ARIZONA AND NEW MEXICO DAIRY NEWSLETTER

COOPERATIVE EXTENSION
The University of Arizona
New Mexico State University

JULY 2005

THIS MONTH'S ARTICLE:

Reduced Age at First Calving: Effects on Lifetime Production, Longevity, and Profitability

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(Reprinted from the 2004 Arizona Dairy Production Conference Proceedings, November 4, 2004, Tempe, Arizona)

4th Annual Arizona Dairy Production Conference

Tuesday, October 11, 2005

Sheraton Phoenix Airport Hotel
1600 South 52nd Street
Tempe, Arizona
(480) 967-6600

Conference Program

9:00 a.m. Registration

9:30 a.m. Welcome and Introduction

9:45 a.m. ***Dollars and Sense of Excellent Calf Management***
Samuel Leadley, PH.D., PAS
Attica Veterinary Associates

10:25 a.m. ***Reducing Clinical Mastitis on Dairies: Experiences with Failure...and Success***
Keith Sterner, DVM
Sterner Veterinary Clinic

11:10 a.m. Break

11:25 a.m. ***Rumen Acidosis, Heat Stress and Laminitis***
Jan Shearer, DVM, MS
University of Florida

12:05 p.m. Lunch served

12:45 p.m. ***State of the Department Address***
Bob Collier, Ph.D.
The University of Arizona

1:00 p.m. ***Systematic Synchronization and Resynchronization Systems for Lactating Dairy Cows***
Paul Fricke, Ph.D.
University of Wisconsin

1:40 p.m. ***Effect of Increased Milking Frequency During Early Lactation on Health and Performance Parameters of Lactating Dairy Cows***
Matthew VanBaale, Ph.D.
The University of Arizona

2:20 p.m. Conference Concludes - Ice Cream Reception

For more information, contact Laura Rittenbach at
ljr22@Ag.arizona.edu or (520) 626-9382

Register at www.ag.arizona.edu/extension/dairy/conferences/2005

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PO Box 210038
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Tucson, AZ 85721

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For addidtional information call 520-626-9382 or email ljr22@ag.arizona.edu

Reduced Age at First Calving:
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INTRODUCTION

The time between birth and first calving represents a period in which replacement heifers are not generating income. Instead this rearing period requires considerable capital expenditures including feed, housing, and veterinary expenses. These expenses constitute 15 to 20% of the total expenses related to milk production (Heinrichs, 1993). A basic approach to reducing this cost is to reduce the amount of time between the heifer's birth and her first freshening. Age at first calving (AFC) has a significant influence on the total cost of raising dairy replacements with older calving heifers being more expensive to raise than younger (Tozer and Heinrichs, 2001). Furthermore, reducing AFC can also improve the profitability of the enterprise by increasing lifetime milk production and milk production per year of herd life (Lin et al., 1988). AFC can be reduced by a combination of increasing prepubertal average daily gain and decreasing age at breeding (Gardner et al., 1988; Van Amburgh et al., 1998; Radcliff et al., 2000) or by reducing age at breeding alone (Lin et al., 1986; Ettema and Santos, 2004).

Universal recommendations for one particular AFC might be an incorrect management goal for all cattle on all farms, since the recommendation might not represent the management goals and/or capabilities of a particular production system or farm. This, however, does not mean that we should not work towards a younger AFC. We realize that each dairy has it's own set of unique management and environmental conditions that make a universal AFC and BW after first calving a difficult goal to achieve. The purpose of this paper is to address the impact reducing AFC has on milk production, cow stayability, and farm profitability. Target growth will also be introduced and a basis for its use will be provided.

MILK YIELD AS INFLUENCED BY BW AT CALVING, PREPUBERTAL ADG, AFC

The biology involved with the interaction between reduced AFC and first lactation milk yield has been difficult to identify and quantify. This is due to the fact that a reduction in AFC is often associated with increased prepubertal daily gain and/or reduced body weight at calving, both of which have been shown to influence future milk yield.

Body weight at calving is positively correlated to first lactation milk yield (Keown and Everett, 1986, Moore et al., 1991; Van Amburgh et al., 1998). Both Keown and Everett (1986) and Van Amburgh et al. (1998) suggest that 1,210 lbs is the approximate optimum post calving body weight to maximize first lactation milk yield by US Holsteins. Indeed, Van Amburgh et al., (1998) reported no effects of AFC or prepubertal ADG on first lactation milk yield when the variation in milk yield associated with post caving BW was removed by covariate analysis.

The effect of elevated prepubertal ADG on first lactation milk yield in Holsteins is not as well defined. There exists a wealth of data describing the negative effect that excessive prepubertal energy intake and elevated ADG has on first lactation milk yield in smaller framed Danish breeds (reviewed in Sejrsen and Purup, 1997). The period during which excessive energy intake is thought to negatively influence first lactation milk yield is between 3 months of age and puberty. Sejrsen and Purup (1997) propose that average daily gain in excess of 0.88, 1.32, and 1.54 lbs for Jerseys, Danish Red, and Danish Friesians, respectively, will impair first lactation milk yield. Using US Holsteins, Radcliff et al. (2000) and Lammers et al. (1999) observed a significant 5 and 13% reduction, respectively, in first lactation milk yield by growing prepubertal heifers at greater than 2.2 lbs/d compared to heifers grown at 1.69 and 1.56 lbs/d, respectively. Radcliff et al., (2000) reduced AFC from 23.6 to 20.7 months while Lammers et al., (1999) AFC averaged 22.8 months without any treatment effect. Contrary to the previous papers, Waldo et al. (1998) observed no significant effect on first lactation milk yield by US Holsteins fed to gain either 2.18 lbs/d or 1.72 lbs/d. Age at first calving in this study averaged 24 months without an effect of prepubertal ADG. These authors (Waldo et al., 1998) proposed that US Holsteins might have a greater mature body weight than the Danish breeds employed by Sejrsen and Purup (1997) whereby making them less sensitive to higher rates of gain. It is well documented that fat deposition in early maturing breeds (i.e. smaller framed) is more responsive to plane of nutrition than larger, late maturing breeds (Fortin et al., 1980; Old and Garrett, 1987). Therefore, it is plausible that the smaller Danish breeds experience greater whole body adiposity than US Holsteins grown at a similar rate. This difference in conditioning at parturition is likely to have a negative influence on health and lactational performance (Fronk et al., 1980; Boisclair, et al., 1987) in the smaller breeds.

