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COMPLETE RATION –A TOOL FOR PRECISION ANIMAL NUTRITION FOR DAIRY CATTLE DURING COVID -19 PANDEMIC

Biju Chacko*, Raseel K. and Rasanath K. *****

**Assistant Professor and Head (I/c), Department of Animal Nutrition, College of Veterinary and Animal Sciences, Pookode, P.O. Lakkidi, PIN- 673576. Wayanad District, Kerala, India*
*** Veterinary Doctor, Doha Falcon Clinic, Doha, Qatar*
**** Veterinary Surgeon, Animal Husbandry Department, Government of Kerala, India*
** Corresponding author: bijuchacko@kvasu.ac.in*

ABSTRACT

The dairy sector, which contributes to 21 per cent of the value of the agriculture and allied sectors in India, is the growth propeller of the rural economy of the country. However, extraneous factors beyond the farmer's control, for instance climatic variations such as low rainfall and heavy drought; fluctuating and many a times low prices for produce and exploitation by middlemen have cast a gloomy spell over the sector, indicating that the prospects of the agricultural sector are gloomy, as evinced by the fact that in the year 2014-15, the sector showed a negative growth (-0.20 per cent), from where it is struggling hard to pick up, indicating that its prospects are more or less saturated. The COVID – 19 pandemic which struck, in the beginning of 2020, has added insult to injury, *vis-à-vis*, the ailing agricultural sector of the country and it hasn't finished its onslaught, yet. This augurs well for the dairy sector, which grew annually at the rate of around five per cent, since 2014-15 and has started asserting great and added significance, as a livelihood ensurer to the poor farmers of the country.

It is in such a backdrop, we are discussing the strategy of 'complete feeds', a novel tool in precision animal nutrition (PAN) which can be adopted for the improvement of the dairy sector, supported by research findings, carried out at Kerala Veterinary and Animal Sciences University (KVASU). The significance of 'PAN', with special emphasis on the innovative technology of 'complete feed' which involves feeding the concentrate and roughage ingredients of the feed together, as the sole feed are analysed, in depth, supported by research – cum -

economic findings. Recommendations for the upliftment of the sector, based on the research findings on 'complete feeds', giving special emphasis to PAN strategies, if implemented at the grass root level, would help dairying to a great extent, which will enable the stake holders, the poor and marginal farmers of India to march forward towards the 'new normal' in the post COVID – 19 scenario are also provided.

Keywords: India**,** Kerala, KVASU**,** Precision animal nutrition (PAN), Complete feed, Neutral Detergent Fibre (NDF), Milk yield, Economics, Cows

INTRODUCTION

The world is currently reeling under the monstrous impact of the COVID – 19 pandemic, for the last one year. Ever since the deadly disease was first reported, exactly a year ago in January 2020, it has caused huge devastations on mankind. The total number of confirmed cases in the world, as on today (April 18th 2021) stands at 141.73 million, of which India, the world's second most populous country stands second, with 15.04 million confirmed cases (more than 10 per cent). The pandemic has so far claimed 3.03 million human lives of which 0.179 million are in India (nearly 6 per cent), which is in third position, as far as death is concerned (JHU CSSE, 2021).

Apart from the huge losses suffered by man, the world over, the dreaded disease has also created massive destruction in the dairy sector, all over the world, more so in India, a developing country and the world's largest milk producer, with 100 million plus dairy farmers (NDDB, 2021); mainly due to the reduced market for fluid milk, a highly perishable commodity, in a country with poor chilling, freezing and storing facilities for fluid milk.

