



Feeding Your Dairy Cows a Total Mixed Ration: Getting Started

Donna M. Amaral-Phillips, José R. Bicudo, and Larry W. Turner

A total mixed ration (TMR) is composed of forages, commodities/byproducts (such as whole cottonseed), grains, protein supplement(s), minerals, and vitamins that have been mixed together to make a balanced ration in which the weight of each ingredient is known. This mixture is then offered to cows as their sole source of feed. By blending together all the forages, grains, commodities, and protein and mineral-vitamin supplements, cows are less able to selectively consume individual ingredients. Ideally, each bite of feed a cow consumes will contain the same proportion of forages and concentrates.

Potential Advantages of Feeding Cows a TMR

Feeding cows a TMR can improve the profitability of a dairy operation if any of the following occur:

- Milk production improves.
- Feed costs decrease.
- Feeds previously hard to feed can now be fed.
- Labor requirements decrease.
- Cow health and/or reproductive performance improves.

Milk production improves: Although increase in milk production depends on how well the previous feeding system met the cows' nutritional and management needs, some farmers who have switched from feeding grain in the parlor to feeding a TMR have seen production increase by 5 pounds or more per cow. If the reproductive performance of the dairy herd (discussed below) and the herd's health are improved, yearly milk production may also increase.

Feed costs decrease: When going to a TMR, some farmers are able to do one or both of the following:

- Include feeds they previously could not feed easily (for example, whole cottonseed).
- Decrease the cost of purchased concentrates when byproducts are purchased in bulk and included in the mixed ration.

For more information on using byproduct feeds, see the Kentucky Cooperative Extension publication *Using Byproducts to Feed Dairy Cattle* (ASC-136).

Feeds previously hard to feed can now be fed: Cows may receive additional nutrients if feeds that could not be fed previously can now be added. These feeds may include whole cottonseed or wet byproducts. For more information on feeding whole cottonseed or other high fat feeds, see Kentucky Cooperative Extension publication *Should You Be Feeding Fat to Your Dairy Cows?* (ASC-134).

Labor requirements decrease: If you are thinking about switching to a TMR system, you need to consider the amount and availability of labor needed to feed a TMR to the milking herd, dry cows, and heifers compared to your current labor requirements. Feeding cows a TMR may decrease labor needs, especially when you previously handled some or all of the forages and other feeds manually. (Typically, 30 to 45 minutes is needed to load, mix, and feed out a batch of TMR.) You also may spend less time milking. For example, since all the grain is fed outside the milking parlor, the amount of time needed to milk may decrease. Less time may also be spent in cleanup, since no feed is spilled on the parlor floor.

Cow health and/or reproductive performance improves: Improvements in the health and reproductive performance of cows are often hard to quantify. With a properly managed TMR feeding system, all the feeds are consumed in the same proportions throughout the day, resulting in potentially fewer digestive upsets and an increase in the amount of feed a cow will consume. These changes can improve milk production (discussed above) and reproductive and overall performance of cows in a herd. This is especially true for early-lactation cows. The biggest improvements in performance are usually seen when cows are switched from a feeding program where they are fed more than 6 pounds of grain within a six-hour time period. Switching to a TMR may decrease the incidence of subclinical ruminal acidosis. By spreading the amount of starch and sugars contained in grain mixes over the day, rumen microbes (bugs) come in contact with the same products throughout the day. The microbes can thus more efficiently digest feeds and possibly prevent problems such as depressed milk fat, laminitis (foot

problems), and ruminal acidosis. If these problems are prevented, the cow may improve her feed intake and may produce more milk as a result. Reproductive performance may also improve as feed intake improves and a cow may experience a lower incidence of health problems.

Types of Mixers

Your first step in feeding a TMR will be to buy a mixer. Several TMR mixers are on the market. Generally, feed is mixed in the TMR mixer using one of the following:

- Horizontal augers.
- Vertical auger or screw.
- Reel.
- Tumbling action within a drum and/or with chain and paddles.

The general principles for each type of mixer are described below.