The data on the effect reduced AFC has on first lactation milk yield by US Holsteins is variable. Some have observed no effect (Gardner et al., 1988) while others have observed a negative effect (Lin et al., 1986; Van Amburgh et al., 1998; Radcliff et al., 2000; Ettema and Santos, 2004). Milk yield in second and greater lactations has consistently been unaffected by reduced AFC (Lin et al., 1986; Gardner et al., 1988, Van Amburgh et al., 1998). In fact, Lin et al., (1988) observed greater lifetime production and greater production per year of herd life in heifers that freshened at 23 vs. 26 months of age. The pool of recent literature (Gardner et al., 1988; Lin et al., 1988; Hoffman et al., 1996; Bar-Peled et al., 1997; Van Amburgh et al., 1998; Radcliff et al., 2000; Vicini et al., 2003a, 2003b; Ettema et al., 2004) suggests that a reduction in AFC from an average of 24.7 to 21.9 months results in an approximate 4.8% reduction in first lactation milk yield (Table 1). In these studies, AFC was reduced by either reducing age at breeding alone or in combination with increasing prepubertal ADG.

HEIFER HEALTH, REPRODUCTION, AND STAYABILITY AS INFLUENCED BY AFC

In addition to milk yield, stayability of cows in a milking herd can have a profound impact on the profitability of the enterprise; therefore, potential effects of reducing AFC must be considered. Gardner et al. (1988) addressed this issue by raising 443 US Holsteins on an elevated or restricted amount of energy from 6 weeks of age to breeding at 748 lbs (supporting 1.96 and 1.74 lbs/d for the elevated and restricted groups, respectively). As a result of the elevated nutrient intake and lower age at first breeding, heifers receiving an elevated amount of energy freshened at 22.4 months compared to 24.6 months for those receiving a restricted amount of energy. Pre-breeding ADG and

AFC had no effect on milk yield in the first or subsequent six lactations. Calving difficulty was not different between the two groups. Percent of heifers in the herd at the start of the 1st, 2nd, 3rd, 4th, 5th, 6th, and 7th lactations averaged 100, 73, 46, 29, 18, 6, and 2%, respectively, with no difference between the two AFC groups. Likewise, after 7 lactations, reasons for cows leaving the herd (including reproductive problems, mastitis, died, low production, reproduction & low production, disease other than mastitis, and crippled) were not affected by prepubertal ADG or AFC.

More recently, Ettema and Santos (2004) evaluated the effects of altering age at breeding to effect a change in AFC. Holstein heifers (n = 1933) on three commercial California dairies were raised similarly from birth through breeding then retrospectively assigned to one of three groups based on AFC. All heifers presumably experienced the same pre- and post-pubertal ADG. Average AFC for the three resulting groups were 22.3 (n = 514), 23.7 (n = 917), and 25.9 months (n = 474) for low, medium, and high AFC, respectively. Total milk yield in the first 310 days in milk was 22,779, 23,461, and 23,665 lbs for low, medium, and high AFC, respectively, with the high and medium AFC groups producing significantly more milk than the low AFC group.

Conception rate at first AI after freshening and number of AI per cow were 27.9% and 3.27, 36.9% and 2.85, and 30.8% and 3.23 for low, medium, and high AFC calving, respectively, with low and high AFC having significantly poorer reproductive performance in both of these categories than medium AFC. Number of days open for pregnant cows was unaffected by AFC and averaged 121.2 across the three groups. However, number of days open for all cows (including those that did not breed back) was 160.9, 148.6, and 154.5 for low, medium and high AFC, respectively. In this case when all cows were considered, cows in the low AFC group spent significantly more days open than cows in the medium AFC group. Despite this, the fraction of cows pregnant at 310 DIM averaged 80.6 and was not different across the groups. The percent of cows experiencing abortion averaged 10.0% and was not influenced by AFC. Difficulty associated with conception in early calving heifers could be attributed to a greater energy demand for growth resulting in less energy available for reproduction when compared to presumably heavier heifers that freshen at an older age.

Calving difficulty has profound negative impacts on the health, reproduction and stayability of first calf heifers (Erb et a., 1985). Furthermore, heifer size at first calving, but not AFC, is correlated to incidence of dystocia (Thompson et al., 1983). Supporting these data, Ettema and Santos (2004) observed no effect of AFC on calving difficulty scores. This suggests that their lowest mean BW at calving (1,254 lbs, low AFC group) was adequate to ensure ease of calf delivery. It should be noted that Ettema and Santos (2004) estimated the BW of pregnant heifers using the heart girth measurement with a measuring tape for Holsteins. In agreement with the findings of Erb et al., (1985), Ettema and Santos (2004) observed that across all AFC treatment groups, cows requiring physical assistance with calving experienced significantly higher mortality (4.9%) than those not experiencing dystocia (2.7%). Given these facts and the fact that calving difficulty is most frequently associated with inadequate BW at calving, it becomes clearly apparent that BW at calving can have a profound impact on the long term heath and stayability of cows.