The multiple crises which occurred in various sectors as result of the pandemic are predicted to decline the global growth rate by 3.00 per cent in the year 2020. The condition of India, a predominantly agrarian country, where 0.72 out of the total 1.34 billion people (nearly 54 per cent) depend upon agriculture for their livelihood, is even worse, with India's GDP estimated to contract by 7.70 per cent (Economic Survey, 2021). Thoughts on revival of the agriculture sector in India are drowned by the stark reality of stagnating growth in the sector, which became a reality in the year 2014-15, when the sector showed a negative growth (-0.20 per cent), for the first time. Even in the current fiscal, ie., 2021-22, the agricultural sector's total growth, is pegged at 3.40 per cent (Economic Survey, 2021). Extraneous factors beyond the farmer's control, for instance climatic variations such as low rainfall and heavy drought;

fluctuating and many a times low prices for produce and exploitation by middlemen have cast a gloomy spell over the agriculture sector, indicating that its prospects are more or less saturated, which augurs well for the dairy sector, which grew annually at the rate of around five per cent, since 2014-15 and has started asserting great and added significance, as a livelihood ensurer to the poor farmers of the country.

This can be gauged from the fact that several organised dairy farms came up in the country, promoted by Gulf returnees and young professionals, especially from the information technology (IT) field; the 'new generation farmers', who took up dairying more seriously; ie., changing the conventional approach from that of a subsidiary sector of agriculture to that of a primary sector, by adopting scientific feeding and management practices, with the net result that the milk production in the country increased considerably and topped the world. However, India cannot afford to rest on her laurel of top milk producer in the world, in the light of the COVID – 19 pandemic, which has left 122 million out of her total 1366 million people jobless, which is 8.93 per cent (World Bank, 2021). Therefore, it is imperative that fool proof strategies, which are practically effective as well, should be adopted for the sustenance and/ or revival of the dairy sectors, in the post COVID – 19 scenario, so as to ensure the livelihood security to not only the 100-million-plus dairy farmers, but also billions of other rural poor, such as a sizable chunk of the above mentioned, 8.93 per cent people rendered jobless, due to COVID – 19 in India.

There is no single ready-made solution for the upliftment of the sector in the post COVID – 19 scenario. A practical way out should be to adopt a holistic approach, wherein tangible improvements can be made in the dairy sector, whereby the farmers, dalits, tribals and other poor people of the country will be benefitted. It is in such a backdrop, the strategic intervention of 'precision farming', is proposed.

Precision farming

A term initially coined to warn the world about the impending severe water shortage, has now become the buzz phrase in the Agriculture sector nowadays, ie., "More crop per drop", which means 'precision farming'. This when translated to Animal Husbandry parlance means, 'precision feeding', which envisages giving the right amount of feed in right proportion in right composition at the right time to animals, commonly referred to as 'Precision Animal Nutrition or PAN' (Banhazi *et al*., 2012).

Tools of PAN

Cerosaletti and Dewing (2008) has detailed the techniques adopted or tools of PAN as follows:

1) Improving the efficiency of nutrients used in feed
2) Adoption of phase feeding in dairy cattle
3) Use of total mixed ration (TMR)/ complete feed
4) Substitute costly ingredients with cheaper unconventional feed ingredients

TOTAL MIXED RATION (TMR)/ COMPLETE FEED

The third tool mentioned above, viz., complete feed/ TMR is a holistic and practical strategy very much relevant to the Animal Husbandry sector in India, Kerala and Wayanad, especially. It also envisages the substance of all the other three tools of PAN. Complete ration involves processing the concentrate and roughage ingredients together into a well mixed blend to which the animals are given free access (Owen, 1984). Senani *et al*. (2013) has defined complete feed or TMR as a quantitative mixture of all dietary ingredients, ie., concentrate and roughage ingredients, powdered, blended and mixed thoroughly enough to prevent separation & sorting, so as to utilise each and every particle (as envisaged in first tool of PAN), formulated to specific nutrient content and offered in quantities so as to meet the requirement of each phase such as milk production, pregnancy, dry etc. (as envisaged in second tool of PAN), incorporating cheap and locally available unconventional feeds to the extent possible (as envisaged in fourth tool of PAN).

