CRITICAL ISSUES IN NUTRITIONAL MANAGEMENT OF DAIRY HEIFERS

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INTRODUCTION

"The goal of the heifer rearing program is to provide a regimen which will enable the heifer to develop her full lactation potential at the minimum of expense." This goal from Eric Swanson (1978) is an admirable one that still represents what managers of the dairy heifer enterprise should seek to attain. How much do we know about this relationship? Probably not as much as we would care to know. The heifer enterprise is an investment in the future. Profit is a function of lactation yield and longevity. Decisions must be made which consider not only present expenses, but also their impact on future income and expense. The expense side of the profit function is dictated by length of the rearing period and rearing cost per day. Like many agricultural systems, the producer seeks to minimize expenses while maximizing present and future income.

This presentation will seek to address factors known to influence expenses during the rearing period and later income with special attention given to the dairy heifer from two to three months of age through calving.

WHAT FACTORS INFLUENCE PRODUCTION DURING THE FIRST AND LATER LACTATIONS?

It has been a commonly held belief by many dairy producers that larger, older heifers produced more milk in their first and later lactations. However, an evaluation of DHI records of 933 Holstein cows by Gill and Allaire (1976) found that an average age at first calving (**AFC**) of 22.5 - 23.5 months resulted in maximum lifetime performance, while maximum lifetime profit was associated with an AFC of 25 months. More recent Pennsylvania DHIA data shows little difference in first lactation yield between 23 - 28 months AFC (Heinrichs, 1996). In addition, numerous studies (Hargrove et al., 1969; Lin et al., 1986; and Roger et al., 1991) have shown a negative relationship between AFC and productive life. These field observations demonstrate that producers calving their heifers at earlier ages do not sacrifice lifetime yield and that a positive relationship actually exists.

Although AFC is strongly related to heifer performance, body weight after calving is significantly more important in determining first lactation yield. Keown and Everett (1986), in an examination of northeast DHI records, found highest yield occurring when heifers weighed between 1200 and 1350 lb after their first calving. A more recent evaluation of northeast DHI records concurred with these findings. It is also apparent that production declines when post calving body weights exceed 1450 lb, probably because these heifers are overconditioned and experience a higher than normal incidence of dystocia. Although body weight is an important measure, it is important to remember that other measures are necessary to adequately describe heifer growth and likely genetic variance associated with growth. In a review of literature, Hoffman (1997) defined optimum body size criteria of Holstein replacement heifers at calving.

This information has enjoyed wide support in the industry; however, the age at which these goals are achieved has been the subject of debate. Considerable research has been conducted by workers at Cornell (VanAmburgh et al., 1994) and Michigan State University (Skidmore, personal communication) to reduce AFC below 22 months in an effort to reduce rearing expenses and expedite income from the heifer.

Target average daily gains (**ADG**) to achieve these body size goals at varying AFC must be viewed within two different time frames - birth to breeding age and bred to calving. The latter category is necessary owing to the weight of the

Table 1: Optimum body size criteria of Holstein replacement heifers at first calving. (Hoffman, 1997)

Criteria	Average	Lower	Upper
Body weight, lb (14 d prepartum)	1366	1312	1422
Body weight, lb (7 d postpartum)	1231	1182	1280
Body weight, lb (30 d postpartum)	1148	1102	1193
Wither height, in.	54.9	54.2	55.5
Body length, in.[1]	67.3	66.5	68.0
Pelvic area, cm^2	>260	>260	>260
Body condition score	3.5	3.5	3.5

[1] Measured from the point of shoulder to the ischium.
All measurements other than weight represent the animal after calving.

fetus and associated placental membranes and fluids. If one assumes a birth weight of 90 lb and a 278 d gestation period, the scenarios shown in Table 2 apply. For simplicity, only the average genetic range is used in this example. Granted, this is an oversimplification and assumes 100% first service conception. However it does demonstrate the challenges to achieving early calving at recommended body weights. It also demonstrates that these goals are readily attained with AFC of 22 months or more.

