



Feed Center Design and Components

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John T. Tyson, Agricultural Engineer, Erie County
 Robert E. Graves, Professor, Agricultural and Biological Engineering

An efficient and effective feed storage and handling system is vital to any modern dairy farm. The feed center can be considered the center of the entire feeding system like the hub of a wheel. From the feed center, feed is carried out the spokes of the wheel to the animals. Harvested crops and off-farm feedstuffs are hauled back to the feed center. In modern dairy design, the feed center should operate as a separate entity. It should have its own location, traffic patterns, and management system. However, it can not be isolated from the rest of the dairy design. Decisions made in feed center design will influence the housing design and vice versa. For example, operation of the feeding system should not interfere with or depend on the flow of animals to and from the parlor.

When designing a feed center and feeding system, think FEEDS: Flexibility, Economy, Ease of operation, Dependability, and Safety.

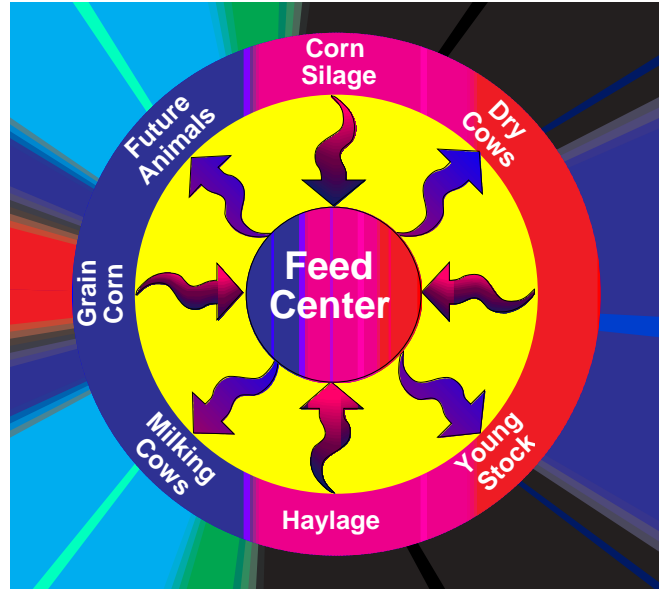
F Flexibility: A good system will allow easy changes in feeding practices or rations. Avoid getting locked into a system which allows only one feeding practice. Plan for expansion. An ideal system provides for alternative methods to keep feeding even though a part or component is out of service.

E Economy: The lowest cost combination of components with effective performance and minimal wastage.

E Ease of operation: The steps and machinery required to feed should be convenient and straightforward. A feeding system can be evaluated by asking, "How easy is it for me to explain to someone else how to feed my cows?"

D Dependability: As mechanization increases so does the potential for breakdown and the cost to repair. Simplicity is a key consideration in any system development project.

S Safety: A well-designed system will keep hazards and risks to a minimum. Work injuries result in loss of productivity, emotional trauma, and various unplanned costs.



For new and expanding dairies, plan the feed center around a mobile feed delivery system. This system is a combination of storage facilities and a mobile mixing and distribution vehicle to move all feedstuffs from storage to various animal units. With a mobile mixer, the weigh/mixer unit performs the weighing, mixing, and transport of the feed. This reduces the initial system costs and maintenance requirements and allows more flexibility in locating feed storages and animal units. The whole system will not shut down if one component fails. A mixer can be replaced with a wagon or cart, tractors can be switched, and a loader can be borrowed or rented for short periods of time.

Design and development of a feed center should be based on well thought-out, logical decisions. Feed storage and handling systems affect future decisions for many years to come. Therefore, the first step is to have a clear idea of the immediate and long-range goals for the dairy business. Based on these goals, follow the four-step process outlined on the next page.

First, prepare a scale drawing of the farmstead showing existing buildings, feedlots, silos, feed storage, fences, power lines, water supply, and drainage patterns. Also include possible sites of future animal housing, machine storage, or other buildings.

