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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The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021.

Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress

Published by the Kenya Agricultural and Livestock Research Organization

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Key words: [feeding trial; grass based rations; regression model; Sri Lanka]

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. 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 perpureum X Pennisetum americarnum)*, beer pulp (wet brewer's grain), dhal meal (*Lens culinaris*), mineral mixture and commercial cattle feed. However, the milk yields were lower than expected affecting the farm profit. Thus a study was undertaken to test a new TMR with the hypothesis that the new TMR would enhance milk production of the cows. Eighteen, Frisian cross bred cows were randomly assigned into two groups (Treatment 1: existing TMR; TMR 1) and Treatment 2: new TMR; TMR 2), 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 a 28 day period. Residual Feed Intake was derived by a 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 than the cows in Treatment 1. Hence it can be concluded that the new TMR (TMR 2) consists of maize, CO3, Guinea grass (*Panicum maximum*), beer pulp, coconut (*Cocos nucifera*) poonac, rice bran, maize meal and mineral mixture was better than the exiting TMR (TMR 1).

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 (Author and Herd 2008).

The major constraint faced by the dairy farmers in Sri Lanka is the high feeding cost. Because the available natural forages are of low nutrient content. Hence in order to meet the daily nutrient requirement, farmers have to purchase nutrient rich concentrate feed ingredients at a high cost. Recently the Sri Lanka Government has imported Frisian cross bred dairy cows from Australia to distribute among the dairy farmers with the aim to increase the present milk production. The areas where the above cows were distributed experience tropical climatic conditions with an average daytime temperature of 30^0C. As being reared in temperate conditions since birth it was a major change for the cows. As a result the expected milk yield was not obtained from these cows. Many cows were stressed due to high temperature and humidity. The farm used for the present study reared these cows in house and fed with a grass based TMR having maize, CO3, beer pulp (wet brewer's grain), dhal meal, 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 litres per day far below the potential. Thus a feeding trial was undertaken using two TMR; existing TMR (Treatment 1;TMR 1) and a new TMR (Treatment 2; TMR 2) with the hypothesis that the Treatment 2 would enhance the milk production of cows. The objectives of the present paper were to estimate the RFI and Efficiency of Feed Utilization (EFU) related to the data obtained from the case study.

Methods and Study Site
Research was undertaken between December 2018 and February 2019 at a privately-owned dairy farm in the Intermediate Zone (7.4322° N, 80.4438° E, altitude 66 m), Sri Lanka abiding to the general ethical guidelines adhered by the farm. 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 litres (means ± SE). The cows were randomly assigned into two groups based on their body weight with each group having 9 cows. The experimental design was Randomized Complete Block Design with three replicates per each treatment (Karunarathna et al. 2019). The as fed composition of Treatment 1 and Treatment 2 are given in Table 1. Stall 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 SAS (2002).

Table 1. Composition of Treatment 1 and Treatment 2 (as fed basis)

Raw ingredient	Treatment 1 %	Treatment 2 %
Maize (whole plant without cobbs)	55.5	10
CO3	13.8	25
Guinea grass	-	20
Commercial Cattle feed	11.1	-
Beer pulp	11.28	4
Dhal meal	5.55	-
Coconut poonac	-	20
Rice bran	-	10
Maize meal	-	10
Mineral mixture	2.77	1
Total	100%	100%

Results

Table 2: Residual Feed Intake (RFI), Efficiency of Feed Utilization (EFU) and mean milk yield of cows in two treatments (means ± SE).

Treatment	RFI (kg/cow)	EFU (%)	Milk yield (ml/cow)
1 (TMR 1)	0.42 ± 0.197^{a}	$29\% \pm 0.797^{b}$	282.2 ± 7.85^{b}
2 (TMR 2)	-0.45 ± 0.197^{b}	$36\% \pm 0.797^{a}$	337.5 ± 7.85^{a}

[a b] means within the same column with different superscripts are significantly different ($p < 0.05$).

Milk yield obtained from Treatment 2 was higher ($P<0.05$) than Treatment 1. The RFI in Treatment 1 was higher ($P<0.05$) than Treatment 2. Efficiency of Feed Utilization in Treatment 2 was higher ($P<0.05$) than Treatment 1.

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 (Author 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 (Athur 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 (Author and Herd 2008). Thus understanding about RFI and EFU is important to maintain an efficient herd.

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 Treatment 2 had produced higher milk yields while consuming less feed when compared to Treatment 1. However as Archer et al. (2004) suggests the length of the research period is vital when analysing feed efficiency traits. Thus it is early to decide whether the Treatmen 2 (TMR 2) is more efficient than Treatment 1 (TMR 1) without long

term research. Presently however, feeding TMR 2 consisting of maize, CO3, Guinea grass, beer pulp, coconut poonac, rice bran, maize meal and mineral mixture has shown a positive impact compared to TMR1.

Acknowledgements

Authors acknowledge the support given by W.J. Mathurata and Mr D.F.J.P. Gamlath and the Head and Staff of the Department of Animal and Food Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka.

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