THE ECONOMICS OF STORING WEST TEXAS POTATOES

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ABSTRACT

Growers in the West Texas area have attempted to determine whether privately owned grower storage facilities would be economically viable. This paper discusses storage goals, investment decision criteria, storage design, and investigates the costs of storing potatoes produced in the West Texas area. Results indicate that fresh market prices generally do not rise enough to cover the costs of storage in a typical year. The analysis is done using two methods, a break-even analysis and the Rister, Skees and Black storage model, and the results are consistent.

INTRODUCTION

The seasonal potato market has been associated with large year to year variations in production and price. A relatively small change in production tends to be accompanied by a relatively large change in price, causing prices to vary substantially from year to year and within the year, as well. Over time potato production has shown a normal inverse relationship to its own price (USDA, 1976-84). Such fluctuations have made potato production a speculative enterprise, causing most growers to face the market with considerable uncertainity. Summer potato prices in the last five years have fluctuated widely and tend to be higher than other seasonal potato prices. These prices are influenced by the fall storage potatoes, the timing of spring and summer crop harvest and potato processors' demand (Hee, 1967). Summer potato production provides almost 50 percent of the total consumption during the summer market period, with the remainder coming from spring and fall storage potatoes.

Texas potato production accounts for about 12.5% of the nation's total summer production and since 1981 has shown an upward trend (USDA, 1976-84). The High Plains has historically accounted for about 60% of the total acreage harvested in the state with the Rio Grande Valley a distant second at 14% (Table 1). The remaining vegetable producing regions in the state contribute very little to the supply, as indicated in the table. Texas potato production goes primarily to fresh markets in the midwest and the east. Recent unload data show that Texas is becoming more active in national markets and less reliant on state and nearby regional markets. However, the small proportion of Texas potato production in relation to the total quantity marketed in the summer causes potato growers to have very little, if any, influence on the market price. Consequently, they are price takers, causing production to be risky.

THE PROBLEM

Recently, growers in the West Texas area have attempted to determine whether privately owned grower storage facilities would be economically viable. These facilities would allow producers to withhold production from the market when prices are depressed at harvest time. A major component in the decision to store potatoes for a period of time is the producer's market price in any given month of the year. The storage investment decision involves such specific considerations as:

1. Selecting facilities to provide storage of potatoes at the lowest cost while maintaining quality; and
2. Deciding how long to store the crop, which is related to when an increase in price will occur.

Table 1. Texas Potatoes: Acreage harvested by state regions 1983-84

	Acreage harvested			
State regions	**1983**	**percent**	**1984**	**percent**
Rio Grande Valley	2,500	16.0	2,400	13.7
Coastal Bend	50	0.3	50	0.2
San Antonio-Winter Garden	1,000	6.7	1,150	6.6
Upper Coast	350	2.4	570	3.3
Central Texas	500	3.3	700	4.0
East Texas	200	1.4	330	1.9
North Texas	1,800	11.9	1,700	9.7
High Plains	**8,800**	**58.0**	**10,600**	**60.6**
State total	15,200	100.0	17,500	100.0

Source: USDA, 1983-84.

STORAGE GOALS

Studies were reviewed to gain a better understanding of the physical requirements of potato storage, the factors affecting the decision of when to store, and the importance of storage in the potato industry. Several authors agree (Brennan 1959, Plissey, 1976, Cargill, 1976, and Hanes, 1969) that the main goals for potato storage are to:

1. Retain water in the tuber because profits depend on holding shrink to a minimum.
2. Hold respiration to a minimum which will both reduce weight losses and quality deterioration.
3. Hold reducing sugars to a minimum for potatoes to be processed.
4. Maintain external appearance.

