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Complete Feeds – An innovative means of Precision Animal Nutrition (PAN) in dairying in India, in the Post COVID - 19 Era

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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

Bacillary dysentery and enteric fevers continue to be important causes of morbidity in both developed and 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 (March 4th 2021) stands at 115 million, of which India, the world's second most populous country stands second, with 11.10 million confirmed cases (nearly 10 per cent). The pandemic has so far claimed 2.55 million human lives of which 0.157 million are in India (nearly 6.15 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 her 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 (PAN)'.

Tools of PAN

The techniques adopted or tools of PAN are:

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 of Kerala and Wayanad especially and it envisages the substance of all the other three tools of PAN. 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

The benefits of complete feed/ TMR are the following:

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

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. Also, adequate roughage is ensured for the cows. Considering the practical relevance of complete feed in the context of making dairying as a sustainable and profitable enterprise in India, the following three studies were undertaken in the Kerala Veterinary and Animal Sciences University (KVASU), Pookode, Wayanad, Kerala, India:

I. Formulating a complete ration using conventional ingredients and comparing it with the conventional system of concentrate plus roughage, given separately

Three paddy straw based complete rations, T1, T2 and T3 with 25, 30 and 35 per cent NDF respectively were formulated as per the recommendations of ICAR feeding standards (ICAR, 2013) for the study. All the three complete rations were isonitrogenous (12% crude protein) and isocaloric (60 - 65% TDN) and were given *ad libitum* to meet the nutrient requirements for lactating dairy cows stipulated by the above standard. The fourth ration, T4, comprised of a conventional concentrate mixture and green grass, given as per the Package of Practices Recommendations of KVASU (2016), so as to meet the nutrient requirements for lactating dairy cows stipulated by the ICAR feeding standards (Chacko *et al*., 2016).

The four rations were compared on the basis of feeding trials conducted in lactating dairy cows, in two phases, of three months each; 1-90 days being the early lactation and 91-180 days being the mid lactation phase. Data on daily feed intake and daily milk production were recorded. The economics of the study was worked out. Data gathered were analysed statistically using ANOVA single factor and the means of various parameters were compared (Snedecor and Cochran, 1994).

The data on milk yield of the animals are given below in Table 1.

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 ($P<0.05$)

The results showed that the average milk yields of the cows during, early, mid and total lactation, in the three complete feed given groups, viz., T1, T2 and T3, were significantly higher (P<0.05) than the grass – concentrate fed group (T4), with no significant difference (P<0.05) among themselves, ie., T1, T2 and T3 (Chacko *et al*., 2016). The higher milk yield obtained in T1, T2 and T3 in comparison to T4 are in agreement with the previous work of Bargo *et al*. (2002) and Lailer *et al*., (2005) in dairy cows fed on total mixed rations (TMRs). Also, the similar milk yields obtained in groups, T1, T2 and T3 are in accordance with of Marston *et al*. (2011), who reported that there is 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.

The average milk yield in kilograms per cow per day in the total 180 days lactation period were 10.80±0.36, 11.37±0.76, 11.89±0.63 and 8.63±0.50 for the animals in the groups T1, T2, T3 and T4, respectively (Chacko *et al*., 2016); with the values in T1, T2 and T3 being higher than those obtained with conventional grass - concentrate rations by Ally (2003), Naicy and Anilkumar (2009) and Dominic (2013) at University Livestock Farm, Mannuthy and Syam Mohan (2003) at Cattle Breeding Farm, Thumburmuzhi. The values in the group T4 were comparable with those obtained by the above four workers at University farms in cross bred cows.

The data on income generated from the sale of milk of cows fed on the four rations are given below in Table 2.

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)

The average daily income per cow per day, obtained in the early, mid and total lactation, in the three complete feed given groups, viz., T1, T2 and T3, were significantly higher (P<0.05) than the grass – concentrate fed group (T4), with no significant difference (P<0.05) among themselves, ie., T1, T2 and T3 (Chacko *et al*., 2016). These results are in agreement with that of Marston *et al*. (2011) in dairy cows. The average income obtained per cow per month, also showed a similar trend. The average daily income per cow, obtained over the total 180 days lactation period, were rupees 431.87±14.34, 454.64±30.54, 475.41±25.22 and 345.39±19.95in the groups T1, T2 and T3 and T4 respectively, with the income in T1, T2 and T3 being significantly higher (P<0.05) than T4.