Advantages of complete feed/ TMR

FAO (2012) has detailed, the benefits of complete feed/ TMR, as follows:

1) Selective feeding is avoided: Cows can't pick & choose what they eat, ie.we can hide less palatable feed ingredients, because some cows eat mostly hay and others eat mostly grain
2) Synchronisation of carbohydrate and protein metabolism: Synchronous supply of carbohydrate and protein in the rumen, which means that all ingredients are supplied to the rumen microbes at the same time, thereby increasing the microbial growth and microbial protein synthesis.
3) Increases the milk yield when compared to the conventional system of feeding concentrate and roughage separately
4) Control excess concentrate intake, whereby sudden change in rumen pH

and incidence of diseases like sub-acute ruminal acidosis (SARA), can be considerably reduced.

5) Saves labour (the daily wage of a labourer in Kerala state of India is Rs. 700 to 800 per day)
6) Saves time spent in the barn, so that the farmer has ample time for other activities
7) Facilitates the use of unconventional feeds that are more difficult to handle and hence reduces feed cost

Significance of complete feeds with respect to:

Feed and fodder status: - Owen (1984) opined that future developments envisage the use of low forage based diets for the arid tropics where the provision of conventional forage is costly. These suggestions are now, especially relevant in India where currently, all three types of feed are in short supply, *viz*., green fodder (63 per cent), dry fodder (24 per cent) and concentrates (76 per cent), as per State of India's Livelihoods Report (2019). As far as Kerala is concerned, even though concentrate feed is readily available in the market for the farmer who is ready to pay a minimum of Rs. 21/- per kg; green and dry fodder are in severe shortage, the deficit amounting to 75 and 81 per cent, respectively (Kerala State Planning Board, 2020). Therefore, the need of the hour, is to formulate a complete feed with the optimum amount of fibre and obtain maximum milk production from the cows.

However, rearing a cow, is easier said than done, as we have to give feed to the cow, in order for it to provide milk, in return. This is because, in Kerala, a state with very high density of population, only less than 1 per cent of the total cultivable is land used for fodder production, and the same is being reflected in the fodder deficit statistics, already mentioned (Government of Kerala, 2013). Even though, the situation in the whole of India is slightly better, with 4 per cent of the total cultivable land being used for fodder production, this proportion has remained stagnant for nearly, the last four decades (State of India's Livelihoods Report, 2019).

Market demand for milk: - Even though the recommended per capita daily intake of milk is 322 g per day (ICMR, 2019), the intake in twelve states of the country including Kerala (234 g per day) and all the eight union territories is less than 250 g per day, which indicates that there is still a huge market for milk, in these places. As far as Kerala is concerned, despite the fact that the co-operative agency concerned with milk procurement, processing and marketing, viz., KCMMF (Kerala Co-operative Milk Marketing Federation), popularly referred to as 'MILMA', for the first time in its history recorded a surplus in January 2021, by procuring 14.20 lakh litres of milk per day, as against the corresponding sales of 13.25 lakh litres, there still exists a considerable gap between total demand and supply, because only 20 per cent of the total requirement of milk in the state is met by MILMA. This is evident from the fact that the daily requirement of milk in Kerala is 75.46 lakh litres, while the availability, including the above 14.20 lakhs procured by MILMA was only 70.82 lakh litres, indicating that there exists a daily deficit of 4.64 lakh litres (APEDA, 2021), which augurs well for the sector as well as for a good number of NRIs who have headed home and turned to the dairy sector, whose numbers will steadily increase, over the coming days. This indicates that the prospects of dairying in the state sounds good.

I. Source of roughage in complete feeds

Hundal *et al.* (2004) reported that lactating dairy cows fed on berseem and oat hay based complete feeds had a similar milk yield, milk fat, protein and SNF content as that of cows fed on a conventional hay-concentrate system. Lade *et al*. (2007) reported that cross bred dairy cows fed on an oats and berseem based complete feed had a similar milk yield as compared to those fed on a complete feed, without green fodder; with the average daily milk yield being 9.15 and 8.43 kg per day, respectively.

