
Walk-in (3' x 7')	$275 x 46.2% =	$127

REFRIGERATION AND VENTILATION

Telephone quote from Kramer-Trenton representative (4/4/88).

Labor is calculated at 10% of equipment according to representative's recommendation.

HEAT

Materials and labor - 1986 Dodge Construction Manual. Labor is calculated as a percentage of material - 43.3% (based on labor costs of $26.50/hr.).

HUMIDIFICATION

Materials and labor - 1986 Dodge Construction Manual. Labor is calculated as a percentage of material - 74.4% (based on labor costs of $28.00/hr.).

ELECTRICAL AND PLUMBING

Fifteen percent of construction total from 1987 Dodge Assemblies Cost Data for refrigerated warehouses.

GENERAL OVERHEAD

Ten percent of construction total from recommendation by Dr. Jon M. Carson, PSU Agricultural Engineer.

INSURANCE

Quote from John Walizer (State Farm Insurance) for similar facility in State College (5/16/88).

CHEMICALS

Telephone quote from Agway representative (5/16/88).

LABOR DIRECTLY ASSOCIATED WITH STORAGE

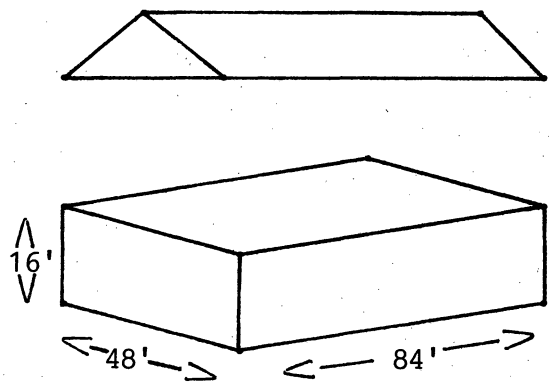
Based on a forklift driver earning $12.00/hr. carrying an average of 25 cwt. per trip. The forklift is assumed to travel at 3 mph (or 264 ft./minute). The distance per trip is calculated to the middle of a ten-unit storage facility (304 ft.), and slightly less than one minute is allowed at each end of the trip for handling of crates, for a total of three minutes per round trip.

$12.00/(20 trips x 25 cwt.) = $0.024/cwt.*

* Rounded to 2.5¢/cwt.

Appendix B
CONSTRUCTION INVESTMENT CALCULATIONS

STORAGE CAPACITY	12,000 cwt.
DIMENSIONS	48'x84'x16'
FLOOR AREA	4032 ft^2
EXTERIOR WALL AREA	4224 ft^2
INTERIOR WALL AREA	—
CEILING AREA	4032 ft^2
ROOF AREA	4634 ft^2
PERIMETER	264 ft



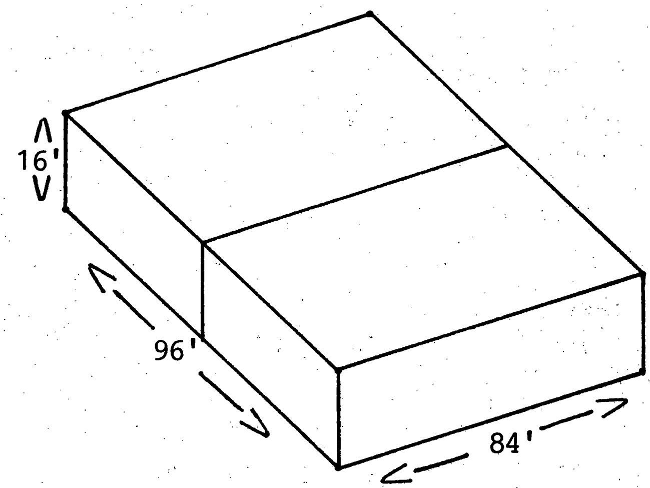
	MATERIALS	LABOR	TOTAL
EXCAVATION	100 yds^3 @ $5.00/$yd^3$		$ 500
CONCRETE			
FOOTING	(8/12)(16/12)(264)/27= 9 yds^3 @ $49.00= $ 441		
FOUNDATION		MAT.	
WALL	(4)(10/12)(264)/27= 33 yds^3 @ $49.00= $1617	x .89=	
STEEL	(264)(2)(1.5lb.)= 792 lb. @ $ 0.30= $ 238	$2044	
FLOOR	(4032)(5/12)/27= 63 yds^3 @ $49.00= $3087	$5685	
	$5383	$7729	$13,112
CARPENTRY			
FRAMING			
STUDS 2"x8"x16'	(264)/3= 88 @ $5.64= $497	$ 726	
SILL 2"x8"x16'-P.T.	(264)/16= 17 @ $9.92= $169		
TOPSILL 2"x8"x16'	(264)/16= 17 @ $5.64= $ 96	MAT.	
TOP PLATE 2"x12"x16'	(264)/16= 17 @ $8.46= $144	x .75	
INTERIOR STRAPPING 2"x4"x16'	132 @ $2.82= $373		
CEILING STRAPPING 2"x4"x16'	72 @ $2.82= $204		
PURLINS 2"x4"x16'	168 @ $2.82= $474		
FACIA 2"x8"x16'	11 @ $5.64= $ 62		
SHEATHING (½" PLYWOOD)		$1142	
WALLS	(4224)/32= 132 @ $8.74= $1154	$1268	
CEILING	(4032)/32= 126 @ $8.74= $1102	$1210	
TRUSSES 48' (4/12 PITCH)	22 @ $87.00= $1914	$ 968	
	$6189	$5314	$11,503
INSULATION (including vapor barrier)			
EXTERIOR WALLS	@ $0.86=		$ 3,633
INTERIOR WALLS	@ $0.32=		—
CEILING	@ $0.45=		$ 1,815
			$ 5,448