Horizontal auger mixer: These mixers come with one, two, three, or four horizontal augers for mixing the feed. With multiple-auger mixers, the mixing action occurs when one or two of the augers counter-rotates, moving the feed opposite to an adjacent auger (or augers). Knife sections attached to the auger flights can cut or tear long-stemmed alfalfa hay into pieces of 3 to 4 inches, which can then be incorporated into the ration. Many horizontal auger mixers do not handle grass hay or baleage well because these feeds tend to wrap around the augers.

Horizontal auger mixers use pressure to move the feed throughout the mixing chamber. If they are not operated properly, the forage particles may decrease in size, resulting in health problems in the herd.

Vertical mixer: This type of mixer consists of a tub with a single, center auger or a tapered screw. The center auger is powered by a transmission and planetary gearbox. These mixers can make TMR rations in which all the forage is dry hay. (Water or wet byproducts are added to the mix to prevent separation.) Knife sections attached to the flights on the center auger and movable shear or restrictor plates on the tub wall help reduce the particle size of dry hay or baleage. Caution should be used so that excessive mixing does not occur. It could decrease the particle size of forages and lead to health problems. Vertical auger mixers can generally handle large round bales of grass or alfalfa hay, but they may cost more than other types of TMR mixers.

Reel mixer: This mixer often combines a set of augers and a reel similar to a combine reel in a hopper. The rotary mixing system lifts feed past the wedging point on the lower side of the auger. The lifting action of the rotor is intended to minimize wedging of alfalfa hay and other

long-stemmed forages under the lower auger, potentially preventing the particle size of the forages being mixed from being reduced. On some models, an optional hay pan is available to allow larger amounts of dry hay or baleage to be added.

Tumble or chain and paddle mixer: Tumble mixers use spirals and pans on the interior of the drum to lift and tumble the ration. Loading and unloading occur at different ports on the mixer. Chain and paddle mixers consist of a tub with a chain and paddles on a conveyor that are used to tumble the ration from one end to the other. Some configurations of both types of mixers use a central auger that circulates the feed, moving it to the front of the mixer, where it is either remixed in the tumbling action or delivered to the unloading port. Dry hay must be chopped to a length of 1 to 3 inches before it can be mixed. These mixers wear less and have lower power requirements than auger or reel mixers of the same capacity, are generally stationary, and, for the most part, have been replaced with auger or reel-type mixers by most equipment manufacturers.

Additional Considerations

When Choosing a TMR Mixer

When selecting a new or used TMR mixer, you should also consider:

- Whether you want a stationary mixer or a mobile one.
- Whether you want to incorporate long-stemmed hay into your cows' diet.
- What size mixer you need to feed not only the milking herd, but also heifers and dry cows.
- What kind of scales and magnets you need on the mixer.
- Whether you need to add a crowd gate in the holding pen to make it easier to move cows into the milking parlor.

Mobile versus stationary mixers: Most mixers are available as either a stationary or mobile model. Stationary mixers are generally located in a covered feed room. Feeds are added to the mixer through a series of conveyors from various storage structures, such as silos and upright feed bins, or are dumped into a hopper from storage structures not connected to the mechanical feeding system.

Mobile mixers can be mounted to a truck frame or pulled by a tractor. They offer flexibility, allowing cattle to be fed at different locations. Feeds and forages can be added from a variety of storage structures (such as commodity sheds and forage bags and bunkers) that may or may not be centrally located.

Long-stemmed hay in a TMR: Incorporating long-stemmed hay, especially grass hay, in the ration poses a unique set of system requirements. Grass hay and baleage may wrap around augers, making it impossible to incorporate it into a mixed ration. Depending on the mixer, the amount of long-stemmed alfalfa hay that can be added to the mixer may be limited. Some models can handle long-stemmed alfalfa hay when it is less than 10 to 20 percent of the TMR. A lot of mixers will not handle grass hay unless it is chopped before being added to the mixer. Therefore, some type of hay processor or tub grinder will be needed. Equipment manufacturers often say a particular mixer will handle hay, but be sure to find out if the mixer can handle alfalfa/grass hay, grass hay, or just fine-stemmed alfalfa hay.

