POTATO STORAGE COSTS

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How much does it cost to store potatoes? The answer will depend on a host of factors, including: the type of storage, length of storage, potato variety, condition of the potatoes going into storage, whether and when a sprout inhibitor is applied, cost of labor, cost of electricity, prevailing interest rate, and the value of the stored potatoes. The answer will also depend on whether you are talking about operating costs, ownership costs, cash costs or economic costs. In summary, there is no single universal cost for storing potatoes. The purpose of this article is to discuss storage costs as part of potato production costs based on economic costs. This article will not discuss the economic feasibility of storing potatoes, the economics of alternative storage systems, nor the various financing alternatives that are available.

As with the cost of growing potatoes, the cost of storing potatoes can be classified as operating (variable) – those costs that change directly with the quantity of potatoes stored, and ownership – those costs that are fixed and will be incurred even if the potatoes are not stored. Costs can also be classified as cash or as economic. Cash costs include only those items where there is a direct out-of-pocket payment. In contrast, economic costs includes all items and the concept of "opportunity cost" which assigns a cost to all resources used in the production process. Opportunity cost is the foregone income from the next best alternative use of that resource. What would the owner's labor be worth if he didn't farm and he worked for someone else? What type of return could the money invested in land or machinery earn for the owner if she had the money invested in stocks, bonds, or some other economic activity. By answering these questions you can assign a "cost" to resources that do not have a cash cost. Since economic costs account for all resources, economic costs are generally higher than cash costs. Opportunity costs are most often used to account for the labor, management and equity that the owner-operator contributes.

OWNERSHIP COSTS

In general, ownership costs are tied to capital assets, such as buildings and equipment. Since they last more than one production season, costs must be allocated over multiple years. Depreciation, or cost recovery, is the first major ownership cost. While the Internal Revenue Service provides procedures and guidelines on depreciating assets for tax purposes, tax depreciation should not be used in calculating field production costs or the cost of storing potatoes. Management depreciation based on years of useful life should be used. While there are several different methods of calculating depreciation, some more complex than others, they are only estimates. Depreciation will only be known when the asset is sold or is no longer capable of providing a useful service. Straight-line depreciation is the simplest method and will provide a meaningful management cost estimate. Straight-line depreciation is simply:

$$\text{Straight-line Depreciation} = (\text{Purchase Price} - \text{Salvage Value}) \div \text{Years of Useful Life}$$

The cost of capital or interest charge on invested capital is the second major ownership cost for the depreciating asset. Growers often consider only the cash interest paid on borrowed money. While that is certainly an important consideration from a cash flow standpoint, an interest charge should be applied to both borrowed capital and owner equity. A market-based interest rate for similar investments should be used. Interest charged on all capital is opportunity cost interest. However, interest should only be charged on the remaining value each year after depreciation has been subtracted. Interest will decline as the asset is depreciated. For cost of production purposes,

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you need the average annual interest charge, not the interest charge in one particular year. You can avoid the tedious process of calculating the annual interest and then calculating the average. A simple method to derive the same value is simply to charge interest on the average value of investment over the useful life. Average investment is calculated as follows:

Average Investment = (Purchase Price + Salvage Value) ÷ 2.

POTATO STORAGE, AIR SYSTEM AND HANDLING EQUIPMENT

The potato storage system is composed of three distinct components: the potato storage facility, the air system, and the potato handling equipment. Each component will be viewed separately. The cost of building a potato storage facility will depend on the size, design, materials used, air plenum location, site preparation and a host of other factors. Since my objective is to illustrate how to calculate storage costs, I will avoid these complex issues and simply use a cost of $3 per hundredweight of storage capacity for my 180,000-cwt facility. Based on system design considerations, the price could range from $2.75 to $3.25. This cost is only for the structure and does not include the air system, which will be handled separately. I choose to separate the air system from the storage facility because they each have a different useful life and treating them separately simplifies the cost calculations.

Assumptions and basic parameters for the storage facility are shown in Table 1. The storage facility has a cost or purchase value of $540,000, an estimated salvage value of $27,000 and a useful life of 30 years. Whether the salvage value is positive or negative depends on whether salvaged items will cover the cost to tear down and remove the facility. I'm assuming that they will. The average annual depreciation based on straight-line is $17,100. The average level of investment over the 30-year useful life is $283,500. Based on a 9.5% interest rate, the annual opportunity cost interest is $26,933. Property tax and insurance adds an additional $4,678 to the annual ownership costs. Total annual ownership costs amount to $48,710. On a per hundredweight basis this amounts to $.271 if the storage is used at capacity. But, if the system is only used at 90% capacity, the annual cost per hundredweight increases to $.301. It's important to consider utilization efficiency since excess or unused capacity in a storage system is expensive.