THE INFLUENCE OF RATE OF GAIN ON MAMMARY DEVELOPMENT AND FUTURE LACTATION PERFORMANCE

Interest in accelerated rearing is not new. In 1948, Herman, Ragsdale and Swanson observed that rapidly grown heifers produced less milk than expected in the first and later lactations. Swanson (1978) conducted one of the first studies on both accelerated rearing and severe underfeeding using identical twins in this country. Eight pairs of twins ranging in age from three to twelve months of age were fed either ad libitum concentrates and hay or were limit-fed concentrates and forages to achieve normal gains. Overfed heifers consumed 153% of the TDN of controls and weighed 32% more with only 1 in. of additional height. Fat-corrected milk production was 84.8% of controls during the first and later lactations. However, there was considerable unaccountable variation in response of heifers to overfeeding. In the companion study one twin from each pair was underfed by restricting TDN intake to 66% of the control. Heifers were bred to calve close to 24 months of age. Dystocia was common in underfed heifers. Control heifer produced 4,734 lb of milk during the first lactation compared to $4,107 lb for restricted heifers. During the first lactation, restricted heifers grew to 95% of the size of controls and after the first lactation there was no difference in performance.

Wickersham and Schultz (1963) examined the influence of accelerated rearing and early breeding (10, 14 or 18 months) on heifers fed at 114% of Morrison standards. Early calving had no adverse effect on height, conception or calf size. Early, medium and late bred heifers calved at average ages of 20.7, 24.2 and 27.9 months. Dystocia was higher for early bred heifers, and milk production was numerically, but not statistically different than heifers calving at older ages.

Sejrsen et al. (1982) demonstrated effects of pre- and postpubertal gain on mammary development using 12 pre- (7 mo.) and 12 post-pubertal (13 mo.) heifers fed to gain either 1.3 or 2.6 lb /day. Prepubertal heifers were slaughtered at similar body weights of 705 lb but varying ages, 15 vs. 10.9 months. Rapid reared heifers had larger mammary glands (2203g vs. 1683g) with smaller amounts of parenchymal tissue (495 g vs. 642 g) and DNA (1061 vs. 1562 mg). For the postpubertal heifers, those fed to gain 2.6 lb per day had heavier glands with no difference in parenchymal tissue weights or DNA.

Evidence for differences in breed response to rearing rates is provided in the summary of an extensive field trial conducted in Denmark which examined the influence of prepubertal rearing rate on milk production in Danish Jersey, Red Danish and Danish Friesian breeds (Hohenboken et al., 1995).

Table 2: ADGs necessary to achieve suggested 750 lb weight at breeding and post calving body weight of 1200 lb at varying ages.

Age at calving goal (mo.)	18	20	22	24
Age at breeding goal (mo.)	9	11	13	15
ADG birth - breeding (lb)	2.4	1.97	1.67	1.45
ADG breeding - calving (lb)	2.2	2.2	2.2	2.2

Table 3: Response of three dairy breeds to varying rearing rates on age and weight at first calving and first lactation yield. [1]

Breed	n	ADG to 700 lb	Age at Calving		FCM
			Age	BW (lb)	(lb)
D. Jersey	41	.80	29	750	11,275
	44	1.07	26	777	10,450
	44	1.23	23	724	9,075
D. Red	52	1.20	29	1166	12,490
	52	1.58	26	1155	10,780
	51	1.86	23	1078	10,340
D. Friesian	53	1.27	29	1129	11,935
	53	1.61	26	1100	11,880
	55	1.90	23	1095	10,780

[1]This study demonstrated a significant influence of the sensitivity of a smaller breed to accelerated rearing systems.

EFFECTS OF RATE OF GROWTH ON MAMMARY DEVELOPMENT

Differences in mammary conformation have been a distinguishing characteristic of rapidly grown heifers in several studies. Udders were smaller and quartered and that difference persisted throughout their lifetimes. Gross examination of udders revealed incompletely developed parenchyma surrounded by excessive amounts of adipose tissue (Ragsdale et al., and Swanson, 1978). More definitive studies of the influence of rearing rate on mammary development have been summarized by Akers and Sejrsen (1996) and Sejrsen and Purup (1997). It appears that there is a critical stage during rearing, between 180 and 715 lb for large breeds and 100 and 450 lb for small breeds, when nutrition has a pronounced influence on udder development. During this time, mammary tissue begins growing allometrically as compared to the overall body growth. Under conditions of overfeeding, such mammary growth appears to be impaired, resulting in incomplete development of secretory tissue in the gland. Once puberty is reached, mammary growth is isometric relative to body growth and increased rates of gain have no negative effects and may enhance mammary development and subsequent milk production.

The mechanism responsible for altering mammary development is undoubtedly hormonal and linked through the relationship of growth hormone or insulin-like growth factors which are altered in the rapidly gaining prepubertal heifer. Possible mechanisms for alteration of mammary development are the subject of intensive reviews by Sejrsen and Purup (1997) and Akers et. al (1998).

