Strategies to Improve Feed Efficiency in Dairy Replacement Heifer Feeding Programs

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Introduction

The goals of a dairy replacement management program are to rear heifers at a low economic and environmental cost without compromising future lactation performance. To meet these objectives, bred heifers are commonly fed diets containing low cost, high fiber forages (MPS, 2003), which meet the low energy requirement (NRC, 2001) of bred replacement heifers. Feeding bred heifers low energy, high fiber forages also helps minimize over-conditioning at calving which can be detrimental to lactation performance (Hoffman et al., 1996). Feed efficiency is an over-looked issue associated with feeding bred heifers diets containing predominately high fiber forages. Feed efficiency can be described as the amount of feed required to produce one pound of gain. Feed efficiency can be increased by a number of practical and nutritional factors when high fiber forages diets are fed. This paper will review issues associated with bunk management and feed efficiency associated with feeding bred replacement heifers.

Over-Conditioning –Fear Factor

Over-conditioning heifers is one of the dairy producers and custom heifer grower's greatest fears because the negative results are so acute. No attempt will be made to discuss various aspects of over-conditioning of heifers because negative impacts, both real and perceived, are well understood. While it is necessary to vary dietary energy to maintain optimal heifer growth, feeding excessive dietary energy is the principal cause of over-conditioning heifers especially in low maintenance energy environments (e.g. free-stall barns). For example, a typical bred heifer diet containing 50 percent corn silage (72 % TDN) and 50 percent alfalfa silage (62 % TDN) has a dietary TDN content of 67 percent which is 5 TDN units above the requirement of a bred heifers reared in a thermal-neutral environment such as a free-stall barn. In this situation heifers will likely become over-conditioned. Another underlying and compounding problem with over conditioning is variance of days on feed. Inefficiencies in getting heifers to breeding weight (at a proper age) and inefficiencies in breeding can create days on feed variance. In the example some heifers maybe fed a 5 percent excessive TDN diet for 275 days while other heifers will be fed a 5 percent excessive TDN diet for 375 days. The higher the dietary TDN is above the requirement and the greater the variance of days on feed the more delirious over-conditioning will become. Therefore over-conditioning does not just represent potential problems post calving but also is indicative that feed efficiency is being reduced because:1) fat is deposited with less efficiency than protein and; 2) heifers with excessive days on feed (older) are less efficient than younger heifers.

Dietary protein does play a minor role in heifer body condition, but overfeeding energy and excessive variance of days on feed remains the biggest culprit. When heifers become over-conditioned, dietary energy should be reduced by including low energy forages, such as straw, into the diet or limiting the amount of feed offered. Maintaining an inventory of low quality forages, testing all forages and formulating diets at the proper energy level is critical to control situations when feed inventories provide excessive energy.

In situations where over-conditioning of heifers has or is occurring management responses are typically to casual. Often, feeding excessive corn silage and limited protein are blamed. This assessment may not fully address the true management problem. Questions that should be asked when over-conditioning of heifer occurs are:

- What is the age weight variance at breeding?
- What is the breeding efficiency? (Conception rate, service rate, pregnancy rate)
- What is the age variance at calving
- What is the true TDN content of the consumed diet?
- What are the true TDN requirements of the heifers for this season and facility?
- What are possible non-nutritional factors causing growth variance?

The aforementioned discussion is offered only to highlight that reasons for over-conditioning of heifers is complex and is ultimately an interplay between dietary energy, days on feed and environmental conditions.

