Feeding Total Mixed Ration (TMR) on Production and Reproductive Performance of Lactating Dairy Cows: A Review

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ABSTRACT

The development of the dairy sector is economically important to many countries of the world. However, the dairy sector has faced many constraints due to the unavailability of quality and quantity of feed resources and their responses on growth, health and reproduction in dairy animals. The total mixed ration (TMR) is an alternate strategy to overcome the feed shortage of lactating cows by utilizing available feed resources effectively and efficiently. This review article elaborates the effects of TMR on the production and reproduction performance of lactating dairy cows. Interestingly, TMR feeding has a significant effect on the body weight, feed intake, feed efficiency, milk yield and composition and reproductive performances of lactating dairy cows. Feeding TMR to dairy animals was investigated to provide a balanced diet, reduce feed wastage and save labour cost and time. Hence, feeding TMR as per the animal requirement is more efficient as compared to traditional feeds.

Key words: Body condition, Feed efficiency, Milk composition, Milk yield, Quality feed, Reproduction.

The dairy sector plays an indispensable role in the economy of many countries. Dairy farming has been identified as a priority sub-sector for development among all the other livestock sub-sectors in Sri Lanka. Dairy farming contributes to the livelihood of farmers in different ways. It provides milk and value-added products, organic manure for crops and biogas as a source of energy. Thus, dairy farming enhances the productivity of the farm by effectively utilizing agricultural by-products and available marginal lands. Hence, the development of the dairy sector uplifts the social and financial status of the farmers *via* providing employment, sustaining income and enhancing the nutritional status (Perera and Jayasuriya, 2008).

FAO (2012) has identified that poor nutrition of farm animals is a severe constraint in the developing world. Accordingly, Sri Lanka has also encountered the unavailability of quality feed sources in the required quantity throughout the year (Houwers *et al*., 2015). Grazing is the major form of feeding practice in many South Asian countries including Sri Lanka. Even though plenty of fresh forage is available for cattle during the rainy season, an acute shortage of feeds is experienced in the dry periods of the year. In most cases, during dry periods animals graze on over matured, fibrous, low-quality forage available in woods and uncultivated fields resulting in poor production performance. The available area for grazing has been reduced due to an increase in human population, urbanization (Beigh *et al*., 2017) and extensive agricultural practices. Further, the majority of the farmers do not cultivate required forage species in the farms due to the lack of knowledge, poor water availability, prolonged drought conditions and the perspective of thinking that crop cultivation is better due to direct returns. Therefore, grazing animals do not meet their optimum nutritional requirement during the dry periods of the year which lead to poor body conditions (Ibrahim and Jayatileka, 2000).

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In efforts to resolve the issue of poor nutrition, a shift from extensively grazing to stall feeding using total mix ration (TMR) has been explored (Nissanka *et al*., 2010; Bodahewa *et al*., 2014). Many of these efforts are targeted to increase the production and reproduction performances of dairy cows. Thus, this review aims to discuss the effect of feeding TMR on the production and reproduction performances of lactating dairy cows.

Total mixed ration (TMR)

Preparation of a nutritionally complete single ration by blending different feed ingredients according to the nutritional requirements of dairy cattle is known as a TMR (Coppock *et al*., 1981). Every bite of TMR contains a balanced ration (Beigh *et al*., 2017). Thus, feeding TMR overcomes the poor nutritional status of dairy cattle. It is also a remedy for the scarcity of available feeds during dry periods of the year. Different forage species, crop residues and industrial byproducts can be used efficiently to prepare TMR. The nutritional status of TMR in tropical countries can be improved by mixing forages or forage-based silages with industrial byproducts such as coconut (*Cocos nucifera*) poonac, rice (*Oryza sativa*) bran, maize (*Zea mays*) meal and soybean (*Glycine max*) meal. Besides, non-protein nitrogenous compounds such as urea can be easily and safely fortified with the TMRs (Beigh *et al*., 2017).

Total mixed ration feeding reduced labour cost and could be formulated according to the individual animal requirement (Schingoethe, 2017). Feeding TMR avoided selection and sorting of feeds and supplied adequate nutrition in the required amount and improved the feed utilization efficiency (Bargo *et al.,* 2003; Morales-Almaráz *et al*., 2010; Charlton *et al*., 2011; Mendoza *et al*., 2016; Beigh *et al*., 2017; Premarathne and Samarasinghe, 2020). Further, it increased feed intake, digestibility and improved the microbial activity of the rumen resulting in increased productivity of the cows (Belyea *et al*., 1975; Wongnen *et al*., 2009).