When potatoes are harvested and placed in storage, they are usually held at a temperature of 50 to 60 degrees Fahrenheit (F.) at a relatively high humidity for 10 to 14 days to allow cuts and bruises to heal and to reduce subsequent losses from shrinkage and decay. Then, temperatures are reduced to 38 to 48 degrees F. for storage (unless the potatoes are to be processed, in which case temperatures are kept at 50 to 60 degrees to retard accumulation of reducing sugars). Another important factor affecting the weight loss of potatoes during storage is the relative humidity of the air used to maintain the temperature within the pile. Studies have shown that minimum weight loss occurred when the tubers were maintained at a temperature of about 45 degrees F. with air at 95% or more relative humidity. Storage temperatures 2.5 degrees F. lower

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significantly increased weight loss and also produced an unacceptable color in unblanched french fries.

INVESTMENT DECISION CRITERIA

The farm operator, as the decision maker, must decide how long to store potatoes based on the expected economic gain. Economic gain is dependent on total storage costs and the increase in sale value. Another factor which affects economic gain is the convenience yield on inventories which is the ability to keep regular customers satisfied by meeting their orders in a timely fashion. The economic gain to the convenience yield on inventories is recognized as the premium that buyers are willing to pay in return for the assurance of a supply of consistent quality from the beginning of the season until the new crop is available. However this requires the proper storage facilities and storage management.

STORAGE DESIGN

Von Bermuth (1964) evaluated storage designs to determine the economically optimum investment. Considering eight storage systems, his designs were based on expected temperature and relative humidity extremes resulting from weather analysis. Results indicated that the frame structure design with automatically controlled forced air ventilation and humidification provides the greatest net return to storage. The facility must have adequate insulation such that walls and ceilings should have no more heat transfer than 0.05 BTU's per square foot of surface area each hour for each degree F. difference between inside and outside temperature. The air distribution system must be capable of maintaining a uniform temperature through the potato pile. Thus, the forced air system should be capable of 0.5 cfm per cwt. during the brief period of cool down, and a sustained rate of 0.25 cfm per cwt. after cooling to the holding temperature has been accomplished. For this study, the potato storage facility selected is refrigerated with a capacity of 100,000 cwt., well insulated, and includes ventilating and humidifying systems. It is also the least cost system of the several designs considered (Cargill, 1976, Summer and Sparks, 1974, and Von Bermuth, 1964).

STORAGE COSTS

Total costs of potato storage fall into three categories: (1) shrinkage and weight loss; (2) quality deterioration and (3) direct costs of owning and operating storage facilities. The costs of storing potatoes for this analysis have been determined by taking into account the following:

1. Cash storage costs for the period are the monthly variable costs incurred from harvest until the time when potato stocks are sold as well as continous variable and fixed facility costs associated with the acquistion of the building and storage equipment. Thus cash storage costs will change as other variable costs are increased due to increased time in storage, as represented in the following equation:

$$CS = FFC + OVC \text{ and } OVC = VC_t * T \qquad (1)$$

where:

CS = cash storage costs for the period ($/cwt.).

FFC = fixed facility costs and continous variable costs ($/cwt.).

OVC = other variable costs for the period ($/cwt.).

VC_t = monthly variable costs ($/cwt.).

T = number of months of storage.

2. Opportunity costs, which are the indirect costs associated with delaying sales past harvest. The interest rate reported by the Dallas Federal Reserve District for farm loans was used in the following formula to reflect the opportunity cost of capital:

$$DF = (1.0 + r), -^{T/12} \qquad (2)$$

where:

DF = discount factor for the period.

r = current annual interest rate.

T = number of months of storage.

3. Costs of physical loss, which are due to losses caused by enviromental conditions during storage. The percent values for weight loss computed by Summer and Sparks (1974) were used in the calculations of these costs based on maintenance of recommended enviromental conditions for minimum weight loss. Minimum weight loss of potatoes stored from 30 to 180 days range from 0.44 to 2.28 percent.

TEXAS POTATO PRICE PATTERN

A trend equation was developed to indicate the average movement of potato prices over time. Secondly, seasonal variations were explored using moving average prices to construct a seasonal index. Data used were monthly average potato prices received by Texas farmers as reported by the Texas Statistical Reporting Service for the period, July, 1976 to June, 1984. Monthly average prices received were estimated from monthly wholesale average potato prices at the Dallas market less transportation costs for months in which there were no published data.