Second, prepare a materials flow chart detailing: 1) types and quantities of feed, 2) storage of feed, 3) removal methods from storage, 4) conveying of feed to and from storage, 5) processing, and 6) feeding. The materials flow chart illustrates the various components and activities required to store and process feed materials. This will provide a clear picture of the operations, equipment, and structures that are required.

Third, evaluate existing buildings and equipment as to whether they can be used as is, renovated or modified, or torn down and replaced.

Finally, design the new feed center using the site drawing, materials flow chart, and a few design rules for feed centers. These design rules consist of a few simple ideas: a single site, traffic control, room for expansion, matching storage and equipment, and

location. Check this design to assure compatibility with the immediate and long-range goals of the dairy business.

Single Site

A single site for storage of all feeds is preferred. Provisions are required for various types and amounts of feed ingredients from several thousand tons of silage to a few hundred pounds of salts and minerals. Using one site allows feed traffic from both on and off the farm to be contained in a certain area. Also, the person responsible for the feeding can load the mixer with a minimal amount of movement, making feeding faster and more efficient. Storage for equipment such as mixers, tractors, and loaders that are used for delivering feed and filling storage should also be provided. This storage may be in an adjacent machinery storage, a section of the commodity storage building, or another building. Allow room for access and dumping of large trucks and semitrailers for delivery of feed from fields or highways.

