W 1060

Estimating Costs for Grain Storage: Bags and Bins

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Introduction

Storage is a powerful risk management tool for Tennessee corn producers. Storage allows producers to reduce harvest delays, avoid seasonal price lows during harvest, expand the marketing window, and harvest grain at higher moisture – if drying or aeration is available. There are two main options to store grain: grain bins or grain bags. Grain bins are a traditional form of storage that can be constructed in a wide variety of sizes and configurations. Bin size varies from 1,000 to over 500,000 bushels. Additionally, grain bins can hold grain safely for extended periods by allowing the grain to be aerated, or dried, before or during storage. Constructing grain bins can be a capital-intensive undertaking. Additionally, storage quantity is fixed in the short-term. For example, if production exceeds storage capacity in a crop year, it is then difficult to expand bin storage to meet immediate needs. In the past decade, grain bags have grown in popularity among Mid-South producers, primarily as a way to store corn. However, milo, soybeans and wheat have also been stored in grain bags. Bags typically range in size from 10,000 to 18,000 bushels and allow for up to six months of storage. Storage bags allow producers to keep their combines working during harvest by reducing trucking delays (hauling time and unloading wait times at elevators). Additionally, storage can be rapidly adjusted to increase capacity in years of abundant production. For corn stored in grain bags, ideally, moisture should be 16 percent or less (soybeans less than 13 percent, wheat less than 14 percent and milo less than 13 percent), which can be challenging when dealing with adverse weather conditions. Grains and oilseeds at higher moisture can be stored for shorter periods of time. This publication serves as a guide to help producers evaluate storage options by discussing the advantages and disadvantages of bin and bag storage systems and assist them in quantifying the storage system's costs.

Figure 1. *Grain bag loader.*

Grain Bags: Overview

Grain bags are mainly used to store corn for six months or less. Higher moisture corn can be stored but this will increase the risk of losses and/or shorten the storage interval. Bags typically range from 10,000 to 18,000 bushels and cost 6 to 17 cents per bushel for the bag. To store grain in bags, a producer will need access to a tractor, grain bag loader (Figure 1), a grain bag unloader, and storage bags. Bags can be filled at the field's edge or in a centralized location. However, bags should be filled in straight rows (Figure 2), in a location with no standing water/adequate drainage and that has a relatively moderate slope. When filling grain bags, attention needs to be paid to the location, as access during winter can be problematic if field conditions change. Filling bags in a straight line will make unloading the bags easier.

Figure 2. *Storage bag at the edge of a corn field.*

If bagging at the field's edge, it is common for many producers to run grain carts over the bag site to knock down stalks before filling a bag. This will reduce the chance of damage to the bags from corn stalks. Other methods of site preparation can be used to reduce the risk of damage to the bag. Placing urea under the bag may help prevent insect and rodent damage to the grain inside the bag. Before beginning to fill a bag, one end must be sealed by placing the bag's end between a piece of wood (Figure 3) and screwing the boards together. After screwing the boards together, wrap the boards under the storage bag three times, and then fill the grain on top of the board. To fill the bag, you will need a grain cart operator and a grain bag operator. The grain cart will start to unload into the bagger; as grain fills the bag, the bagger will be pushed forward. The bagger operator will need to apply pressure on the brakes to slow the push, stretching the bag out. The bag needs to be stretched to optimize storage capacity while ensuring it is not overfilled, risking tears (Figure 4). Once a bag is filled, a producer will need to leave slack in the bag to seal the opposite end of the bag. Once the bag is filled, producers should monitor the bags for tears or damage and repair quickly to avoid losses. Many producers use Gorilla Tape®, or the tape included with bag purchases, to repair any tears, holes or other damage to the bags. Once a bag is filled, it is recommended to check on the bag for damage weekly and before and after rain or adverse weather is expected to come through the area. Promptly fixing damage to bags will help maintain grain quality through the storage interval. Producers can take samples of the grain to check for quality by probing the bag and repairing the hole with tape. Insecticide treatments in bags are recommended to reduce infestation but may not always be necessary.