Limit-Feeding

Another feeding strategy to control over-conditioning and improve feed efficiency would be to limit-feed a more nutrient dense diet which provides an alternative management strategy to reduce feed cost and nutrient excretion both of which are becoming of greater concern in the dairy industry. Lammers et al., 1999 used a limit-feeding strategy to control growth rates of pre-breeding Holstein heifers and observed no negative effects on first lactation performance. Limit-feeding strategies have also been employed successfully with other livestock species such as beef cows, (Loerch, 1996), ewes (Susin et al. 1995) and beef heifers (Wertz et al. 2001). In dairy replacement heifer management systems limit-feeding of bred heifers may yield the maximum management benefit because bred heifers have high feed intakes (NRC, 2001) and excrete more manure DM (Wilkerson, et al., 1997) as compared to pre-breeding heifers. Recently we explored a simple limit-feeding feeding system for replacement heifers (Hoffman et al., 2006). Bred Holstein heifers were fed diets (C-100, L-90 and L-80) containing 67.5, 70.0 and 73.9 percent TDN respectively but heifers fed the 70.0 and 73.9 percent TDN diets were limit-fed at 90 and 80 percent of their intake potential (Table 1). The experimental feeding system resulted in heifers being fed less dry matter per day but the total amount of calories consumed per day was equal (Table 2). We did not observe any differences in the size or body condition scores of the heifers after a 111 day feeding period (Table 3). The limit fed heifers had numerically higher average daily gains as compared to control fed heifers. The limit-feeding regimen did however result in a 30 % improvement in feed efficiency (Table 3), and heifers excreted significantly less manure (Table 4). We observed no long term effects of limit feeding heifers and lactation performance was similar between control and limit-fed heifers (Figure 1). Recent research at the Pennsylvania State University observed similar responses when heifers were limit fed. Zanton and Heinrichs, (2006) limit fed 300 lb Holstein heifers for 35 weeks a diet containing 25 percent forage as compared to feeding a greater DM allocation of a diet containing 75 percent forage and observed no differences in average daily gain or skeletal growth of the heifers.

There are some limitations to implementing a limit-feeding strategy. First, heifers do vocalize to minor extent for approximately one week with vocalization ending thereafter (Table 5). Second, adequate bunk space is required to assure all animals have full access to feed because heifers fed to 80 percent of their intake potential will consume all feed available within one hour. Lack of adequate bunk space could result in un-even rates of gain. Despite disadvantages the positive aspects of limit-feeding such as increases in feed efficiency, decrease manure output and ability to control over-conditioning without long term effects make limit-feeding and attractive management alternative but more data is required.

Heifers Sort Feed

When feeding high fiber forages or corn silage it should be remembered that heifers will sort feed very similar to lactating dairy cows. In a recent study (Hoffman et al., 2006) we fed heifers five different physical methods of feeding hay to explore possible differences in nutrient intake and feed sorting behavior. Diets were fed to eighty Holstein heifers, and included (1) incorporation of long hay (**LH**) in a total mixed ration (**TMR**) mixer (**TMR-LH**); (2) incorporation of bale cut hay (**BC**) in a TMR mixer (**TMR-BC**); (3) incorporation of chopped hay (**CH**) in a TMR mixer (**TMR-CH**); (4) top-dressing (**TD**) long hay (**TD-LH**) without TMR incorporation, and (5) top-dressing BC hay (**TD-BC**) without TMR incorporation. Top dressing LH or BC hay to heifers resulted in a suppression (0.5 kg/d) of DM intake as compared to heifers fed TMR diets in which hays were incorporated in the TMR. Heifers heavily refused long particles (>12.5 mm) on all diets (Table 6). In particular, heifers refused 70 to 80 percent of corn cobs fed. Because long forage particles and or corn cobs generally contain more NDF or less energy than small feed particles, such as grain, data suggest heifers may consume diets higher in energy than formulated. Likewise data suggest bunk management of heifer diets is critical to assure heifers are consuming high fiber low energy feeds as intended.

Manage the Bunk

Feeding heifers is expensive and great care should be taken not to waste feed. Feed bunks should be designed and managed to control feed waste. Properly adjusting neck rails, throat heights, or installing slant bars in the feed alley can often dramatically reduce feed wastage. Hay racks, portable bunkers, or other make-do feeders should not be used as too much feed is lost on the ground. In addition, research data from South Dakota State University suggest heifers (or steers) should not be over-fed. Precisely monitoring and controlling feed intakes and feeding heifers to exact intakes will reduce feed wastage and increase feed efficiency. The combination of proper bunk design and feeding heifers to exact intakes may result in a 10 percent improvement in feed efficiency. To feed heifers to exact intakes a bunk scoring management system should be utilized. A simplified bunk scoring system is 0) no feed remaining, 1) a few small scatter particles of feed remaining, 2) many feed particles remaining but concrete still visible and 3) large amounts of feed remaining with no bunk concrete visible. The objective of a controlled bunk management feeding system is to feed to a bunk score of 1 every day. If bunks are empty (Score 0) or excessive feed is remaining (Scores 2 and 3) then feed intakes are moved up or down in very small increments (2 %) to facilitate feeding heifers to a bunk score of 1. This type of feeding systems also helps assure that heifers consume all large feed particles and feeds such as corn cobs. Full consumption of diet also assures the formulated diet is actually being totally consumed.