MATERIALS		LABOR	TOTAL
ROOFING AND SIDING			
SIDING	4224 @ $0.42=$1774	$1774	
ROOFING	4634 @ $0.42=$1946	$1946	
ROOF CAP	84 @ $0.90=$ 76	$ 100	
	$3796	$3820	$7,616
DOORS			
ROLL-UP OVERHEAD (10'x12')	1 @ $825.00=$ 825	$ 715	
WALK-IN (3'x7')	1 @ $275.00=$ 275	$ 127	
	$1100	$ 842	$1,942
REFRIGERATION AND VENTILATION	$8000	$ 800	$8,880
HEAT (85,000 BTU OIL FURNACE)	$ 505	$ 219	$ 724
HUMIDIFICATION (50 GAL/HOUR)	$ 605	$ 450	$1,055
SUBTOTAL			$50,702
ELECTRICAL AND PLUMBING (15% OF SUBTOTAL)			$ 7,606
GENERAL OVERHEAD (10% OF SUBTOTAL)			$ 5,070
TOTAL CONSTRUCTION INVESTMENT			$63,378

$$\frac{\$63{,}378}{4032\ ft^2} = \$15.72/ft^2$$

$$\frac{\$63{,}378}{12{,}000\ cwt.} = \$5.28/cwt.$$

STORAGE CAPACITY	24,000 cwt.
DIMENSIONS	96'x84'x16'
FLOOR AREA	8064 ft^2
EXTERIOR WALL AREA	5760 ft^2
INTERIOR WALL AREA	1344 ft^2
CEILING AREA	8064 ft^2
ROOF AREA	9268 ft^2
PERIMETER	360 ft



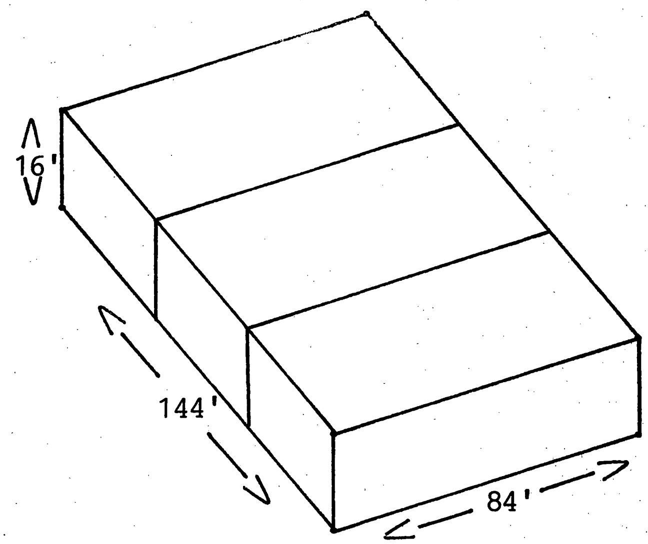
	MATERIALS	LABOR	TOTAL
EXCAVATION	200 yds^3 @ $5.00/$yd^3$		$ 1,000
CONCRETE			
FOOTING	(8/12)(16/12)(404)/27= 14 yds^3 @ $49.00=$ 686		
FOUNDATION		MAT.	
WALL	(4)(10/12)(404)/27= 50 yds^3 @ $49.00=$2450	x .89=	
STEEL	(404)(2)(1.5lb.)= 1212 lb. @ $ 0.30=$ 364	$ 3115	
FLOOR	(8064)(5/12)/27= 125 yds^3 @ $49.00=$6125	$11370	
	$9625	$14485	$24,110
CARPENTRY			
FRAMING			
STUDS 2"x8"x16'	(404)/3= 135 @ $5.64=$ 762	$ 1114	
SILL 2"x8"x16'-P.T.	(404)/16= 26 @ $9.92=$ 258		
TOPSILL 2"x8"x16'	(404)/16= 26 @ $5.64=$ 147	MAT.	
TOP PLATE 2"x12"x16'	(404)/16= 26 @ $8.46=$ 220	x .75	
INTERIOR STRAPPING 2"x4"x16'	264 @ $2.82=$ 745		
CEILING STRAPPING 2"x4"x16'	144 @ $2.82=$ 407		
PURLINS 2"x4"x16'	336 @ $2.82=$ 948		
FACIA 2"x8"x16'	22 @ $5.64=$ 125		
SHEATHING (½" PLYWOOD)		$ 2138	
WALLS	(8448)/32= 264 @ $8.74=$2308	$ 2655	
CEILING	(8064)/32= 252 @ $8.74=$2203	$ 2420	
TRUSSES 48' (4/12 PITCH)	44 @ $87.00=$3828	$ 1936	
	$11951	$10263	$22,214
INSULATION (including vapor barrier)			
EXTERIOR WALLS	5760 @ $0.86=		$ 4,954
INTERIOR WALLS	1344 @ $0.32=		$ 430
CEILING	8064 @ $0.45=		$ 3,629
			$ 9,013

MATERIALS		LABOR	TOTAL
ROOFING AND SIDING			
SIDING	5760 @ $0.42=$2419	$2419	
ROOFING	9268 @ $0.42=$3893	$3893	
ROOF CAP	168 @ $0.90=$ 152	$ 200	
	$6464	$6512	$12,976
DOORS			
ROLL-UP OVERHEAD (10'x12')	2 @ $825.00=$1650	$1430	
WALK-IN (3'x7')	2 @ $275.00=$ 550	$ 254	
	$2200	$1684	$ 3,884
REFRIGERATION AND VENTILATION	$13516	$ 1350	$14,866
HEAT (85,000 BTU OIL FURNACE)	$ 505	$ 219	$ 724
HUMIDIFICATION (100 GAL/HOUR)	$ 680	$ 450	$ 1,130
SUBTOTAL			$89,917
ELECTRICAL AND PLUMBING (15% OF SUBTOTAL)			$13,488
GENERAL OVERHEAD (10% OF SUBTOTAL)			$ 9,000
TOTAL CONSTRUCTION INVESTMENT			$112,405

$$\frac{\$112,405}{8064 ft^2} = \$13.94/ft^2$$

$$\frac{\$112,405}{24,000 \text{ cwt.}} = \$4.69/\text{cwt.}$$

STORAGE CAPACITY	36,000 cwt.
DIMENSIONS	144'x84'x16'
FLOOR AREA	12,096 ft^2
EXTERIOR WALL AREA	7.296 ft^2
INTERIOR WALL AREA	2,688 ft^2
CEILING AREA	12,096 ft^2
ROOF AREA	13,902 ft^2
PERIMETER	456 ft