Sadagopan and Sunder (1997) observed that fibrous crop residues such as paddy straw could successfully be used as the sole source of roughage in complete feeds for obtaining optimum milk production in dairy cows. Complete feed blocks and mash prepared using 40 per cent wheat straw as the roughage component and 20 per cent molasses had a significantly higher dry matter intake than the conventional grass-concentrate ration in lactating Murrah buffaloes, indicating the better palatability and the subsequently higher dry matter intake of straw based complete feed (Dwivedi *et al*., 2003), even though the increase was not statistically significant. Lailer *et al*. (2010) found that feeding of complete feed blocks made up of wheat and bajra straw had a comparable effect on dry matter intake (DMI), nutrient digestibility and daily feeding cost in comparison to the conventional concentrate-straw feeding system. Feeding of straw based complete feed blocks enhanced DMI by 15 to 20 per cent and milk yield by 10 to 14 per cent when compared to the conventional concentrate-straw feeding system, in dairy cows (Senani *et al*., 2013).

II. NDF levels in complete feeds

Ruminants require roughage in the form of fibre in their diets to maximise production and to maintain health by sustaining a stable environment in the rumen (Allen, 1997). Excessive fibre levels limited intake and energy concentration while a shortage of fibre reduced rumen digestibility and milk fat percentage. Fibre in the diet of ruminants are met from fibrous carbohydrate portions, generally measured as neutral detergent fibre (NDF). The NDF is the best estimate of total fibre in a feed, also called as cell wall contents, it consists of cellulose, hemicellulose and lignin. Mertens (1997) opined that balancing fibre or NDF and the non-fibre carbohydrate (starches and sugars) fractions to optimise energy intake and rumen health was a challenging aspect of dairy nutrition.

NRC recommendations NRC (2001) of USA has stipulated that dairy cows of large as well as small breeds, producing 25 kg of milk per day should be fed with rations containing a minimum of 25 to 33 per cent NDF and 17 to 21 per cent acid detergent fibre (ADF).

Effect of varying levels of NDF in complete feeds on milk yield

Weiss and Wyatt (2002) reported on the basis of studies conducted in Holstein cows that the milk yield and four per cent fat corrected milk (FCM) yield of Holstein cows fed on corn silage based complete diets, with NDF content ranging from 27.00 to 32.00 per cent, prepared from corn hybrids with low NDF content and low digestibility were similar to those fed on diets prepared from corn hybrids with high NDF content and high digestibility. Delahoy *et al*. (2003) studied the effect of supplemental sources of carbohydrates for lactating dairy cows and reported that the milk yield of animals fed on a ground corn containing complete ration and a NFFS based complete feed were similar. Qiu *et al*. (2003) prepared two complete diets of varying forage NDF (FNDF), viz. 17 and 21 per cent, each with two different varieties of corn silage, viz. a high digestible brown mid rib corn silage (BMRCS) and a conventional corn silage (CCS) and reported that FNDF had no effect on DMI and milk yield.

Leonardi *et al*. (2005) conducted experiments in Holstein cows fed on complete rations with similar CP and NDF, formulated to study the effect of addition of dried distillers grains with added solubles (DGS) at varying levels, replacing soybean meal and soy hulls and reported that increasing the dietary DGS, linearly increased the milk yield. Kelzer *et al*. (2009) performed studies in lactating Holstein cows by feeding them with complete diets containing corn-milling coproducts such as DDGS, germ and HPDDG at 15 per cent of DM and reported that the milk yield of cows fed on the germ supplemented group was significantly higher than those fed on the other three diets, while the fat corrected milk (FCM) yield in all the groups were similar. Chacko *et al.* (2019) reported that lactating dairy cows fed on complete feeds with varying levels of NDF, viz., 25, 30 and 35 per cent had similar DMI and milk yield, with the DMI and milk yield tending to be higher at higher levels of NDF, ie., 30 and 35 per cent.

In India, paddy straw, which can be made as the sole source of forage NDF; as paddy straw is burnt in many of the Northern states of India, where wheat straw is preferred for feeding of livestock. The rest of the NDF can be met from non-forage fibre sources (NFFS) such as brans like rice bran and oil cakes like coconut cake which are high in NDF. By adopting the practice of complete feed or all – in – one feed, cows can even be reared in big towns and cities. Thus milk production is promoted, where there is market for milk. Moreover, adequate roughage is ensured for the cows (Chacko, 2015).

