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Use of total mixed rations (TMR) for dairy cows

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Topics Include:

Advantages of a TMR feeding system
Disadvantages of a TMR feeding system
Feeding management on TMR systems
General approach to formulating TMRs

INTRODUCTION

A. Feeding a total mixed ration (TMR) helps a dairy cow achieve maximum performance. This is accomplished by feeding a nutritionally balanced ration at all times, allowing cows to consume as close to energy requirements as possible, and maintaining physical or roughage characteristics required for proper rumen function.

B. Advantages and disadvantages of any feeding system must be weighed before choosing a TMR. Consider herd size, animal groupings, economics, facilities, and degree of mechanization. If all feeds are to be mixed on the farm, consider purchasing and storing commodity feeds.

C. Good feeding management practices must be followed to achieve maximum performance from cows.

1. Monitor forage and feed inventory on a regular basis and allocate to the appropriate animal groups.
2. Test forage and feeds several times throughout the year or when any noticeable change occurs.
3. Update ration formulations based on milk production, milk fat and milk protein percent, current body weight and body condition scores, moisture changes in forages or high moisture feed ingredients, and prices of current feeds.

D. Various strategies can be used in TMR systems.

1. TMRs can be developed for different animal groups. They can be formulated for fresh cows, early, mid-, late-lactation animals. Multi-group TMRs can be used for early and close-up dry cows. One group TMRs can be used for lactating cows with or without top-dress feeding.
2. Cows can be grouped based on actual or fat-corrected milk, days in milk, reproductive status, age, nutrient requirement, and health.

ADVANTAGES OF A TMR FEEDING SYSTEM

A. Improved feed efficiency often occurs with herds using a TMR.

1. Each mouthful of feed that the cow consumes contains the proper amount of ingredients for a balanced ration. This results in a more stable and ideal environment for the rumen microbes and increased nitrogen utilization, including nonprotein nitrogen (NPN). This in turn can lead to production of higher levels of microbial protein by the rumen microbes.
2. A 4-percent increase in feed utilization can be expected, compared to a conventional ration of forage and grain fed separately, twice daily.
3. The incidence of digestive and metabolic problems often decreases.
4. Milk production has been shown to be as much as 5% higher with a TMR, compared to conventional rations.

B. A TMR provides greater accuracy in formulation and feeding if managed properly. Using feed scales allows the quantity of each ingredient fed to be closely controlled. When a TMR is mixed properly, a cow cannot consume significantly more or less of a forage or concentrate.

C. Parlor and selective feeding can be discontinued or limited to token amounts to facilitate cow movement.

D. The TMR system is well adapted to mechanization with either a mixer wagon, cart or a stationary mixer with conveyors or mobile feeders.

ADVANTAGES OF A TMR FEEDING SYSTEM (CONTINUED)

E. Mixers can be purchased that handle the addition of long hay. This is advantageous on forage rations, which contain excellent-quality ensiled forages that are fine in particle size.

F. Commodity ingredients can be fed quite effectively in the diet.
   1. Unique or common types of commodities are often less expensive due to bulk and direct purchasing.
   2. Quality control must be maintained when purchasing commodity feeds. This often entails additional feed analysis.
   3. Additional costs of transportation and handling required by a commercial feed manufacturer are avoided.
   4. The quantity of commodity feeds purchased depends on rate of spoilage, level of use, and available storage space. Purchasing large quantities may not be economical due to increased inventory costs.
   5. Total feed losses for commodity feeds, including what occurs during storage and handling, can range form 3% for a dry grain product to 15% for a wet product such as wet brewers grain.
   6. Purchasing should be based on quality and nutrients needed for the ration, not solely on price.

G. A greater variety of ingredients allow more flexibility in formulating the ration for various production groups.

H. Blending all the feeds together in a TMR can mask the flavor of less palatable feeds. Feeds such as urea, limestone, bicarbonate, fats, and by-pass protein sources like blood and fish meal can be added to TMRs in reasonable amounts without significant reduction in feed consumption.

DISADVANTAGE OF A TMR FEEDING SYSTEM

A. Mixing or blending devices needed for the ration requires small to moderate expenditures for equipment and maintenance.