Before the formulation of a standard TMR, certain factors need to be considered related to the animal such as; age, weight, body condition score (BCS), level of production and environment (Mohammad *et al*., 2017; Li *et al*., 2012). Improper mixing of different feed ingredients in TMR resulted in sorting and inconsistency of nutrient intake (Leonardi and Armentano, 2003; Stone, 2004; Sova *et al.,* 2014). Errors in the mixing equipment and the order of mixing different ingredients also affected the consistency of TMR (Mikus *et al*., 2012). Hence, feeding a precise and accurately formulated TMR provided consistent production performances in dairy cows (Sova *et al*., 2014).

Effect of feeding TMR on lactating dairy cows

Body weight

The proper balance of nutrition led to a healthy and ideal body weight of lactating dairy cows and body weight could be used as an important tool to identify the reproductive performance of dairy cows (Rehak *et al*., 2012). The livestock owners get benefits through the TMR as it improves body weight. Further, cows fed with TMR may completely maintain or gain BCS (Kolver and Muller*,* 1998*;* Tucker *et al.,* 2001; Bargo *et al.,* 2002a) while cows consuming only-pasture diets lose BCS (Kolver and Muller, 1998; Tucker *et al*., 2001). The main intention of preparing a TMR is to improve the performance of dairy cattle. Many researchers observed losses in body weight and body condition of high-producing cows when they were fed only with pasture. However, feeding TMR may not always bring the expected outcomes (Table 1).

Dry matter intake (DMI) and efficiency of feed utilization

Dairy cattle fed with roughages and concentrates showed more preference towards concentrates than roughages (Ingvartsen *et al*., 2001; Bach *et al*., 2007; Moujahed *et al*., 2009). Hence by feeding TMR, it is possible to overcome selective feeding since TMR consists of both roughages and concentrate and each bite contains a similar composition. Also, a lower feed conversion ratio is reported for the TMR fed group than the control (Teshome *et al*., 2017). This revealed that TMR fed group efficiently utilize the DM to produce one liter of milk compared to the control group.

Mendoza *et al.,* (2016) concluded that the cows with 4 hours of access to high-quality fresh forage had similar DMI as cows fed only with TMR, but if the duration of access to fresh forages was more than 4 hours, DMI was reduced. Further, Prayitno *et al*. (2017) revealed that the lower chewing time with the TMR decreases the feed intake while digestibility increased. Sova *et al.,* (2014) reported that when the daily variability of TMR is minimum, it would lead to an increase in the DMI resulting in herd profitability. Jonker *et al*., (2002) explained that improving the efficiency of feed nitrogen utilization by dairy cattle is the most effective way to reduce the nutrient losses from dairy farms. They further suggested that when offering protein closer to the required levels, resulted in a higher production improving feed nitrogen utilization.

Lower DMI may result in diets containing less than 40% DM. However, wet TMR may reduce DMI per meal and also the TMR with higher moisture are less stable in elevated environmental temperatures (Eastridge, 2006). More than 60% of DM in the TMR would result in lower DMI of the animal, which also leads to a higher level of sorting too (Felton and DeVries, 2010). The moisture content and particle size of the forage are primary factors which influence the sorting feed ingredients. Large particles are more prone to be sorted by the animal. Tafaj *et al*. (2004) reported that particle size of the TMR influenced the feed intake, digestion and milk production of early lactation cows.

Interestingly, Vibart *et al.,* (2008) observed higher feed efficiencies of the cows grazing on pasture compared to cows fed with TMR and pasture (55% TMR and 45% pasture). Milk urea nitrogen (MUN) is a tool to assess the protein and energy balance of dairy cows (Hristov *et al.,* 2018). Further looking at MUN value, rations could be adjusted for crude protein (CP) which improved sufficient utilization of protein in the ration, this increased the milk yield and milk protein content (Nousiainen *et al*., 2004).

