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Prospective Effects of Regrouping, Number of Animals in Each Group and Concentrate Specificity on Profitability of Lactating Dairy Cows

Research Article

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ABSTRACT

Profitability of different grouping criteria was simulated in a dairy farm with 153 lactating cows that were divided into three groups of high (79), medium (40) and low (34) cows based on the milk records. Animals were reassigned to the new groups based on the following criteria using a decision support tool and the same three groups scenario: fat corrected milk 4%, days in milk (DIM), dairy merit (fat-corrected milk (FCM)/body weight (BW)$^{0.75}$), and cluster (cow's energy and protein requirements). Four total mixed ration (TMR) were formulated for feeding three simulated groups in which group 2 (medium producing animals) could consume either concentrate type I or concentrate type II, whereas groups 1 and 3 always had their specific concentrate mixture. The number of animals in the high, medium and low producing groups altered following the re-grouping and the highest number of cows fell in either the new medium (FCM and dairy merit) or low (DIM and cluster) producing groups. Cluster and dairy merit grouping criteria resulted the most income over feed costs (IOFC) and maximum profitability compared to the milk records and other simulated scenarios. In all of the grouping criteria, when the second group consumed concentrate type II, the amount of IOFC was higher than situations where this group utilized concentrate type I. Overall, profitability and economic efficiency of the herd increased when a more precise grouping method was used. Furthermore, cluster method provided a liberty for choosing the type of concentrate for medium producing animals with a negligible effect on the calculated IOFC from the simulated data.

KEY WORDS cluster, grouping criteria, IOFC, profitability.

INTRODUCTION

Precision feeding according to an individual cow's requirements guarantees her nutritional necessities, but this is not yet practical, especially in larger herds (Sniffen *et al.* 1993). Therefore, cows are often group-fed. Diet is usually formulated for high-producing cows to ensure that milk production is maintained, but it provides extra nutrients to the less productive animals, which makes it unsuitable (Weiss, 2014). Therefore, distributing lactating cows in smaller groups and feeding group-specific rations provides more precise nutrients to similar cows in the same group (Cabrera *et al.* 2012) and decreases the variability among the cows within the group. Hence, nutritional grouping can be beneficial through saving feed costs, improving productivity (Bach, 2014), improving herd health through promoting optimal body condition, and decreasing the excretion of nutrients such as ammonia to the environment (Cabrera and Kalantari, 2016).

The criteria for grouping lactating dairy cows are fat correct milk (FCM), days in milk (DIM), dairy merit (FCM/BW$^{0.75}$) and cluster (McGilliard *et al.* 1983). However, the cluster strategy uses cow's energy and protein requirements which is, theoretically, more accurate than the other methods and can increase profitability by placing more similar cows in one group and precise group feeding (Cabrera and Kalantari, 2016; Kalantari *et al.* 2016). In order to estimate cow's energy and protein requirements, the milk yield, composition, body weight, and condition score of individual animals have to be measured. However, other information such as DIM, lactation number and days pregnant are also required (NRC, 2001). This would lead to more farm work which may not be feasible in practice, especially when there is lack of information about the economic advantages of cluster technique over the other common methods used for nutritional grouping of lactating dairy cows. The purpose of this study was to compare the economic efficiency and profitability of different nutritional grouping scenarios (simulated by online decision support tool using the records of 153 lactating dairy cow) with the following assumptions: three groups of lactating dairy cows in each strategy could consume their own TMR and total herd milk output and composition did not change by regrouping.

MATERIALS AND METHODS

This study was conducted at the Dairy Cattle Research Center of Ferdowsi University of Mashhad, Mashhad, Iran. Conventionally, 153 lactating dairy cows (Table 1) had been divided into three groups of high, medium and low milk producing cows based on their daily milk yield (existing grouping) including 79, 40 and 34 cows, respectively. Milking was performed three times a day and milk production was measured for each individual cow by a milking machine (Metatron 21, Westfalia-Surge, Inc. Germany). Sum of the three consecutive values were further subjected as a record.