B. It is important to follow the manufacturer's recommendations for mixing. Over mixing can cause serious problems due to grinding and pulverizing the feed. Under mixing can result in less effective feed utilization by the cows.

C. Accurate weighing with calibrated scales, which also may involve additional cost and maintenance, is essential.

D. Care must be taken in formulating and mixing the ration. If the diet is not balance correctly or mixed properly, the cow ultimately will suffer reduced performance. While this is true of any feeding system, it is under the control of the person feeding the herd.

E. Existing buildings, feed alleys, and mangers may make a TMR system nearly impossible to use. Some housing and feeding facilities also may not be well suited.

F. A TMR system may not be economical for small herds or those using pasture feeding over an extended period of time, which increases the cost of the feeding system per animal-day utilized.

FEEDING MANAGEMENT ON TMR SYSTEMS

A. Forages should be chopped properly before ensiling. Most forage particles in silage and haylage should range from 3/8 to 3/4 inch in length. Forage particles that are very fine, or grain that is too coarse or whole, should be avoided in the ration.

B. Develop rations based on current forage analysis reports.

1. Make ration adjustments when a change in forage is observed.
2. The dry matter of ensiled material should also be checked at least every other week. A change in dry matter can alter the TMR drastically.
3. The TMR itself should be sampled and sent for analysis at least three to four times a year or when any major change takes place. This checks the accuracy of the scales and mixing system.

C. Determine the actual dry matter intake of cows three to four times yearly.

1. Cows should be within 5% of the expected dry matter intake.
2. If the dry matter intake exceeds 5% from the expected, that ration should be reformulated.
3. Extremely low intakes may indicate that forage quality and/or dry matter contents have changed and may be a limiting factor to intake.

D. The number of animal groups to have in a TMR system is determined by the existing herd size and layout of the barns and loafing areas.

1. The ideal TMR system for an entire farm would have seven main groups.
    a. lactating cows: high, medium, and low production
    b. dry cows: early and close-up , and
    c. heifers: prebreeding and postbreeding
    d. young calves can be fed a small amount of a TMR, although the majority of the diet must be concentrates.
2. The cost of installing a TMR system, including things like renovations and equipment purchases, may make it impossible to have this many groups. However, compromises often have to be made. For lactating cows using a computer feeder in one- or two- group TMR systems provide a way to offer higher levels of energy and protein to the heavier milk-producing cows. This can achieve nearly the same effect as a three-group TMR system.
3. There are shortcomings from not feeding more than one- or two-group TMRs. In a one- or two-group system, the lower-producing cows receive the same forage as the higher-producing cows. This may not allow for optimal use of various forages. In a three-group system, the low-group cows can usually be fed cheaper forage to reduce costs.
4. Using a one-group TMR system usually results in higher feed costs because more expensive ingredients such as undegradable protein sources, fats, and certain feed additives are fed to cows in later stages of lactation. These cows should be fed a ration with higher levels of forage than a one-group TMR would provide.
5. Lower-producing cows may become over conditioned in a one-group TMR system. Many of the problems of the one-group system can be avoided by using two groups, especially if one of them is fed according to above average group production.

E. Dry cows should be divided into two groups, early and close-up.

1. Using a two-group TMR system for dry cows can minimize the level of metabolic and nutritional disorders observed at calving and in the postpartum period.
2. The close-up group should be cows two to three weeks from calving, or if it is being balanced for anions and cations, three to four weeks.

FEEDING MANAGEMENT ON TMR SYSTEMS (CONTINUED)

F. To ensure proper ration formulation for growth and development, a two-group TMR system is necessary for heifers.

1. Include a prebreeding and postbreeding heifer group.
    a. young heifers lack the capacity to consume very high forage diets while maintaining proper growth.
    b. prebreeding heifers need an energy and protein-dense diet.

G. Other points to consider when feeding a TMR:

1. The ration should be available to the cows 22 to 24 hours daily.
2. Maximum intake can be achieved by feeding 5 to 10% refusals in the bunk, which can be fed to older heifers.
3. First-calf heifers should be placed into a higher group than their production level to compensate for growth.
4. If hay or grain is fed separate from the TMR, it should be limited to two to five pounds per head per day.
5. Supplemental grain feeding to high producers may be necessary in one-group TMRs. However, the amounts to feed will depend on the level of concentrate that is being fed in the TMR.
6. When large quantities of feedstuffs are fed separately from the TMR (even two to five pounds of hay), the TMR loses many of the advantages it has over conventionally fed rations. Therefore, if possible keep all the ingredients in the TMR to maximize performance and profit.