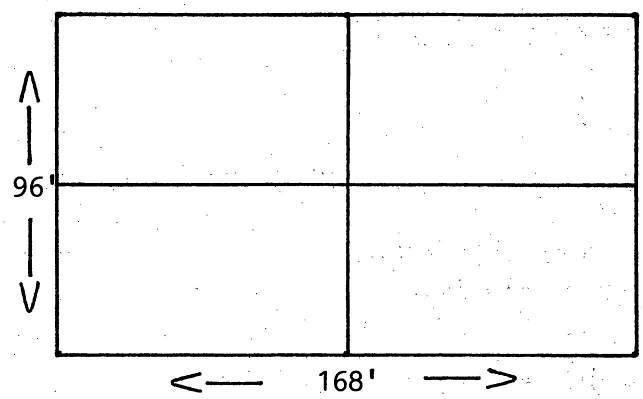
	MATERIALS	LABOR	TOTAL
EXCAVATION	300 yds^3 @ $5.00/yd^3		$ 1,500
CONCRETE			
FOOTING	(8/12)(16/12)(624)/27= 21 yds^3 @ $49.00=$1029		
FOUNDATION		MAT.	
WALL	(4)(10/12)(624)/27= 78 yds^3 @ $49.00=$3822	x .89=	
STEEL	(624)(2)(1.5lb.)= 1872 lb. @ $ 0.30=$ 562	$ 4818	
FLOOR	(12096)(5/12)/27= 187 yds^3 @ $49.00=$9163	$17055	
	$14576	$21873	$36,449
CARPENTRY			
FRAMING			
STUDS 2"x8"x16'	(624)/3= 208 @ $5.64=$1174	$ 1716	
SILL 2"x8"x16'-P.T.	(624)/16= 40 @ $9.92=$ 397		
TOPSILL 2"x8"x16'	(624)/16= 40 @ $5.64=$ 226	MAT.	
TOP PLATE 2"x12"x16'	(624)/16= 40 @ $8.46=$ 339	x .75	
INTERIOR STRAPPING 2"x4"x16'	396 @ $2.82=$1117		
CEILING STRAPPING 2"x4"x16'	216 @ $2.82=$ 609		
PURLINS 2"x4"x16'	504 @ $2.82=$1422		
FACIA 2"x8"x16'	33 @ $5.64=$ 186		
SHEATHING (½" PLYWOOD)		$ 3222	
WALLS	(12672)/32= 396 @ $8.74=$3462	$ 3802	
CEILING	(12096)/32= 378 @ $8.74=$3304	$ 3629	
TRUSSES 48' (4/12 PITCH)	66 @ $87.00=$5742	$ 2904	
	$17978	$15273	$33,251
INSULATION (including vapor barrier)			
EXTERIOR WALLS	7296 @ $0.86=		$ 6,533
INTERIOR WALLS	2688 @ $0.32=		$ 860
CEILING	12096 @ $0.45=		$ 5,446
			$12,836

MATERIALS		LABOR	TOTAL
ROOFING AND SIDING			
SIDING	7296 @ $0.42=$3604	$3604	
ROOFING	13902 @ $0.42=$5839	$5839	
ROOF CAP	252 @ $0.90=$ 227	$ 300	
	$9670	$9743	$19,413
DOORS			
ROLL-UP OVERHEAD (10'x12')	3 @ $825.00=$2475	$2145	
WALK-IN (3'x7')	3 @ $275.00=$ 825	$ 381	
	$3300	$2526	$ 5,826
REFRIGERATION AND VENTILATION	$19913	$1990	$21,903
HEAT (85,000 BTU OIL FURNACE)	$ 505	$ 219	$ 724
HUMIDIFICATION (150 GAL/HOUR)	$ 720	$ 450	$ 1,170
SUBTOTAL			$133,072
ELECTRICAL AND PLUMBING (15% OF SUBTOTAL)			$19,961
GENERAL OVERHEAD (10% OF SUBTOTAL)			$13,307
TOTAL CONSTRUCTION INVESTMENT			$166,340

$$\frac{\$166,340}{12,096\ ft^2} = \$13.75/ft^2$$

$$\frac{\$166,340}{36,000\ cwt.} = \$4.62/cwt.$$

STORAGE CAPACITY	48,000 cwt.
DIMENSIONS	96'x168'x16'
FLOOR AREA	16,128 ft^2
EXTERIOR WALL AREA	8,448 ft^2
INTERIOR WALL AREA	4,224 ft^2
CEILING AREA	16,128 ft^2
ROOF AREA	17,768 ft^2
PERIMETER	528 ft