During each milking session, 100 mL of milk samples were analyzed using Milko-Scan 605 analyzer (Foss electric, hillerod, Denmark) and the weighted mean values of milk components were used for estimation of the nutrient requirements of each cow (McGilliard *et al.* 1983). Body weight was measured after morning milking for two consecutive days (McGilliard *et al.* 1983).

Body condition score (0-5 point) was determined using the method proposed by Edmonson *et al.* (1989). NRC (2001) was used for calculating the energy and protein requirements of animals and diet formulation and all the other required inputs including DIM and lactation number (Table 2).

Re-grouping criteria

Using an online decision support tool (http://dairymgt.info/tools.php) developed by Cabrera (2016), 153 cows were re-assigned to three new groups based on the following criteria: fat corrected milk 4% (FCM), days in milk (DIM), dairy merit ($FCM/BW^{0.75}$), and cluster (McGilliard *et al.* 1983). Because of the limitations in farm facilities, the similar three-group scenario was used in all of the above criteria. Furthermore, the following assumptions were entered into the decision support tool:

Corn grain: 19 cents/kg
Soybean meal: 38.3 cents/kg
Raw milk price: 36 cents/kg

Diets

The existing feeding criteria for cows consisted of two types of concentrates; one for the high and medium groups (with different quantity) and another for the low producing group. In this strategy, average milk yield of each group was used to formulate diet as shown in Table 2. The logic behind the number of animals in each group was to maximize the possibility of grouping the high producing cows into the same group which receives the highest amount of concentrate. To compare the different grouping criteria, the rations were formulated based on the new groups of animals and 83rd percentile of group nutritional requirements as described by Stallings and McGilliard (1984). Four TMR were formulated for the three groups, in which group no. 2 (medium producing animals) could consume either concentrate type I (similar to the existing situation) or concentrate type II.

Groups 1 and 3 always consumed their specific concentrate mixture. Earlier studies have indicated that group-specific TMR was preferred in order to reduce feed costs (Cabrera and Kalantari, 2016). However, similarity of TMRs between groups decreases changes in the rumen microbial population and adaptation period and subsequently minimizes the depression of milk production after alteration of the groups (Kalantari *et al.* 2016). For the above reasons, two types of concentrate were assumed to calculate income over feed costs (IOFC). Rations were formulated with the least possible costs. After getting new group members and formulating the ration, feed costs were calculated using individual ingredients cost and average IOFC was estimated for the group members present in the existing and new simulated groups.

RESULTS AND DISCUSSION

The number of animals in each group based on different regrouping criteria, average DIM, average milk yield, 83rd percentile values for net energy and metabolizable protein are presented in Table 2. As explained earlier, the existing groups had 79, 40 and 34 cows in high, medium and low producing classes, respectively.

Table 1 Distribution of lactating cows with a herd average milk yield= 36.3 kg and average days in milk= 165.94 (min=11 and max=680 d) used in the grouping study

Lactation number	1	2	3	4	5	6	7
Number of animals	48	48	34	15	4	3	1
Average days in milk	210	145	141	196	96	120	27
Average milk yield (kg)	33.27	37.96	37.77	34.09	41.58	38.23	53.94
Average body weight (kg)	583.83	622.5	649.03	666	652	626.67	616
Average body condition score (BCS)	3.56	3.45	3.56	3.58	3.88	3.17	3.25

Table 2 Specifications of nutritional groups simulated using different grouping methods

