Why heifer maturity matters: “The Peter Pan Problem”

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Abstract

Evaluation of dairy farm records from across the United States revealed an interesting, yet not surprising, pattern: heifer immaturity appears to have a significant and lasting adverse impact on future milk production. This impact manifests primarily in the first and second lactations, but may persist beyond the third lactation. Initial observations used the age of calving as a proxy for maturity. Further review of a large number of dairy herd records revealed key observations: 1) average annual herd milk production approximates Week 10 milk of first-lactation animals; 2) there is a fixed relationship (difference of 30 lb; 13.6 kg) between lactation 1 and 2 at Week 5 milk; and 3) age at calving impacts lactation 1-3. By implication, it is imperative that the heifer raising enterprise utilize objective parameters, such as body weight, to manage the process so that the heifers attain desired maturity at calving to achieve maximum lifetime milk production.

Key words: dairy, heifer maturity, milk production

Introduction

Every dairy practitioner will have some herds in their practice that are consistently high-producing. While these herds tend to have high levels of herd management, a consistent observation will be that these herds will have well-framed (“mature”) 2-year old heifers. High-producing heifers are a feature of high-producing herds; and, conversely, there are no high-producing herds that have a preponderance of immature heifers. Naturally this begs the question, what is a mature heifer? Heifer maturity, for the purposes of this discussion, will be described by the phenotypic characteristics – such as body weight – that allow full expression of milk production during all lactations.

High-producing herds typically have heifers that have been intentionally raised with some iteration of an “accelerated growth” model with higher average daily gain (ADG) and the goal of calving earlier (such as at 21 to 22 months). More commonly, however, these high-producing herds raise heifers that are bred later and calve later (typically at 23 to 24 months). However, it is also apparent that many dairies have no objective rationale for when to breed virgin heifers, and there is a great deal of variability. This betrays an underlying uncertainty of when it is appropriate to breed virgin heifers. On many dairies, the decision when to breed is entirely subjective and is typically based on 1 or more of the following reasons. These may include 1) whether the heifers look “big” enough, 2) have reached a certain age, 3) if breeding is manipulated to fill a “hole” in the future calving pattern, or 4) if the breeding pen has become crowded and the dairy has to move the animals on (such as with seasonal fluctuations).

An industry-wide trend to breed heifers at earlier ages has exacerbated heifer immaturity in recent years, even breeding as early as 10 to 11 months in Holsteins. While the potential financial benefits of calving heifers earlier are well understood, recognized and promoted, the management changes (increased ADG for example) necessary to achieve optimally productive maturity at these earlier calving ages have been widely ignored. Clearly there must be a “sweet spot” of maturity and age at calving that can be identified and attained to maximize the full genetic expression of a herd. Given this balance, the critical question then becomes when are heifers mature enough to breed? The following discussion will address this issue and offer suggestions on how to manage this important facet of dairying.

Impact of Heifer Maturity on Future Production

Review of on-farm records utilizing dairy software[a] from a large number of dairies across the US reveals a lasting and significant adverse impact of immaturity (as revealed by either age or weights) on future milk production. Dairy-Comp records from 174 herds, totaling 456,000 animals, were evaluated. These herds were predominantly Holstein, with ~20 Jersey herds included. Records were drawn from backups taken over a 3-year period and evaluated in 2016. All observations were based on graphs of average annual milk production. Patterns drawn from these records outline 4 key observations that will be elaborated below.

Observation 1

Observation 1: the average annual milk production (per cow) of the whole herd is within 1 to 2 lb (0.45 to 0.9 kg) of the average Week 10 milk production of first-lactation (“Lact 1”) animals (Figures 1 and 2).

The percentage of Lact 1 animals in the herd can directly influence this relationship described above. For example, at 38% Lact 1 animals in the herd, the Week 10 milk production and annual milk production (of the whole herd) (per cow) values are very close, even coinciding exactly. However, with a lower percentage of Lact 1 animals (e.g. 34% of the herd), the annual milk production (per cow) is typically 1 to 2 lb (0.45 to 0.9 kg) higher than the Week 10 milk production of Lact 1 animals; with a higher percentage of Lact 1 animals (e.g. 42% of the herd), the annual milk production is typically 1 to 2 lb (0.45 to 0.9 kg) lower than the Week 10 production of Lact