Figure 3. *Sealing grain storage bags using a 1-by-4 and screws.*

To unload a bag, a producer will need a grain cart (or truck if field conditions permit) operator and an unloader operator. The unloader operator will drive the unloader down the bag. The unloader has a blade that cuts the bag open, allowing the grain to fall into an auger that runs into the grain cart or truck. The whole bag will need to be hauled off after being opened as resealing an opened bag can be problematic. Once a bag is unloaded, many producers will use poly pipe rollers to roll up the used bag for disposal. Bag disposal practices and costs will vary depending on the location.

Figure 4. *Ensuring a bag is not over or under filled.*

Grain Bins: Overview

Grain bins are permanent structures used to store grain for short and extended amounts of time. Grain bins come in various capacities, diameters and heights. When choosing what size grain bin to build be sure to check requirements for cost share programs such as the Tennessee Agriculture Enhancement Program (TAEP) as this can help reduce total costs. Also, it is important to consider the equipment needed to load and unload grain out of bins. As the number of grain bins or bin size increases, a producer may need to install a system to load the bins instead of loading them with an auger. Storing grain in a bin gives you the option to dry or aerate grain. This allows for the harvest of grain at higher moisture, potentially decreasing the amount of infield loss. Most often, grain bins are placed in a straight line or in a semi-circle around a dryer or leg on a centralized location. However, bins can be constructed at fields edge or in multiple locations for the farm. The site needs to be prepared for a grain bin by having an access road, a level site and electricity to the property. Depending on distance from field to bin, trucking limitations may reduce harvest speed or increase the cost of transporting grain to the storage site. To fill the bin, a producer will typically use a small tractor (100 hp or more), and a grain auger (size varies depending on the bin), or a grain leg or grain blower depending on sophistication of bin configuration and storage set up on the operation. For example, unload times for a 950-bushel truck can range from 15-40 minutes, depending on the operation and equipment. In storage, grain should be monitored to avoid quality deterioration or infestation. Under controlled conditions grain can be stored indefinitely in a bin – although typically bins are emptied annually to make way for the new crop or avoid hot humid summers.

Insecticide use is a recommended practice to keep insects out of the bins and maintain grain quality. Moving grain from the bin to market can occur at a time that is convenient for the producer or when prices are desirable. Grain can be loaded into the bin over time (multiple loads over days, weeks or months). To unload the bin, producers need to have a tractor attached to an auger or a bin conveyance system. The average time to load out a 950-bushel truck is 15-40 minutes, depending on the operation. Permanent structures such as bins can increase your land taxes or insurance.

Advantages and Disadvantages

Grain bags can be a short-term storage solution with flexibility in the number of bushels stored and the ability to reduce harvest delays/transportation time if bags are placed at the edge of the field. Additionally, grain bags are conducive to operations that may require flexibility in annual storage quantity. For example, producers that have cotton, corn and soybeans may use bags to increase storage if more grains and oilseeds and less cotton is produced in a year. Grain bins provide a long-term storage solution and allow producers to dry or aerate grain after harvest. Figure 5 displays advantages and disadvantages for grain bag and bin storage systems.

Figure 5. *Advantages and disadvantages for grain bags and grain bins.*

Bags	
Advantages	***Disadvantages***
Reduced harvest delays/lower transportation cost	Harvest at higher moisture levels can increase risk
Storage at field edge	No drying capability or aeration
Adjustable storage amount	Possible wildlife and human damage
Loads and unloads faster than a grain bin	Loading/unloading can be difficult
No fixed structure on farm	Not suited for long term storage in the Mid-South
Does not affect land taxes	Partial storage can be problematic (loading and unloading should be completed once the process begins)
Can change storage capacity rapidly	Bag disposal

Bins	
Advantages	***Disadvantages***
Longer storage	Fixed structure
Drying and aeration possible	More difficult to expand storage rapidly within a season
Depreciable asset	May affect land taxes
Harvest at higher moisture levels/earlier harvest	Higher upfront cost
Load and unload in multiple truck loads	Higher transportation cost
Wider variety of grain storage (i.e., soybeans)	May increase insurance cost
Lower risk of human and animal damage	Slower load and unload times compared to bags

Seasonal Price Appreciation

Grain storage is an important marketing and risk management tool for grain producers in the Mid-South. Figure 6 shows the 5-year average and 2021 basis at elevators and barge points across Tennessee. Using grain storage allows producers to extend the marketing window beyond harvest to take advantage of seasonal price increases and reduce production uncertainty when making marketing decisions. Seasonal price appreciation can occur in the futures market (Figure 7) and/or through basis improvements (Figure 6). It is important to note that every marketing year is different, so annual results will vary.