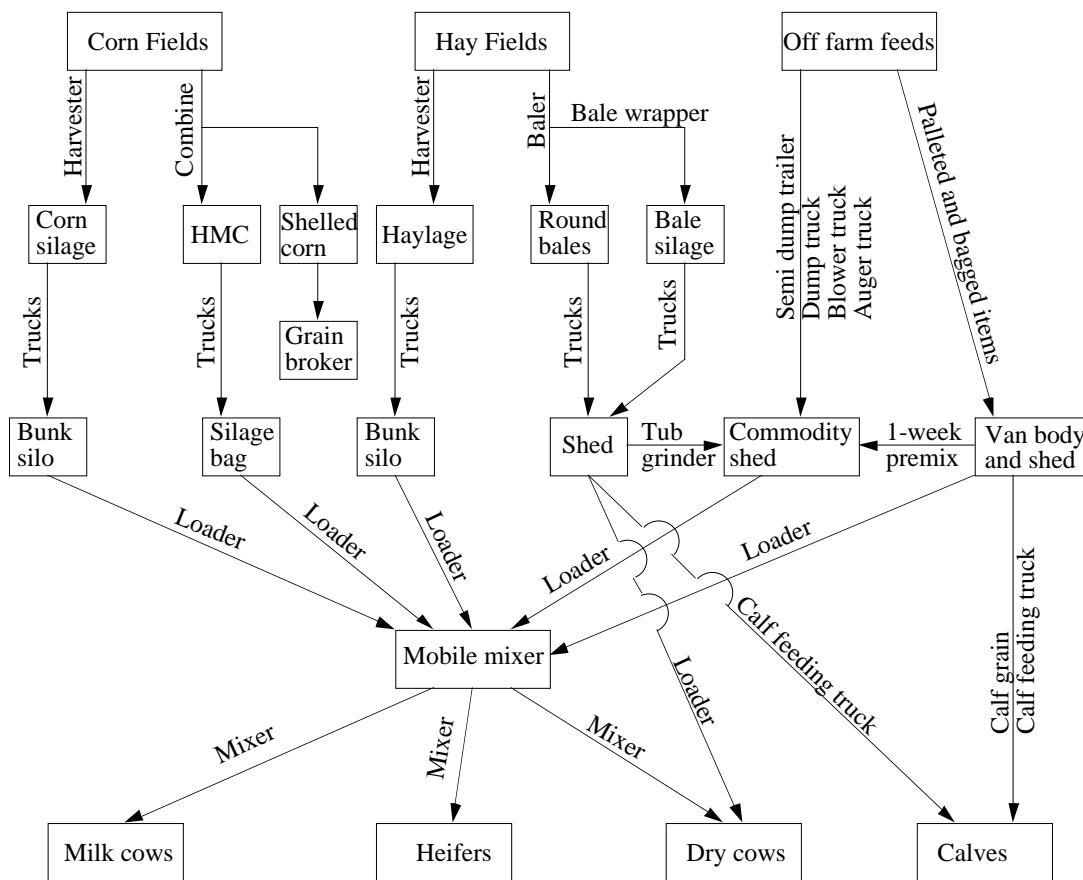


Figure 1. A materials flow chart will allow the feed storage and handling to be defined and changed as needed on paper. All feedstuffs, storages, and transport methods should be outlined.

Traffic Control

Plan the location of storages and feeding areas around good traffic patterns. Limit traffic through this area to that directly involved with the feeding system. This includes vehicles delivering feed to storage and vehicles moving feed to animals. Route other traffic around this area to its appropriate location. Adequate room is required during harvest to bring feed into the feed center from the fields without interfering with the everyday feeding process. Lanes, roads, and aisles should be wide enough to allow for unhindered movement of feed vehicles. Separate travel paths for pedestrian and animal traffic result in less interference and reduce accident potential.

A layout that allows the feeding unit to move primarily in the forward direction is best. Provide adequate space and reference markers if backing is required. Automatic gate or door openers and cattle guards make feeding easier. Plan all-weather roads to and from the feed center. Also consider storage locations for feeding equipment that do not interfere with other vehicular, pedestrian, or animal traffic.

Room for Expansion

Allow adequate room for expansion and flexibility in the feed center design. Invariably, a system planned and sized based only on present needs will be difficult and expensive to expand. Farmsteads are not static; animal numbers increase and equipment and storage requirements change. In planning, the rule of thumb is to project needs five years into the future and then double. This leaves room for expansion, even though only the capital investment is made to meet immediate or near-term needs.

Matching Storage and Equipment

Different storage types require different equipment to fill and unload them. Some of this equipment is specialized to the feed center, while other equipment may be used throughout the farming operation. If large quantities of feeds need to be harvested and stored quickly, horizontal silos offer an advantage over tower silos. Loading a mixer wagon is also much faster from a horizontal silo than a tower silo and unloader. Harvest, transport, and packing equipment must also be coordinated.