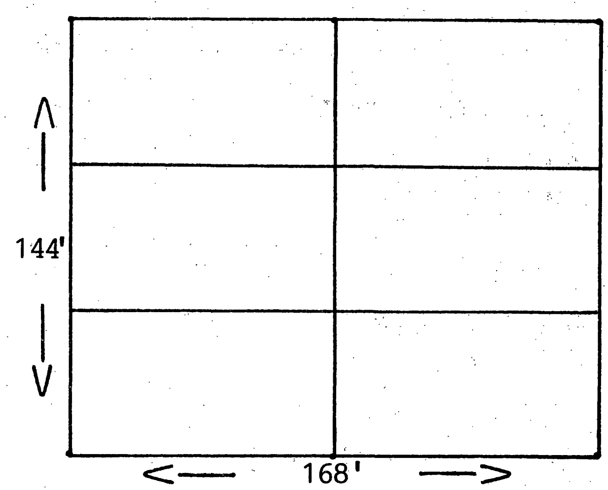
	MATERIALS	LABOR	TOTAL
EXCAVATION	400 yds^3 @ $5.00/$yd^3$		$ 2,000
CONCRETE			
FOOTING	(8/12)(16/12)(888)/27= 30 yds^3 @ $49.00=$ 1470		
FOUNDATION		MAT.	
WALL	(4)(10/12)(888)/27= 110 yds^3 @ $49.00=$ 5390	x .89=	
STEEL	(888)(2)(1.5lb.)= 2664 lb. @ $ 0.30=$ 800	$ 6818	
FLOOR	(16128)(5/12)/27= 249 yds^3 @ $49.00=$12201	$22740	
	$19861	$29558	$49,419
CARPENTRY			
FRAMING			
STUDS 2"x8"x16'	(888)/3= 296 @ $5.64=$ 1670	$ 2442	
SILL 2"x8"x16'-P.T.	(888)/16= 56 @ $9.92=$ 556		
TOPSILL 2"x8"x16'	(888)/16= 56 @ $5.64=$ 316	MAT.	
TOP PLATE 2"x12"x16'	(888)/16= 56 @ $8.46=$ 474	x .75	
INTERIOR STRAPPING 2"x4"x16'	444 @ $2.82=$ 1252		
CEILING STRAPPING 2"x4"x16'	288 @ $2.82=$ 812		
PURLINS 2"x4"x16'	672 @ $2.82=$ 1895		
FACIA 2"x8"x16'	44 @ $5.64=$ 249		
SHEATHING (½" PLYWOOD)		$ 4166	
WALLS	(16896)/32= 528 @ $8.74=$ 4615	$ 7266	
CEILING	(16128)/32= 504 @ $8.74=$ 4405	$ 4839	
TRUSSES 48' (4/12 PITCH)	88 @ $87.00=$ 7656	$ 3872	
	$23900	$20388	$44,288
INSULATION (including vapor barrier)			
EXTERIOR WALLS	8448 @ $0.86=		$ 7,266
INTERIOR WALLS	4224 @ $0.32=		$ 1,352
CEILING	16128 @ $0.45=		$ 7,258
			$15,876

MATERIALS		LABOR	TOTAL
ROOFING AND SIDING			
SIDING	8448 @ $0.42=$ 3548	$ 3548	
ROOFING	17768 @ $0.42=$ 7463	$ 7463	
ROOF CAP	336 @ $0.90=$ 303	$ 400	
	$11314	$11411	$22,725
DOORS			
ROLL-UP OVERHEAD (10'x12')	4 @ $825.00=$ 3300	$ 2860	
WALK-IN (3'x7')	4 @ $275.00=$ 1100	$ 508	
	$ 4400	$ 3368	$ 7,768
REFRIGERATION AND VENTILATION	$29194	$ 2900	$32,094
HEAT (85,000 BTU OIL FURNACE)	$ 505	$ 219	$ 724
HUMIDIFICATION (200 GAL/HOUR)	$ 875	$ 560	$ 1,435
SUBTOTAL			$176,329
ELECTRICAL AND PLUMBING (15% OF SUBTOTAL)			$26,449
GENERAL OVERHEAD (10% OF SUBTOTAL)			$17,633
TOTAL CONSTRUCTION INVESTMENT			$220,411

$$\frac{\$220{,}411}{16{,}128\ ft^2} = \$13.67/ft^2$$

$$\frac{\$220{,}411}{48{,}000\ cwt.} = \$4.59/cwt.$$

STORAGE CAPACITY	72,000 cwt.
DIMENSIONS	144'x168'x16'
FLOOR AREA	24,192 ft^2
EXTERIOR WALL AREA	9,984 ft^2
INTERIOR WALL AREA	7,680 ft^2
CEILING AREA	24,192 ft^2
ROOF AREA	27,804 ft^2
PERIMETER	624 ft



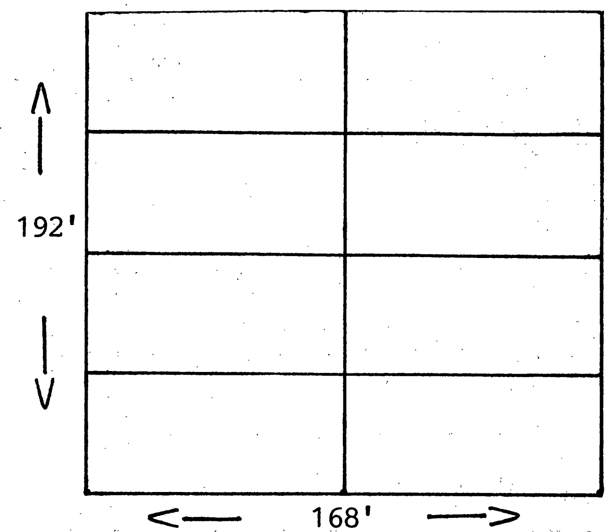
	MATERIALS		LABOR	TOTAL
EXCAVATION	600 yds^3 @ $5.00/$yd^3$			$3,000
CONCRETE				
FOOTING	(8/12)(16/12)(1104)/27= 37 yds^3 @ $49.00=	$ 1813		
FOUNDATION			MAT.	
WALL	(4)(10/12)(1104)/27= 137 yds^3 @ $49.00=	$ 6713	x .89=	
STEEL	(1104)(2)(1.5lb.)= 3312 lb. @ $ 0.30=	$ 994	$ 8473	
FLOOR	(24192)(5/12)/27= 374 yds^3 @ $49.00=	$18326	$34111	
		$27846	$42584	$70,430
CARPENTRY				
FRAMING				
STUDS 2"x8"x16'	(1104)/3= 368 @ $5.64=	$ 2076	$ 3036	
SILL 2"x8"x16'-P.T.	(1104)/16= 69 @ $9.92=	$ 685		
TOPSILL 2"x8"x16'	(1104)/16= 69 @ $5.64=	$ 390	MAT.	
TOP PLATE 2"x12"x16'	(1104)/16= 69 @ $8.46=	$ 584	x .75	
INTERIOR STRAPPING 2"x4"x16'	552 @ $2.82=	$ 1557		
CEILING STRAPPING 2"x4"x16'	432 @ $2.82=	$ 1219		
PURLINS 2"x4"x16'	1008 @ $2.82=	$ 2843		
FACIA 2"x8"x16'	66 @ $5.64=	$ 373		
SHEATHING (½" PLYWOOD)			$ 5739	
WALLS	(25344)/32= 792 @ $8.74=	$ 6922	$ 7604	
CEILING	(24192)/32= 756 @ $8.74=	$ 6608	$ 7258	
TRUSSES 48' (4/12 PITCH)	132 @ $87.00=	$11484	$ 5808	
		$34741	$29445	$64,186
INSULATION (including vapor barrier)				
EXTERIOR WALLS	9984 @ $0.86=			$ 8,587
INTERIOR WALLS	7680 @ $0.32=			$ 2,458
CEILING	24192 @ $0.45=			$10,887
				$21,932