Another ownership cost shown in Table 1 is repairs. Some repairs are associated with use and others are a function of time, which is often the case for buildings. The repairs on a storage facility will not come in a nice even annual stream of $2,700 per year as shown in Table 1. There may not be any repairs at all for the first 5-10 years, but some attempt should be made to evaluate these costs and tie them back to an annual estimate. Think of the cumulative costs that will likely be encountered over the life of the facility and then divide by the years of useful life. Engineering and economic studies often express repairs as a percentage of purchase price or the average level of investment. I opted to use a repair factor of .5% of the initial cost to estimate annual repair costs. Some might prefer to handle the repairs as an operating cost. That certainly makes sense for machinery and equipment where repairs are more a function of use than of time. On a per hundredweight basis, repairs add another $.015 to the ownership costs.

The basic parameters for the air system are shown in table 2. A 20 cfm evaporative air cooling system for this storage facility is estimated to cost $.85 per hundredweight of storage capacity. This would include electrical panels and ventilation pipe. Again, based on system design considerations the price could range from $.85 to $.95 for a 20 cfm system and $.75 to $.85 for an 18-cfm system. The air system has a cost or purchase value of $153,000, an estimated salvage value of $15,300, and a useful life of 15 years. The average annual depreciation based on straight-line is $9,180. The average level of investment is $84,150, and based on a 9.5% interest rate, the average annual opportunity cost interest is $7,994. Property tax and insurance adds an estimated $1,388 to the annual ownership cost for the air system. Total annual ownership costs amount to $18,563. On a per hundredweight basis this amounts to $.103 if the system is used at capacity and

$.115 if the system is only used at 90% capacity. Estimated annual repair costs amount to $1,530, based on 1% of the initial cost. This adds $.09 cents per hundredweight to the ownership costs.

To place potatoes into a storage facility, some specialized potato handling equipment is needed. The type of handling equipment and the cost of the equipment used in this example are shown in Table 3. The term equipment capacity is used to indicate how many hundredweight these annual costs will be spread over. This equipment can be used on more than one storage facility. My assumption is that the handling equipment is being allocated to 300,000 cwt. To simplify the calculations, all handling equipment is analyzed using the same 15 years of useful life. The handling equipment has a combined cost or purchase value of $225,725, an estimated salvage value of $22,573, and a useful life of 15 years. The average annual depreciation based on straight-line is $13,544. The average level of investment is $124,149, and based on a 9.5% interest rate, the average annual opportunity cost interest is $11,794. Property tax and insurance adds an estimated $2,048 to the annual ownership cost for the handling equipment. Total annual ownership costs amount to $27,386. On a per hundredweight basis this amounts to $.091 if the system is used to capacity and $.101 if the system is only used at 90% capacity. Annual repair cost, estimated at 1.5% of the purchase price, amounts to $3,386.

The total annual ownership costs of the storage facility and air system amounts to $71,503, which includes the annual repair expenses. This works out to just under $.40 per hundredweight with full utilization. The total annual ownership costs for the handling equipment cannot be added to the total ownership costs for the storage facility and air system because they have different assumed capacities. However, the cost per hundredweight for the handling equipment can be combined with the cost per hundredweight for the storage facility and air system. When these are combined, the ownership cost for the potato storage system is $.50 per hundredweight.

OPERATING COSTS

Operating costs are those that vary directly with the quantity of potatoes stored and the length of time they are stored. Costs include labor, power, a sprout inhibitor, sanitization chemicals, interest, insurance and shrink. For the most part, operating costs are scale neutral so that the size of the storage will not alter the cost per hundredweight of storage. The model storage used to calculate operating costs is based on storage capacity of 100,000 cwt. This simplifies the conversion from total costs to cost per hundredweight. Other basic parameters used in calculating the operating storage costs are shown in Table 4. The monthly storage costs shown in Tables 5 and 6 are calculated to the end of month.

What value should be placed on the crop? There are two basic options. The first option is to use the current market value and the second option is to use the accrued cost of production through harvest based on cash costs. The appropriate value to use will depend on the analysis being conducted. For marketing decision, current market price is the appropriate value. When the objective is to know how much it costs to produce a crop of potatoes, then accumulated production costs should be used. The value of the crop placed in storage is used for two important calculations. First is a shrink value and the second is an interest charge. Unlike grain, you won't remove the same weight of potatoes after storage as went into the storage facility. Potatoes respire and loose moisture. The amount of weight loss will depend on a host of factors such as variety, condition of the tubers placed into storage and the type of air system and how the air system is managed. During the first two to three weeks of storage, potatoes go through a higher initial weight loss or "sweat." The shrink or weight loss will then stabilize for a number of months and will start to increase as the potatoes break dormancy. The monthly shrink values shown in Table 5 are typical of well-conditioned Russet Burbank potatoes in a modern storage facility with a humidified air system. These potatoes are also receiving two sprout inhibitor applications, which will influence shrink loss over time. Using the monthly shrink percentage and the value of the crop, the monthly shrink value shown in Table 5 was calculated. Using the interest rate (9.5%

annual) and the value of the potatoes shown in Table 4, the monthly interest charge shown in Table 5 was calculated.