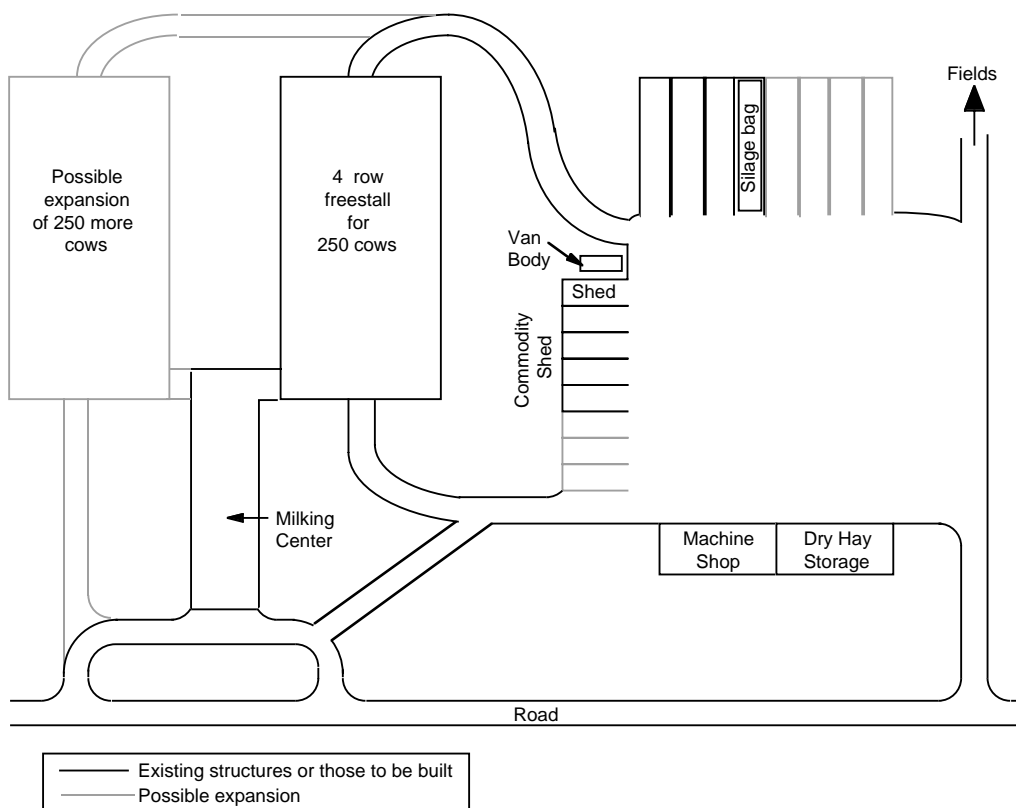


Figure 2. The final site plan should include existing buildings, those to be built, and possible future expansion options.

When cropping fields are located some distance from the storage, trucks offer faster turnaround time and are safer for highway travel. Farm wagon running gears are not rated for highway speeds.

Location

Feed centers are no longer simply attached to the barn as they were in the past. With the use of mobile feeding, the feed center can be located anywhere on the farmstead and still have access to the animal housing facilities.

Locate the feed center for easy delivery of purchased feeds, easy filling of silos, and convenient movement between silos, bulk storage, and the animals. Locate silos so vehicles can come from the field, unload, and return to the field with little problem. Bulk or commodity storage requires easy access to the roadway. This allows delivery trucks to enter, unload, and leave with minimal maneuvering.

Other things to keep in mind during design are silage leachate control and disposal, general surface water flow, rodent control, safety, lighting, and feeding during harvest.

Safety

Hazards around feed centers include silo fires, gases, dust, and equipment. Silo fires are usually the result of ensiling feed material below 50 percent moisture content. Heating of the material and air leakage can allow a slow-charring fire to start in the mass. To limit the potential of fire, chop silage above 50 percent moisture content, mow, and condition only what can be harvested in a day, and pack the silo well.

Silo gases are formed by the ensiling process and may persist for up to three weeks after filling. Tower silos, feed rooms, and other confined spaces such as sumps and pits are of serious concern. In these confined areas, the gases cannot escape. Ventilating confined spaces such as the feed room can remove these gases. Proper protection should be worn if a tower silo must be entered during the times when silo gases may be present.

All equipment used in filling, unloading, and delivering feed has dangers. PTO-driven equipment such as blowers, wagons, and mobile mixers cause many serious injuries or loss of life each year. Proper PTO guards and shields should be in place and in working order. Do not step over PTO shafts or wear loose-fitting clothing when operating this equipment. Children and visitors should be kept away from the feed center during harvest when large machines are unloading and packing silage. The operator may not be looking for people and accidentally run over them.

Filling and packing of horizontal silos requires special care and attention to reduce the risk of accidents and severe injury. Maneuvering machinery on and around loose silage requires a mature experienced operator using proper equipment. (see sidebar)

When entering a tower silo to repair an unloader, make sure the power is turned off. Follow appropriate tag and lockout procedures, and place a switch at or on the unloader to assure the unloader is not turned back on by someone on the ground who does not know you are in the silo. Safe, confined space, entry procedures require that someone be outside the silo and ready to assist in emergency situations.

Safety First When Filling Horizontal Silos

Equipment turnover is a major concern when filling horizontal silos. For this reason, special precautions should be taken to minimize the risk of serious injury or death to the operator and damage to the equipment.