Neither the incidence of health problems, culling, or mortality was influenced by AFC in the study by Ettema and Santos (2004). Health problems (and average incidence across the three AFC groups) included retained placental membrane (3.3%), left displaced abomasum (2.9%), lameness (15.0%), and incidence of mastitis (19.4%). AFC did not affect the incidence of these health problems. Likewise, AFC had no affect on the fraction of heifers culled after calving (17.6%) or mortality (3.9%). The authors, did, however, observe a tendency for the low AFC heifers to die earlier in lactation than the high AFC cows (20.3 vs. 77.7 d). However, the fraction of heifers that died or were sold before 310 DIM averaged 21.7% and was similar across all three AFC groups. Additionally, the interval from calving to date leaving the herd averaged 255 d and was not affected by AFC.

In agreement with the data of Thompson et al. (1983), Gardner et al. (1988), and Ettema and Santos (2004), Simerl et al. (1992) observed no affect of AFC on first calf heifer survival to second lactation for 1,144 Florida Holstein heifers. Taken together, these data strongly suggest that heifers freshening at ~22 months and with adequate post calving BW have similar stayability in the herd as those freshening at an older age. Furthermore, the negative effect of freshening heifers under weight is quite profound and cannot be ignored.

ECONOMICS OF INCREASED PREPUBERTAL ADG AND REDUCED AFC

The economics associated with reducing AFC has been the topic of much debate. Under the auspices that elevated prepubertal ADG negatively influences first lactation milk yield, St-Pierre (2002) analyzed data from three studies (Van Amburgh et al., 1998; Lammers et al., 1999; and Radcliff et al., 2000) to determine the economically optimal prepubertal ADG for US Holsteins. To assess the financial impact of freshening heifers at a younger age, St-Pierre considered the net present value or time value of money ("a dollar five years from now is not worth the same as a dollar today"). This assigns economic benefit to heifers generating income earlier by initiating lactation at a younger age. Using this analysis, St-Pierre estimated the economic optimum prepubertal ADG and AFC to be between 1.98 and 2.42 lbs/d and 22.4 and 20.6 months, respectively.

Ettema and Santos (2004) conducted an economic analysis of the AFC study that was discussed above. As mentioned, average AFC (and 310 d milk yield, lbs) for the three resulting groups were 22.3 (22,779), 23.7 (23,461), and 25.9 months (23,665 lbs) for low, medium, and high AFC, respectively. Rearing costs for the medium and high AFC groups were $40.34 and $107.89, respectively, more than that of the low AFC group. Income for each AFC group was adjusted for the cost of rearing, estimated feed to increase milk yield, stillbirths, diseases, days open, culling, mortality, labor cost, and the value of milk and calf produced as well as the value of a cow at the end of the 310 day study. Adjusted income was $119.73 and $9.08 more for the medium and high AFC, respectively, than for the low AFC. These values were not significantly different, implying no single AFC had an economic advantage over another. However, these authors (Ettema and Santos, 2004) did not consider the net present value of money in their analysis as St-Pierre (2002) did. If this had been considered, it would presumably shift the economic advantage to the low AFC heifers.

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A WITHIN HERD ANALYSIS: EFFECTS OF AFC ON MILK PRODUCTION AND STAYABILITY

Recently, we evaluated the within herd effect of varying AFC on lifetime milk production, stayability, and number of lifetime productive days. Lactation records from 2,519,232 first lactation cows from 937 herds in California and the Northeast were analyzed using the test-day model (TDM) (Kachman and Everett, 1989). The lactations occurred between January 1985 and December 2002. The TDM was employed for this analysis because it describes and accounts for factors that influence lactation performance such as calving year, season, management, and environment. Test day residuals include the random genetic cow effects and treatment effects (AFC in this case). These residuals are simultaneously adjusted for herd test day, days in milk, calendar month fresh, pregnancy, and management effects. Test-day analysis is considered a more appropriate approach to this type of data analysis because it assumes that global conditions are inappropriate for evaluating management (i.e. AFC) among different herds.

Average AFC for each year was calculated for each of the 973 herds. Within a herd, heifers were then retrospectively assigned to one of five treatment groups that fit around the herd mean AFC. The AFC treatment groups consisted of 1) less than -63 days from the herd by year average AFC, 2) -22 to -63 days from the herd by year average AFC, 3) -21 to 21 days from the herd by year average AFC, 4) 22 to 63 days from the herd by year average AFC, and 5) greater than 63 days from the herd-year average AFC. Actual AFC across all herds for the five groups were 23.3, 24.3, 25.6, 27.2, and 30.3 months, respectively.

Once assigned to an AFC group, cows were assigned to one or more opportunity groups defined as 3, 4, 5, 6, 7 or 8 years of age. Heifers were assigned to opportunity groups if they had the opportunity to be the age of the group. For example, a cow that has had the opportunity to be 5 years old at the time of test would be assigned to the 3, 4 and 5 year opportunity groups, but not to the 6, 7, or 8 year group. The sum of her 5 year total milk production and the sum of her 5 year total productive days (defined as the number of days lactating) would be averaged with all other cows in the 5 year opportunity group. Likewise, the sum of her 4 year total production and the sum of her 4 year total milk production would be averaged with all other cows in the 4 year opportunity group, and so forth. By the definition of an opportunity group, her data would be included in the 5 year opportunity group even if she had died at 4 years of age. The use of opportunity groups in this analysis permits the evaluation of total milk produced and total productive days at a given age across treatment groups (i.e. AFC) while simultaneously discounting the treatment groups for any treatment associated differences in early death loss.

