



agriculture & rural development

Department:
agriculture
& rural development
PROVINCE OF KWAZULU-NATAL

DAIRYING IN KWAZULU-NATAL

Total Mixed Rations for Dairy Cattle

Martin H Neitz
Meadow Feeds

T J Dugmore
Cedara Agricultural Development Institute

Total Mixed Ration (TMR) can be described as a mixture of both the roughage and the processed ingredients, formulated and mixed to supply the cows requirements, in a form that precludes selection. It is designed to be the sole feed source given over a 24 hour period and fed ad lib. for optimum results. This cannot be accomplished without the use of accurate weighing equipment and adequate and proper mixing equipment (feed mixer wagon).

ADVANTAGES OF A TMR

- Increased dry matter intakes (DMI). Peak DMI is achieved 4 to 8 weeks earlier than conventional systems.
- Increased milk production by approximately 5 to 8%. Each additional kg DM consumed increases milk yield by 0,9 to 1,5l.
- Improved fat tests as a result of improved rumen fermentation, and optimal pH (acidity) levels of 6,2 to 6,8 achieved in the rumen, resulting in both maximal rumen fermentation and cellulose digestion leading to the formation of acetic acid, the precursor of butterfat production.
- Reduced digestive upsets due to each bite of feed having the same composition, minimising pH fluctuations in the rumen.
- Optimal protein synthesis in the rumen, as microbial protein synthesis is maximised at a rumen pH of 6,3 to 7,4.
- No need to feed mineral/vitamin supplements as all the requirements can be included in the TMR.
- Eliminate concentrate feeding at milking.
- A wider variety of less palatable feeds can be utilized in the ration as these are masked by the other ingredients by the elimination of selection.
- Better control of the cow's diet.

KEYS TO TMR SUCCESS

- Forage quality must be good.
- Accurate weighing.
- Accurate moisture determination of feeds.
- Correctly balanced ration.
- Dry cow programme, i.e. adequate preparation.
- Feed intake monitoring is absolutely critical.

Checklist for optimal intake

- Moisture content of 35 to 44% of the total diet.
- NDF and ADF content of forages checked to ensure correct fibre and ration intake.
- Correct feeding rates (ad lib), scale calibration and proper feed mixing.
- Feed 5 to 10% more than the cow is expected to eat.
- Limit unpalatable ingredients, e.g. tallow, poorly fermented silage, fishmeal, meat & bone meal, etc.
- A maximum of 50% of the ration moisture content derived from fermented feeds, e.g. brewers grain and silage.
- Ensure adequate trough space (900 mm/cow) and trough management, e.g. clean troughs, rain protection, shade, leaking troughs.
- Cow comfort, protection from heat stress or cold winds, e.g. shade or windbreaks.
- Adequate protein and salt levels in ration.
- Water quality and availability (up to 200 l/cow/day in hot weather).

To maximise DMI feed the ration in 4 to 5 portions over the day, avoiding rations with over 50% moisture. Ensure that the ration contains a minimum of 27% NDF or 19% ADF (DM basis), with 75% of the ration NDF derived from forage/roughage. Non-structural carbohydrates (NSC) should range from 38 to 40% of the DM for optimal rumen fermentation. Higher NSC levels can lead to lactic acid fermentation and acidosis, thereby reducing DMI.

The ration should contain an optimal rumen degradable protein (RDP) to undegradable (UDP), or bypass, protein ratio of 60 to 40 to ensure adequate rumen fermentation, as well as adequate bypass protein for high production. Excess RDP will be detrimental to DMI.

Include a maximum of half a kg of unprotected fat and half a kg of protected fat in the ration as excessive fat levels decrease palatability.

The inclusion of feed buffers and a yeast culture is recommended to ensure optimal rumen fermentation.

EQUATIONS TO ESTIMATE DMI

General

$$\text{DMI (kg/day)} = [1,8\% \times \text{body mass (kg)}] + [4\% \text{ FCM (kg)} / 3]$$

where: $4\% \text{ FCM} = (0,4 \times \text{kg milk}) + (15 \times \text{kg fat})$
(source: University of Minnesota)

Early lactation

DMI (kg/day) = [0,01641 x bodymass (kg)] + [0,1713 x kg daily milk yield] + [4,534 x daily fat yield]

Mid and late lactation

DMI (kg/day) = Early lactation DMI x 1,07
(source: University of Wisconsin)

DMI (kg/day) = [0,0185 x bodymass (kg)] + [0,305 x 4% FCM (KG)]
(source: University of Georgia)

If the expected and actual intake differ by more than 5 to 10% re-asses the "Keys to Success" and DMI checklist.