Because increased rates of gain can be achieved with a variety of diets, many workers have questioned, if negative effects of high ADG might be altered by changing diet composition. In one of the largest studies conducted in a single location, Van Amburgh et al. (1994) fed 192 prepubertal heifers three levels of energy and achieved calving ages of 24.3, 22 and 21 months. Half of each group of heifers also received a protein source of higher rumen undegradable protein (**RUP**). Milk yield was lower, but not significantly, for heifers calving at 22 and 21 months. Protein source had no influence on lactation yield. Mantysaari et al., (1996) and Pirlo (1995) also observed that prepubertal dietary protein

Table 4: Growth and body measurements of 40 Holstein heifers fed from 277 lb through puberty as effected by energy level of the diet and BST administration (Radcliff et al., 1997).

	Control	Control + BST	High	High + BST
Overall ADG (lb)	1.7	1.87	2.6	2.79
Age @ puberty (days)	313	337	266	269
Weight @ puberty (lb)	651	717	671	724
Pelvic area (cm^2)	82.7	94.8	85	94.1
Carcass wt. (lb)	376	429	491	513
Carcass protein (%)	17.4	17.9	16.3	17
Carcass fat (%)	16.6	14.1	24.8	21.6
Total parenchyma (g)	401	520	408	661

source or level failed to prevent the negative effect on mammary growth or lactation yield.

Since it is known that endogenous BST levels in the blood are lower in rapidly growing heifers, several workers have examined the response of such heifers to BST supplementation. Recently, Radcliff et al., (1997) evaluated the influence of elevated energy and protein in combination with daily injections of BST on the growth and mammary development in 40 Holstein heifers beginning at 277 lb body weight. The high diet was formulated for 2.6 lb ADG and control diet for 1.76 lb ADG. One half of each group received daily injections (25ug/kg) of BST. Heifers were slaughtered after their third luteal phase. Results are shown in Table 4.

As expected, heifers fed for high gain weighed more and had more carcass fat. BST injections resulted in less fat, no more carcass protein and more total mammary parenchyma. Total DNA and RNA were higher for the high gain heifers indicating that rapid gain in this experiment was not associated with reduced mammary development. However, total parenchyma was not different in heifers not receiving BST, in spite of the fact that the high gain heifers weighed 120 more lb at slaughter. This suggests parenchymal growth was not proportional to body weight in rapidly reared heifers when BST was not supplemented.

WHAT DO WE KNOW ABOUT ACCELERATED REARING AND LIFETIME MILK PRODUCTION?

There still are many unanswered questions. A large body of research indicates that when prepubertal gains exceed 2.0 lb / day in Holsteins and 1.3 lb/day in small breeds there is a risk of permanent impairment of mammary development. Nearly all studies indicate there is no advantage obtained from freshening heifers weighing more than 1350 lb regardless of their age. Therefore, if rapid rearing is to be successful, rates of gain must be closely monitored during the prepubertal period to assure that overfattening does not occur.

A point rarely mentioned is that it is difficult to maintain gains in excess of 2.0 lb/day for prolonged periods of time. Richardson (1987) found that confinement-reared heifers fed high energy rations (67% TDN, DM basis) reduced their daily dry matter intake (**DMI**) as energy requirements were met. As DMI plateaued and decreased slightly, body weight gain moderated. In this scenario, metabolic factors of energy intake regulated intake rather than physical fill factors commonly found to regulate intake in heifers.

FACTORS INFLUENCING DAIRY HEIFER GROWTH AND FEED EFFICIENCY

A common misconception regarding dairy heifer nutrition is that the NRC recommendations provide sufficient nutrients to assure the same rate of gain under a wide variety of environments. One must remember that these recommendations are based on the assumption that replacement heifers are clean, dry, fed ad libitum, free of disease and parasites, unbred and raised at moderate temperatures. In a survey of Wisconsin dairy herds Hoffman et al. (1994) found much of the variation in gains could be attributed to environment rather than feeding programs. Net energy maintenance requirements were 12 - 24 % higher for fall, spring

Table 5: Intake, daily gain, wither height and apparent feed efficiency of Holstein heifers from 6 months until calving fed two levels of energy and two levels of rumen undegradable protein (Bethard 1997).