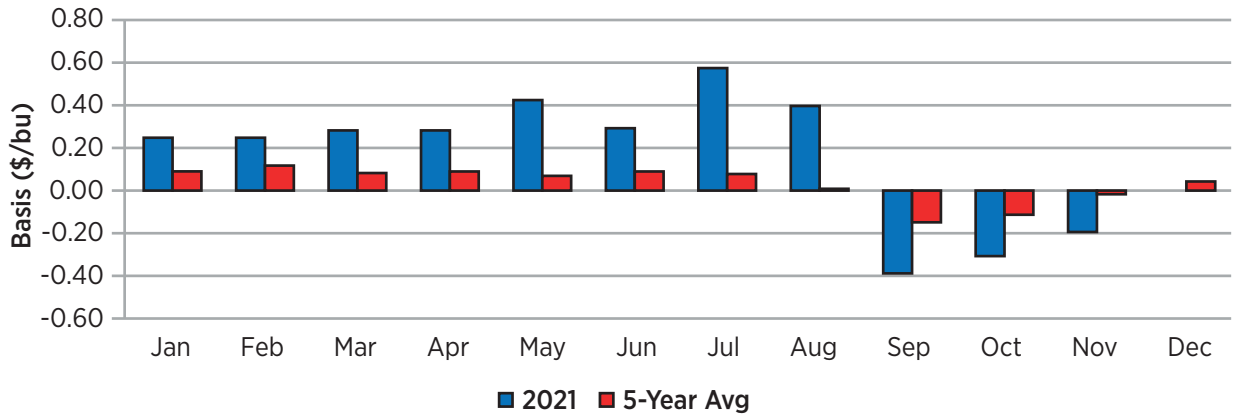

Figure 6. *Tennessee Average Monthly Corn Basis at Elevators and Barge Points, 5-Year Average (2016-2020) and 2021.*

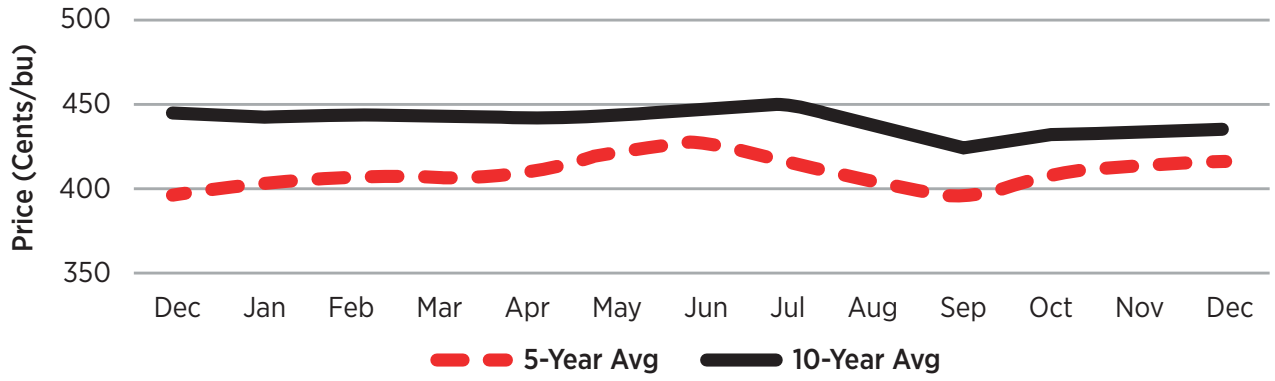

Figure 7. *Average Monthly December Corn Futures Contract Price, 5-Year Average (2017-2021) and 10-Year Average (2012-2021).*

Harvest Speed

Grain storage can increase the speed of harvest. Elevator and barge point unloading lines for trucks can be exceptionally long during harvest, causing the combine to stop in the field. If a producer can fill bags at the field's edge or haul grain to bins, this will reduce the number of hours a combine is not harvesting because of trucking wait times. This increase in harvest machinery efficiency can result in more acres being harvested during a smaller time frame, reducing the potential for field level losses due to adverse weather.