- 1) Only tractors equipped with an approved roll-over protection frame or cab should be used, and the operator should use a seatbelt for both safety and comfort.**
- 2) Use low clearance, wide front-end tractors (not tricycle type) with the wheels extended for maximum stability. The use of dual tires will also increase stability.**
- 3) Adding weights to the tractor will assist in packing and can provide stability. Add weights to both the front and rear of the tractor to maintain safe weight distribution. Avoid rear wheel weights that will interfere with packing close to any wall on the silo.**
- 4) Wheel-type tractors should not be driven on silage surfaces with slopes steeper than 4 to 1 (1 foot of rise in 4 foot of run).**
- 5) Back up or drive down slopes to avoid the risk of an overturn.**
- 6) Distribute silage in uniform 6 inch layers for even packing and to help prevent soft spots.**
- 7) Front-wheel, assist-drive tractors can provide extra traction and stability for packing and towing on the silage.**
- 8) Only mature, experienced operators should be allowed to operate the packing tractor or the unloading tractor and forage wagon on the silage.**

Silage Leachate Control and Disposal

Silage is more than a nutrient-rich foodstuff. It is also a strong pollutant. The silage-making and storing process can result in liquid effluents, or leachate, gases, malodors, undesirable microorganisms, and spoiled silage.

The most important characteristics of silage effluent are: 1) corrosive effects, 2) high-polluting strength, and 3) poisonous gas-forming ability. When contained in tanks or sumps, silage effluent can produce deadly gases and should be treated with respect. Silage effluent has a high biochemical oxygen demand (BOD) which means if allowed to enter a water supply, it removes a large portion of the available oxygen from the water, resulting in fish kills. The potency of uncontrolled effluent not only severely pollutes water, it will also burn or kill vegetation if applied at full strength or allowed to run directly onto crops from a leaching silo. Properly ensiled silage results in little, if any, leachate. However, even small amounts of leachate can accumulate and result in large flows from big silos.

Locate silos as far as is practical from critical water resources. In addition to surface flow, consider wells, sink holes, and other potential paths to ground water. For silos that are partially or completely below ground level, also consider ground water exclusion and control. Use water-tight construction joints to prevent the flow of liquids either into or out of the silo. Horizontal silos produce effluent not only from the silage but also from the precipitation that moves through the silo. Covering these silos helps limit leachate by limiting the amount of water that flows through the silo. Consider how precipitation running off the cover will be directed away from the silo area.

Potential for leachate production and pollution should be considered in overall waste management planning. If effluent is produced as part of the selected silage-making process, then measures must be taken to protect ground and surface waters. Common disposal practices include: 1) diluting leachate with equal parts of milking center wastewater or barnyard runoff before using it for irrigation, and 2) diverting to an open-topped liquid manure storage. However, **Do not** add effluent to storage tanks, reception pits, or sumps located inside livestock buildings, other enclosed spaces, or any covered underground manure storage. Silage effluent, especially when mixed with manure, can produce hydrogen sulfide and other poisonous gases. These gases can result in human and/or animal deaths. Whatever the control system, it must also have a regular maintenance schedule to assure it will

continue to function correctly. The Natural Resource Conservation Service (NRCS) offers design information and assistance dealing with silage leachate control.

Tires and Plastic

Horizontal silos, silage bags, and silage bales also involve handling, storage, and disposal of plastic covers and weights, which are usually tires. If tires are used, an area must be provided for their storage when not in use. The tires should be out of the way and not interfere with regular traffic. Cutting tires reduces storage space required, because they can be stacked in a nested fashion. Also, this will prevent pools of water from collecting in the tires and creating a breeding ground for insects. Tires also represent a fire hazard on the farm. Reuse of plastic covers or bags is not practical, and therefore disposal is required. A portion of the plastic can perhaps be used for tarp-like material or sidewall curtains. However, if large amounts are used, the issue of disposal or recycling must be addressed. While land filling is an option, opportunities for recycling are now becoming available. Two fact sheets concerning recycling of agricultural plastics are listed at the end of this fact sheet.