From the results of the present study, it can be concluded that paddy straw based complete feeds having fibre levels ranging from 25 to 35 per cent NDF, performed better than the conventional grass-concentrate system of rearing and hence complete feeds/ TMRs with NDF in the above range, can be recommended for use among the dairy farmers of tropics like India, especially in those areas where availability of land for fodder cultivation is poor. Among the three levels, complete feed/ TMR with 35 per cent is the most optimum level of NDF for dairy cows of the country/ state/ district.

II. Formulating a complete ration using unconventional ingredients and comparing it with a conventional complete ration

A. Replacing part of the energy source

As mentioned earlier, 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). Therefore, an investigation was carried out by Raseel *et al*. (2020) to replace 1/3rd part of the maize with energy rich unconventional feeds. Four energy rich unconventional feeds, which are abundant in Kerala; viz., pineapple waste, cashew apple waste, banana stem waste and jackfruit waste were used for the study.

They were first tested *in vitro* in the laboratory to estimate their 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 on the basis of production performance of cross bred dairy cows in early lactation (0-90 days).

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**

Two experimental complete rations, T1 with the conventional feed ingredient maize and T2 with one third of energy source maize being replaced by pineapple waste, the best unconventional feed ingredient identified from the *in vitro* study, were formulated. The two experimental rations T1 and T2 were isonitrogenous (12.00 to 12.70 per cent crude protein), isocaloric (64 to 65 per cent TDN) and were formulated as per the recommendations of ICAR (2013) and were tested in dairy cows of early lactation (Raseel *et al.*, 2020).

The fortnightly milk yield of cows are given below in Table 4.

Table 4: Average daily milk yield (kg) of cows maintained on the experimental rations

Fortnight	Mean ± SE	
	T1	T2
Initial	10.13 ±0.34	10.98±0.59
1	11.19^{a} ±0.44	13.39^{b} ±1.21
2	11.76^{a} ±0.48	12.38^{b} ±0.65
3	11.45^{a} ±0.49	12.32^{b} ±0.67
4	11.62^{a} ±0.50	12.61^{b} ±0.62
5	11.91^{a} ±0.46	13.00^{b} ±0.68
6	12.92^{a} ±0.49	13.47^{b}±0.79
7	12.75^{a} ±0.53	13.38^{b} ±0.85
Mean ± SE	11.94^{a} ±0.19	12.94^{b} ±0.29

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

The milk yield of cows was significantly higher (p<0.01) in T2 than T1, the values being 11.94 and 12.94 kg, respectively (Raseel *et al.*, 2020).. The significantly higher milk yield in cows fed on ration T2 with added pineapple waste, as against those fed on T1 without pineapple waste, might probably be due to the increased level of easily digestible carbohydrate and increased energy digestibility of pineapple waste as reported by Maneerat *et al.* (2013) who obtained similar results in an experiment conducted in Holstein cows.

The cost per kg of milk produced is given in Table 5.

Table 5: Cost of production of milk of cows maintained on the experimental rations

Parameter	T1	T2
Cost per kg of milk produced, Rs.	36.82	34.22

The cost per kg milk produced by cows fed on the two experimental rations; T1 and T2 was Rs.36.82 and 34.22, respectively, with T2 having a lower cost of production by Rs. 2.60 than T1 (Raseel *et al.*, 2020). These cost of production values were higher than that of Chacko (2015) who reported a cost of Rs. 29.22 per kg milk produced in cows fed on a complete ration with 35 per cent NDF.

B. 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). Therefore, an investigation was carried by Rasanath (2020) to replace 1/3rd part of the soyabean with protein rich unconventional feeds. Four locally available, protein rich unconventional feeds, viz., tapioca leaf meal, tea waste, coffee husk and pepper waste were procured. They were first tested *in vitro* to estimate ME, DOM and IVDN; scores assigned on the basis of values obtained and the feed having the highest aggregate total score was selected, just like in the previous experiment (Rasanath *et al.*, 2020). The individual as well as the aggregate scores obtained for each proteinaceous unconventional feed are shown in Table 6 below:

Table 6: 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**

Coffee husk which had the highest aggregate total score as shown in Table 6 above was selected as the best protein rich unconventional feed for further *in vivo* study. (Rasanath *et al.*, 2020). The *in vivo* study was carried out to assess the production performance of early lactation dairy cows, fed on two grass based complete rations; T1 formulated with the conventional protein source soyabean meal alone and T2 with 1/3rd part of the total protein in T1, being replaced with coffee husk (Rasanath, 2020).