Table 4 also shows an estimated cost of preparing the storage facility and potato handling equipment. This does not include storage facility and equipment repairs, which are included elsewhere. The storage facility and handling equipment must be cleaned and sanitized and the ventilation pipe must also be cleaned and straightened. Some growers take care of this and others use a commercial company that provides this service for a fee. In either case, a cost is incurred. You should also consider any other up front storage costs that might be incurred. For example, if a fungicide is applied to potatoes placed in storage, the total cost could be included in this category, or it could be added to the value of the potatoes. In this example, no additional costs are included. The last item is the estimated cost of removing the potatoes from storage. Depending on the purchase agreement, this may not be a cost incurred by the grower. This cost must be added to the cumulative cost at the end of every month because each month has the potential of being the last month of storage. This cost should not be carried forward to the next month, however, since it is a one-time occurrence.

Table 5 shows the total operating costs by month for the various cost categories. The crew labor cost is based on 12 10-hour days to fill the storage, split evenly between September and October. The crew has one piler operator, paid $13.45 per hour, and five general laborers, paid $7.95 per hour. The hourly labor charge includes payroll taxes and other labor overhead expenses. Electricity includes the cost to run the air system based on assumed monthly run times. It also includes an estimate for the cost of running the potato handling equipment during September and October when the storage is being filled. Electricity costs are based on Idaho Power's 2006 Rate Schedule 9, Primary Service Non Summer. The air system has motors with a total of 41 horsepower. Monthly electricity costs include the kW demand charge, monthly meter charge and an energy charge based on total kW hours used. Insurance is charged on the estimated value of the crop at an annual rate of 1.0%. The monthly storage cost and the cumulative costs include all costs except the cost of removing the potatoes. Tables 5 and 6 show cumulative monthly storage both without and with the removal cost.

Table 6 shows the operating costs by month on a cents per hundredweight basis. Since some of the costs are only a fraction of a cent, expressing the costs in cents rather than in dollars is more meaningful. The operating cost of storing potatoes until the end of February is 63.5 cents. When this is added to the initial crop value of $5.10, you get a breakeven price of $5.73 if the grower does not have to cover the cost of removing the potatoes from the storage. The cost of removing potatoes from the storage adds an additional 24.5 cents. The breakeven cost jumps to $5.98 when removal cost is included.

With rising costs and thin profit margins, even in the good years growers must carefully analyze every aspect of their operation. The cost of owning and operating a potato storage system adds significantly to the overall cost of production. While a grower can withstand prices below cost of production in the short run, he must eventually recover all costs if he is going to stay in business in the long term.

Those interested in obtaining a copy of the Excel spreadsheet that was used to calculate the potato storage costs found in this article can email the author and request a copy. Paul Patterson's email address is pattersn@uidaho.edu.

Table 1. Potato storage facility basic parameters and costs.

Basic Parameters			
Size: cwt	180,000		
Useful Life: years	30		
Interest Rate: %	9.5		
Purchase Price *	$540,000		
Salvage Value (5% x PP)	$27,000		
Average Investment	$283,500		
		100% Utilization Cents Per Cwt	90% Utilization Cents Per Cwt
Ownership Costs:			
Annual Depreciation	$17,100	9.5	10.6
Annual Interest	$26,933	15.0	16.6
Annual Insurance	$2,126	1.2	1.3
Annual Property Tax	$2,552	1.4	1.6
Total	$48,710	27.1	30.1
Annual Repairs (.5% x PP)	$2,700	1.5	1.7
Total Annual Ownership	$51,410	28.6	31.8

*Price of the storage facility was estimated @ $3 per cwt.

Table 2. Potato storage air system basic parameters and costs.

Basic Parameters			
Size: cwt	180,000		
Useful Life: years	15		
Interest Rate: %	9.5		
Purchase Price *	$153,000		
Salvage Value (10% x PP)	$15,300		
Average Investment	$84,150		
		100% Utilization Cents Per Cwt	90% Utilization Cents Per Cwt
Ownership Costs:			
Annual Depreciation	$9,180	5.1	5.7
Annual Interest	$7,994	4.4	4.9
Annual Insurance	$631	0.4	0.4
Annual Property Tax	$757	0.4	0.5
Total	$18,563	10.3	11.5
Annual Repairs (1% x PP)	$1,530	0.9	0.9
Total Annual Ownership	$20,093	11.2	12.4

*Price of the air system was estimated @ $.85 per cwt of storage capacity.