However, Moore and Varga (1996) observed no differences in MUN in pasture-fed and TMR-fed cows and ranged between 10-15 mg/dL (Vibart *et al*., 2008). Further, the ratio of rumen degradable:undegradable protein and protein:energy ratio in the ration also affect MUN (Baker *et al*., 1995). Wachirapakorn *et al*., (1997) revealed that TMR feeding increased DMI and milk production compared to the pasture-fed system (Wongnen *et al*., 2009). Incorporating TMR into the cattle feed partially, totally, or in fermented type have a positive effect upon feed intake and utilization (Table 2).

Milk production and composition

The TMR feeding resulted in more milk yield than normal feeding (Gordon *et al.,* 1995; Mohammad *et al.,* 2017).

Table 1: Effect of feeding TMR on body weight change in dairy cattle.

Treatment	Increased/decreased	Publication/s
Feeding heifers with a TMR containing Kikuyu grass (*Pennisetum clandestinum*), commercial pelleted feed and commercial mineral mixture	Increased	(Nissanka *et al*., 2010)
Feeding lactating Holstein cows with *ad libitum* TMR (43.5% of roughage on DM basis) compared to concentrates and forages (control)	Increased	(Mohammad *et al*., 2017)
Feeding lactating cows with TMR containing corn silage, grass hay, whole cottonseed and commercial concentrate	Increased	(Tucker *et al*., 2001)
Feeding lactating cows with TMR containing 18% corn grain, 59% corn silage, 22% sunflower meal, 0.5% urea and 0.9% mineral-vitamin premix	Increased	(Schroeder *et al*., 2003)
Feeding lactating dairy cows with TMR consisting of 60% corn silage and 40% concentrate	No change	(Rego *et al*., 2004)

TMR: Total mixed ration; DM: Dry matter.

Table 2: Effect of feeding TMR on Dry matter intake (DMI) in dairy cows.

Treatment	Increased/decreased	Publication/s
Feeding lactating dairy cattle with TMR containing berseem hay and oat hay	No change	(Hundal *et al*., 2004)
Feeding lactating Holstein cows with *ad libitum* TMR containing 43.5% of roughage	Increased	(Mohammad *et al*., 2017)
Feeding lactating cows with TMR containing natural pasture hay (60%), formulated dairy concentrate mix (39%) and salt (1%)	Increased	(Teshome *et al*., 2017)
Feeding cows with alcohol fermented TMR	Increased	(Teshome *et al*., 2017)
Feeding lactating cows with TMR containing silage, concentrates and salt	Increased	(Vibart *et al*., 2008)
Feeding lactating cows with TMR containing maize silage (60.0%), barley grain (11.2%), maize grain (8.0%), soybean meal (19.2%), calcium carbonate (0.4%), sodium bicarbonate (0.4%), mineral premix (0.8%)	No change	(Rego *et al*., 2016)

TMR: Total mixed ration.

Bargo *et al*., (2002b) reported there were no differences in milk yields of cows fed TMR as compared to 6 or 12 hours feeding on mixed pasture (grasses and legumes). Further, the rumen acids and linolenic acids in milk fat have been increased with grazing time. Three different grazing times in TMR-fed cows were compared by Storm and Kristensen (2010) and reported that milk yield was higher in cows grazing for 4 to 9 hours. Du *et al.,* (2020) reported higher milk yield from the dairy cows fed with TMR compared to local grain-based diet but the milk quality did not differ significantly between the two treatment groups. However, in a TMR-based study, the cows have minimum energy expenditure due to less walking or zero-grazing compared to cows in a pasture-based system. Hence, cows in the TMR based study could divert more energy to milk synthesis than when they were grazed (Elgersma *et al.,* 2006). Sova *et al.* (2014) reported that higher milk yields and efficient milk production could be achieved by reducing the sorting of fine particles over long particles. Their findings also interpreted that frequent consistent nutrient consumption might have resulted in greater productivity. This might be due to the consequence of higher DMI and higher digestibility values of the TMR rations resulted in higher milk yields in lactating dairy cows (Istasse *et al*., 1986; Yan *et al.,* 1997). However, it is possible to obtain a milk yield similar to that of cows fed only a TMR also by incorporating high-quality fresh forage in the diets (Mendoza *et al.,* 2016).