Item	Low energy/ Low RUP	Low energy/ High RUP	High energy/ Low RUP	High energy/ High RUP
Daily DMI (lb)	9.81	11.9	16.2	13.1
ADG (lb)	1.36	1.63	2.22	2.11
Wither Height (in.)	41.1	42.2	44.5	43.0
D.M. Efficiency [1]	8.12	7.56	7.44	6.43
TDN Efficiency [1]	4.85	4.65	4.98	4.27
Daily gain - 2 mo. after phase I	.22	-1.12	-1.25	-.81
Total ADG 6 mo. - calving	1.23	1.23	1.30	1.43
Calving weight (lb)	1100	1133	1151	1223
Calving age (yr.)	2.3	2.3	2.2	2.3

[1] Efficiency = lb DM or TDN/ lb of gain.

and winter as compared to summer. Failure to adjust for these added nutrient needs could decrease ADG by .2 to .4 lb. A second adjustment is for cold stress. Cold stress occurs at low temperatures when the animal has lost the insulating capacity of its coat due to excess mud or moisture (Hoffman, 1996).

Temperature has an influence on DMI. However, research in studies in Virginia and other northern states by Quigley et al., (1986) and Hubbert (1991) found that although temperature had a statistically significant influence on intake, it was of little practical value. In heifers, intake does not increase appreciable unless weather is less that 10^{o}F for more than several days. Likewise heifers are not as prone to experiencing a meaningful depression in daily DMI during hot weather. Heifers delayed eating during the day and consumed the majority of their ration during the cooler hours of the evening (Quigley et al., 1986a).

Housing type has a strong influence on growth and feed efficiency. Heifers raised in well designed confinement systems are not subjected to wind, rain, snow or solar radiation. Nutrient expenditures for exercise are also reduced compared to pasture or more open housing systems. Several studies (Quigley et al., 1986a,b, and Tomlinson et al., 1997) conducted in a counter-sloped heifer barn have demonstrated that housing systems with 45 sq. ft./head result in higher feed efficiency than expected according to NRC. The relationship of housing system to animal performance is shown in a study by Bethard (1997). Thirty two Holstein heifers were studied in a 2 X 2 factorial design involving 2 levels of energy (1.32 or 2.0 lb ADG) and two levels of rumen undegradable protein (30 or 50% of CP). The total mixed ration was comprised of corn silage, alfalfa silage, ground orchardgrass hay, corn and either soybean meal or blood meal. Heifers were reared in the counter-slope facility from six to fourteen months of age, after which they were housed in outdoor lots and fed a ration with sufficient nutrients for 1.5 lb ADG (NRC, 1989). Intake, growth and apparent feed efficiency for the first phase are shown in Table 5.

After leaving confinement housing, heifers lost appreciable amounts of weight for nearly two months before returning to a positive ADG. Weight loss is attributed to excessive exercise of confinement-reared heifer once they had gained *their freedom*. Subsequent recommendations have been made to include transition housing and higher energy and protein rations during the adjustment to increased physical activity. It is interesting to note that animals that gained the most prior to 14 months lost the most weight post-confinement. Slow growing heifers during phase I were still smaller at calving.

RUMEN UNDEGRADABLE PROTEIN IN DAIRY REPLACEMENT RATIONS

The most recent version of the NRC (1989) included recommendations for RUP in dairy replacement rations. Since then, we have conducted several short and long term trials to investigate responses to RUP in dairy heifer rations. Our most positive response occurred in a trial reported by Tomlinson et al. (1997) which studied the response to four levels of RUP in isonitrogenous and isocaloric rations over a 60 day period. Rations formulated for

Table 6: Diet nutrient composition, body weight gain and intake of heifers consuming TMR's with four different levels of RUP (Tomlinson et al., 1997).

Item[1]	RUP, % CP 31	43	50	55
Initial BW, lb	491	474	509	478
Diet CP, % DM	11.8	11.7	12.2	12.7
Diet TDN, % DM	64.4	63.6	63.4	63.9
BW Gain, lb/d	1.9	2.0	2.0	2.1
Dry matter intake, lb/d	13.2	11.0	10.6	9.7

[1] BW = body weight, CP = crude protein, RUP = rumen undegradable protein, TDN = total digestible nutrients.

1.7 lb ADG were based on corn silage, ground barley straw, soybean meal or blood meal, corn and minerals.