MATERIALS		LABOR	TOTAL
ROOFING AND SIDING			
SIDING	9984 @ $0.42=$ 4193	$ 4193	
ROOFING	27804 @ $0.42=$11678	$11678	
ROOF CAP	504 @ $0.90=$ 454	$ 600	
	$16325	$16471	$32,796
DOORS			
ROLL-UP OVERHEAD (10'x12')	6 @ $825.00=$ 4950	$ 4290	
WALK-IN (3'x7')	6 @ $275.00=$ 1650	$ 762	
	$ 6600	$ 5052	$11,652
REFRIGERATION AND VENTILATION	$48658	$ 4866	$53,524
HEAT (125,000 BTU OIL FURNACE)	$ 639	$ 292	$ 931
HUMIDIFICATION (300 GAL/HOUR)	$ 900	$ 645	$ 1,545
SUBTOTAL			$259,996
ELECTRICAL AND PLUMBING (15% OF SUBTOTAL)			$38,999
GENERAL OVERHEAD (10% OF SUBTOTAL)			$26,000
TOTAL CONSTRUCTION INVESTMENT			$324,995

$$\frac{\$324{,}995}{24{,}192\ ft^2} = \$13.43/ft^2$$

$$\frac{\$324{,}995}{72{,}000\ cwt.} = \$4.51/cwt.$$

STORAGE CAPACITY	96,000 cwt.
DIMENSIONS	192'x168'x16'
FLOOR AREA	32,256 ft^2
EXTERIOR WALL AREA	11,520 ft^2
INTERIOR WALL AREA	11,136 ft^2
CEILING AREA	32,256 ft^2
ROOF AREA	35,536 ft^2
PERIMETER	720 ft



	MATERIALS	LABOR	TOTAL
EXCAVATION	800 yds^3 @ $5.00/$yd^3$		$ 4,000
CONCRETE			
FOOTING	(8/12)(16/12)(1416)/27= 47 yds^3 @ $49.00=$ 2303		
FOUNDATION		MAT.	
WALL	(4)(10/12)(1416)/27= 175 yds^3 @ $49.00=$ 8575	x .89=	
STEEL	(1416)(2)(1.5lb.)= 4248 lb. @ $ 0.30=$ 1275	$10816	
FLOOR	(32256)(5/12)/27= 498 yds^3 @ $49.00=$24402	$45481	
	$36555	$56297	$92,852
CARPENTRY			
FRAMING			
STUDS 2"x8"x16'	(1416)/3= 472 @ $5.64=$ 2662	$ 3894	
SILL 2"x8"x16'-P.T.	(1416)/16= 89 @ $9.92=$ 883		
TOPSILL 2"x8"x16'	(1416)/16= 89 @ $5.64=$ 502	MAT.	
TOP PLATE 2"x12"x16'	(1416)/16= 89 @ $8.46=$ 753	x .75	
INTERIOR STRAPPING 2"x4"x16'	708 @ $2.82=$ 1997		
CEILING STRAPPING 2"x4"x16'	576 @ $2.82=$ 1624		
PURLINS 2"x4"x16'	1344 @ $2.82=$ 3790		
FACIA 2"x8"x16'	88 @ $5.64=$ 496		
SHEATHING (½" PLYWOOD)		$ 7534	
WALLS	(33792)/32= 1056 @ $8.74=$ 9230	$10138	
CEILING	(32256)/32= 1008 @ $8.74=$ 8810	$ 9677	
TRUSSES 48' (4/12 PITCH)	176 @ $87.00=$15312	$ 7744	
	$46059	$38987	$85,046
INSULATION (including vapor barrier)			
EXTERIOR WALLS	11520 @ $0.86=		$ 9,907
INTERIOR WALLS	11136 @ $0.32=		$ 3,564
CEILING	32256 @ $0.45=		$14,515
			$27,986

MATERIALS		LABOR	TOTAL
ROOFING AND SIDING			
SIDING	11520 @ $0.42=$ 4838	$ 4838	
ROOFING	35536 @ $0.42=$14925	$14925	
ROOF CAP	672 @ $0.90=$ 605	$ 800	
	$20368	$20563	$40,931
DOORS			
ROLL-UP OVERHEAD (10'x12')	8 @ $825.00=$ 6600	$ 5720	
WALK-IN (3'x7')	8 @ $275.00=$ 2200	$ 1016	
	$ 8800	$ 6736	$15,536
REFRIGERATION AND VENTILATION	$62174	$ 6218	$68,392
HEAT (150,000 BTU OIL FURNACE)	$ 672	$ 337	$ 1,009
HUMIDIFICATION (400 GAL/HOUR)	$ 1036	$ 697	$ 1,733
SUBTOTAL			$337,485
ELECTRICAL AND PLUMBING (15% OF SUBTOTAL)			$50,623
GENERAL OVERHEAD (10% OF SUBTOTAL)			$33,749
TOTAL CONSTRUCTION INVESTMENT			$421,857

$$\frac{\$421,857}{32,256\ ft^2} = \$13.08/ft^2$$

$$\frac{\$421,857}{96,000\ cwt.} = \$4.39/cwt.$$

STORAGE CAPACITY 120,000 cwt.

