Residual Feed Intake (RFI) and Efficiency of Feed Utilization (EFU) of Total Mixed Ration (TMR) fed Frisian cross bred cows – a case study

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Abstract
Residual Feed Intake (RFI) is the difference between an animal’s actual feed and expected feed intakes for a given period of time. Literature shows that highly efficient animals have a negative or lower RFI. Thus understanding about RFI is important to maintain an efficient herd of producers in the farm. A feeding trial was undertaken at a commercial farm in Sri Lanka having Frisian cross bred cows. The cows were fed with a grass based Total Mixed Ration (TMR) having maize (Zea mays), CO3 (Pennisetum perpereum X Pennisetum americanum), beer pulp (wet brewer’s grain), dhal meal (Pisum Sativum), mineral mixture and commercial cattle feed. However, the milk yields were lower than the expected with the present TMR affecting the farm profit. Thus a study was undertaken to test a new TMR with the hypothesis that the new TMR would enhance the milk production of cows. Eighteen, Frisian cross bred cows were randomly assigned into two groups (Treatment 1: existing TMR and Treatment 2: new TMR), in a Randomized Complete Block Design (RCBD). Each treatment had three replicates. Data were collected (daily feed intake, milk yield and live body weight of cows) for 28 day period. Residual Feed Intake was derived by regression model using feed intake and live weight data. Efficiency of Feed Utilization was calculated using cumulative milk yield and feed intake data. The RFI in treatment 1 (0.42±0.197 kg/ cow) was higher (P<0.05) than Treatment 2 (0.45±0.197 kg/cow). Efficiency of Feed Utilization in Treatment 2 (36% ±0.797 ml/cow) was higher (P<0.05) than Treatment 1 (29% ±0.797 ml/cow). The results show that the cows in Treatment 2 were more efficient to the cows in Treatment 1. Hence it can be concluded that the new TMR consists of maize, CO3, Guinea grass (Panicum maximum), beef pulp, coconut (Cocos nucifera) poomac, rice bran, maize meal and mineral mixture was better than the exiting TMR.

Introduction

• The concept of Residual Feed Intake (RFI) is becoming important and research has shown that RFI and feed conversion ratio (FCR) are heritable.
• Feed intake is affected by age, sex and composition of diet (Arthur and Herd 2008).
• The major constraint faced by the dairy farmers in Sri Lanka is the high feeding cost.

Problem Identification

• Recently the Sri Lanka Government has imported Frisian dairy cows with the aim to increase the present milk production.
• The cows were distributed were having tropical climatic conditions (ave. daytime temperature of 30°C)
• Many cows were stressed due to high temperature and humidity and as a result, the expected milk yield was not obtained from these cows.
• The farm used for the present study reared these cows in house and fed with a grass based TMR having maize (Zea mays), CO3 (Pennisetum perpereum X Pennisetum americanum), beer pulp (wet brewer’s grain), dhal meal (Pisum Sativum), mineral mixture and commercial cattle feed.
• However, the milk yields were lower than the expected with the present TMR affecting the farm profit.
• The average milk yield was 9.70±14 liters per day and the potential.
• Thus a feeding trial was undertaken using two total mixed rations (TMR); existing TMR (TMR 1) and a new TMR (TMR 2) with the hypothesis that the new TMR would enhance the milk production of cows.

The objectives of the present paper

To estimate the RFI and Efficiency of Feed Utilization (EFU) related to the data obtained from the case study.

Methods and Study Site

• A research was undertaken between December 2018 and February 2019 at a privately owned dairy farm in the Intermediate Zone (7.432°N, 80.438°E, altitude 66 m), Sri Lanka abiding to the ethical guidelines.
• Two total mixed rations prepared according to NRC (2001) were tested using 18 Frisian X Jersey cross bred lactating cows (age 3.5 years, average body weight 418 ±13 kg) giving an average milk yield of 9.7 ±14 liters (means ± SE).
• The cows were randomly assigned into two groups based on their body weight thus each group would have 9 cows.
• The experimental design was Randomized Complete Block Design with three replicates per each treatment (Karunarathna et al. 2019).
• The composition of TMR 1 and TMR 2 are given in Table 1.
• Stal feeding was undertaken at 5.30 and 17.00 hours daily and machine milking was practised at 3.30 and 15.30 hours daily. Water was available ad lib.
• Data (daily feed intake, milk yield and live body weight of cows) were collected for 28-day period.
• Residual Feed Intake (RFI) was derived by regression model provided by Arthur and Herd (2008) using feed intake and live weight data.
• Efficiency of Feed Utilization (EFU) was calculated using cumulative milk yield and feed intake data. All the data were analysed using statistical analysis system (SAS) (2002).

Table 1. Composition of new and existing Total Mixed Ration (TMR)

<table>
<thead>
<tr>
<th>Raw ingredient</th>
<th>Existing TMR (TMR 1) %</th>
<th>New TMR (TMR 2) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize (whole plant without cobbs)</td>
<td>55.5</td>
<td>10</td>
</tr>
<tr>
<td>CO3</td>
<td>13.8</td>
<td>25</td>
</tr>
<tr>
<td>Guinea grass</td>
<td>11.1</td>
<td>-</td>
</tr>
<tr>
<td>Commercial Cattle Feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef pulp</td>
<td>11.28</td>
<td>4</td>
</tr>
<tr>
<td>Dhal meal</td>
<td>5.55</td>
<td>-</td>
</tr>
<tr>
<td>Coconut poomac</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Rice bran</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Maize meal</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Mineral mixture</td>
<td>2.77</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>RFI (kg/cow)</th>
<th>EFU (%)</th>
<th>Milk yield (ml/cow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMR 1</td>
<td>0.42 ± 0.197a</td>
<td>29% ± 0.797b</td>
<td>282.2 ± 7.85a</td>
</tr>
<tr>
<td>TMR 2</td>
<td>-0.45 ± 0.197b</td>
<td>36% ± 0.797a</td>
<td>337.5 ± 7.85a</td>
</tr>
</tbody>
</table>

* means within the same column with different superscripts are significantly different (p<0.05).

Discussion

• Residual Feed Intake (RFI) is the difference between the actual feed intake and expected feed intake of an animal depending on its size and growth (Arthur and Herd 2008) which is a trait related to feed efficiency yet independent of live body weight and live weight gain (Basarab et al. 2003).
• Literature shows that highly efficient animals have a negative or lower RFI (Arthur and Herd 2008: Begli et al. 2016: Yi et al. 2018).
• If the RFI is negative it shows that the actual feed intake is lower than the expected feed intake. If that is the case, then the cost of production would be less in the farm (Basarab et al. 2003).
• Evaluating EFU is vital to rectify the issues related to high cost of feeding as EFU is estimated using the amount of production per unit of feed intake (Arthur and Herd 2008).
• Thus understanding about RFI and EFU is important to maintain an efficient herd of producers in the farm.
• The results in the present study show that the cows in Treatment 2 had lower and negative RFI and a higher EFU than the cows in Treatment 1.
• According to the above results, the cows fed with TMR 2 had given higher milk yields by consuming less amount of feed when compared to TMR1.
• However as Archer et al. (2004) suggest the length of the research period is vital when analysing feed efficiency traits.

Feeding TMR 2 consists of maize, CO3, Guinea grass, beef pulp, coconut poomac, rice bran, maize meal and mineral mixture has shown a positive impact compared to TMR1. However, it is early to decide whether the TMR 2 is more efficient than TMR1 without a long term research.