Cost Estimates (Excel Based Decision Aid)

Bag Cost Estimate

An Excel based decision aid was developed to assist producers in estimating the cost of grain bag and grain bin storage. The decision aid allows producers to modify variables to obtain a total or per bushel cost estimate. For bag storage, producers can modify or accept defaults for the variables in Tables 1-2 (all variables that can be user specified are highlighted in orange in the spreadsheet). Estimated production (acres and yield) determines the quantity of corn to be stored. Estimated price should be the current market price for corn. The price is used to determine shrink or storage losses. Bag size will determine the number of bags required to store the estimated production. Bag weight is used to calculate bag disposal costs. Labor rate is the average hourly wage for support activities for crop production, indicated by USDA Economic Research Service (ERS) and should be adjusted to reflect prevailing wages for the farm. Diesel price should be adjusted to reflect current diesel prices paid by the farm. Interest rates are defaulted to the average rate for operating and intermediate loans in the Federal Reserve Bank of Kansas City – National Survey of Terms of Lending to Farmers. Taxes, insurance and housing of 2 percent and repair and maintenance of 4 percent of purchase price are estimated for all machinery in Table 2 (Edwards, 2015). Estimated shrinkage or spoilage should be user specified but is defaulted to 2 percent.

Table 1. *Grain bag storage assumptions.*

	Value	Unit
Acres	400	acres
Estimated Yield	200	bu/acre
Estimated Production	80,000	bu
Estimated Price	$5.00	$/bu
Bag Size	16,000	bu
Bag Weight	450	lbs.
Bag Price	$1,100	$/bag
Number of Bags	5	Number (rounded up)
Labor Rate	$15.61	$/hour
Diesel Price	$2.49	$/gallon
Interest Rate (Operating)	5.0%	percent
Interest Rate (Fixed)	4.0%	percent
Taxes, Insurance and Housing	2.0%	percent of purchase price
Repair and Maintenance	4.0%	percent of purchase price
Estimated Shrinkage/Storage Loss	2.0%	percent

Machinery costs do not include harvest equipment (combine, grain cart, etc.) or trucking costs. Machinery will vary greatly from operation-to-operation. As such, Table 2 allows users to specify purchase price, useful life and salvage value for the required machines. PTO horsepower is used to estimated fuel cost according to American Society of Agricultural and Biological Engineers (ASABE) standards. Share of tractor annual use assigns a proportion of the fixed cost of ownership for the tractor, which may be used for other purposes on the farm operation.

Table 2. *Grain bag machinery assumptions.*

Machinery	Purchase Price ($)	Useful Life (years)	Salvage Value ($)
Loader	$44,801	10	$5,000
Unloader	$50,861	10	$5,000
Tractor	$125,000	15	$10,000
Tractor PTO HP	120		
Share of Tractor Annual Use		5.0%	

Using the variables in Tables 1 and 2 and specifying assumptions highlighted in orange in Table 3, total operating costs and per bushel operating costs can be estimated. Users can accept the default estimates or enter specific values for site preparation ($/bag), loading and unloading time (hours/bag), number of people, bag sealing ($/bag), insecticide quantity (lbs.) and cost ($/lbs.), number of sensors per bag and cost per sensor, hours monitoring and repairing bags, and bag disposal cost ($/ton). Users can enter zero for categories not utilized on their operations. For the default scenario, operating costs are estimated at $10,596 or $0.132/bu (Table 3).

Table 3. *Grain bag estimated operating and ownership costs and shrink/storage loss.*

Operating Costs	Quantity	Unit	Number of people	Cost per unit	Unit	Total Cost	$/bu
Site Preparation	5	bags	-	$5.00	$/bag	$25	
Bag	5	bags	-	$1,100	$/bag	$5,500	
Labor Loading	1.2	hours/bag	2	$15.61	$/hour	$187	
Labor Unloading	1.2	hours/bag	2	$15.61	$/hour	$187	
Machinery Repair and Maintenance	$2,248	$	-	-	$	$2,248	
Fuel and Lubrication	$181	$	-	-	$	$181	
Bag Sealing	5	bags	-	$15.00	$/bag	$75	
Insecticides	800	lbs.	-	$2.00	$/lbs.	$1,600	
Sensors	2	Number per bag	-	$15.00	$/sensor	$150	
Labor - Bag Repair and Monitoring	2	hours/bag	-	$15.61	$/hour	$156	
Bag Disposal/Ton	5	bags	-	$25.00	$/ton	$28	
Operating Interest						$258	
Total Operating Costs						**$10,596**	**$0.132**
Ownership Costs							
Capital Recovery (Depreciation + Interest)						$11,499	
Taxes, Insurance, and Housing						$1,124	
Total Ownership Costs						**$12,623**	**$0.158**
Shrink/Storage Loss						**$8,000**	**$0.100**
Operating + Ownership + Shrink/Storage Loss Costs						**$31,219**	**$0.390**