GENERAL APPROACH TO FORMULATING TMRS

A. The key to formulating TMRs is to optimize dry matter intake.
1. Total dry matter intakes should be consistent with production and breed (see Table 1).
2. Intakes may be depressed when ensiled materials undergo abnormal fermentation.
3. Forage dry matter should consist of good- to excellent-quality forages, especially for high-producing animals.
4. Palatability of forages, the presence of certain weeds, and water quality can affect intake.
5. Dry matter intakes may be elevated when forage is chopped too fine and excessive concentrate dry matter is present.
6. Dry matter intake during the first two weeks post calving may average 2% of body weight.

B. The ration differences between groups should be minimal otherwise cows will decrease milk yield significantly when they are moved to a different group. Limit differences in concentrate dry matter proportions to not over 10 to 15% between groups. The level of concentrate dry matter and protein depends to a certain extent on the production level and the type of forage used (see Table 2).

C. Moving cows through groups in multi-group systems may control body condition in herds fed a TMR. In single-group TMRs, the percent concentrate dry matter may be altered; thin cows could receive supplemental feed and over-conditioned cows could be somewhat limited in amounts of the ration fed.

D. Follow sound nutrition practices in respect to crude protein, energy, neutral detergent fiber, nonfiber carbohydrates, fat, macro and micro minerals, and vitamins for the respective levels of production.

GENERAL APPROACH TO FORMULATING TMRS (CONTINUED)

E. Dry cows may need at least five pounds of long-stem hay along with a TMR to provide sufficient "effective fiber". Monitor intakes of the TMR so animals do not over- or under-consume.

F. Dry cows placed in a close-up TMR should be kept on the ration until the day they freshen. This applies to both a regular and anionic close-up ration (see Table 3).

G. Dry cows that are not grouped and offered one TMR may be fed limited amounts of the milk cow TMR, two to three weeks prior to freshening. However, restrictions must be set to ensure there is adequate forage dry matter intake and that the nutrient densities of protein, minerals, and vitamins do not exceed recommendations for the close-up dry cows.

H. Nutrient specification for heifer TMRs are in Table 4. Total dry matter intakes are regulated by the bulk of the ration and its energy density. If corn silage is fed heavily in a heifer TMR, intakes may have to be controlled and more closely monitored to avoid over conditioning.

The benefits of using a TMR far outweigh the disadvantages, but each farm has different goals and facilities that may or may not adapt well. Each case should be analyzed to find the most profitable alternative. A carefully designed and well thought-out system will pay off in the long run.

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Table 1. Expected daily intakes of total dry matter by dairy cattle.

Milk production, 4% FCM (lb/day)	Dry matter intake (lb/cwt of body weight)	
	Large breeds	Small breeds
100	4.30	5.80
90	4.10	5.40
80	3.80	5.00
75	3.65	4.80
70	3.50	4.50
65	3.40	4.25
60	3.25	4.00
55	3.13	3.85
50	3.00	3.70
45	2.85	3.50
40	2.70	3.30
35	2.60	3.10
30	2.50	2.90
20	2.10	2.50

Table 2. Guide to ration composition for high-producing cows[a]

