



Bulk Ingredient Storage

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Processing feed on-farm requires storage of ingredients in either bulk or bagged form. Microingredients such as vitamins or medications are often stored in bagged form, while ingredients such as soybean meal or dical are stored in bulk form. Ingredients stored in bulk form are delivered to the feed processing center in 3- to 20-ton shipments. Bulk ingredient bins should be used exclusively for one ingredient. For example, soybean meal should not be placed in an empty dical bin if the soybean meal bin cannot hold all the meal when delivered.

The importance of proper ingredient storage is highlighted in the Food and Drug Administration's (FDA) Good Manufacturing Practices (GMPs). These regulations stipulate that incoming ingredients should be accompanied with a label and that an accurate inventory of medicated ingredients, including the date of use, be kept. Bulk ingredient storage must be designed, constructed, and installed in such a manner that facilitates inspection and clean out of the bins and mill. Proper planning, design, and installation of bulk storage will help meet regulatory compliance and enhance the efficiency and profitability of the feed manufacturing operation.

A 2- to 8-week supply, of bulk ingredients should be maintained in storage. Bulk bins should be sized at a minimum of 125 percent of the expected purchase increment. For example, if 20 tons of meal are purchased at a time, the minimum bulk bin capacity should be 25 tons. Allowances should be made for bad weather, delayed deliveries, and rush seasons. Price advantages from timely, seasonal, or volume purchases of ingredients may result in additional storage space being required. With proportional mills,

volume purchases may reduce the adjustment required in rations. For each new shipment of ingredients, proportional mills require adjustment since moisture, protein, energy, fiber, or other nutrient contents may vary appreciably between purchases.

Producers using a portable grinder-mixer often store soybean

meal in bulk form. Depending on usage, dical and calcium also may be stored in bulk form. All other ingredients should be handled in bagged form when using a portable grinder-mixer. A stationary mill setup may store the other ingredients in either a bagged or bulk form depending on their usage rates.

Table 1, intended only as an aid in planning ingredient storage requirements, presents approximate ration compositions. Table 2 gives approximate ingredient needs for various production units and periods. The values in Table 2 may be multiplied by the appropriate number of production units to estimate the storage space required. Other factors that need to be considered include medicated early weaning, segregated early weaning, split sex feeding and phase feeding.

Types of Storage

Feed ingredients are stored or temporarily held in a variety of structures. The following are normally employed:

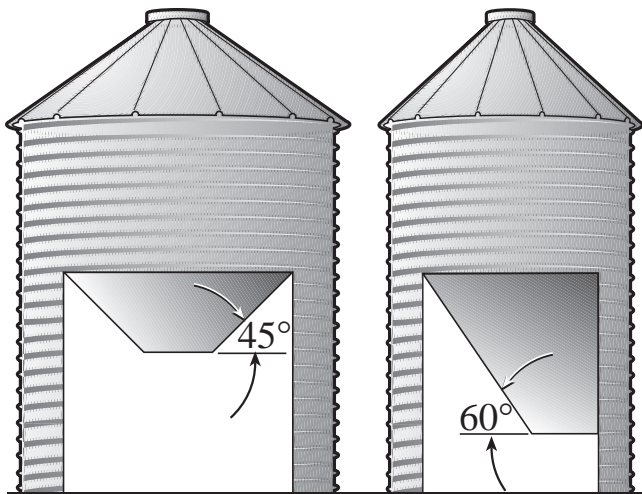
- Ground level, flat-bottom bins with unloading augers are normally used for the storage of grain. These bins may be sized for a two-week to one-month supply (in systems where all grain is purchased), or they may hold a one-year supply when the producer is feeding grain produced on-farm. Ground-level, flat-bottom bins cost about \$40 to \$50 per ton capacity, on a turnkey basis.

- Ground level, hopper-bottom bins are normally used for soybean meal, complete rations and/or grains, such as oats, that are required in relatively small amounts. These bins cost two to three times as much per ton capacity as flat-bottom bins.
- Overhead bins normally are used to provide gravity flow to processing or mixing equipment. Because these bins are expensive (about twice the cost per ton capacity as ground level, hopper-bottom bins), their use must be justified by flexibility, efficiency and labor savings in feed preparation. Overhead bins in high volume systems are sometimes used to temporarily hold complete rations. Overhead bins are called working bins and are not intended for long-term storage.
- Bagged ingredients are normally stored on pallets or a raised wooden platform. Small pallets can be moved by a portable hand-truck.