BREAK-EVEN POST-HARVEST POTATO PRICES

Post-harvest potato prices that should encourage growers to hold potatoes in storage during successive periods of time (30, 60, 90 and 180 days) were computed by adding the total storage costs for the period to the average price for the month of August.

$$PPH_t = TSC/T + PH_{t_O} \text{ and } TSC = CS + OC + PLC + IFSC \qquad (3)$$

where:

PPH_t = post-harvest potato price in month t ($/cwt.).

TSC = total storage costs for the period ($/cwt.).

PH_{to} = potato price at harvest ($/cwt.).

CS = cash storage costs for the period ($/cwt.).

OC = opportunity costs for the period ($/cwt.).

PLC = physical loss costs for the period ($/cwt.).

IFSC = initial fixed storage costs ($/cwt.).

T = number of months in the storage period.

NET RETURNS TO STORAGE

The profitability of storing potatoes for several lengths of time was computed using an equation developed by Rister, Skees, and Black (1984) in their analysis of grain sorghum storage decisions in the Texas Coastal Bend. The equation represents net returns to post-harvest sales from storage as opposed to sales at harvest.

$$NR_{tto} = ((PPH_t - CS_t) * (1 - w_t) * DF_t) - PH_{to} - IFSC \quad (4)$$

$$CS_t = CS/T \quad (5)$$

$$w_t = (\% * 0.01) \quad (6)$$

$$DF_t = (1 + r)_t^{-1/12} \quad (7)$$

where:

NR_{tto} = net revenues from storage in month t as opposed to sales at harvest ($/cwt.)

w_t = proportional weight loss adjustment factor for month t, and all other terms are as previously defined.

RESULTS

Estimated storage costs shown in Table 2 relate the costs of ownership and operation of a well-constructed and well-maintained 100,000 cwt. storage facility to the length of storage season. Costs are expressed per cwt. of potatoes and are estimated on a 5 percent shrinkage giving 95,000 cwt. of marketable potatoes out of storage.

Cash storage costs include continous variable costs, fixed facility costs and other variable costs. Continous variable costs represent the costs of unloading and piling the potatoes in storage as well as the cost of removal from storage. Fixed facility costs are the costs related to investment in the facility such as depreciation, taxes, insurance and interest. For the purpose of this analysis interest was 14.35 percent. Even at this relatively high interest rate, continous variable costs and fixed facility costs were only $0.48 per cwt. Other variable costs include such items as electricity for ventilation and refrigeration and the service costs of such units. Other variable costs vary according to the length of the storage period and range from $0.10 to $0.39 per cwt. as time changes from 30 to 180 days.

Table 2. Estimated storage costs for a 100,000 cwt. potato storage facility, selected time periods.

Cost Items	Length of Storage 30 days	60 days	90 days	180 days
	dollars per cwt.			
Cash storage costs[1]	0.58	0.62	0.67	0.87
Opportunity costs	0.04	0.09	0.13	0.28
Physical loss costs	0.04	0.06	0.09	0.20
Initial fixed costs	**3.63**	**3.63**	**3.63**	**3.63**
Total storage costs	4.29	4.40	4.52	4.98

[1]Cash storage costs are composed of continous variable costs and fixed facility costs of $0.48 per cwt. regardless of length of storage, and other variable costs of $0.10, $0.14, $0.19, and $0.39 for 30, 60, 90 and 180 days, respectively.

The opportunity costs include the indirect costs associated with delaying sales after harvest as interest on operating capital and interest on potato stocks and range from $0.04 to $0.28 per cwt. as time varies from 30 to 180 days.

The physical loss costs represent the percentage of weight and quality change that occur during storage. The value used in estimating the monetary costs of storage losses in this study was the price of potatoes at harvest ($8.61 per cwt.). The costs associated with each length of storage were computed by multiplying the proper percentage of physical loss for the period by the harvest price.

Initial fixed costs include the purchase value of the building, complete with ventilation and refrigeration systems, and were estimated to be $3.63 per cwt. Thus, the total storage costs for potatoes were estimated to be between $4.29 and $4.98 per cwt. as storage varies between 30 and 180 days (Table 2).