Table 3. Potato handling equipment basic parameters and costs.

Basic Parameters			
Equipment Capacity: cwt	300,000		
Useful Life: years	15		
Interest Rate: %	9.5		
Potato Handling Equipment	Purchase Price		
Even-flow Bin: 600 cwt	$52,250		
Dirt Eliminator: 60”	$46,250		
Potato Sizer: 60”	$18,375		
Dirt Bin w/conveyer: 24”	$15,750		
Portable Conveyers: 30” x 40’			
4 @ $8,500	$34,000		
Telescoping Conveyer	$18,000		
Telescoping Piler: 30” x 45’	$41,100		
Total	$225,725		
Salvage Value (10% x PP)	$22,573		
Average Investment	$124,149		
		100% Utilization Cents Per Cwt	90% Utilization Cents Per Cwt
Ownership Costs:			
Annual Depreciation	$13,544	4.5	5.0
Annual Interest	$11,794	3.9	4.4
Annual Insurance	$931	0.3	0.3
Annual Property Tax	$1,117	0.4	0.4
Total	$27,386	9.1	10.1
Annual Repairs (1.5% x PP)	$3,386	1.1	1.3
Total Annual Ownership	$30,772	10.3	11.4

Potato handling equipment costs are based on a 2006 University of Idaho survey.

Table 4. Potato storage operating cost parameters.

Hundredweight Stored	100,000
Cost of Production * (or Price at Harvest)	$5.10
Annual Interest Rate on Operating Interest	9.5%
Initial Cost to Store Crop, Not Specified	$0
Storage Preparation Cost	$1,500
Crop Removal Cost	$24,500

*When using cost of production, include the ownership cost of the potato storage system.

Table 5. Total potato storage operating costs by month for a 100,000-cwt facility.

Month		Crew Labor	Monthly Shrink	Chemicals & Sprout Inhibitor	Shrink Value	Electricity	Insurance	Interest	Total Cost	Cumulative Total Cost	Cumulative Cost + Removal
1	(Sept)	$3,830	0%	$250		$728		$50	$4,859	$4,859	
2	(Oct)	$3,830	2.0%		$10,200	$929	$425	$4,076	$19,460	$24,319	$48,819
3	(Nov)		0.6%	$6,000	$3,060	$758	$425	$4,192	$14,435	$38,754	$63,254
4	(Dec)		0.6%		$3,060	$638	$425	$4,152	$8,275	$47,029	$71,529
5	(Jan)		0.6%		$3,060	$638	$425	$4,103	$8,226	$55,255	$79,755
6	(Feb)		0.6%		$3,060	$638	$425	$4,103	$8,226	$63,481	$87,981
7	(Mar)		0.6%		$3,060	$638	$425	$4,103	$8,226	$71,707	$96,207
8	(Apr)		0.75%	$6,000	$3,825	$718	$425	$4,103	$15,071	$86,778	$111,278
9	(May)		0.75%		$3,825	$758	$425	$4,157	$9,165	$95,943	$120,443
10	(Jun)		1.0%		$5,100	$758	$425	$4,110	$10,394	$106,337	$130,837
Total		$7,660	7.5	$12,250	$38,250	$7,204	$3,825	$37,147	$106,337		

Table 6. Potato operating costs in cents per hundredweight by month and breakeven price.

Month		Labor	Chemicals & Sprout Inhibitor	Shrink	Electricity	Insurance	Interest	Total Monthly Cost	Cumulative Storage Cost	Breakeven Price	Cumulative + Removal	Breakeven Price
1	(Sept)	3.8	0.3		0.07	0		4.9	4.9			
2	(Oct)	3.8		10.2	0.9	0.4	4.1	19.5	23.3	$5.34	48.8	$5.59
3	(Nov)		6.0	3.1	0.8	0.4	4.2	14.4	38.8	$5.49	63.3	$5.73
4	(Dec)			3.1	0.6	0.4	4.2	8.3	47.0	$5.57	71.5	$5.82
5	(Jan)			3.1	0.6	0.4	4.1	8.2	55.3	$5.65	79.8	$5.90
6	(Feb)			3.1	0.6	0.4	4.1	8.2	63.5	$5.73	88.0	$5.98
7	(Mar)			3.1	0.6	0.4	4.1	8.2	71.7	$5.82	96.2	$6.06
8	(Apr)		6.0	3.8	0.7	0.4	4.1	15.1	86.8	$5.97	111.3	$6.21
9	(May)			3.8	0.8	0.4	4.2	9.2	95.9	$6.06	120.4	$6.30
10	(Jun)			5.1	0.8	0.4	4.1	10.4	106.3	$6.16	130.8	$6.41
Total		7.7	12.3	38.3	7.2	3.8	34.6	106.3				