Rodent Control

Rodents cannot be completely eliminated. However, some steps can be taken to limit the appeal of the feed center. A narrow trench, about one foot deep and filled with medium-sized gravel, will discourage rodents from burrowing, when placed around building foundations and slabs. When they attempt to burrow into the gravel, it will collapse as they dig. Most will move on, looking for a better place to call home. Keeping the feed center clean can also reduce its appeal to rodents. Mowing around the silos and feed center will help limit habitat.

Bird problems can be addressed by limiting the amount of roosting area available. Open trusses and knee braces seem to be very popular roosts. Use hardware cloth or small bird netting to screen close these areas. Covering silos eliminates an attractive feed source but causes other problems.

Feeding During Harvest

Feeding partially fermented silage during silo filling results in various herd health problems. The following are various methods to allow access to properly fermented feed: 1) The use of multiple smaller silos instead of one large silo. For crops such as hay with

multiple harvests, silos can be sized to hold a single cutting. 2) Providing access to the back of a horizontal silo while filling from the front. 3) Alternate filling of two silos, tower or horizontal, with haylage, first and third cutting in one and second and third cutting in the other. Some farms fill one existing tower silo for use during filling of a large horizontal silo.

Components

Basic components of a feed storage and handling system may include:

- Tower silos for storage of corn silage, haylage, or high moisture grains. Usually limited to smaller amounts of feed and farms with mechanical feeding or in transition to mobile feeding systems.
- Horizontal silos (bunks, trenches, pits, and stacks) for storage of corn silage, haylage, or high moisture grains. Provide for fast filling and unloading, fit well with mobile feeding systems, and are very flexible fitting both small and large herds.
- Plastic silage bags and silage bales used for emergency, temporary, or long-term storage. Systems fit particularly well into expanding herds needing low-cost, flexible storage.
- Flat storage commodity sheds for bulk materials. Several bays allow for bulk purchases.
- Hopper bottom bins for gravity unloading of stored materials before and after processing.
- Small sheds, existing buildings, or van bodies for the storage of micro items such as salts and minerals.
- Storage for dry hay, either small bales or large bales.
- Feeding equipment, matched to the types of storages and the housing system used, to monitor and maximize dry matter intake, mix accuracy, and maintain the chemical analyses.
- A truck-sized scale for determining how much feed is stored in the silo and for weighing feeds that are bought and/or sold by the farm.

Conclusion

A good feed center and feeding system are important parts of a successful dairy. High quality feed must be stored, mixed, and delivered each and every day. Investing time and resources in the design of an efficient feeding system will help ensure a profitable dairy farm.

The following are related Fact Sheets available from Agricultural and Biological Engineering, 246 Agricultural Engineering Building, University Park, PA 16802, phone: (814) 865-7685 Fax: (814) 863-1031 email: mxh16@psu.edu.

C-8 *Recycling Used Agricultural Plastics*

C-22 *Recycling Your Used Agricultural Plastics*

H-72 *Site Evaluation for Dairy Housing Systems*

H-73 *Planning Feeding Systems For Expansion*

H-75 *Bulk Storage*

H-76 *Horizontal Silos*

Related publications available from the Publications Distribution Center, 112 Agricultural Administration Building, University Park, PA 16802, phone: (814) 865-6713. Call for current pricing and availability of these publications.

MWPS-7 *Dairy Freestall Housing and Equipment*

MWPS-13 *Grain Drying, Handling, and Storage Handbook*

NRAES-01 *Pole and Post Buildings*

NRAES-38 *Dairy Feeding Systems Proceedings*

EC 396 *Harvesting and Utilizing Silage*

For a copy of our fact sheet listing contact: Agricultural and Biological Engineering Extension 246 Agricultural Engineering, University Park, PA 16802, phone: (814) 865-7685, Fax: (814) 863-1031 or email mxh16@psu.edu.

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