Consider Ionophores

Studies have demonstrated that ionophores improve feed efficiency or average daily gain when fed to dairy heifers. When fed, heifer raisers can expect average daily gain increases of 0.15 pounds per heifer per day or feed efficiency increases of 5 to 10 percent. It is important to understand that improving feed efficiency is the primary reason to feed an ionophore to heifers because increasing average daily may or may not be and improvement in heifer management. In addition to feeding efficiency, ionophores help control coccidiosis. Bambermycin is also approved as a growth promotant for dairy replacement heifers. Bambermycin has ionophore-like properties, but is not a true ionophore and does not control coccidiosis. Bambermycin is fed at 10 to 20 milligrams per heifer per day. If ionophores are feed great care should be taken in bunk management and diet formulation to assure heifers are consuming the exact amount of calories to avoid over-conditioning.

Conclusions

Feed efficiency of dairy replacement heifers can be improved and should be a primary discussion point between heifer growers and their nutrition consultants. Feeding heifers in facilities with properly designed bunks to minimize feed loss, employing a bunk management system, feeding heifers to exact levels of intake (or slightly less) and considering ionophores in the feeding system are potential tools to improve feed efficiency.

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Table 1. Ingredient and nutrient composition of treatment diets.

Item	Treatment (% Ad libitum intake)		
	C-100	L-90	L-80
Ingredient	--------------	% of DM	---------------
Small grain silage	47.0	39.6	30.5
Corn silage	47.3	40.7	32.2
Shelled corn	2.1	11.5	23.5
Soybean meal	2.0	6.4	11.7
Urea	0.51	0.52	0.51
Calcium carbonate	0.32	0.43	0.61
Sodium bicarbonate	0.11	0.14	0.19
Magnesium Sulfate	0.39	0.43	0.49
Vitamin premix	0.18	0.20	0.22
Mineral premix	0.13	0.15	0.17
Nutrient composition			
DM	40.2	43.0	51.2
CP	11.3	12.7	14.2
NDF	47.3	41.8	35.6
IV NDFD, % NDF	60.9	59.1	59.7
NFC	34.0	38.2	42.9
Fat	2.3	2.3	2.5
P	0.27	0.29	0.31
Ca	0.40	0.45	0.49
K	1.7	1.6	1.5
Mg	0.18	0.19	0.20
Ash	7.1	7.0	6.9
Energy Calculations			
TDN	67.5	70.0	73.9
ME, Mcal/kg	2.46	2.55	2.69
NE_g, Mcal/kg	0.97	1.04	1.15
NE_m, Mcal/kg	1.41	1.48	1.57

Table 2. Nutrient and energy intake of limit-fed heifers.

	Treatment[1]		
Item	C-100	L-90	L-80
Nutrient intake, lbs/d			
DM	21.3	19.9	18.3
CP	2.42	2.54	2.57
NDF	10.06	8.29	6.50
Digestible NDF	6.11	4.90	3.87
Non-fiber carbohydrate	7.26	7.60	7.85
Energy intake			
TDN, lbs/heifer/d	14.4	13.9	13.5
ME, Mcals/d	23.8	23.0	22.3
NE_g, Mcals/d	9.4	9.4	9.5
NE_m, Mcals/d	13.7	13.3	13.0

Table 3. Effect of limit-feeding on body size and growth of replacement heifers.

	Treatment		
Item	C-100	R-90	R-80
Intial			
Weight, lbs	1036	1021	1011
Hip height, in	54.20	54.60	54.90
Body condition score	3.1	3.0	2.9
Final			
Weight, lbs	1220	1234	1217
Hip height, in	56.0	56.3	56.4
Body condition score	3.2	3.2	3.2
Growth			
Gain, lbs/111 d	184	213	206
Hip height, in/111 d	1.8	1.7	1.5
Body condition score, units/111d	0.1	0.2	0.2
Feed efficiency, lbs DM/lb gain	13.2	10.7	11.1

Table 4. Effect of limit-feeding on fecal excretion of replacement heifers.