As with previous studies, although rations were formulated for 1.7 lb ADG, heifers gained nearly 2.0 lb. As RUP in the diet increased, DMI decreased while ADG remained the same, indicating a significant influence on apparent feed efficiency. Whether declines in DMI were due to palatability or lower soluble protein in the ration could not be determined. Caution is advised in interpreting results of this study due to its short length and that blood meal, which is known to be deficient in methionine, was used as the RUP source. Subsequent studies by Bethard (1997) failed to observe as significant a response to RUP as this study did.

Eichler et al. (1997) evaluated four different protein sources using 32 Holstein heifers in a counter-sloped confinement facility. Diets were on corn silage, ground orchardgrass hay, ground corn, minerals and a protein supplement in a 60 day feeding trial as shown in Table 7. Protein was supplied by either soybean meal, blood meal, fish meal or Pro-Lak (H. J. Baker and Brothers, Inc., Atlanta, GA).

As seen previously, gains were much higher than expected. Short duration feeding trials are more likely to result in such findings than those conducted for several months duration. Feed efficiency was higher for heifer receiving Pro-Lak or fish meal. Heifers receiving fish meal consumed more DM/day, but differences in ADG were not significant. In this scenario, feed costs were such that improved feed efficiency justified the higher price of the blended RUP source.

Over all of our studies and those of others (Penn State) responses to RUP have been inconsistent with the exception of improved feed efficiency. However, the producer rarely is likely to benefit from this unless reductions in nutrient content are made to the ration to save money.

ECONOMY OF DAIRY HEIFER REPLACEMENT FEEDING SYSTEMS

Providing an adequate supply of replacements represents approximately 15 - 20% of the cost of producing milk, second only to feed cost for the lactating cows. Daily expenditures range from an average $1.40 to $1.75/day of life with expenditures during some stages of the life cycle of the heifer reaching over $2.00/day. Estimates of expenses per calving replacement heifer range from

Table 7: Diet characteristics, intake, daily gain and apparent feed efficiency of Holstein heifers fed one of four different protein supplements (Eichler et al., 1997).

Item[1]	Soybean Meal	Blood Meal	Fish Meal	Protein Blend
Initial BW, lb	551	551	551	544
CP, % DM	12.0	12.0	12.0	12.0
TDN, % DM	66.0	66.0	66.0	66.0
RUP, % CP	26	46	46	40
Dry matter intake, lb/d	15.3	15.4	15.9	15.4
Gain, lb/d	2.4	2.2	2.9	2.8
BW gain/DMI	0.159	0.161	0.188	0.198
Ration $/lb	0.050	0.053	0.062	0.056
$/lb BW gain	0.334	0.346	0.346	0.298

[1] BW = body weight, CP = crude protein, RUP = rumen undegradable protein, TDN = total digestible nutrients.

Table 8. Costs to intensively rear Holstein heifers from 120 days to breeding size in 187 days (Radcliff et al., 1997).

Item	$/heifer	$/day	% of total
Grain	$155.45	$.83	38.6
Haylage	$32.52	$.17	8.1
Bedding	$50.65	$.27	12.6
Health	$2.07	$.01	0.5
Utilities, supplies	$5.13	$.03	1.3
Labor	$52.45	$.28	13.0
Interest	$7.65	$.04	1.9
DIRTI	$97.15	$.52	24.1
Total	$403.17	$2.15	100

$800 to $1,300 (Cady and Smith, 1996). In the typical budget, feed and labor comprise 50 to 75% of the cost of rearing. Therefore, significant savings are realized in systems which control feed costs, maintain a high degree of labor efficiency and permit the grower to achieve age and weight at calving goals. Systems have been proposed which are diametrically opposed in how they achieve these goals. Intensive systems have been proposed which seek to achieve a 20 month AFC. Radcliff et al. (1997) proposed a system which resulted in gains exceeding 2.5 lb per day as a means to breed heifers at an early age. Cost for this management program are shown in Table 8.

This program comprises less than a third of the rearing period, yet results in a daily charge exceeding $2.15/day, which is substantially above current estimates of $1.50 - $1.75/day. This program emphasizes an aggressive feeding program which utilizes substantial quantities of grain, haylage and confinement housing to achieve the desired rates of gain.

In contrast, Miller and Amos (1986) from Georgia proposed a low intensive system which maximized the use of pasture forages, minimized quantities of grain and achieved a 31 mo. AFC. This program is shown in Table 9. This system results in a daily cost of $.59/heifer. A more recent pasture-based system has been proposed by Randle et al. (1998) which realizes a 24 mo. AFC and a daily cost of $1.11.