	Stage of Lactation		
	Early[b]	*Mid*[c]	*Late*
Crude protein, %DM	17-18	16-17	15-16
Soluble protein, %CP	30-34	32-36	32-38
Degradable protein, %CP	62-66	62-66	62-66
Undegradable protein, %CP[d]	34-38	34-38	34-38
NEL, Mcal/lb DM[e]	0.76-0.80	0.72-0.76	0.68-0.72
Forage NDF, %DM	21-24	25-26	27-28
Total NDF, %DM	28-32	33-35	36-38
NFC, %DM	32-38	32-38	32-38
Fat, maximum, %DM[f]	5-7	4-6	4-5
Calcium, %DM[g]	0.81-0.91	0.77-0.87	0.70-0.80
Phosphorus, %DM[g]	0.40-0.42	0.40-0.42	0.40-0.42
Magnesium, %DM[g]	0.28-0.37	0.25-0.34	0.22-0.28
Potassium, %DM[h]	1.00-1.50	1.00-1.50	1.00-1.50
Sulfur, %DM	0.23-0.24	0.21-0.23	0.20-0.21
Salt, %DM or	0.45-0.50	0.45-0.50	0.45-0.50
Sodium, %DM	0.20-0.25	0.20-0.25	0.20-0.25
Chlorine, %DM	0.25-0.30	0.25-0.30	0.25-0.30
Manganese, ppm	44	44	44
Copper, ppm[i]	11-25	11-25	11-25
Zinc, ppm	70-80	70-80	70-80
Iron, ppm	100	100	100
Added selenium, ppm	0.30	0.30	0.30
Added cobalt, ppm	0.20	0.20	0.20
Added iodine, ppm	0.50	0.50	0.50
Total vitamin A, IU/lb DM	4,500	4,500	4,500
Added vitamin D, IU/lb DM			
Minimum	750	750	750
Maximum	1,100	1,100	1,100
Total vitamin E, IU/lb DM	30	30	30
Approximate concentrate, %DM[j]	55-60	45-50	35-40
Approximate DMI, %BW	4.0+	3.5+	3.0+

See footnotes on next page

Table 2. Guide to ration composition for high-producing cows[a] (continued)

[a]Refers to milk production equivalent to a DHI rolling herd average of 18,000 lb of 4% fat-corrected milk or higher.

[b]Refers to cows in approximately the first 15 weeks of the lactation. If cows fresh less than 4 weeks are kept in a separate group or fed individually, or founder is encountered in first-calf heifers, use the following modified specifications: CP 19%, UIP 38%, NEL .76, forage NDF 24%, fat 3 to 5%, the higher levels of minerals indicated and approximately 50% concentrate dry matter. DMI during the first month may range from 2.2% BW at calving to 2.8% BW at 14 days and 3.3% at 30 days.

[c]Follow guidelines for mid lactation animals if a one-group TMR is being fed

[d]Use more than one high protein supplement to meet undegradable protein needs (UIP). Often lysine and sometimes methionine are the most limiting essential amino acids. On a largely corn-based ration as silage, grain or corn by-products; part of the UIP should be furnished by animal or fish protein, soybean protein or cottonseed protein to provide more lysine. Limit use of brewers, distillers, corn gluten meal, and feather meal on high corn diets.

[e]NEL needs are dependent upon production level, body condition scores, and deviations in dry matter intake.

[f]Fat at over 5% should be furnished by rumen-inert or by-pass fats.

[g]Use these minerals at the higher level indicated when fat content exceeds 4.0%.

[h]Use the higher potassium level during periods of hot, humid weather.

[i]Use the higher copper levels when low serum copper occurs on rations containing usual levels of 10-12 ppm. Induced copper deficiency may result from excessive intake of iron, manganese, molybdenum, and sulfur.

jWhen feeding total mixed rations avoid differences between rations that exceed 10 to 15% for milking groups to avoid excessive drops in production when moving to a lower group.