Criteria[1]	**Groups**[2]																				
	1							**2**							**3**						
	No	**MY**	**DIM**	**DMI**	**NE**	**MP**	**F/C**	**No**	**MY**	**DIM**	**DMI**	**NE**	**MP**	**F:C**	**No**	**MY**	**DIM**	**DMI**	**NE**	**MP**	**F/C**
Existing	79	43.29	104	29.8	45.2	3222	40:60	40	33.52	206	25.7	36.6	2534	a60:40 b55:45	34	23.12	264	23.4	31.7	2195	62:38
FCM	40	46.96	76	31.4	49.3	3478	35:75	79	36.52	170	26.9	38.6	2620	a60:40 b52:48	34	23.23	264	23.5	31.5	2083	73:27
DIM	34	43.27	46	29.3	48.1	3257	32:68	40	40.27	99	28.7	43.1	2912	a48:52 b54:46	79	31.35	251	26.6	37.6	2540	68:32
Dairy merit	40	46.95	77	31	47.5	3259	40:60	79	36.26	162	27.2	39.1	2640	a55:45 b55:45	34	23.85	274	23.1	31.4	2101	65:35
Cluster	34	46.12	50	30.4	48.6	3377	32:68	40	40.36	106	28.3	42.6	3025	a40:60 b45:55	79	30.09	246	26.4	37.2	2507	68:32

MY: average milk yield (kg); DIM: days in milk; DMI: dry matter intake (kg); NE: net energy requirement (Mcal/d); MP: metabolizable protein requirement (g/d); F/C: forage to concentrate ratio; FCM: fat corrected milk 4% and DIM: days in milk.

After regrouping, the number of animals in each group did not remain the same. Group 1, the high-producing group, used to have the largest number of cows (79 heads) with an average milk production of 43.29 kg in the existing grouping method, however, the decision support tool assigned the largest number of cows to the medium producing group (FCM and dairy merit) followed by the low producing group (DIM and cluster). A hidden cost of all grouping methods is the number of animals receiving higher nutrients than they require.

Generally, high yielding animals consume the highest amount and best quality of concentrate and when placed together in the same group, they would impose more costs compared to the cows with medium and low milk production. Therefore, during regrouping, the high producing groups always had the lowest possible size so as to minimize feeding costs and prevent overfeeding in some herd members.

In the present study we used 83rd percentile of new group nutritional requirements for diet formulation. With the cluster criteria, 67 dairy cows in the three groups received dietary nutrients greater than their requirements and 153-67= 86 animals received either energy or protein or both nutrients as sufficient as their requirements. However, in the FCM, DIM and dairy merit methods, there were 128, 125, 130, and 106 dairy cows that consumed dietary nutrients greater than what they needed, respectively.

This is another advantage of the cluster technique which reduces the cost of feed, nutrient excretion and emissions to the environment and risk of metabolic disorders in overfed animals (Cabrera *et al.* 2012; Cabrera and Kalantari, 2016; Kalantari *et al.* 2016).

Concentrate and forage proportion based on the predicted dry mater intake and average milk yield were estimated (Table 2) after regrouping the animals to three new groups for each grouping criteria. Medium producing animals assumed to consume either lower amount of concentrate I compared to high producing cows or greater quantity of concentrate II than low producing cows. The calculated IOFC for each grouping and concentrate scenario is illustrated in Table 3. Cluster and DIM grouping criteria led to the highest IOFC. Furthermore, Table 3 indicates that in all of the grouping criteria when the second group consumed concentrate type II (formulated for low producing animals), the amount of IOFC was higher than cases where this group utilized concentrate type I (formulated for high producing animals). Therefore, if it is not possible to use cluster method in the farm due to the difficulties of obtaining individual information of each cow and the lack of knowledge for grouping herds according to professional and scientific grouping criteria (Contreras Govea *et al.* 2015), using a concentrate especially formulated for low producing animals to fed the medium producing cows resulted in a greater IOFC compared to that of high producing cows' concentrate in all other scenarios. However, when herd was grouped using the cluster technique, the difference between concentrate type I and II scenarios in terms of IOFC was negligible. This is another advantage of the cluster criteria for grouping dairy herd which gives liberty to the farmers to select concentrate mixture for a group of animals.