Table 3 shows the cost of ownership for the equipment specified in Table 2. Ownership costs are calculated using ASABE and Edwards, 2015 machinery cost estimates. The default scenario ownership costs are estimated at $12,623 or $0.158/bu. Shrink/storage loss is estimated as amount stored (bu) multiplied by estimated crop selling price ($/bu) multiplied by estimated shrinkage/storage loss (percent). Estimated shrink/storage loss should account for loss due to damage, spoilage, losses during loading and unloading, and shrink (if any). For the default scenario, shrink/storage loss is estimated at $8,000 or $0.10/bu. Aggregating operating, ownership and shrink/storage loss provides an estimated total and per bushel cost for grain bag storage. Total costs for the default scenario are estimated at $31,219 or $0.390/bu for 80,000 bushels of storage. Users are strongly encouraged to use their own estimated values to improve the accuracy of the cost estimates provided.

Bin Cost Estimate

An Excel based decision aid was developed to assist producers in estimating the cost of grain bag and grain bin storage. The decision aid allows producers to modify variables to obtain a total or per bushel cost estimate. For bin storage, the decision aid, allows the user to select a 10,000-, 20,000-, 40,000-, 60,000- and 80,000-bushel bin to estimate storage costs. Selecting a bin size creates the size specific default assumptions for the estimated costs of construction, labor, operating, and machinery. This tool provides a cost estimate with accuracy based on the information input by users. Prices will vary depending on operation and location.

Users can modify or accept defaults for the variables in Tables 4-7 (all variables that can be user specified are highlighted in the spreadsheet). Estimated price should be the current market price. The price is used to determine shrink or storage losses. Labor rate is the average hourly wage for support activities for crop production, indicated by USDA ERS and should be adjusted to reflect prevailing wages for the farm. Diesel price should be adjusted to reflect current diesel prices paid by the farm. Interest rates are defaulted to the average rate for operating and intermediate loans in the Federal Reserve Bank of Kansas City – National Survey of Terms of Lending to Farmers. Taxes, insurance and housing of 2 percent, machinery repair and maintenance of 4 percent, and bin repair and maintenance of 1 percent of purchase price is estimated for all machinery and bins in Tables 5, 6 and 7 (Edwards, 2015). Estimated shrinkage or spoilage should be user specified but is defaulted to 1 percent.

Table 4. *Grain bin storage assumptions.*

Select Bin Size	80,000	Bushels
	Value	**Unit**
Estimated Price	$5.00	$/bu
Bin Size	80,000	bu
Bin Price	$200,834	$/bin
Labor Rate	$15.61	$/hour
Diesel Price	$2.49	$/gallon
Interest Rate (Operating)	5.0%	percent
Interest Rate (Fixed)	4.0%	percent
Taxes, Insurance and Housing	2.0%	percent of purchase price
Machinery Repair and Maintenance	4.0%	percent of purchase price
Bin Repair and Maintenance	1.0%	percent of purchase price
Estimated Shrinkage/Spoilage	1.0%	percent

Construction costs are shown in Table 5. Default construction costs are specific to the size of bin selected. Cost categories include the bin, floor, fan, sweep auger, labor, freight, additional bin components, supplier discounts and site costs (preparation, electrical, gravel and concrete). Default construction costs were obtained through phone conversations with suppliers in summer of 2021. Substantial annual variation is construction costs can occur due to material and labor costs. All construction costs can be user specified.