Table 3. Guide to ration composition for dry cows

	Early	*Close-up*[a] *regular*[b]	*Close-up*[a] *anionic*[c]
Crude protein, %DM	12-13	13.5-14.5	13.5-14.5
Soluble protein, %CP	30-38	30-38	30-38
Degradable protein, %CP	—	—	—
Undegradable protein, %CP	—	—	—
NEL, Mcal/lb DM	0.60-0.64	0.62-0.66	0.63-0.67
Forage NDF, %DM	27, min	27, min	27, min
Total NDF, %DM	36, min	36, min	36, min
NFC, %DM	26, min	26, min	28, min
Fat, maximum, %DM	—	—	—
Calcium, %DM	0.45-0.55	0.45-0.55	1.40-1.60
Phosphorus, %DM	0.30-0.32	0.30-0.32	0.32-0.35
Magnesium, %DM	0.24-0.28	0.28-0.32	0.28-0.32
Potassium, %DM	0.80-1.00	0.80-1.00	0.80-1.10
Sulfur, %DM[d]	0.16-0.17	0.17-0.19	0.35-0.40
Salt, %DM or	0.25-0.30	0.25-0.30	0.25-0.30
Sodium, %DM	0.10-0.12	0.10-0.12	0.10-0.12
Chlorine, %DM	0.20-0.24	0.20-0.24	0.70-0.80
Manganese, ppm	44	44	44
Copper, ppm[e]	11-25	11-25	11-25
Zinc, ppm	70-80	70-80	70-80
Iron, ppm	100	100	100
Added selenium, ppm	0.30	0.30	0.30
Added cobalt, ppm	0.20	0.20	0.20
Added iodine, ppm	0.50	0.50	0.50
Total vitamin A, IU/lb DM	3,500	3,500	3,500
Added vitamin D, IU/lb DM			
Minimum	750	750	750
Maximum	1,100	1,100	1,100
Total vitamin E, IU/lb DM	35	35	35
Approximate concentrate, %DM	12-15	22-25	22-25
Approximate DMI, %BW	2.0	1.80	1.80

See footnotes on next page

Table 3. Guide to ration composition for dry cows (continued)

[a]The last three to four weeks prior to expected calving.

[b]Regular or cationic (alkaline) diet.

[c]Anionic or acidic diet with a cation-anion balance of -100 to -150 milliequivalents per kilogram (mEq/kg). This is based on the simple equation of: mEq/kg = mEq (Na + K) - mEq (Cl + S).

Factors to convert from nutrient % to mEq/kg of diet are Na: 435, K: 256, Cl: 282, and S: 624.

Example: Calculate the cation-anion balance of a ration with Na at 0.15%, K at 1.10%, Cl at 0.80%, and S at 0.40% (all values are on a dry matter basis).

mEq/kg = [(0.15 x 435) + (1.10 x 256)] - [(0.80 x 282) + (0.40 x 624)] = (65.3 +281.6) - (225.6 + 249.6) = 346.9 - 475.2 = - 128.3

[d]Sulfur level of 0.45% in the close-up anionic diet may be tolerated for short periods of time (three to four weeks).

[e]Use the higher or intermediate levels when an induced copper problem exists due to high iron, manganese, molybdenum, or sulfur intakes.

Table 4. Guide to ration composition for dairy replacements

	0-6 Mo.	*7-11 Mo.*	*12-24 Mo.*
	Dry Matter Basis		
Crude protein, %	16	13	12
Soluble protein, %CP	25-30	30-35	30-38
Undegradable protein, %CP	45-55	33-37	25-30
Degradable protein, %CP	45-55	63-67	66-72
NEM Mcal/lb	.77	.72	.65
NEG Mcal/lb	.49	.44	.38
TDN%	69	66	63
Total NDF, min., %	25	30	35
Calcium, %	.60	.48	.45
Phosphorus, %	.40	.32	.30
Magnesium, %	.22	.22	.22
Potassium, %	.80	.80	.80
Sulfur, %	.21	.17	.16
Salt, % or	.25-.30	.25-.30	.25-.30
Sodium, %	.10-.12	.10-.12	.10-.12
Chlorine, %	.20-.24	.20-.24	.20-.24
Manganese, ppm	44	44	44
Copper, ppm[a]	11-25	11-25	11-25
Zinc, ppm	70-80	70-80	70-80
Iron, ppm	100	100	100
Added selenium, ppm	.3	.3	.3
Added cobalt, ppm	.2	.2	.2
Added iodine, ppm	.5	.5	.5
Total Vitamin A, µ/lb DM	2500	2500	2500
Added Vitamin D, µ/lb DM	400	400	400
Total Vitamin E, µ/lb DM	35	35	35
Approximate Concentrate, %DM	60-65	30-35	15-20
Approximate DMI, %BW	2.6	2.4	2.2
Approximate Forage DMI, %BW	.9	1.6	1.8
Estimated Bodyweight, lb.			
Large Breed	250	550	900
Small Breed	155	480	700

[a]Use higher or intermediate copper levels when an induced copper problem exists due to high iron, manganese, molybdenum, or sulfur intake.