The total number of cows in each of the five AFC treatment groups and the number assigned to their appropriate opportunity groups is given in Table 2. As mentioned above, the average AFC for the five treatment groups were 23.3, 24.3, 25.6, 27.2, and 30.3 months. These treatment groups will be referred to by their average AFC from this point on. The differences in AFC within each farm and year are assumed to have arisen from a combination of differences in prepubertal ADG and age at first breeding or by differences in age at first breeding alone.

Perhaps the most obvious benefit of reducing AFC is its effect on the number of productive days in a cow's lifetime. Total productive days of cows in each AFC treatment group are given in Table 3. As discussed above, by freshening heifers at a younger age, they enter the productive phase of their life sooner. Heifers with a lower AFC have an advantage over those freshening at an older age throughout all 6 opportunity groups. Within a given AFC treatment group, the number of productive days increases rapidly in the first three opportunity groups and then its rate of increase slows as you approach the 8 year opportunity group. This occurs because going from the 7 to the 8 year opportunity group, for example, likely only adds a few cows that have actually survived this long. Their number of productive days (presumably quite high) is averaged with all other cows in that AFC group which is likely heavily weighted with animals that died at a younger age and therefore had fewer productive days. This causes the increase in number of productive days to slow in the older opportunity groups. This can be observed happening across all 5 AFC treatment groups.

Effect of AFC on number of productive days for the 5 AFC treatment groups is more clearly illustrated in Figure 1 where the data are represented as the difference from the 25.6 month AFC treatment group. Again, it is apparent that heifers in the 23.3 month AFC treatment group have the obvious advantage over all other AFC groups. This is despite the fact that the average number of productive days decreases from a high of 59 days above the 25.6 month AFC group at the 3 year opportunity group to approximately 35 days from the 5 through the 8 year opportunity groups.

The most effective way to evaluate the benefit of reducing AFC and increasing the number of productive days in a cow's lifetime is to consider her lifetime milk production. Lifetime milk production for each of the five AFC treatment groups at the six opportunity groups is given in Table 4. For heifers in the 3 year opportunity group, those that freshened at 23.3 months produced nearly twice the amount of milk as those that freshened at 30.3 months. This trend for increased lifetime milk production continues even to the 8 year opportunity group. As was observed with the total number of productive days, within a given AFC treatment group the total milk production at each opportunity group increases rapidly from the 3 through 5 year opportunity groups then slows as you progress through to the 8 year opportunity group. This occurs for the same reason total number of productive days increases at a rapid then slower rate, as described above.

The differences across the five AFC treatment groups in lifetime milk yield are more visually apparent in Figure 2. Lifetime milk production in this figure is presented as the difference from the 25.6 AFC group, which represent the herds' average AFC. Heifers calving in the 23.3 month AFC group produced more milk in their lifetime than all other AFC groups through the 5 year opportunity group with the greatest difference being at the 3 and 4 year opportunity groups. In the 3 year opportunity group, few heifers in the 30.3 month AFC group have freshened and those that have are likely only in the early stages of their first lactation. Even though the increase in milk yield for the 23.3 and 24.3 month AFC treatment groups becomes similar by 6 years, the production and economic advantage lies with the 23.3 AFC group due to the fact that they produce more milk sooner. This allows the producer to capitalize on the time value of money concept discussed previously. In agreement with data for Lin et al., (1988), this increase in lifetime milk production clearly illustrates the advantage of freshening at a younger age.

At first glance, average stayability (percent survival) for the five AFC treatment groups (Table 5) seems to weight heavily against calving at lower AFC. Others (Thompson et al., 1983; Simerl et al., 1992; Gardner et al., 1998; and Ettema and Santos, 2004) have reported that stayability is not influenced by AFC. While our data may appear to reach a different conclusion, it is important to understand that we have calculated stayability using a different time reference than these other authors. Both Ettema and Santos (2004) and Gardner et al., (1988) calculated stayability after the conclusion of the first lactations. Therefore, heifers from both high and low AFC groups were "exposed" to the same length of lactation and all have an equal amount of production data upon which culling decisions were made. In our case, we compared stayability at a common age so, for example, in the three year opportunity group, heifers in the 23.3 AFC treatment group have been milking an average of 354.8 days where as those in the 30.3 AFC treatment group have been milking an average of 165.7 days (Table 3). Therefore, younger calving heifers have more than twice the amount of production data with which culling decisions could be made and they have a decidedly greater opportunity to be culled. Perhaps most importantly, the differences in stayability between heifers in the 23.3, 24.3, and 25.6 AFC treatment groups are quite similar, even at the lowest age opportunity groups. The differences between how we compare stayability across AFC treatments and how Gardner et al. (1988) and Ettema and Santos (2004) made their comparisons is important to understand.

SUMMARY OF WITHIN HERD ANALYSIS OF AFC

Taken together, these data support management decisions that result in working towards a lower AFC. The increase in lifetime milk production that results from calving at 23.3 months compared to 25.6, 27.2, or 30.3 months is substantial and difficult to ignore. While the lowest average AFC in this data set was 23.3 months, it appears safe to conclude that further increases in number of productive days and lifetime milk production would occur if average AFC was further reduced to 22 months. This conclusion is based upon the stayability data of Tompson et al. (1983), Simerl et al. (1992), Gardner et al. (1988), and Ettema and Santos (2004) and the lifetime production data of Lin et al. (1988).