Post-harvest potato prices required to offset storage costs for specific time periods were obtained by adding total storage costs for the period to the price of potatoes at harvest time. These values are the prices required to return the same income that would be realized if the potatoes were sold at harvest rather than stored. Post-harvest prices must increase by more than 50% above the harvest price to offset storage costs and return the same profit that would have been available at harvest (Table 3).

Table 3. Post-harvest average potato prices required to offset storage costs for selected time periods.

Storage period	Average harvest price	Total storage costs	Post-harvest price
	dollars per cwt.		
30 days	8.61	4.39	12.90
60 days	8.61	4.41	13.02
90 days	8.61	4.52	13.13
180 days	8.61	4.98	13.59

In comparing Texas potato prices over time, it is apparent that there have been only a few periods in which it would have been profitable to store potatoes. The data in Figure 1 are for the period August 1976 to July 1984, representing 96 months. In only 13 of those months, or about 1 year in 7, were prices high enough to justify storage. The cost data presented have assumed annual use of the storage facility. If it were used in some pattern other than annually, such as 1/7th of the time, actual costs of use would be higher. Thus, storage of summer potatoes produced in West Texas is infeasible if one crop must carry storage fixed costs for seven years. The outlook for the average movement in Texas potato prices is that they will move upward over time. However, the seasonal price pattern shows that post-harvest prices will generally not increase by more than 10 percent over a yearly period. It seems that expected average potato prices will not rise sufficiently to cover the costs of storage in the long run unless they are substantially higher than we have historically seen.

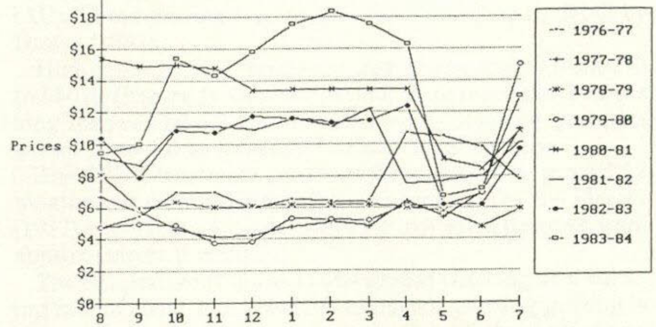

Figure 1. West Texas Potato Prices by Month, 1976-84.

LITERATURE CITED

Brennan, Michael. 1959. "A Model of Seasonal Inventories." **Econometrica. Vol. 27**, pp. 228-244. April.

Cargill, B.F. 1976. "The Potato." **in The Potato Storage: Design, Construction, Handling and Enviromental Control**. pp. 3-7. Michigan State University Press.

Hanes, John K. 1969. "Organization and Structure of the Red River Valley Potato Industry." Department of Agricultural Economics. University of Minnesota. March.

Hee, Olman. 1967. "Demand and Price Analysis for Potatoes." USDA Ėconomic Research Service. Washington, D.C. Technical Report No. 1380. July.

Plissey, Edwin. 1976. "Philosophy of Potato Storage." **The Potato Storage**. pp. 7-14. Michigan State State University Press.

Rister, Edward, Jerry Skees and J. Roy Black. 1984. "Evaluating Use of Outlook Information in Grain Sorghum Storage Decisions." **Southern Journal of Agricultural Economics**. pp. 151-158. July.

Sparks, Walter. 1975. "Potato Storage Factors of Economic Importance." **American Potato Journal**. Vol. 52, pp. 89-97.

Summer, Larry and Walter Sparks. 1974. "Potato Weight Losses, Quality Changes and Cost Relationships During Storage." Idaho Agricultural Experiment Station. Bulletin 535. January.

U.S. Department of Agriculture. 1976-84. Texas Statistical Reporting Service. **Texas Agriculture Cash Receipts and Price Statistics**. Austin, Texas, selected issues.

Von Bermuth, Richard. 1964. "Economics of Potato Storage in the San Luis Valley of Colorado." M.S. Thesis. Colorado State University. June.