Studies on complete rations, formulated using conventional and unconventional ingredients, are reviewed below:

Complete vs conventional

Verma *et al.* (1996) observed that Murrah buffaloes in early lactation, fed with compressed complete feed blocks (CCFB) had a higher intake of dry matter (DM) and digestible DM as compared to those fed on a ration consisting of concentrate along with wheat straw and molasses. Bargo *et al*. (2002) conducted a study in Holstein cows and reported that milk production was highest for cows fed on TMR, lowest for those on pasture and concentrate and intermediate for the pasture and TMR fed group, when these three rations were compared. Hundal *et al.* (2004) observed that crossbred milking cows fed on a TMR had a significantly higher milk yield than those fed on a conventional hay-concentrate feed. Lailer *et al*. (2010) reported that lactating Murrah buffaloes fed on complete feed blocks made up of wheat and bajra straw had a similar digestibility coefficient of EE in comparison to those fed on conventional concentrate-straw feeding system. Marston *et al*. (2011) reported that there was no significant difference in milk yield in Holstein cows fed on two different TMRs containing corn silage and grass silage as the respective roughage sources, as compared to those fed on a conventional grass – concentrate ration. Chacko *et al*. (2016) reported that early lactation dairy cows fed on complete rations with three different levels of NDF, viz., T1, T2 and T3 with 25, 30 and 35 per cent, respectively had a significantly higher milk yield and average income than those fed on the conventional grass-concentrate system (T4), with T1, T2 and T3 being similar, as shown in Tables 1 and 2, respectively, given below:

Complete ration with unconventional vs conventional ingredients

I. Replacing part of the energy source

For dairy farming to be economical, we have to incorporate unconventional feeds to the extent possible. Energy is a very important component in dairy cattle rations. The main energy source used in cattle feeds is maize, which is costly (Rs. 18-20 per kg).

Energy rich unconventional feeds incorporated in complete ration/ TMR

Sruamsiri (2007) observed that pineapple waste from the field or from the cannery can be used as dairy feed and dried pineapple waste could replace 50 per cent roughage in TMR for dairy cattle. They reported that the bran (outer peel, skin and core from the pineapple canning industry) and leaves can be used as feed for ruminants. These workers concluded that fermented pineapple waste with higher acidity was preferred over fresh waste from field. Dried and ensiled pineapple waste can be used as a supplemental roughage source and could replace 50 percent of the same in TMR for cattle (Hossain and Bepary, 2015).

Kusmartono (2012) reported that jackfruit waste consisting of aerial part, skin, seed and pith can be utilised as ruminant feed. Escala and Bestile (2014) estimated the nutritive value of the jackfruit waste and reported that it contained 9.6 percent crude protein (CP) with high OM digestibility and ME.

Sundaram (1986) conducted a study in dairy cows by feeding ration formulated with and without 10 per cent cashew apple waste (CAW) and found that even though the milk yields were similar, the cost per kg milk production was significantly lower

Table 1: Average daily milk yield (per animal, kg) of cows fed on the four experimental rations

Stage of lactation	T1	T2	T3	T4
Early	11.02 ± 0.56^{a}	11.89 ± 0.73^{a}	12.18 ± 0.69^{a}	9.12 ± 0.45^{b}
Mid	10.57 ± 0.41^{a}	10.85 ± 0.84^{a}	11.59 ± 0.60^{a}	8.15 ± 0.63^{b}
Total	10.8 ± 0.36^{a}	11.37 ± 0.76^{a}	11.89 ± 0.63^{a}	8.63 ± 0.50^{b}

a,b: means with different superscripts in the same row differ significantly ($P<0.05$)

Table 2: **Average income (per animal per day, Rs.) generated from the sale of milk from the animals fed on the four experimental rations (@ Rs.40 / kg)**