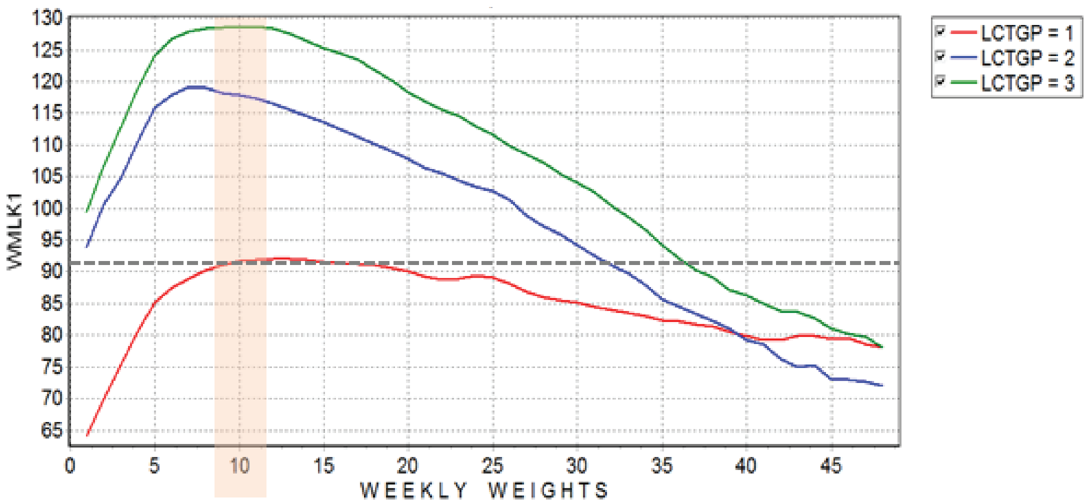


Figure 1. Annual lactation curves by lactation group, sample dairy.
Notes on Figure 1:
1. The Week 10 Lact 1 value was 92 lb (46 kg) (red star)
2. Average annual milk production for this herd (all lactation groups) was also 92 lb (46 kg) (grey dotted line). This can be identified in DairyComp from *Reports* tab in Econ\ID
3. DairyComp command to generate graph: PLOT WMLK1 by LCTGP; if the dairy does not have item WMLK1 in its DairyComp program, run "Guide", then hit Escape and run command again. If this fails, try the item WMKHI instead of WMLK1