Item		Treatment[1]		
		C-100	L-90	L-80
Intake				
	DM, lbs/d	22.0	20.0	17.2
	N, g/d	182.9	181.4	181.8
	P, g/d	27.2	26.1	24.3
Excretion				
	DM, lbs/d	7.7	6.9	5.8
	N, g/d	140.2	141.7	146.8
	P, g/d	24.7	25.2	27.2

Table 5. Effect of limit- feeding on voluntary behavior of replacement heifers.

Item	Treatment[2]		
	C-100	L-90	L-80
Eating, % of time	19.3	15.7	10.3
Standing, % of time	19.6	24.4	32.9
Lying, % of time	60.9	59.8	56.7
Vocalization, % of time	0.02	0.04	1.10
Eating, hrs/day	2.3	1.9	1.2
Standing, hrs/day	4.7	5.8	7.9
Lying, hrs/day	14.6	14.4	13.6

Table 6. Dietary particle sorting by bred Holstein heifers.

Item	Experimental diet[a]				
	TMR-LH	TMR-BC	TMR-CH	TD-LH	TD-BC
Nominal screen openings, mm	-----------'%[b]-----------				
19.1 (other forage)	85.4	86.4	62.3	61.3	74.2
19.1 (corn cobs)	26.5	19.6	-18.6	30.4	14.7
12.7	84.3	85.3	74.2	80.2	79.2
6.35	98.5	98.7	99.7	101.6	99.7
3.96	102.1	101.1	103.4	103.3	103.1
1.17	104.6	104.7	104.6	105.5	105.6
Pan	106.8	105.9	105.7	107.9	107.7

[a] TMR-LH = total mixed ration containing long hay, TMR-BC = total mixed ration containing bale cut hay TMR-CH = total mixed ration containing chopped hay, TD-LH, partial mixed ration with topdressed long hay, TD-BC = partial mixed ration with topdressed bale cut hay.

[b] Sorting by screen was calculated on as-fed basis as (100 x ($screen_i$ intake/ $screen_i$ predicted intake)).

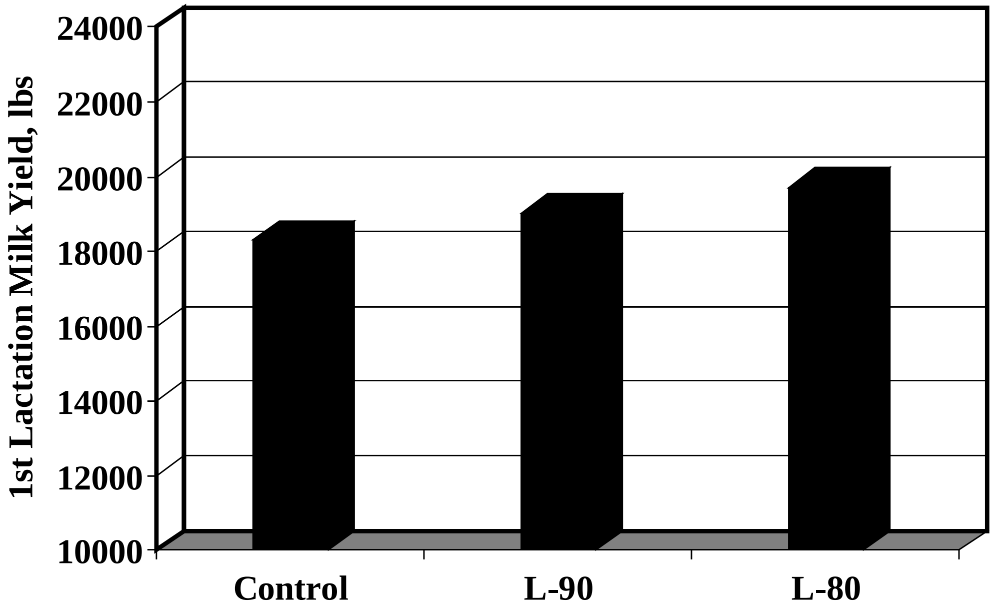

Figure 1. The effect of limit-feeding Holstein heifers on first lactation milk yield.