Stage of lactation	T1	T2	T3	T4
Early	440.95[a] ±22.44	475.42[a] ±29.03	487.16[a] ±27.51	364.72[b] ±17.84
Mid	422.79[a] ±16.22	433.86[a] ±33.45	463.67[a] ±23.94	326.05[b] ±25.25
Total (per day)	431.87[a] ±14.34	454.64[a] ±30.54	475.40[a] ±25.22	345.39[b] ±19.95
Total (per month)	12956.11[a] ±430.20	13639.22[a] ±916.18	14262.44[a] ±756.51	10361.56[b] ±598.51

a,b: means with different superscripts in the same row differ significantly (P<0.05)

Table 3: Score card after assigning grade to each parameter tested *in vitro*

Feed	ME (MJ/Kg)	DOM (%)	IVDN (% of total N)	CP (%)	Total
Pineapple waste	6	3	4	4	**17**
Cashew apple waste	2	2	4	5	**13**
Banana stem waste	5	2	5	4	**16**
Jackfruit waste	4	2	4	4	**16**

Table 4: Milk yield and cost of production of milk of cows maintained on the experimental rations

Parameter	T1	T2
Average daily milk yield, kg	11.94[a] ±0.19	12.94[b] ±0.29
Cost per kg of milk produced, Rs.	36.82	34.22

a,b: means with different superscripts in the same row differ significantly (P<0.05)
** Significant at 1% level

Table 5 : Score card after assigning grade to each parameter tested *in vitro*

Feed	ME (MJ/kg)	DOM (%)	IVDN (% of total N)	CP (%)	Total
Tea waste	2	1	0	6	**9**
Coffee husk	2	1	4	4	**11**
Tapioca leaf meal	2	1	0	6	**9**
Pepper waste	1	0	0	5	**6**

Table 6: Milk yield and cost of production of milk of cows maintained on the experimental rations

Parameter	T1	T2
Average daily milk yield, kg	17.45±0.803	14.87±1.51
Cost per kg of milk produced, Rs.	37.97	41.04

ns- Non-significant

in cows fed on CAW. He opined that CAW can be incorporated upto 10 per cent level in cattle feed without influence on health and production.

Sraumisri (2007) reported that banana stems can be sliced or chopped and ensiled with rice bran. He reported that banana stem can be fed, either as fresh or in ensiled form in cattle ration. Banana stem peel is a rich source of starch, crude protein, crude fat and total dietary fibre (Mohapatra *et al.*, 2010).

Raseel *et al.* (2018) conducted an *in vitro* experiment to evaluate four energy rich unconventional feeds viz., pineapple, cashew apple, banana stem and jack fruit waste to estimate the metabolisable energy (ME), digestible organic matter (DOM) and *in vitro* degradable nitrogen (IVDN) content. Based on the values obtained, these four unconventional feeds were graded using a six point scoring system by assigning scores ranging from 0 to 6 and the aggregate total score was calculated. Based on the *in vitro* study, pineapple waste which had the highest aggregate total score of 17, as shown in Table 3 below, was selected for further *in vivo* study.

The milk yield of early lactation (0-90 days) cows fed on complete rations in which $1/3^{rd}$ of the energy source maize in the complete ration was replaced by pineapple waste were significantly higher, with the cost per kg milk production being lower than those fed on the conventional complete ration (Raseel *et al.*, 2020); as shown in Table 4, below:

II. Replacing part of the protein source

Just like energy, protein also is a very essential nutrient as far as a milk producing dairy cow is concerned. The main protein source used in cattle feeds is soyabean, which is costly (Rs. 40-45 per kg).

Protein rich unconventional feeds incorporated in complete ration/ TMR

Just like energy, protein also is a very essential nutrient as far as a milk producing dairy cow is concerned. The main protein source used in cattle feeds is soyabean, which is costly (Rs. 40-45 per kg).