Milk composition depends on genetic and non-genetic factors like breed, heredity, dietary regime, time and frequency of milking and season (Sarker *et al*., 2019). Ruminants fed high concentrate diet, the milk composition changed due to decreasing MUN content (NRC, 2001). However, while feeding with concentrates, the protein content of milk could be increased (Yan *et al*., 1997). The milk fat content, lactose, solids non-fat and total solid content were also high in cattle fed with TMR (Gaafar *et al*., 2010). The higher saturated fatty acid content in milk was reported by Rego *et al*., (2004). However, Teshome *et al*., (2017) reported that the fat, protein, lactose, ash and total solids in milk were not affected by feeding TMR or pasture. Nevertheless, Rego *et al*., (2004) and Hundal *et al*., (2004) revealed that the milk fat yield was not affected when animals were fed with the TMR. According to Schroeder *et al.,* (2003), there was no significant difference between milk composition or milk production among TMR fed and pasture-fed dairy cows. White *et al.,* (2001) and Bargo *et al.* (2002a) have reported that lower milk production was obtained by grazing dairy cattle as compared to TMR fed cattle. Further, Schroeder *et al.,* (2003) revealed the milk protein concentration was higher in the TMR fed cows as compared to the grazing dairy cattle (3.70% vs. 3.45%) although the milk protein yield was the same (0.71 kg/day) (Kolver and Muller, 1998; Bargo *et al*., 2002a).

Schroeder *et al.,* (2005) reported that milk production tended to be lower and fat, protein and lactose contents were also lower when the cows were fed with pasture instead of TMR. Similarly, Kolver and Muller, (1998) and Bargo *et al*. (2002a) stated that due to low intake of energy, milk production and BCS in grazing cattle were lower. Teshome *et al*., (2017) observed a higher daily milk yield in cows fed TMR than cows fed a conventional feed, however, there was no significant difference in milk composition between the two treatments. Jonker *et al.* (2002) stated that in commercial dairy farms, the rations were frequently balanced thus resulted in a greater milk yield. Also, they observed that TMR rations improved milk yield, or nitrogen use efficiency (NUE) compared to its product carbon footprint (PCF).

Jonker *et al.* (2002) investigated a TMR block that was made out of forage and grain. It increased milk yield but decreased the milk fat percentage, which might be due to inadequate intake of effective fibre. Teshome *et al.* (2017) revealed that the differences in CP and energy intake may be associated with the difference among milk yields. As Kolver and Muller (1998) and Schroeder *et al.* (2003) explained, the lower milk yields of grazing cows resulted in the difficulty of achieving the high levels of DMI.

Milk fat composition/profile was strongly affected by the feed offered. A typical fatty acid (FA) profile in cow's milk is around 70% saturated fatty acids (SFA), 25% mono-unsaturated fatty acids (MUFA) and 5% poly-unsaturated fatty acids (PUFA) (Grummer, 1991). According to Loor *et al*. (2003), milk obtained from grazing cows contains more trans-fatty acids compared to cows fed with TMR. Eastridge (2006) stated that cows fed with TMR have a lower concentration of conjugated linoleic acid (CLA) in the milk compared to the cattle fed with pasture. Similarly, Dewhurst *et al*., (2001) and Mackle *et al.,* (2003) observed that the cows consuming high-quality pastures produced milk rich with C18:3 fatty acid (Linolenic acid) which was beneficial for human health. Similar results were found in previous studies (Loor *et al*., 2003). Even though there is a beneficial effect of high-quality pasture on milk FA composition, supplementation strategies are needed to avoid the reduction in production and reproduction performance (Schroeder *et al*., 2003).

In contrast, Schroeder *et al.,* (2005) stated that the total concentration of short, medium and long-chain FA in milk were not affected by treatment either TMR or pasture-fed. The concentration of C18:0 and C18:2 FA were higher in TMR fed, which was possibly due to the high level of corn grain in the TMR diet. The saturated fatty acid content could be increased in dairy cattle fed with TMR compared to concentrate supplemented pasture-feeding regime (Rego *et al.,* 2004). Many research revealed that dairy cattle grazed on pasture had a lower saturated: unsaturated FA ratio in their milk and a CLA concentration than cattle on TMR. These changes in FA composition may produce more beneficial dairy products in terms of human health. Therefore, the results suggested that the incorporation of TMR may influence milk production as well as milk composition with positive effects upon the human.

Rumen processes and health

Beauchemin (2002) reported that the rumen environment must be healthy to digest the fibre at the highest rate and to maximize the feed intake. Rumen microbial population has the foremost opportunity to digest the feed which the cow ingests and that may ultimately affect the nutrient availability for productive purposes.