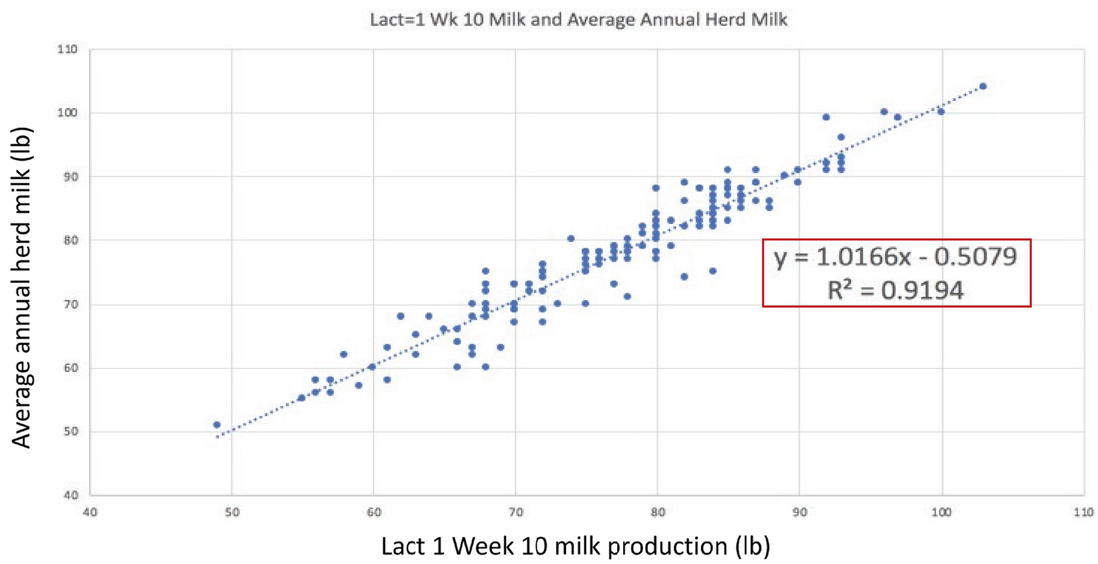


Figure 2. Average annual milk production (per cow) and Week 10 milk of Lact 1.
Notes on Figure 2:
1. The data include 149 herds comprising 401,000 animals (derived from DairyComp, Econ\ID, reports and "wk10mk" (Week 10 milk production) for Lact 1)
2. These herds were not supplementing with rBST
3. On average 38% of the animals in these herds were Lact 1
4. The correlation suggests that 92% of the variation in average annual milk production can be explained by the Week 10 milk production of Lact 1 animals
5. If one sets wk10mk of Lact 1 to 80 lb (36.4 kg) in the regression (x value), the equation predicts average annual herd milk of 80.8 lb (36.7 kg) (y value), a near perfect match; the slope is essentially a 1-to-1 relationship, suggesting an increase in average annual milk of 1 lb (0.45 kg) for every increase in wk10mk of Lact 1

1 animals. In Figure 1, the average annual milk production was ~92 lb (46 kg) (as recorded by the Econ\ID command under the *Reports* tab of DairyComp). Notably, the Week 10 milk of Lact 1 animals is also ~92 lb (46 kg).

To validate this observation, DairyComp data from 149 herds representing 401,000 cows was collated and the relationship determined (Figure 2). This subset of herds was selected because they did not supplement cows with rBST which would have raised the average annual milk production and added a confounding factor. Figure 2 below shows the strong correlation ($R^2 = 0.92$) between Week 10 milk production for Lact 1 animals and average annual milk production. Furthermore, the slope of the graph indicates that as Week 10 Lact 1 milk production increases by 1 unit (1 lb [0.45 kg] of milk), so does the average annual milk production by the same amount. Therefore, it follows that an improvement of 1 lb (0.45 kg) of milk for Week 10 Lact 1 animals will translate into an additional 1 lb (0.45 kg) of milk production for every cow, every day, as these higher-producing Lact 1 animals move on up into later lactations.

Observation 1 is important because it strongly suggests that heifer milk production sets the "ceiling" for the entire herd. A herd cannot overcome the restrictions placed on it by under-performing heifers. As mentioned before, high-producing herds have high-producing heifers. It's been said, "prevention is better than cure." In the case of dairy production, allowing full maturity before calving is better than attempting to correct for subsequent underproduction. Management interventions, such as cow comfort, heat abatement, and effective reproductive programs cannot overcome the downward drag on milk production caused by bringing a heifer into production before she is fully mature. The loftiest aspirations for production will run aground on the rocks of immaturity.

Observation 2

Observation 1 was that the milk production of the whole herd converges to a single point (Week 10 milk) of Lact 1 animals. Observation 2: the difference in milk production between Lact 1 and second lactation ("Lact 2") animals at Week 5 of lactation is 30 lb (13.6 kg) (for Holsteins).

Week 5 milk production was chosen as a comparable time period to account for the temporal difference in peaks between lactation groups (both groups featured rising lactation curves at this stage of lactation, Figure 3). This observation is consistently seen in "stable" herds. Stable herds in this discussion are defined as herds where there is very little fluctuation in average annual milk production year-to-year and little intentional change to the heifer program over time. In other words, all animals in the herd have had a similar heifer-raising experience. This observation is independent of milk production level or milking frequency, but is influenced by differences in milking frequency of lactation groups within a herd. For example, this relationship is no longer true in a situation where Lact 1 animals are milked 3 times a day and the rest of the herd twice a day.

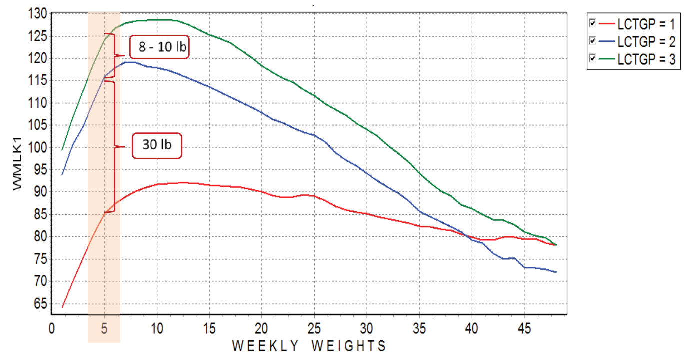


Figure 3. Annual lactation curves by lactation groups, same dairy as Figure 1.