A SYSTEMATIC APPROACH TO MANAGING HEIFERS: TARGET GROWTH

The target growth system (Fox et al., 1999; Van Amburgh, 2004) was first modified for dairy heifers and further modified and adapted by the NRC (2001) to establish a systematic approach to heifer management. The objective of a farm manager should be to determine at what age/weight relationship do cattle generate the highest marginal profit and then manage to that target. Data presented above suggest that the optimal age and BW after first calving is around 22 months and 1,210 lbs. However, variability in mature body size was not considered in these suggestions. The biologically and economically ideal BW and age at calving is expected to vary with BW at maturity. Therefore, knowing a herd's mature BW is required for successful application of this system. At its core, the target growth program is a straightforward approach to determining, managing, and attaining these age and BW targets.

The NRC (2001) has recommended that BW at first conception and after first calving should be 55 and 82% of mature body weight, respectively. If the mature BW of the typical high merit US Holstein is assumed to be 1,474 lbs, this would set the target BW at conception and after calving at 807 and 1,210 lbs, respectively. The third set of targets consists of preweaning ADG and weaning age. Naturally, lower target AFC requires higher rates of gain in order to achieve target weights at conception and after calving. However, with an efficient breeding program, AFC can be effectively lowered without requiring excessive prepubertal rates of gain. An additional approach to control rates of gain between 3 months of age and puberty is to feed for elevated preweaning rates when body growth is most efficient.

Two examples of target growth solutions are shown in Figures 3 and 4. Both examples illustrate the target weights, ages, and rates of gain for heifers freshening at 22 months and 1,210 lbs after calving. All assumptions are the same between the two examples with the exception of the preweaning program. Figure 3 assumes that a traditional preweaning program is employed, which supports an ADG of 1.0 lbs/d during the milk fed phase. Figure 4 assumes an intensified preweaning program, which supports a preweaning ADG of 2.0 lbs/d.

Use of an intensified preweaning program yields approximately 56 lbs of additional growth after 8 weeks on milk relative to a traditional calf program. This advantage in BW at weaning permits a lower ADG from weaning to conception (2.0 vs. 1.8 lbs/d) while still meeting the target age and BW at conception. This particular intensified preweaning program is, however, more costly than a traditional program simply because more milk (or milk replacer) is required to achieve the additional weight gain. If a high quality all-milk milk replacer is used, a heifer on this intensified program would require approximately 57 lbs more powder to achieve the additional 56 lbs of BW at weaning. Starter would also be consumed starting around 3 weeks of age to support this additional BW at weaning.

CONCLUSIONS

The primary advantages of reducing AFC include reducing rearing costs as well as reducing the amount of time in which the heifer is only a capital drain on farm resources. The primary disadvantage of reducing AFC is that it is frequently associated with a reduction in first lactation milk yield. Despite this reduction in first lactation milk yield, production per year of herd life is typically increased by reduced AFC. Furthermore, while the first lactation may be influenced by AFC, future lactations are decidedly not. Additionally, stayability and health of cows is not influenced by reduced AFC as long as first calf heifers freshen at an adequate weight.

Most analysis indicates that the financial advantage afforded to heifers that freshen at a low AFC appears to at the least offset any milk lost in the first lactation. Furthermore, when the time value of money is considered in this analysis, a reduced AFC (~22 months) appears to likely represent the more fiscally sound management decision. When applying these ideas on the farm, a properly managed feeding and breeding program should permit a first calf heifer to weight ~1,210 lbs after freshening at 22 months of age. The NRC (2001) recommends a post weaning BW equal to 82% of her mature body weight. This can be achieved with a maximal prepubertal ADG of 2.0 lbs/d if a traditional preweaning program is employed or 1.8 lbs/d if an intensified preweaning program is employed. Due to the well defined link between inadequate BW at calving and increased mortality and morbidity in first calf heifers, achieving this target post calving BW is of critical importance.

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Table 1. Recent publications evaluating the effect of reduced AFC on first lactation milk yield.

Study[1]	Prepubertal ADG, lbs/d Late AFC	Prepubertal ADG, lbs/d Early AFC	Weight after calving, lbs Late AFC	Weight after calving, lbs Early AFC	AFC, months Late AFC	AFC, months Early AFC	First lactation milk yield, lbs Late AFC	First lactation milk yield, lbs Early AFC	Milk Yield, % Change
1	1.63[2]	1.63[2]	1,107	997	26.1	22.9	9,797[3]	9,189	- 6.2
2	NR[4]	NR	NR	NR	24.6	22.2	15,367	14,804	- 3.7
3	NR	NR	1,276	1,212	23.6	20.6	18,240	16,548	- 9.3
3	NR	NR	1,324	1,291	25.6	22.7	17,789	17,310	- 2.5
4	1.50	1.84	1,115	1,197	23.0	21.9	20,176[x]	21,173[y]	+ 4.9
5	1.50	2.07	1,210	1,144	24.5	21.3	21,721[a]	20,651[b]	- 4.9
6	1.69	2.46	1,186	1,133	23.6	20.7	18,962[a]	16,507[b]	- 12.9
7	1.69	2.49	NR	NR	25.4	22.4	15,745[a]	14,969[b]	- 4.9
8	1.65[2]	1.65[2]	1,327	1,256	25.9	22.3	23,665[a]	22,779[b]	- 3.7
Mean	-	-	-	-	24.7	21.9	-	-	- 4.8

[1]1) Lin et al., 1986; 2) Gardner et al., 1988; 3) Hoffman et al., 1996; 4) Bar-Peled et al., 1997; 5) Van Amburgh et al., 1998; 6) Radcliff et al., 2000; 7) Vicini et al., 2003a, 2003b; 8) Ettema and Santos, 2004.
[2]Prepubertal ADG not reported. Rate was calculated based on data included in the paper.
[3]First lactation milk yields were reported to be similar when AFC was used as a covariate.
[4]Not reported.
[a,b]Within study, means with uncommon superscripts differ at $P < 0.05$.
[x,y]Within study, means with uncommon superscripts differ at $P < 0.10$.