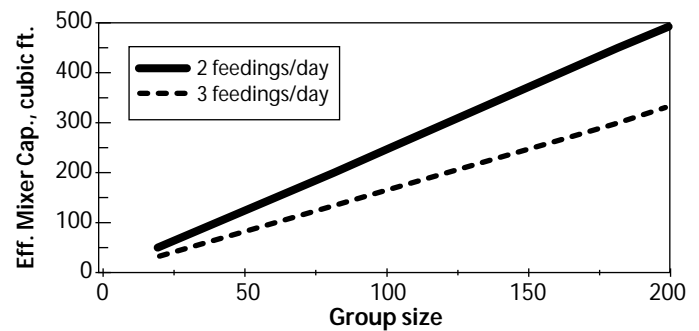
Mixer size: TMR mixers are rated in terms of volume, usually cubic feet. Mixer manufacturers typically will list a struck capacity and a mixing capacity. The struck capacity is the volume of the mixer when feed is level with the top of the mixer's sides. The mixing capacity is the volume at or near the top of the mixing devices (augers, paddles, etc.) and is usually 70 to 80 percent of the struck capacity. Filling the mixer beyond its mixing capacity will increase mixing time, decrease mix uniformity, and may even increase feed wastage.

When feeding cows a TMR, cows are fed and managed as one or more groups. They can be divided into groups based on stage of lactation (fresh-cow group), age (first-calf heifer group), by milk production and/or body condition (high or low production group), or reproductive status (pregnant or open cows). No matter what grouping scheme is used, cows should be grouped to allow easy handling, adequate bunk space, and milking of each group of cows in under two hours.

The size of your mixer should accommodate the largest group of cows but also be able to mix smaller batches of feed, such as the smaller batches needed for dry cows, close-up dry cows, heifers, or, in larger herds, fresh cows. Using a smaller mixer to make multiple batches may be more economical than purchasing a larger mixer. You also need to consider increased capacity because larger batches of feed are needed to feed cows in the heat of the summer, when they may consume 70 percent of their feed in the cooler hours of early morning and evening. More capacity will also be needed if you are going to add more cows in the near future, whether it is a few cows or a major expansion. Figure 1 illustrates the size of a mixer needed for various size groups of milking cows when cows are fed equal amounts of feed either twice or three times

a day. Mixer sizes shown in Figure 1 are the manufacturer's specified mixing capacity, or 70 percent of struck capacity. For example, the feed needed to feed a 100-cow group twice daily would require 250 cubic feet of mixing space in a TMR mixer.

Figure 1. TMR mixer size requirements for various size groups and two or three feedings per day. (Note: figure assumes 50 lb dry matter per cow per day. Feed ration weighs 20 lb/ft³ at 50% dry matter, or approximately 5.0 ft³ per cow-day. Effective capacity allows some room for mixing; figured at 70% of struck capacity. Therefore, multiply the effective capacity by 1.43 to get struck capacity.)



For mobile mixers, as the size of the mixer increases, the size of tractor to operate the mixer also needs to increase. Table 1 lists the relative horsepower needed to operate various sizes of mobile TMR mixers, but check with the equipment manufacturer for the horsepower required to operate a particular mixer. A tractor is often dedicated to the daily operation of the TMR wagon. An additional tractor or skid steer is often needed to load forages and/or commodities into the mixer.

Table 1. Tractor horsepower required for mobile TMR mixers of various sizes.

Effective mixer capacity (ft ³)	Tractor size (HP)
100	75
200	75
300	100
400	125
500	125
600	150
700	150

Adapted from: Spain, J.N., L.W. Turner, D.M. Amaral-Phillips, J.M. Zulovich, and D.G. Overhults. 1994. *An Economic Feasibility Study of Adapting Total Mixed Dairy Rations*. Dairy Systems for the 21st Century Third International Dairy Housing Conference.

Choosing scales and magnets: Scales and magnets on a TMR mixer are a necessity and should be used when mixing each batch of feed. Magnets should be located on the discharge chutes, where they can collect metals such as nails and wire—thus helping prevent hardware disease that can occur when cattle consume metal objects.