Koakhunthod *et al*. (2001) reported that lactating dairy cows fed on complete feed blocks containing cassava hay as a protein source at 30 per cent level had a significantly higher DMI, milk yield and better digestibility coefficient of nutrients than those fed on conventional grass-concentrate system. Kondo *et al*. (2004) and Eruden *et al*. (2005) reported that green tea waste can be incorporated as a protein source up to five per cent level in complete feeds for lactating dairy cows. Lunsin *et al*. (2012) found that lactating dairy cows fed on complete feeds containing cassava hay at 13 per cent level had a significantly higher DMI and milk yield than those fed on conventional grass-concentrate system.

Tavarez *et al*. (2005) reported that replacement of corn with coffee hulls at 25 per cent level in TMR of Holstein-

Zebu cows, receiving adequate amount of concentrate feed stuffs, resulted in a significant decrease in milk production, even though coffee hull incorporation, reduced the cost per kg of TMR, by 19 per cent. Badarina *et al*. (2013) performed an *in vitro* experiment by adding fermented coffee husk at levels of 0, 10, 20, 30 and 40 per cent in Napier grass based TMR having a total CP of 13.0 to 13.42 per cent and TDN of 61 to 65 per cent and reported that the dry matter digestibility significantly decreased with increase in level of incorporation above 20 per cent.

Antaya *et al*. (2015) performed an experiment in early lactation Jersey cows by supplementing them with incremental amounts of the macroalga species *Ascophyllum nodosum* (ANOD) meal, did not significantly increase the milk yield, even though it was numerically lower with increasing levels of ANOD supplementation. Choi *et al*. (2019) found that fermented spent instant coffee grounds could replace cotton seed at five per cent level in the rations of dairy cows. Sundarman *et al*. (2019) reported that coffee husk could be incorporated up to ten per cent level in the rations of Madura cattle with economic benefits.

Rasanath *et al.* (2020) performed an *in vitro* experiment to evaluate four locally available protein rich unconventional feed ingredients, viz., tapioca leaf meal, tea waste, coffee husk and pepper waste which were tested *in vitro* to estimate the ME, DOM, IVDN and CP. These ingredients were ranked on the basis of a four point ranking system (Raseel *et al.*, 2020) and coffee husk, which had the highest aggregate total score of 11 as shown in Table 5 below was selected for further *in vivo* study.

The *in vivo* experiment was carried out by replacing 1/3rd of the soyabean in the grass based, conventional complete ration (T1) with coffee husk, in T2, the grass based, treatment ration. Even though there was no significant difference, the average daily milk yield of cows in group T2 was numerically lower by 2.58 kg (17.35 per cent), as compared to those in group T1, with T2 having a higher cost of production by Rs. 3.07 than T2, ie., a 8.09 per cent increase, as shown in Table 6, below, indicating that T2 was not as effective as T1, in eliciting production performance in early lactation dairy cows, as evinced by the statistically non- significant, but numerically lower milk yield and higher cost per kg milk production in T2 than T1, indicating that, studies with lower levels of replacement of protein with coffee husk are needed for further conclusion (Rasanath, 2020).

Nevertheless, paddy straw/ grass

based complete rations with minimum of roughage component, such as the ones used in this study, can be recommended for use among dairy farmers in Kerala/ India, depending upon the availability; with incorporation of locally available, energy and protein rich unconventional feed ingredients such as pineapple waste and coffee husk, respectively, to the maximum possible extent, which will help to reduce the feed cost, without compromising on production performance. It is also advised that bulk production of the same should be carried out, so that feed cost can be restricted within the affordable limits of dairy farmers.

The devastation caused by the calamitous COVID – 19 pandemic in developing countries of the tropics such as India are huge. However, if right and positive constructive steps such as adoption of the novel feeding practice of complete feeds, a critical tool of PAN, are carried out and the Governments (both central and state), various District administrations, Panchayaths, Co-operative Societies, Veterinary Universities, Non-Governmental organisations (NGOs) and the ultimate beneficiaries, the farmers, work hand in hand, the challenges posed by the pandemic can be surmounted and the dairy sector can be developed into a promising sector, whereby the sustenance and livelihood of farmers can be ensured.

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