DIMENSIONS 168'x240'x16'

FLOOR AREA 40,320 ft^2

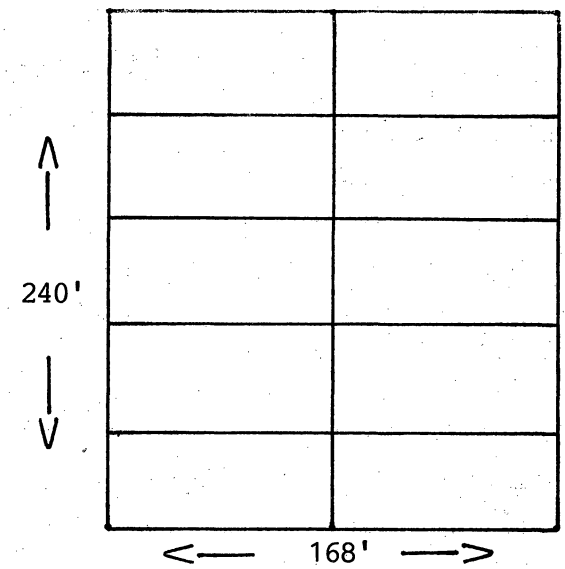
EXTERIOR WALL AREA 13,056 ft^2

INTERIOR WALL AREA 14,592 ft^2

CEILING AREA 40,320 ft^2

ROOF AREA 45,572 ft^2

PERIMETER 816 ft



		MATERIALS	LABOR	TOTAL
EXCAVATION	1,000 yds^3 @ $5.00/$yd^3$			$ 5,000
CONCRETE				
FOOTING	(8/12)(16/12)(1728)/27= 57 yds^3 @ $49.00=	$ 2793		
FOUNDATION			MAT.	
WALL	(4)(10/12)(1728)/27= 214 yds^3 @ $49.00=	$10486	x .89=	
STEEL	(1728)(2)(1.5lb.)= 5184 lb. @ $ 0.30=	$ 1555	$13202	
FLOOR	(40320)(5/12)/27= 623 yds^3 @ $49.00=	$30527	$56851	
		$45361	$70053	$115,414
CARPENTRY				
FRAMING				
STUDS 2"x8"x16'	(1728)/3= 576 @ $5.64=	$ 3249	$ 4752	
SILL 2"x8"x16'-P.T.	(1728)/16= 108 @ $9.92=	$ 1071		
TOPSILL 2"x8"x16'	(1728)/16= 108 @ $5.64=	$ 609	MAT.	
TOP PLATE 2"x12"x16'	(1728)/16= 108 @ $8.46=	$ 914	x .75	
INTERIOR STRAPPING 2"x4"x16'	864 @ $2.82=	$ 2437		
CEILING STRAPPING 2"x4"x16'	720 @ $2.82=	$ 2030		
PURLINS 2"x4"x16'	1680 @ $2.82=	$ 4738		
FACIA 2"x8"x16'	110 @ $5.64=	$ 620		
SHEATHING ($\frac{1}{2}$" PLYWOOD)			$ 9315	
WALLS	(42240)/32= 1320 @ $8.74=	$11537	$12672	
CEILING	(40320)/32= 1260 @ $8.74=	$11012	$12096	
TRUSSES 48' (4/12 PITCH)	220 @ $87.00=	$19140	$ 9680	
		$57357	$48515	$105,772
INSULATION (including vapor barrier)				
EXTERIOR WALLS	13056 @ $0.86=			$ 11,228
INTERIOR WALLS	14592 @ $0.32=			$ 4,670
CEILING	40320 @ $0.45=			$ 18,144
				$ 34,042

	MATERIALS	LABOR	TOTAL
<u>ROOFING AND SIDING</u>			
SIDING	13506 @ $0.42=$ 5484	$ 5484	
ROOFING	45572 @ $0.42=$19140	$19140	
ROOF CAP	840 @ $0.90=$ 756	$ 900	
	$25380	$25524	$50,904
<u>DOORS</u>			
ROLL-UP OVERHEAD (10'x12')	10 @ $825.00=$ 8250	$ 7150	
WALK-IN (3'x7')	10 @ $275.00=$ 2750	$ 1270	
	$11000	$ 8420	$19,420
<u>REFRIGERATION AND VENTILATION</u>	$68571	$ 6857	$75,428
<u>HEAT</u> (200,000 BTU OIL FURNACE)	$ 949	$ 438	$ 1,387
<u>HUMIDIFICATION</u> (500 GAL/HOUR)	$ 1172	$ 748	$ 1,920
<u>SUBTOTAL</u>			$409,287
<u>ELECTRICAL AND PLUMBING</u> (15% OF SUBTOTAL)			$61,393
<u>GENERAL OVERHEAD</u> (10% OF SUBTOTAL)			$40,929
TOTAL CONSTRUCTION INVESTMENT			$511,609

$$\frac{\$511,609}{40,320\ ft^2} = \$12.69/ft^2$$

$$\frac{\$511,609}{120,000\ cwt.} = \$4.26/cwt.$$

Appendix C
MONTHLY CASH FLOWS FOR POTATO STORAGES

MONTHLY CASH FLOWS OF 12,000 CWT. STORAGE FOR NOVEMBER USAGE (12,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	40	285	240		300	173		78960			-79998
OCT						81					-81
NOV					300	60			85920	-1289	84271
DEC	40	127				10					-177
JAN						10					-10
FEB						10					-10
MAR	40	127				10					-177
APR						10					-10
MAY						10					-10
JUNE	40	127				10					-177
JULY						10	797				-807

ANNUAL NET CASH INFLOW $2804

PAYBACK PERIOD (years) 31.16

MONTHLY CASH FLOWS OF 12,000 CWT. STORAGE FOR DECEMBER USAGE (12,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	40	285	240		300	173		78960			-79998
OCT						81					-81
NOV						60					-60
DEC	40	127			300	92			89880	-1834	87487
JAN						10					-10
FEB						10					-10
MAR	40	127				10					-177
APR						10					-10
MAY						10					-10
JUNE	40	127				10					-177
JULY						10	797				-807

ANNUAL NET CASH INFLOW $6137

PAYBACK PERIOD (years) 14.24

MONTHLY CASH FLOWS OF 12,000 CWT. STORAGE FOR JANUARY USAGE (12,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	40	285	240		300	173		78960			-79998
OCT						81					-81
NOV				960		60					-1020
DEC	40	285				92					-417
JAN					300	100			95400	-2519	92481
FEB						10					-10
MAR	40	127				10					-177
APR						10					-10
MAY						10					-10
JUNE	40	127				10					-177
JULY						10	797				-807