Scales located directly on the mixer are necessary so that each ingredient in the ration will be weighed accurately and the nutrient density of the ration can be kept relatively constant from batch to batch. Either electronic or beam-type mechanical mechanisms can be used to weigh the amount of feed added to the mixer. Most mixers can now be equipped with electronic scale mechanisms, which are attached to an electronic digital readout. A digital readout allows the operator to tare the mixer (bring it back to zero weight) and to see from a distance the amount of feed added to it—for example, as from the tractor seat or from another piece of equipment used to load the mixer. When purchasing a particular scale, be sure to consult the manufacturer’s specifications. Most scales are accurate up to 1 percent. If less than 20 pounds of a feedstuff is added to a batch of feed, that feedstuff should be weighed out separately on a scale calibrated specifically to weigh small amounts of feed, such as a spring or milk scale. To maintain accuracy, weekly calibration is important for all types of scales.

Crowd gates needed in holding pen: Because all the grain is fed in the TMR, crowd gates may be needed in the holding pen to encourage cows to come into the parlor to be milked. Cows that are not hungry will be content in the parlor and quickly adapt to no grain being fed there.

Maintenance of TMR Equipment

Routine maintenance of a TMR mixer is important. A malfunctioning mixer can significantly affect the uniformity of the ration fed and ultimately the performance of the cows that are fed that ration. A good maintenance schedule should include routinely replacing or sharpening knives and checking grease fittings, oil levels, and accuracy of the scale. Alternate the replacement or sharpening of knives to avoid drastic changes in size of forage particles that can occur if all of the knives are sharpened or changed at once.

A TMR mixer should be cleaned out on a routine schedule. Buildup of wet feedstuffs can impair the mixer and inhibit the uniform distribution and mixing of feedstuffs and thus delivery of the nutrients needed by the cows. Routine calibration of the scale and its digital readout are important to ensure accuracy of the mix being fed to dairy cows. The accuracy of the scale should be checked weekly. It can be measured by adding a bag of mineral of known weight (for example, 50 pounds) at the beginning, middle, and end of the loading sequence.

Will a TMR Mixer Pay for Itself?

Before you make any changes to your current feeding system, you need to consider the effect of additional capital outlay on your operation’s cash flow. To calculate the number of cows necessary to pay for the additional investment in a TMR feeding system, consider the cost of the TMR mixer against expected improvements in milk production and savings in feed cost. For example, if yearly milk production averages 17,000 pounds, production increases by 5 percent, and the cost of the concentrate mixture is reduced by \$20 per ton, more than 89 cows are needed to pay for an \$18,000 TMR mixer wagon. Table 2 illustrates the number of cows necessary to financially break even with different costs for a mixer. Additional economic benefits that are difficult to assess may be realized, such as improved health of the cows as a result of feeding a more properly formulated and delivered ration.

TMR Plan, a computer spreadsheet, has been developed to evaluate the economics of purchasing or changing a TMR system on an individual dairy. By inputting mixer size and cost, herd size, expected production increase, feed cost savings, and any additional costs, the economics of a possible change to a TMR system can be evaluated. A copy of this Excel spreadsheet is available by contacting the authors of this publication.

Table 2. Number of cows needed to pay back the additional investment in a TMR mixer.

Mixer Cost	—Yearly Average Milk Production—		
	15,000 lbs	17,000 lbs	20,000 lbs
	<i>(Number of Cows Necessary to Pay for Investment)</i>		
\$10,000	87	77	66
\$14,000	93	83	71
\$18,000	100	89	77
\$20,000	104	92	79
\$25,000	112	100	85
\$30,000	120	107	92

Assumptions: In addition to the cost of a used or new TMR mixer, \$4,000 is spent to renovate existing facilities. Milk production is increased by 5 percent with milk priced at \$12 a hundredweight. Feed costs for purchased complete grain mixes are reduced by \$20 a ton. Feed wastage is reduced by 3 percent.

Mention or display of a trademark, proprietary product, or firm in text or figures does not constitute an endorsement and does not imply approval to the exclusion of other suitable products or firms.