"Cow rumen is a host microbial ecosystem that enables cows to convert complex dietary carbohydrates that cannot be digested by mammalian enzymes into short-chain fatty acids (SCFA)" (Aschenbach *et al.,* 2011). Absorption of SCFA and some minerals took place in the rumen (Tomas and Potter, 1976; Schröder and Breves, 2006). Proper development and health of the rumen are also important in providing the cow with energy and essential minerals. Around 80% of total fibre digestion and 50-70% of total amino acid supply in cattle take place during rumen fermentation. Thus, proper functioning of the rumen is very important for better performances and health of dairy cattle (Zerbini *et al*., 1988; Archimede *et al*., 1997; Soriano *et al*., 2001).

Abudabos *et al.,* (2020) observed that the rumen environment of cattle fed with a TMR produced with dried distillers' grains with soluble (DDGS) was healthy. Furthermore, he suggested that the DDGS can be utilized as a substitute for Soybean and Barley. A disturbed rumen often results in incomplete degradation and digestion processes at rumen (Metzler-Zebeli *et al*., 2013). Proper functioning of the rumen is crucial for the synthesis of microbial protein, vitamins and B-vitamins (NRC, 2001).

Sharifi (2014) emphasized that the quality of the TMR and the ability of the animals to sort were important facts to maintain rumen health. Callaghan *et al*. (2018) revealed that the feeding system influenced rumen functions and milk production. An increased amount of volatile fatty acids were observed in TMR-fed cows. Furthermore, significantly higher rumen choline content was recorded with feeding TMR. Acetic acid is the main energy source for ruminants and choline is vital in animal health and milk production. Further, it is recommended to incorporate 30-40% of the concentrates in the dairy rations which optimized the efficiency of the rumen microbial population (Archimede *et al*., 1997).

Cattle were often fed with large amounts of concentrates to reduce the inconsistency in intake and nutrients requirement (Zebeli *et al*., 2012). This may cause major dietary imbalances which are critical to the rumen. However, health scientists have found that feeding TMR ensures adequate intake of physically effective neutral detergent fibre (peNDF). Further sorting of TMR would result in a low intake of peNDF and a high intake of ruminally degradable starch. This may increased the risk of rumen disorders (Leonardi and Armentano, 2003; Sova *et al.,* 2014).

In fact, rumen health is one of the vital importance in ensuring healthy and efficient dairy cattle production.

The term “subacute ruminal acidosis” (SARA) is used for “poor rumen health”. Decreased chewing time due to lesser intake of the forage-rich TMR contributed to the lower ruminal pH in the susceptible cows (Humer *et al.,* 2018) and might be resulted in poor rumen health.

Reproductive performance

The reproductive performance of dairy cattle is directly controlled by nutrition, health, genetics and management (Zebeli *et al*., 2015). Drackley and Cardoso (2014) stated that the main key parameter affecting reproductive performance is the ‘metabolic health’. Accordingly, Swanepoel and Robinson, (2019) discovered that most of the reproductive measures are disturbed by the Negative energy balance (NEB) developed in the body. The NEB may also induce physiological changes such as delaying the resumption of ovarian activity, decreasing LH pulse frequency, reducing growth rate and diameter of the dominant follicle, decreasing weight of corpus luteum, reducing peri-oestrus hormones like estradiol (E2), progesterone, reducing conception and pregnancy rate and ultimately increasing calving intervals (Garnsworthy *et al*., 2008; Khan *et al*., 2018; Cardoso *et al*., 2020).

When dairy cows are in NEB, non-esterified fatty acids (NEFA) and β-hydroxy butyric acid (BHBA) concentrations are high in the blood circulation. These metabolites negatively affect the growth of the oocytes. Hence, impaired fertility is resulted, when NEFA and BHBA are elevated in the blood circulation of the animal (Butler, 2014). Total mixed ration would be a good solution to overcome NEB controlling proper nutritional management of dairy cattle resulting in an optimized level of fertility.