More than one type of bin may be used for a single ingredient. As an example, large truckloads of soybean meal may be received in a ground level, hopper-bottom bin. The meal can then be transferred to an overhead, working bin as needed for processing.

Hopper-bottoms are probably most justified on those bins emptied and refilled many times and those for which complete clean out is important. Complete clean out is important in bins holding purchased grain or those used for different ingredients at different times. Two bins, or a two compartment bin, for a single ingredient will permit complete clean out of one unit while using from the second, assuring no long carry-over of material in the bottom of a bin.

Figure 1. The 45 degree bin is a center discharge and the 60 degree bin is a side discharge



Hopper-bottoms must be steep enough to cause free-flow of the material (Figure 1). Grains require a hopper slope of at least 37 degrees. Soybean meal is not a free-flowing material. Bins for soybean meal must be designed for the weight and flow characteristics of the material. The slope of the valley angle (shallowest corner angle) in hoppers for soybean meal and other materials that do not flow freely should never be less than 50 degrees with 60 degrees preferred. Experience indicates it is better to use large intake openings with reduced or stepped pitch flighting in the loading section on the conveyors used to remove the product from the bin than to use agitators.

Anti-Bridging Devices

Agitators (anti-bridging devices) are usually high maintenance items that often lose parts into the product stream and damage equipment. When they fail, it is extremely difficult to discharge a bin as they cause bridging. Bins of less than 25-ton capacity are available with a 70-degree hopper bottom. Off-center hoppers (hoppered to one corner in rectangular bins or to the side in round bins) also will help to control bridging. The best mechanical anti-bridge device, either commercial or homemade, consists of rotating vertical pipe with hanging chains. Vibrating devices have not proven to be effective in preventing bridging. Complete rations have somewhat better flow characteristics than soybean meal, but they should be held in 60-degree hoppers. With regular use and proper bin and unloading conveyor design, soybean meal and other nonfree flowing materials should flow out of the bin. If occasional bridging does occur, use a rubber mallet to bump the bin hopper.

Bagged or Bulk Purchases

Soybean meal may be purchased either bagged or in bulk. The decision of which to use is based on the labor of handling bags, the cost of bulk storage and the cost of bagged vs. bulk product. Processing feed for a 100-sow, farrow-to-finish system requires double handling of about 88 50-pound bags of soybean meal per week. Only about 26 50-pound bags of other ingredients will be used weekly. Bin sizes, for ingredients received in bulk, are determined by the expected size of delivered lots.

Salt, calcium, and phosphorus sources, milk by-products, and vitamin and trace mineral premixes are normally purchased and stored in bags. Enough bag storage space is needed for easy access to all ingredients.

In large systems, the labor and expense of handling bags will sometimes justify bulk purchase, handling, and storage of truckload lots of all ingredients except vitamin and trace mineral premixes. Calcium, phosphorus, and salt sources are corrosive and will draw moisture from surrounding materials. These minerals are commonly held in ground level and overhead wooden or steel bins. Corrosion in steel bins can be reduced by coating the inside with epoxy or other coating. Bins constructed of fiberglass or other noncorroding materials are available.

Handling of Feed Ingredients

Auger conveyors are commonly used to handle grain, soybean meal, and mixed feed. Capacities vary with auger diameter and operating speed. Four-inch diameter augers, operating at a slow speed, can be matched to the capacity of PTO- or electric-powered mills. To save time and labor, at least 8-inch, preferably 10-inch or larger, diameter augers should be used for placing grain and soybean meal in storage and for load-out and delivery of finished feed. Grain augers are occasionally used to fill ground level bins, but should only be used with nonmedicated ingredients. It is difficult to avoid residue in augers or drag conveyors and extensive flushing is required to remove it. Once again, medicated ingredients are best handled in bags to avoid potential problems.

For large feed systems, particularly those that include grain drying and storage, bucket elevators might be appropriate. They cost more than auger systems, but they have a lower power requirement and give longer, more reliable service. A bucket elevator can replace several augers in a system and reduce space required for handling equipment.