Bethard (1997) developed a program to simulate dairy heifer growth to evaluate the influence of various management strategies on rearing costs. He examined the impact of 6 different combinations of accelerated, slow and normal growth during two periods (5 weeks to 14 months and 14 months to calving) on total rearing cost and estimated profit. Heifers were bred at 750 lb or when they reached 14 months and weighed at least 660 lb. Accelerated heifers weighed 176 lb more than slow gaining heifers at calving. Accelerated heifers weighed 110

Table 9: Low intensive pasture- based heifer rearing program (Miller and Amos, 1986).

Item	Quantity	$/unit	Cost ($)
Milk replacer	50 lb	.75	38
Grain	570 lb	.085	48
Hay	1.5 tons	$75	$112
Pasture	4.1 tons DM	$20	$82
Vet., Med. , Utilities			$45
Labor	20 hours	$7	$140
Operating capital		$600	
Interest on operating capital	8%		$48
Building and equipment			$40
Total			$553

Table 10: Daily gain, AFC and estimated costs for 6 different rearing systems (Bethard, 1997).

Item	Control	Accel	Slow	C/A	A/C	S/A
ADG (lb) birth - calving	1.72	2.00	1.36	1.72	1.54	1.76
Age at first calving (mo.)	25.1	23.1	27.4	23.1	23.0	23.1
Total rearing cost ($)	1246	1220	1275	1148	1148	1138

C = control, A = accelerated, S = slow rate of gain.

lb more than slow gaining heifers at 14 months and 55 lb more than controls at calving. ADG, AFC and total rearing cost are shown in Table 10. Rearing costs were lower with more moderate prepubertal gains followed by more rapid postpuberal gains than normally occurring on heifer replacement programs.

More economical heifer feeding programs have been focused around either minimizing length of the rearing period by feeding rations of higher nutrient concentration or through minimizing daily feeding costs while accepting a slightly higher AFC. Based on our experience, it is difficult to justify the additional cost of premium quality ingredients such as RUP sources in the growing dairy heifer ration. Feeding rations of high nutrient density during the prepartum period entails risk of causing impairment of mammary development. If this approach is to be followed, it is imperative that animal growth be closely monitored by frequent weighing and body condition scoring and that adjustments be made to the ration to prevent overfattening. Heifers must calve at average ages below 24 months to justify the added daily expense.

However, an overwhelming body of evidence suggests that systems which don't result in freshening by at least 24 months with body weights after calving of at least 1200 lb are not profitable either. The extra days of rearing, delayed income, and poorer first lactation yields, if body weight goals are not achieved, are not profitable. It seems that the optimum may occur at some compromise of both extremes where gains of 1.5 to 2.0 lb per day are achieved for large breed heifers using low cost ingredients, whether they be forages or by-products. Some of the most economical feeding programs can be found in areas with high availability of by-product feeds and low cost forages. In north central Colorado, poorer quality alfalfa haylage, carrots, potatoes, onions, beet pulp, wet brewers grains and grain screenings are used in rations which enable heifers to gain in excess of 1.7 lb/day with a low daily feed cost. It is also likely that no one system is best for all regions of the U.S., as each area has its own limitations and unique resources for heifer rearing.

KEY INGREDIENTS TO PROFITABLE HEIFER MANAGEMENT SYSTEMS

1. Evaluate unique feed resources available as heifer feeds. Economical feed ingredients are essential. High quality ingredients in terms of nutrient content, are not a prerequisite to success, as heifer nutrient requirements are much lower than those of lactating cows. Pasture, poorer quality forages and by-product feeds are especially suited to serve as the base of most heifer feeding systems.

2. Utilize labor efficient feeding facilities, which enable the manager to monitor feed intake, and provide conditions for optimal daily ration intake with minimal labor. Fence-line feeders are a good example.

3. Provide facilities which permit safe, routine handling for health procedures and routine weighing.

4. Monitor growth in weight and height, record it and make adjustments to rations based on animal performance. This is especially important during the prepubertal period when excessive growth might impair mammary development. Most heifers are not weighed because it is too dangerous or too much trouble. Well designed facilities eliminate this argument.

5. Don't overfeed heifers. It is an added expense with no economic benefit when post calving body weights exceed 1350 lb. There is evidence that increased dystocia may result.

6. Maintain a favorable environment when it is cost effective. Heifers must be dry during cold weather to minimize maintenance expense, however, achieve this as economically as possible.

7. Maintain records that enable informed management decisions.

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