COMPONENTS OF FORAGE QUALITY

Factors affecting nutritive value

- ADF/NDF ratio
- CP and UDP (bypass protein)

Factors affecting palatability

- Moisture, especially in fermented feeds e.g. silage
- Effective fibre (length)
- Heat damage of feeds

Fibre components of the forage plant

NDF is the chemical fraction determining the cell wall (or structural material) content of forages. It is the most accurate predictor of DM consumption. An increase in NDF content means poorer forage quality and reduced forage consumption by the animal. A percentage point increase in the ration NDF results in a 1,2% (0,45 kg) drop in the milk yield. A percentage point decrease in NDF (higher forage quality) will result in a 1,2% increase in milk production.

ADF represents the relatively indigestible fibre in forage. It is a better prediction of energy content (digestible fibre) in forages than NDF. A percentage point increase in the ration ADF reduces milk yield by 0,3 kg per cow. A decrease in the ration ADF results in increased milk yield.

The fibre (structural) and non-structural components of the forage plant cell are illustrated in Figure 1.

Rules of thumb for ration fibre

- Supply 2,5 kg long fibre (2,5 to 4,0 cm) per day for effective chewing of the cud and saliva production.
- The physical structure of the ration is designed to ensure at least 26 minutes chewing time per kg DMI or 600 minutes of chewing time per day (10 hours). One third to half of the herd should be ruminating at any one time.

- The physical structure of the ration is designed to ensure at least 26 minutes chewing time per kg DMI or 600 minutes of chewing time per day (10 hours). One third to half of the herd should be ruminating at any one time.
- Supply 21 to 22% NDF (DM basis) from roughage, however, for a predominantly maize silage ration (>50%) 23% NDF from forages is required.
- Supply 27 to 30% NDF in total ration dry matter.
- Supply 19 to 21% ADF in ration dry matter.

The impact of the forage NDF content on the percentage forage required in the ration to meet a 21% minimum NDF from forage is shown in Table 1.

Figure 1. The chemical fractions of the forage organic matter

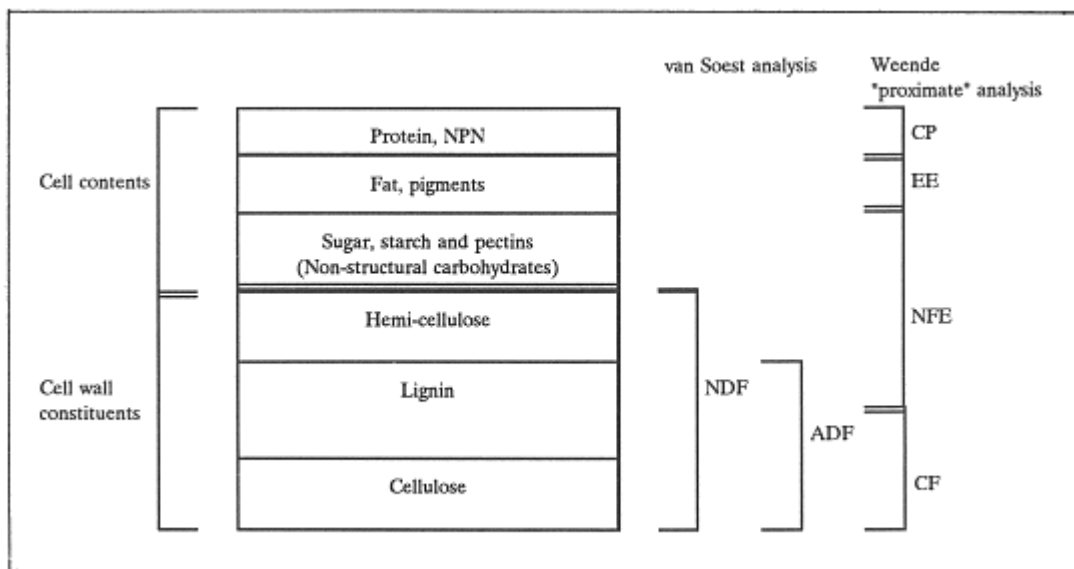


Table 1. The percentage of forage required to produce 21% NDF in the diet from forage for forage of varying NDF content

Forage NDF %	% Forage in dietary DM
35	60,0
40	52,5
45	46,7
50	42,0
55	38,0 (40)*
60	35,0 (40)*

* It is not advisable to balance a ration with less than 40% roughage for dairy cows.

NSC : RDP ratio

The NSC (starch, sugars) in the diet provides the energy required for microbial protein synthesis, ensuring microbial protein flow from the rumen to the duodenum. Fats and protein provide limited energy for microbial growth. However, when high levels of NSC are fed, insufficient ruminally degradable protein can limit microbial growth. Therefore, diets should be formulated to provide 35 to 40% NSC and 60 to 65% of the protein as RDP.