Table 2. Number of cows utilized in the analysis of 5 AFC treatment groups and 6 age opportunity groups.

	Age at First Calving Treatment Groups, Months				
Age, yr	23.3	24.3	25.6	27.2	30.3
			Number of cows		
3	251,399	737,311	824,970	360,487	345,065
4	221,654	638,167	715,156	314,981	305,576
5	193,777	550,140	610,959	272,799	266,159
6	165,115	461,744	515,814	232,651	228,212
7	138,243	383,724	426,985	193,439	191,674
8	110,552	304,365	347,693	159,481	158,338

Table 3. Average number of productive days for 5 AFC treatment groups and 6 age opportunity groups.

	Age at First Calving Treatment Groups, Months				
Age, yr	23.3	24.3	25.6	27.2	30.3
	Productive Days				
3	354.8	328.5	296.0	252.4	165.7
4	614.2	593.8	565.7	527.6	450.5
5	796.9	781.0	756.5	723.9	652.4
6	915.9	902.6	880.7	850.6	781.9
7	990.8	975.6	956.1	929.3	861.2
8	1,035.0	1,017.8	998.0	973.1	906.5

Figure 1. Average number of productive days for 5 AFC treatment groups and 6 age opportunity groups, difference from mean AFC treatment group (25.6 months).

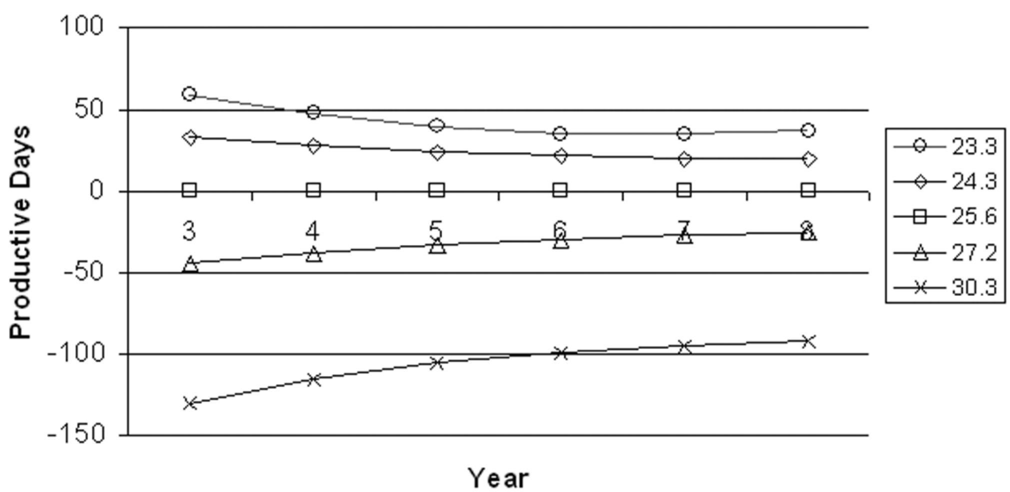

Table 4. Average total milk production across 5 AFC treatment groups and 6 age opportunity groups.

	Age at First Calving Treatment Groups, Months				
Age, yr	23.3	24.3	25.6	27.2	30.3
	Average total milk production, lbs				
3	19,758	18,484	17,345	15,803	10,941
4	34,659	33,609	32,318	30,540	26,224
5	45,445	44,568	43,243	41,503	37,554
6	52,483	51,746	50,490	48,809	45,054
7	56,874	56,005	54,846	53,330	49,632
8	59,424	58,450	57,255	55,858	52,239

Figure 2. Average total milk production for 5 AFC treatment groups and 6 age opportunity groups, difference from mean AFC treatment group (25.6 months).

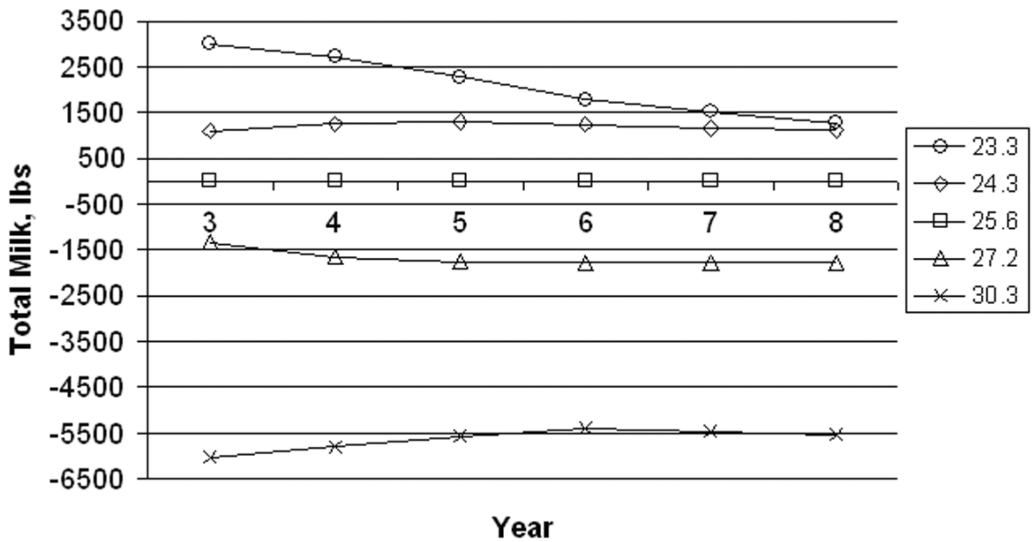

Table 5. Average stayability (percent survival) across 5 AFC treatment groups and 6 age opportunity groups.