ANNUAL NET CASH INFLOW $9764

PAYBACK PERIOD (years) 8.95

MONTHLY CASH FLOWS OF 12,000 CWT. STORAGE FOR FEBRUARY USAGE (12,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	40	285	240		300	173		78960			-79998
OCT						81					-81
NOV				960		60					-1020
DEC	40	285				92					-417
JAN						100					-100
FEB					300	88			99000	-3505	95107
MAR	40	127				10					-177
APR						10					-10
MAY						10					-10
JUNE	40	127				10					-177
JULY						10	797				-807

ANNUAL NET CASH INFLOW $12300
PAYBACK PERIOD (years) 7.10

MONTHLY CASH FLOWS OF 12,000 CWT. STORAGE FOR MARCH USAGE (12,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	40	285	240		300	173		78960			-79998
OCT						81					-81
NOV				960		60					-1020
DEC	40	285				92					-417
JAN						100					-100
FEB						88					-88
MAR	40	127			300	73			103080	-4700	97840
APR						10					-10
MAY						10					-10
JUNE	40	127				10					-177
JULY						10	797				-807

ANNUAL NET CASH INFLOW $15122
PAYBACK PERIOD (years) 5.78

MONTHLY CASH FLOWS OF 12,000 CWT. STORAGE FOR APRIL USAGE (12,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	40	285	240		300	173		78960			-79998
OCT						81					-81
NOV				960		60					-1020
DEC	40	285				92					-417
JAN						100					-100
FEB						88					-88
MAR	40	285				73					-398
APR					300	45			109920	-6112	103463
MAY						10					-10
JUNE	40	127				10					-177
JULY						10	797				-807

ANNUAL NET CASH INFLOW $20357
PAYBACK PERIOD (years) 4.29

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR NOVEMBER - APRIL USAGE (12,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				3840	300	319			85920	-1289	80172
DEC	206	1284			300	386			89880	-1834	85870
JAN					300	339			95400	-2519	92242
FEB					300	230			99000	-3505	94965
MAR	206	808			300	135			103080	-4700	96931
APR					300	45			109920	-6112	103463
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $68465

PAYBACK PERIOD (years) 6.85

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR DECEMBER - APRIL USAGE (14,400 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				4608		319					-4927
DEC	206	1408			360	456			107856	-2200	103226
JAN					360	315			114480	-3022	110783
FEB					360	299			118800	-5417	112724
MAR	206	1029			360	198			123696	-5641	116262
APR					360	88			131904	-7334	124122
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $77011

PAYBACK PERIOD (years) 6.09

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR JANUARY - APRIL USAGE (18,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN					450	490			143100	-3778	138382
FEB					450	415			148500	-5257	142378
MAR	206	887			450	198			154620	-7051	145828
APR					450	88			164880	-9167	155175
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $88245

PAYBACK PERIOD (years) 5.31

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR FEBRUARY - APRIL USAGE (24,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN						490					-490
FEB					600	432			198000	-7009	189959
MAR	206	966			600	259			206160	-9401	194728
APR					600	88			219840	-12223	206929
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $97608
PAYBACK PERIOD (years) 4.80

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR MARCH - APRIL USAGE (36,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN						490					-490
FEB						432					-432
MAR	206	1124			900	378			309240	-14101	292531
APR					900	131			329760	18335	310394
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $108485
PAYBACK PERIOD (years) 4.32

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR NOVEMBER USAGE (120,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV					3000	523			859200	-12888	842789
DEC	325	1023				10					-1358
JAN						10					-10
FEB						10					-10
MAR	325	1023				10					-1358
APR						10					-10
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $31761
PAYBACK PERIOD (years) 23.66

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR DECEMBER USAGE (120,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV						523					-523
DEC	325	1023			3000	738			898800	-18336	875378
JAN						10					-10
FEB						10					-10
MAR	325	1023				10					-1358
APR						10					-10
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $65185
PAYBACK PERIOD (years) 11.53

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR JANUARY USAGE (120,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN					3000	792			954000	-25186	925022
FEB						10					-10
MAR	325	1023				10					-1358
APR						10					-10
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $101574
PAYBACK PERIOD (years) 7.40

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR FEBRUARY USAGE (120,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN						792					-792
FEB					3000	698			990000	-35046	951256
MAR	325	1023				10					-1358
APR						10					-10
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $127026
PAYBACK PERIOD (years) 5.92

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR MARCH USAGE (120,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN						792					-792
FEB						698					-698
MAR	325	1023			3000	616			1030800	-47004	978832
APR						10					-10
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $155262
PAYBACK PERIOD (years) 4.84

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR APRIL USAGE (120,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN						792					-792
FEB						698					-698
MAR	325	2602				616					-3543
APR					3000	432			1099200	-61116	1034652
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NOMINAL NET CASH INFLOW $207549
PAYBACK PERIOD (years) 3.62

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR NOVEMBER - APRIL USAGE (20,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				6400	500	523			143200	-2148	133629
DEC	325	2076			500	668			149800	-3056	143175
JAN					500	566			159000	-4198	153736
FEB					500	366			165000	-5841	158293
MAR	325	1286			500	259			171800	-7834	161596
APR					500	88			183200	-10186	172426
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $114573
PAYBACK PERIOD (years) 6.56

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR NOVEMBER - APRIL USAGE: (12,000 CWT./MONTH), NOVEMBER - DECEMBER (24,000 CWT.), JANUARY - APRIL (24,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				7680	300	523			85920	-1289	76128
DEC	325	2287			300	668			89880	-1834	84466
JAN					600	641			190800	-5037	184522
FEB					600	432			198000	-7009	189959
MAR	325	1339			600	259			206160	-9401	194236
APR					600	88			219840	-12223	206929
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $127958
PAYBACK PERIOD (years) 5.87

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR DECEMBER - APRIL USAGE (24,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				7680		523					-8203
DEC	325	2287			600	738			179760	-3667	172143
JAN					600	641			190800	-5037	184522
FEB					600	432			198000	-7009	189959
MAR	325	1339			600	259			206160	-9401	194236
APR					600	88			219840	-12223	206929
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $131304
PAYBACK PERIOD (years) 5.72