It is critical that rations are formulated to promote microbial growth in the rumen. DMI declines when too much energy in the ration is derived from NSC or at high ration fibre levels which limit intake.

A surplus of NSC (starch and sugars) in the diet may shift the ruminal fermentation pattern towards a lactic acid fermentation that would lead to acidosis and low fat levels in the milk.

Guidelines for nutrient concentrations in TMRs

The recommended guidelines for TMRs formulated for lactating cows, fresh in milk (0 to 21 days of lactation), early lactation (21 to 120 days), mid-lactation (120 - 220 days) and late lactation (>220 days) are given in Table 2, and for dry cows in Table 3.

It is recommended that cows do not mobilize more than 1 kg/day and that they should return to a positive energy balance by 10 to 12 weeks post-partum i.e. they should not lose more than 60 kg, equivalent to 1 condition score for large cows and not to drop lower than a 1,5 condition score. Additional undegraded protein is required to utilize mobilized body reserves.

A pre-calving dry cow ration should include:-

- 2,7 to 4,0 kg DM of a bulky dry cow forage with low Ca & P, i.e. limited legumes or poultry litter
- a dry cow grain source to a maximum of 0,75 to 1,0% of the cow's bodymass
- a dry cow mineral mixture
- 4,5 to 6,8 kg DM of the high Group TMR to allow the rumen to adapt to this mixture
- remove salt from dry cow ration

Table 2. Recommended nutrient concentrations in TMRs for lactating cows

Stage of lactation				
	Fresh (0-21 days)	Early (21-120 days)	Mid (120-220 days)	Late (>220 days)
DM intake (kg) (Holstein-Friesland)	18	25	22	19
(Jersey)	14.5	18	16	15

Protein (% DM)	19	18-19	16	14
Protein degradability (%)	56	60	64	68
ME (MJ/kg DM)	11,0-11,4	11,4-11,7	10,7-11,1	10,1-10,7
ADF (% DM)	20	19	21	24
NDF (%DM)	30	28	32	36
NSC (% DM)	35	40	37	34
Fat (% DM)	5	7	5	3
Ca without added fat (% DM)	0,8-0,9	0,8-0,9	0,6-0,8	0,6-0,7
Ca with added fat (% DM)	1,1	1,18	0,8-1,0	0,7-0,8
P (% DM)	0,55	0,5-0,55	0,46	0,40
Mg (% DM)	0,3	0,3	0,3	0,3
Se (mg/day)	8	8	8	8

Table 3. Recommended nutrient concentrations in TMRs for dry cows

	Early Dry*	Close to calving**
DM intake (kg)	.	.
Holstein-Friesland	13	11
Jersey	10	9
Protein (% DM)	13	15
Protein degradability (%)	70	60
ME (MJ/kg DM)	8,5	9,2
ADF (% DM)	36	30
NDF (% DM)	48	42
NSC (% DM)	30	33

Fat (% DM)	2	3
Ca (% DM)	0,6	0,7
P (% DM)	0,3	0,35
Mg (% DM)	0,16	0,20
Se (mg)	8	8

* Early dry period is from drying off to two weeks pre-partum

** **Close to calving** refers to last 2 weeks pre-partum to 2 days post-partum
Close to calving refers to last 2 weeks pre-partum to 2 days post-partum

Do's and Don'ts

- Purchase only those ingredients that can be used within 30 to 60 days.
- Don't purchase a truckload of an ingredient that will last for a year or so as this will cost you money (interest/overdraft) and feed ingredients can deteriorate over time.
- Ingredients fed in small quantities or that require careful mixing are best purchased as part of a supplement, either a commercial product or a custom mix by a good miller.
- Non-persistent cows that are getting fat must be moved to a low energy ration or culled.
- Condition score
 - early lactation, minimum of 2,0 to 2,5
 - drying off and calving 3,0 to 3,5
- The stress on the cows should be minimized where possible. The following constitute stress conditions in dairy cows:-
 - 2 weeks prior and 2 weeks post calving
 - cows losing over 1 kg bodymass per day
 - intake lagging behind output (negative energy balance)
 - first lactation cows producing over 30 kg FCM
 - heat and humidity
 - mud, snow or rain exposure
 - disease and metabolic disorders

These stress conditions could have a negative effect on milk composition and milk production, as well as reproduction.

CONCLUSION

TMRs must be formulated to get expected DMI's and cows on these rations probably require 3x a day milking for maximum benefit from the ration.

Remember to compare feeding guidelines and cow performance to the ration consumed by the cows when troubleshooting, rather than simply comparing to the computer printouts.

Finally, it is anticipated that only cows on TMRs will be able to fully benefit from BST treatment.

FURTHER READING

McCULLOUGH, Marshall E., 1989. Feeding the supercow. Fort Atkinson: Hoards Dairyman.