Gravity spouts for dry grain must slope at least 37 degrees from horizontal ($\frac{3}{4}$ foot fall in 1 foot run); spouts for wet grain must include at least 45 degrees from horizontal. Gravity spouts for soybean meal must slope at least 60 degrees from horizontal ($1\frac{3}{4}$ foot fall in 1 foot run).

Overhead ingredient bins are filled using down spouts from an elevator leg. The downspout angle must be 60 degrees, or greater. Since the spout angle is high, most bulk storage bins must be located near the leg. The distance from the leg is proportional to the height of the leg. Often a second distributor is used to fill the bulk bins allowing better utilization of the main leg distributor. Medicated ingredients should be handled in bags in order to avoid residue problems.

Feeds are often temporarily stored in overhead bins above a driveway prior to delivery to the feed tanks. Medicated feeds may have to pass through the leg and some residue may remain in the leg and in certain locations of the downspouts. This type of feed should be followed by a nursery ration to help flush out the equipment. It is important to mix enough medicated feed each time to avoid daily mixing and the potential for residue left in the handling system. The clean out or flush ration must be one in which the drug residue that may be picked up should not affect the pigs to whom it is fed. This ration must be fed to pigs such that labelled requirements for withdrawal times are met.

Many delivery trucks can reach to the top of ground level hopper bins with their unloading augers. Most trucks cannot reach the fill port of a bin if it exceeds 25 foot. It may be necessary to specify in a purchase contract that feed must be delivered via truck with an unloading auger if this is the only way to handle the ingredients.

Table 1. Approximate ration composition

Ingredient	Ration*				
	Gestation (lb/ton)	Lactation (lb/ton)	Nursery (lb/ton)	Growing (lb/ton)	Finishing (lb/ton)
Grain (corn, grain sorghum, wheat, oats, etc.)	1650	1475	1250	1500	1650
Protein Meal (soybean, meat and bone, peanut, etc.)	250	375	550	450	300
Macro-minerals (salt, calcium, phosphorus)	100	150	50	50	50
Milk by-products	-	-	150	-	-
Vitamin, trace-mineral, antibiotic premix	5-10	5-10	5-10	5-10	5-10

*This table should not be used to formulate rations. (Adapted from *Kansas Swine Nutrition Guide*, Cooperative Extension Publication No. C719.)

Bulk bins need to be located near the mixer to minimize the investment in handling equipment. Normally, soybean meal will be added directly to the mixer, assuming it is on scales, or to a weighing/batching hopper above the mixer. As the distance between bins and the mixer increases, additional handling equipment is required and increases energy and maintenance cost.

Summary

Handling ingredients in bulk can reduce purchase cost per ingredient if sufficient quantities can be handled with the equipment and storage. If at all possible for on-farm application, all medicated ingredients should be purchased in bagged form to minimize the potential of carry-over. This reduces residue problems in the storage structure and handling equipment. If medicated ingredients are purchased in bulk form, a dedicated bulk bin should be used. All bulk bins should be clearly labelled, or numbered, to avoid any cross-contamination of ingredients while filling a bin or mixing feed. Proper flushing and sequencing of feeds must follow usage of medicated feed to be in compliance with Good Manufacturing Practices.

Table 2. Approximate ingredient needs for various production units

Ingredient	100 sow, farrow-to-finish continuous production, 200 litters, 1,600 head/year			100 feeder pigs grown from 40 lb. to 220 lb. in 4 months		
	1 week	1 month	Annual	1 week	1 month	4 months
Grain	390 bu	1,850 bu	22,000 bu	50 bu	250 bu	1,000 bu
Soybean Meal	2.5 ton	11 ton	131 ton	0.4 ton	1.75 ton	7 ton
Macro-minerals	775 lb	1.7 ton	20 ton	115 lb	450 lb	1,800 lb
Milk by-product	75 lb	325 lb	3,900 lb	-	-	-
Vitamin, trace mineral, antibiotic premix	70-140 lb	300-600 lb	1.8-2.6 ton	10-20 lb	40-80 lb	150-300 lb
Totals	13.5 ton	58 ton	700 ton	1.9 ton	7.5 ton	30 ton

(Adapted from *Kansas Swine Nutrition Guide*, Cooperative Extension Publication No. C719)

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