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR JANUARY - APRIL USAGE (30,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN					750	792			238500	-6296	230662
FEB					750	565			247500	-8762	237424
MAR	325	1418			750	319			257700	-11751	243137
APR					750	131			274800	-15279	258640
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $147792
PAYBACK PERIOD (years) 5.09

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR FEBRUARY - APRIL USAGE (40,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN						792					-792
FEB					1000	698			330000	-11682	316620
MAR	325	1550			1000	438			343600	-15668	324619
APR					1000	174			366400	-20372	344854
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $163231
PAYBACK PERIOD (years) 4.60

MONTHLY CASH FLOWS OF 120,000 CWT. STORAGE FOR MARCH - APRIL USAGE (60,000 CWT./MONTH)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	325	2602	1200		1500	824		388800			-395251
OCT			1200		1500	785		400800			-404285
NOV				9600		523					-10123
DEC	325	2602				738					-3665
JAN						792					-792
FEB						698					-698
MAR	325	1813			1500	616			515400	-23502	487644
APR					1500	217			549600	-30558	517325
MAY						10					-10
JUNE	325	1023				10					-1358
JULY						10	7358				-7368

ANNUAL NET CASH INFLOW $181409
PAYBACK PERIOD (years) 4.14

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR NOVEMBER USAGE (72,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV					1800	319			515520	-7733	505668
DEC	206	650				10					-866
JAN						10					-10
FEB						10					-10
MAR	206	650				10					-866
APR						10					-10
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $18727
PAYBACK PERIOD (years) 25.04

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR DECEMBER USAGE (72,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV						319					-319
DEC	206	650			1800	456			539280	-11001	525167
JAN						10					-10
FEB						10					-10
MAR	206	650				10					-866
APR						10					-10
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $38773
PAYBACK PERIOD (years) 12.10

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR JANUARY USAGE (72,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN					1800	490			572400	-15111	554999
FEB						10					-10
MAR	206	650				10					-866
APR						10					-10
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $60595
PAYBACK PERIOD (years) 7.74

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR FEBRUARY USAGE (72,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN						490					-490
FEB					1800	432			594000	-21028	570740
MAR	206	650				10					-866
APR						10					-10
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $75856
PAYBACK PERIOD (years) 6.18

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR MARCH USAGE (72,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN						490					-490
FEB						432					-432
MAR	206	650			1800	378			618480	-28203	587243
APR						10					-10
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $92793
PAYBACK PERIOD (years) 5.05

MONTHLY CASH FLOWS OF 72,000 CWT. STORAGE FOR APRIL USAGE (72,000 CWT.)

	OUTFLOWS								INFLOWS		NET CASH
MONTH	TAXES	INSURANCE	MERTECT	CIPC	LABOR	UTILITIES	MAINTENANCE	POTATOES	POTATOES	LOSS	INFLOWS
AUG						10					-10
SEPT	206	1598	720		900	501		233280			-237205
OCT			720		900	473		240480			-242573
NOV				5760		319					-6079
DEC	206	1598				456					-2260
JAN						490					-490
FEB						432					-432
MAR	206	1598				378					-2182
APR					1800	260			659520	-36669	620791
MAY						10					-10
JUNE	206	650				10					-866
JULY						10	4505				-4515

ANNUAL NET CASH INFLOW $124169
PAYBACK PERIOD (years) 3.78

Appendix D
INTERNAL RATE OF RETURN ON INVESTMENT TABLES

Payback Period yrs.	Approximate I.R.R.[1]%
15.0	2.91
14.9	2.98
14.8	3.06
14.7	3.13
14.6	3.20
14.5	3.28
14.4	3.35
14.3	3.43
14.2	3.51
14.1	3.59
14.0	3.67
13.9	3.75
13.8	3.83
13.7	3.91
13.6	3.99
13.5	4.07
13.4	4.16
13.3	4.24
13.2	4.33
13.1	4.42
13.0	4.51
12.9	4.60
12.8	4.69
12.7	4.78
12.6	4.87
12.5	4.96
12.4	5.06
12.3	5.15
12.2	5.25
12.1	5.35
12.0	5.45
11.9	5.55
11.8	5.65
11.7	5.76
11.6	5.86
11.5	5.97
11.4	6.07
11.3	6.18
11.2	6.29
11.1	6.41
11.0	6.52
10.9	6.64
10.8	6.75
10.7	6.87
10.6	6.99
10.5	7.11
10.4	7.24
10.3	7.36
10.2	7.49
10.1	7.62
10.0	7.75
9.9	7.89
9.8	8.02
9.7	8.16
9.6	8.30
9.5	8.45
9.4	8.59
9.3	8.74
9.2	8.89
9.1	9.04
9.0	9.20
8.9	9.36
8.8	9.52
8.7	9.68
8.6	9.85
8.5	10.02
8.4	10.20
8.3	10.37
8.2	10.55
8.1	10.74
8.0	10.93
7.9	11.12
7.8	11.32
7.7	11.52
7.6	11.72
7.5	11.93
7.4	12.15
7.3	12.37
7.2	12.59
7.1	12.82
7.0	13.06
6.9	13.30
6.8	13.55
6.7	13.80
6.6	14.06
6.5	14.33
6.4	14.60
6.3	14.88
6.2	15.17
6.1	15.47
6.0	15.77
5.9	16.09
5.8	16.42
5.7	16.75
5.6	17.10
5.5	17.45
5.4	17.82
5.3	18.20
5.2	18.59
5.1	19.00
5.0	19.42
4.9	19.86
4.8	20.32
4.7	20.79
4.6	21.28
4.5	21.79
4.4	22.32
4.3	22.88
4.2	23.46
4.1	24.06
4.0	24.70
3.9	25.36
3.8	26.05
3.7	26.79
3.6	27.56
3.5	28.37
3.4	29.23
3.3	30.14
3.2	31.11
3.1	32.13
3.0	33.22
2.9	34.39
2.8	35.63
2.7	36.97
2.6	38.40
2.5	39.95
2.4	41.63
2.3	43.45
2.2	45.43
2.1	47.60
2.0	49.98

[1] These are approximate Internal Rates of Return (IRR) for investments assuming that the net cash inflows remain constant for twenty years and then end and that the storage equipment and crates will have no salvage value after twenty years.