	Age at First Calving Treatment Groups, Months				
Age, yr	23.3	24.3	25.6	27.2	30.3
			Survival, %		
3	80.2	81.5	82.6	85.5	90.1
4	56.6	61.0	62.3	64.6	66.8
5	39.9	40.9	41.9	43.4	44.2
6	25.5	25.0	25.7	26.6	27.1
7	13.9	14.1	14.6	15.3	15.4
8	7.4	7.4	7.7	8.2	8.2

Figure 3. Required rates of gain from birth to freshening to meet target BW and age at conception and first calving when a standard preweaning program is employed.

Inputs	
Age first calving, mo	22
Preweaning ADG, lbs/d	1.00
Weaging age, weeks	8
Mature BW, lbs	1474
BW at Conception, %MBW	55%
BW after 1st Calf, % MBW	82%

Assumptions	
Birth wt, lbs	90
Conceptus wt at birth, lbs	132
Conceptus growth in last 1/3 of gest., %	65%
Gestation length, days	279
BW at Puberty, lbs	620

	Birth	Weaning	Puberty	Conception	Pre-Calving	Post-Calving
BW, lbs	90	146	620	811	1341	1209
Age, weeks	0	8	38	56	96	96
Age, days	0	56	268	392	671	671
Age, months	0	0.3	8.8	12.9	22	22
BW, % Mature BW	6%	10%	42%	55%	91%	82%

ADG SOLUTIONS:

Required Rates of Gain	lbs/d	
Weaning to Conception	1.98	
Conception to Pre-Calving	1.90	(includes conceptus growth)
Conception to Pre-Calving	1.43	(does NOT include conceptus growth)

Figure 4. Required rates of gain from birth to freshening to meet target BW and age at conception and first calving when an intensified preweaning program is employed.

Inputs	
Age first calving, mo	22
Preweaning ADG, lbs/d	2.00
Weaging age, weeks	8
Mature BW, lbs	1474
BW at Conception, %MBW	55%
BW after 1st Calf, % MBW	82%

Assumptions	
Birth wt, lbs	90
Conceptus wt at birth, lbs	132
Conceptus growth in last 1/3 of gest., %	65%
Gestation length, days	279
BW at Puberty, lbs	620

	Birth	Weaning	Puberty	Conception	Pre-Calving	Post-Calving
BW, lbs	90	202	620	811	1341	1209
Age, weeks	0	8	42	56	96	96
Age, days	0	56	293	392	671	671
Age, months	0	0.3	9.6	12.9	22	22
BW, % Mature BW	6%	14%	42%	55%	91%	82%

ADG SOLUTIONS:

Required Rates of Gain	lbs/d	
Weaning to Conception	1.81	
Conception to Pre-Calving	1.90	(includes conceptus growth)
Conception to Pre-Calving	1.43	(does NOT include conceptus growth)

HIGH COW REPORT
JUNE 2005

MILK

Arizona Owner	Barn#	Age	Milk	New Mexico Owner	Barn #	Age	Milk
* Withrow Dairy	3210	04-01	38,030	* Providence Dairy	9864	4-04	40,050
* Mike Pylman	1026	03-03	36,640	* Providence Dairy	9903	4-04	39,640
* Triple G Dairy Inc	3309	06-01	35,570	* Tallmon Dairy	784	3-06	39,560
* Triple G Dairy Inc	1713	05-10	35,340	* Providence Dairy	9982	4-04	38,320
* Triple G Dairy Inc	1911	06-10	35,090	Pareo Dairy	4421	3-08	38,081
* Withrow Dairy	408	05-04	34,810	S.A.S. Dairy	4521	6-00	36,343
* Withrow Dairy	2814	05-05	34,800	Pareo Dairy	8894	6-01	35,943
* Mike Pylman	5913	05-06	34,450	* New Direction Dairy	2325	------	35,260
* Triple G Dairy Inc	3457	04-07	34,190	* Wayne Palla Dairy	8087	4-11	35,170
* Triple G Dairy Inc	3428	04-03	34,170	Pareo Dairy	780	6-01	35,160

FAT

* Shamrock Farms	5017	04-01	1,542	Pareo Dairy	1958	6-08	1,456
* Shamrock Farms	U270	06-07	1,469	* Providence Dairy	9864	4-04	1,431
* Mike Pylman	1522	02-01	1,406	Mccatharn Dairy	462	5-04	1,372
* Shamrock Farms	2651	05-00	1,403	Pareo Dairy	1454	6-04	1,367
* Shamrock Farms	8252	03-02	1,347	* Providence Dairy	8501	5-01	1,364
* Mike Pylman	6679	04-11	1,339	Pareo Dairy	4421	3-08	1,339
* Shamrock Farms	5800	03-11	1,338	Mccatharn Dairy	3155	8-06	1,329
* Triple G Dairy	3309	06-01	1,335	Pareo Dairy	9463	6-08	1,312
* Shamrock Farms	1963	05-01	1,325	Pareo Dairy	968	6-04	1,309
* Triple G Dairy	1911	06-10	1,318	Pareo Dairy	7550	4-11	1,308