Table 5. *Grain bin construction costs.*

	Price	
Bin (Tank)	$99,123.21	
Floor	$38,618.14	
Fan	$15,129.10	
Sweep Auger	$13,246.02	
Additional Options	$7,293.18	
Labor	$32,000.00	
Freight	$3,600.00	
Discount	**($21,676.21)**	
	Bin Total	$187,333.44
	Concrete	$10,934.00
	Gravel	$566.33
	Site Prep	$500.00
	Electrical	$1,500.00
	Total:	$200,833.77

Machinery cost assumptions are shown in Table 6. Costs will vary based on machinery and bin size and should be user specified. Table 6 allows users to specify purchase price, useful life and salvage value for the required augers, tractor and bin. PTO horsepower is used to estimate fuel cost according to ASABE standards. Share of tractor annual use assigns a proportion of the fixed cost of ownership for the tractor, which may be used for other purposes on the farm operation.

Table 6. *Grain bin and machinery costs.*

Machinery	Purchase Price ($)	Useful Life (years)	Salvage Value ($)
Truck Auger	$4,650	10	$233
Fill Auger	$19,925	10	$996
Tractor	$125,000	15	$10,000
Bin	$200,834	25	$0

Tractor PTO HP	120
Share of Tractor Annual Use	5.0%

Operating cost assumptions and defaults are shown in Table 7. Where applicable defaults will be modified based on the size of bin selected. For the default 80,000-bushel bin scenario, operating costs are estimated at $9,016 or $0.113/bu.

Table 7. *Grain bin operating and ownership costs and shrink/storage loss.*

Operating Costs	Quantity	Unit	Cost per unit	Unit	Total Cost	$/bu
Site Maintenance	1	bin	$500.00	$/bin	$500	
Labor Loading	80	hrs/bin	$15.61	$/hour	$1,249	
Labor Unloading	80	hrs/bin	$15.61	$/hour	$1,249	
Repair and Maintenance	$1,655	$	-	$	$1,655	
Fuel and Lubrication	$2,408	$	-	$	$2,408	
Insecticides	800	lb	$2.00	$/lbs.	$1,600	
Sensors	8	Number per bin	$15.00	$/sensor	$120	
Labor - Bin Repair and Monitoring	1	hours/bin	$15.61	$/hour	$16	
Operating Interest					$220	
Total Operating Costs					**$9,016**	**$0.113**
Ownership Costs						
Capital Recovery (Depreciation + Interest)					$16,320	
Taxes, Insurance and Housing					$393	
Total Ownership Costs					**$16,713**	**$0.209**
Shrink/Storage Loss					**$4,000**	**$0.050**
Operating + Ownership + Shrink/Storage Loss Costs					**$29,730**	**$0.372**

Table 7 also shows the cost of ownership for the equipment specified in Table 6. Ownership costs are calculated using ASABE and Edwards (2015) machinery cost estimates. The default scenario for an 80,000-bushel bin estimates annualized ownership costs at $16,713 or $0.209/bu. Shrink/storage loss is estimated as bin size (bu) multiplied by estimated crop selling price ($/bu) multiplied by estimated shrinkage/storage loss (percent). Estimated shrink/storage loss should account for loss due to damage, spoilage, losses during loading and unloading and shrink (if any). For the default scenario, shrink/storage loss is estimated at $4,000 or $0.05/bu. Aggregating operating, ownership and shrink/storage loss provides an estimated total and per bushel cost for bin storage. Total annual costs for the default scenario are estimated at $29,730 or $0.372/bu for 80,000 bushels of storage. Users are strongly encouraged to use their own estimated values to improve the accuracy of the cost estimates provided.

Conclusions and Discussion

Both grain bags and bins are valid storage options for Mid-South corn producers. However, the preferred system will depend on the operation size, proximity to fields, availability of labor, crops grown, field size and topography, management practices (drying, aeration etc.), and the operation's storage goals. Comparing grain bag and bin storage costs provide similar per bushels estimates of $0.390 and $0.372 for 80,000 bushels of storage. Grain bags are a great tool for short-term corn storage and to increase harvest speed. Bins will be preferred if corn is harvested at higher moisture or if longer term storage is desired. Additionally, bins require greater initial capital than bags resulting in higher ownership cost $0.209/bu, compared to bags $0.158/bu. Field size and proximity to a centralized location or elevator may also dictate storage preference. Smaller fields can increase the cost of bagging systems as smaller bags or partially filled bags can increase costs. Grain bins are a great option to store a wider variety of grain and oilseeds for longer. Producers are encouraged to evaluate both storage options to determine the costs and suitability for their operations. The Excel decision aid allows producers to estimate the cost of bin or bag storage.

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