The fortnightly milk yield of animals are given below in Table 7.

Table 7: Fortnightly average daily milk yield* (kg) of cows maintained on the experimental rations

Fortnight	Mean ± SE	
	T1	T2
Initial	17.97±1.47	18.03±1.67
1	19.12±0.82	16.89±1.43
2	19.29±0.74	15.88±1.66
3	19.16±0.68	15.53±1.58
4	18.51±0.85	14.77±1.56
5	18.10±0.84	15.17±1.51
6	17.45±0.803	14.87±1.51

ns- Non-significant

Perusal of the data on milk yield, reveal that, even though there was no significant difference (P>0.05), the average daily milk yield of cows in group T2, with coffee husk was numerically lower by 2.58 kg (17.35 per cent), as compared to those in group T1 (Rasanath, 2020). Tavares *et al*. (2005) reported that replacement of corn with coffee hulls at 25 per cent level in TMR of Holstein-Zebu cows resulted in a significant decrease in milk production. A similar decline in milk yield, even though, statistically non significant, was observed in the present investigation also.

The values of milk yield obtained in the present study of Rasanath (2020) are higher than, with the findings being comparable to those of Lade *et al*. (2007) who observed that the average daily milk yield of cross bred dairy cows fed on a grass based, viz., oats plus berseem based complete feed and another complete feed, without green fodder were 9.15 and 8.43 kg per day, respectively, with the values being similar. Similarity in milk yield between treatments, with numerically lower milk yield in cows fed on T2 with coffee husk as compared to those in T1, without coffee husk, is in perfect agreement with the findings of Antaya *et al*. (2015) who reported that early lactation Jersey cows fed on a TMR supplemented with incremental amounts of *Ascophyllum nodosum* (ANOD) meal, a protein rich macroalga species, had a similar milk yield, but the yield decreased numerically with increase in level of ANOD supplementation.

The cost per kg of milk produced is given in Table 8.

Table 8: Cost of production of milk of cows maintained on the experimental rations

Parameter	T1	T2
Cost per kg of milk produced, Rs.	37.97	41.04

The cost per kg milk produced by cows fed on the two experimental rations; T1 and T2, in the present study were Rs.37.97 and 41.04, respectively, with T2 having a higher cost of production by Rs. 3.07 than T2, ie., a 8.09 per cent increase (Rasanath, 2020). The cost of production values of both the groups were however higher than that of Chacko *et al.* (2019) who reported costs of Rs.28.46, 28.26 and 29.22 per kg milk produced in cows fed on complete rations T1, T2 and T3, respectively and Raseel (2018) who reported cost per kg of milk production values of Rs. 36.82 and 34.22, respectively in lactating dairy cows fed on complete rations, T1 and T2, as described above.

The possible reasons for the higher cost per kg DM and cost per kg milk production observed in the present study as compared to the above two works may be due to the fact that both the above works were carried out five and three years earlier, when the ingredient costs, processing and transportation charges, were much less. The high cost of production occurred as a result of high overheads incurred due to the fact that feed formulation and production were carried out on a small scale, exclusively for research purpose, not only in this, but also in both the other research works carried out at KVASU.

An overall critical evaluation of the results of the present investigation, revealed that even though, both the grass based complete rations T1 and T2, performed well; T2, formulated with the protein rich unconventional byproduct feed, coffee husk, selected from the *in vitro* study; which replaced 1/3rd of the CP in T1, on DM basis; was not as effective as T1, in eliciting production performance in early lactation dairy cows, as evinced by the statistically non-significant milk yield and higher cost per kg milk production in T2 than T1.

The probable reason for the same could be attributed to the findings of Taverez *et al*. (2005) who observed that coffee husk, contained phytochemicals such as tannin and caffeine, which have got intake reducing characteristics, as result of which feed and subsequently nutrient intake got reduced. Tannin present in coffee husk could have bound with protein and carbohydrate in the rumen, whereby digestion and absorption of protein and carbohydrate, might have got reduced (Badarina *et al*., 2013), with subsequent reduction in milk yield and consequent increase in the cost per kg milk production in T2, as compared to T1.

From a thorough scrutiny of this experiment, it can be inferred that, incorporation of coffee husk at lower levels, in ration T2; such as replacing 1/4th or 1/5th of the total protein of the ration T1, would probably have been effective, instead of 1/3rd replacement adopted in this study, for which further studies, are warranted.

Nevertheless, grass/ paddy straw 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.

Conclusion

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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