According to Roche, (2006), to have optimum reproductive efficiency, 90% of cows must be resumed ovulation and oestrus by day 42. The BCS is a determining factor that affects the first postpartum dominant follicles to ovulates. Cows at the poor BCS (<2.5) have a less diameter of the dominant follicles, reduced oestradiol, insulin and IGF-I concentrations, low LH pulse frequency (Roche, 2006). The low estradiol concentration is insufficient to induce LH surge and ovulation and thereby experience a prolonged anoestrous period. Furthermore, Overton and Waldron, (2004) suggest that at calving the BSC should be 2.75-3. Moreover, the authors stated that between calving and first service cows should not lose more than 0.5 of a unit of BCS (Overton and Waldron, 2004). The conception rate, services per conception and interval from calving to conception are greatly affected by the plane of nutrition during the dry period and after calving of dairy cows (Roche, 2006). Nutrition management affects reproduction efficiency through BCS changes, metabolic diseases and abnormal metabolic profiles. Cows that develop metabolic diseases are prone to have a lower conception rate and require more inseminations, or get delayed to become pregnant (LeBlanc *et al*., 2002; Gilbert *et al.,* 2005). Furthermore, negative energy balance that occurred early in lactation is the main factor that contributes to delay in the interval from calving to conception (Staples *et al*., 1990).

In TMR systems, a diet should be formulated to meet the nutrient requirements of most of the cows rather than allocating amounts of concentrate based on milk production. Proper nutritional formulation of the diet is essential to ensure that the supply of all nutrients. Total mixed ration could be a better nutritional strategy to improve the follicular dynamics concerning the reproductive hormones and metabolites. Since there is a strong relationship between energy balance and fertility, this would be a very useful method to alleviate most of the problems (Alves *et al*., 2019). When high-yielding cows are reared in TMR-fed systems, it promotes fertility performance and reduces metabolic disorders (Cardoso *et al*., 2013). To obtain a successful reproduction, estrogen production by the dominant follicle, restoration of pulsatile LH secretion and responsiveness of the ovary to LH are mainly responsible (Drackley and Cardoso, 2014). However, according to Endo *et al*., (2013), feeding has no impact on LH secretion but progesterone does. Khan *et al*., (2018) and Cardoso *et al*., (2020) revealed that, when an animal was fed with high-energy TMR diets, progesterone concentration was increased from 0.16 to 0.73 ng/mL. Also, Geppert *et al*., (2017) stated that ovarian function is promoted by providing sufficient nutrient compounds. According to Drackley and Cardoso, (2014), before calving, provision of all the required nutrients in appropriate amounts in the TMR system could help to release the animal from NEB after calving. Cardoso *et al*., (2013) also emphasized that the high-yielding dairy cows reared in confined systems fed with high-fibre TMR diets reduced BCS gain during the dry period, promoted postpartum appetite, reduced the occurrence of metabolic disorders and improved fertility performance. Gong *et al*., (2002) reported that feeding a TMR diet stimulated higher circulation of glucose and insulin adding a favourable impact on the reproductive system. Moreover, Zebeli *et al*., (2015) revealed that to improve the health and reproduction in dairy cows, maintaining rumen health and reducing systemic inflammation could be practised as strategies. Hence, nutritional management plays a main role in achieving positive fertility goals in dairy cattle (Butler, 2014).

Kolver and Muller, (1998) and Washburn *et al*., (2002) indicated that the body weights and condition scores are generally higher for TMR fed cows than pastured cows and Washburn *et al*., (2002) suggested that it may be due to the variation of the total consumption, pasture type, quality, quantity and the energy expenditure. Furthermore, Kolver and Muller, (1998) and Bargo *et al*., (2002a) reported losses of BCS for pasture-fed cows while cows consuming a TMR maintained or gained BCS. Hence, according to Roche *et al*., (2013) and Roche (2006), a successful reproductive outcome may be gained by optimum BCS and BW of the dairy cattle and it can be well maintained by supplying a TMR ration to the animals. However, Löf *et al*., (2007) reported that TMR-fed cows had a longer calving interval and calving to last AI interval and the authors stated that it may be due to the improper management of the TMR fed cows. When the cows are over-conditioned, their DMI is less and they experienced a higher loss of BCS thereby a higher chance for an anovulatory anestrus.

CONCLUSION

Implementation of the TMR to dairy cattle is efficient and effective, especially it improves the production performances of dairy cattle in terms of milk production, milk composition, dry matter feed intake, feed utilization and reproductive performance. Accordingly, the literature review provides an in-depth understanding for possible stakeholders to have constant milk production throughout the year and to maintain good health and reproduction.

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