Table 3 Group and herd average income over feed cost (IOFC, $/cow/d) for different criteria of grouping, a and b determine when the second group consumed concentrate type I (formulated for high producing animals) and type II (formulated for low producing animals), respectively

Grouping criteria	Group 1	Group 2a	Group 2b	Group 3	Herd (a)	Herd (b)
Existing	5.36	4.14	4.35	1.92	3.81	3.88
Fat corrected milk 4% (FCM)	5.58	4.56	5.20	2.81	4.32	4.53
Days in milk (DIM)	4.89	5.13	5.83	4.15	4.72	4.96
Dairy merit	6.24	4.36	5.18	2.37	4.32	4.60
Cluster	6.07	5.70	5.82	3.89	5.22	5.26

CONCLUSION

Based on the findings of this study, it may be concluded that grouping dairy cows by considering a lowest mean (23.12 kg/d) and equalizing of the average milk intervals and putting animals in the groups in such a way as to have maximum high producers in one group (the method used in the present study) did not guarantee highest efficiency. Using real records of 153 lactating dairy cows and simulating new groups with different number of animals in each group, profitability and economic efficiency of the herd increased when a more accurate grouping method was used with major implications from the cluster technique. Furthermore, cluster method provided a liberty for choosing the type of concentrate only with a negligible effect on the IOFC.

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REFERENCES

Bach A. (2014). Precision feeding to increase efficiency for milk production. *Adv. Dairy Technol.* **26,** 177-189.

Cabrera V.E. (2016). Impact of nutritional grouping on the economics of dairy production efficiency. Pp. 23-34 in Proc. 25th Annu. Tri-State Dairy Nutr. Conf. Fort Wayne, Indiana, USA.

Cabrera V.E. and Kalantari A.S. (2016). Economics of production efficiency: Nutritional grouping of the lactating cow. *J. Dairy Sci.* **99,** 825-841.

Cabrera V.E., Contreras F., Shaver R.D. and Armentano L.E. (2012). Grouping strategies for feeding lactating dairy cattle. Pp. 40-44 in Proc. Four-State Dairy Nutr. Manag. Conf., Dubuque, IA. Wisconsin Agri-business Association, Madison.

Contreras Govea F.E., Cabrera V.E., Armentano L.E., Shaver R.D., Crump P.M., Beede D.K. and VandeHaar M.J. (2015). Constraints for nutritional grouping in Wisconsin and Michigan dairy farms. *J. Dairy Sci*. **98,** 1-9.

Edmonson A.J., Lean I.J., Weaver L.D., Farver T. and Webster G. (1989). A body condition scoring chart for Holstein dairy cows. *J. Dairy Sci*. **72,** 68-78.

Kalantari A.S., Armentano L.E., Shaver R.D. and Cabrera V.E. (2016). Economic impact of nutritional grouping in dairy herds. *J. Dairy Sci*. **99,** 1-21.

McGilliard M.L., Swisher J.M. and James R.E. (1983). Grouping lactating cows by nutritional requirements for feeding. *J. Dairy Sci*. **66,** 1084-1093.

NRC. (2001). Nutrient Requirements of Dairy Cattle. 7th Ed. National Academy Press, Washington, DC, USA.

Sniffen C.J., Beverly R.W., Mooney C.S., Roe M.B., Skidmore A.L. and Black J.R. (1993). Nutrient requirements versus supply in the dairy cow: Strategies to account for variability. *J. Dairy Sci*. **76,** 3160-3178.

Stallings C.C. and McGilliard M.L. (1984). Lead factors for total mixed ration formulation. *J. Dairy Sci*. **67,** 902-907.

Weiss B. (2014). Setting nutrient specifications for formulating diets for groups of lactating dairy cows. WebMD. http://www.extension.org/pages/70124/setting-nutrient specifications-for-formulating-diets-for-groups-oflactating-dairy cows#.VDKX2_ldVEI.