PROTEIN

* Triple G Dairy Inc	3309	06-01	1,077	* Hide Away Dairy	4098	6-06	1,251
* Triple G Dairy Inc	1713	05-10	1,068	* Hide Away Dairy	5065	4-03	1,225
* Triple G Dairy Inc	1911	06-10	1,059	* Hide Away Dairy	4407	6-06	1,217
* Mike Pylman	7894	03-06	1,048	Pareo Dairy	4421	3-08	1,217
* Withrow Dairy	3210	04-01	1,040	* Hide Away Dairy	4953	5-06	1,201
* Triple G Dairy Inc	3428	04-03	1,031	* Goff Dairy	16086	5-06	1,188
* Triple G Dairy Inc	3457	04-07	1,030	* Hide Away Dairy	2881	7-06	1,172
* Triple G Dairy Inc	1311	04-11	1,012	* Providence Dairy	9864	4-04	1,171
* Triple G Dairy Inc	1185	05-07	1,010	* Hide Away Dairy	4920	5-06	1,165
* Mike Pylman	1026	03-03	1,000	* Hide Away Dairy	5096	5-06	1,164

*all or part of lactation is 3X or 4X milking

ARIZONA - TOP 50% FOR F.C.M.[b]
JUNE 2005

OWNERS NAME	Number of Cows	MILK	FAT	3.5 FCM	CI
* Stotz Dairy West	2,059	26,402	955	26,897	15.3
* Triple G Dairy, Inc.	4,468	25,149	934	26,015	13.7
* Joharra Dairy	1,405	25,698	893	25,587	13.4
* Red River Dairy	5,342	24,791	866	24,757	13.8
* Del Rio Dairy, Inc.	1,143	24,541	869	24,698	13.2
* Mike Pylman	4,270	24,082	864	24,418	14.7
* Zimmerman Dairy	1,141	23,785	859	24,209	15.3
* Stotz Dairy East	1,089	23,872	843	23,987	-
* Arizona Dairy Company	5,715	23,151	811	23,157	14.3
* Goldman Dairy	2,215	22,578	796	22,666	14.1
* Dairyland Milk Co.	3,084	22,595	794	22,641	14.1
* Shamrock Farm	8,494	22,952	776	22,503	13.6
* Withrow Dairy	5,081	23,403	752	22,309	13.3
* Danzeisen Dairy, Inc.	1,306	21,970	787	22,257	15.5
* DC Dairy, LLC	1,028	21,821	788	22,209	13.6
* Parker Dairy	4,065	21,744	788	22,176	15.0
Paul Rovey Dairy	186	21,412	785	21,983	13.7
* Dutch View Dairy	1,588	21,658	761	21,701	13.9
Lunts Dairy	579	20,765	769	21,444	13.5
* Saddle Mountain Dairy	2,841	22,184	716	21,199	14.0
* RG Dairy, LLC	1,102	20,979	746	21,164	13.8
* Jerry Ethington	642	20,198	728	20,534	14.1

NEW MEXICO - TOP 50% FOR F.C.M.[b]
JUNE 2005

OWNERS NAME	Number of Cows	MILK	FAT	3.5 FCM	CI
* Pareo Dairy #1	1,431	26,058	933	26,769	14.8
* Providence Dairy	2,846	26,762	836	25,128	13.5
* Tallmon Dairy	470	26,018	851	25,050	14.9
* Hide Away Dairy	2,076	26,126	837	24,870	-
Ken Miller	407	24,834	864	24,749	14.7
* Macatharn	1,020	24,980	849	24,569	14.1
* Do-Rene	2,243	24,569	840	24,245	13.9
* New Direction Dairy 2	1,847	23,417	862	24,104	14.4
* Pareo Dairy #2	3,053	23,361	844	23,788	14.0
* New Direction Dairy 1	37	22,925	851	23,713	15.2
* Wormont Holsteins	1,390	22,721	830	23,284	15.2
Prices Roswell Farm	2,739	22,789	806	22,924	13.4
* Halflinger Dairy	1,967	22,323	814	22,852	13.8
* Goff Dairy 1	4,158	22,331	811	22,807	14.5
* Milagro	3,301	22,699	797	22,739	13.2
Vaz Dairy	1,817	23,263	781	22,724	14.0

* all or part of lactation is 3X or 4X milking
[b] average milk and fat figure may be different from monthly herd summary; figures used are last day/month

ARIZONA AND NEW MEXICO HERD IMPROVEMENT SUMMARY FOR OFFICIAL HERDS TESTED JUNE 2005

		ARIZONA	NEW MEXICO
1.	Number of Herds	44	27
2.	Total Cows in Herd	82,719	53,796
3.	Average Herd Size	1,880	1,992
4.	Percent in Milk	88	87
5.	Average Days in Milk	213	198
6.	Average Milk – All Cows Per Day	61.6	65.3
7.	Average Percent Fat – All Cows	3.5	3.4
8.	Total Cows in Milk	76,760	46,575
9.	Average Daily Milk for Milking Cows	69.8	75.1
10.	Average Days in Milk 1st Breeding	81	72
11.	Average Days Open	152	145
12.	Average Calving Interval	13.9	13.9
13.	Percent Somatic Cell – Low	86	77
14.	Percent Somatic Cell – Medium	8	17
15.	Percent Somatic Cell – High	6	6
16.	Average Previous Days Dry	63	66
17.	Percent Cows Leaving Herd	34	34
		STATE AVERAGES	
	Milk	22,259	22,671
	Percent butterfat	3.58	3.50
	Percent protein	2.95	3.10
	Pounds butterfat	794	800
	Pounds protein	646	693

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Tempe, Arizona

October 11, 2005