Notes on Figure 3:

1. In the highlighted column at Week 5 (35 days-in-milk, "DIM"), the difference between Lact 1 (red) and Lact 2 (blue) milk production is 30 lb (13.6 kg) (Holstein)
2. The 30 lb (13.6 kg) shown is typical in a "stable" herd where no major changes have been made in heifer raising over past 3 years
3. The difference between Lact 2 (blue) and Lact 3 (green) at Week 5 is typically 8 to 10 lb (3.6 to 4.5 kg) (Holstein)
4. The differences in milk production between Jersey cow lactation groups are less, typically 20 lb (9 kg) between Lact 1 and Lact 2 animals at Week 5; however, there appears to be more variability in this difference. A possible explanation is that early breeding of virgin Jersey heifers is very prevalent in the breed, and may be much more impactful in contributing to the variability seen on Jersey dairy graphs.

Observation 2 is important because it clearly demonstrates the predictable change in herd milk production resulting from some substantial change in heifer management. For example, recall that the difference between Lact 1 and Lact 2 milk production at Week 5 is 30 lb (13.6 kg); suppose there is an improvement in Lact 1 milk production at Week 5 as a result of a positive change in heifer management that results in a 5 lb (2.27 kg) increase in Lact 1 milk production at Week 5. Consequently, the resulting difference between Lact 1 and Lact 2 milk production now decreases by 5 lb (2.27 kg) from 30 to 25 lb (13.6 to 11.4 kg). We can predict that in the following year the difference between Lact 1 and Lact 2 will increase back to 30 lb (13.6 kg) as the improved Lact 1 animals become higher-producing Lact 2 animals. Similarly, a 5 lb (2.27 kg) drop in Lact 1 milk production would result in a 35 lb (16 kg) difference between Lact 1 and Lact 2, predicting a drop in overall milk production in the following year(s). Metaphorically, "all ships rise (or fall) on the tide."

This absolute relationship in milk production is important for another reason. Typically, the performance of Lact 1 is measured as a percentage of later lactations. For example, the peak milk or average milk production of Lact 1 is often expressed as a percentage of the peak milk production of all mature cows (Lact > 1). So, in a sample herd this value may be 75%, suggesting the Lact 1 animals are performing reasonably well.

The problem with this approach, however, is that it has no future predictive value. It may in fact be misleading. For example, if the dairy described above (with the 75% ratio) makes improvements in its heifer raising and the ratio improves from 75% to 80%, the conclusion drawn, correctly, after 1 year, is that the intervention was positive. However, the following year the cohort of improved Lact 1 animals become Lact 2 and are now included in the denominator of the ratio (of Lact 1 to Lact > 1 milk production). The denominator has now increased. However, assuming no further improvements in the heifer-raising program, the ratio of Lact 1 over Lact > 1 milk production predictably goes down. This suggests that the heifer program has decreased in its performance gains, an incorrect assumption. The Lact 1 animals are in fact performing at the same higher level of milk production. With no further improvements in the heifer program, the ratio will eventually converge to a fixed percent as all cows across all lactations have experienced the same improvement. This equilibrium, however, is at a higher level of total milk production; the ratio can be 75% as before, but numerator and denominator are larger than before but still proportional. To sustain the impression of year-on-year improvement, the dairy would have to make incremental improvements in their heifer program EVERY year as each successive cohort transitions into the denominator.

Furthermore, there may be an under-performing herd that has an acceptable ratio of Lact 1 to Lact >1 milk production – this acceptable ratio does not necessarily mean that the heifer program is successful. For example, a herd could be vastly under-performing with an acceptable ratio of milk production between parity groups (Lact 1 and Lact >1). The whole herd is consistent, but still a "B" herd.

Observation 3

Observation 3: the age at calving impacts Lact 1 milk production.

In Figure 3 above, the average milk production of the dairy in question was shown to be 92 lb (41.8 kg). In Figure 4 below (of the same dairy), lactation curves of the most prevalent age at calving cohorts (23 to 25 months) for Lact 1 animals are visualized. Heifers in the 25-month cohort (highest maturity) express a 96 lb (43.6 kg) Week 10 production, while 24- and 23-month heifer cohorts express a 94 and 92 lb (42.7 and 41.8 kg) production, respectively. Since the Week 10 milk production of Lact 1 animals is highly correlated with the average annual milk production of the herd (R^2 = 0.92), it follows that if all the animals had the maturity of the

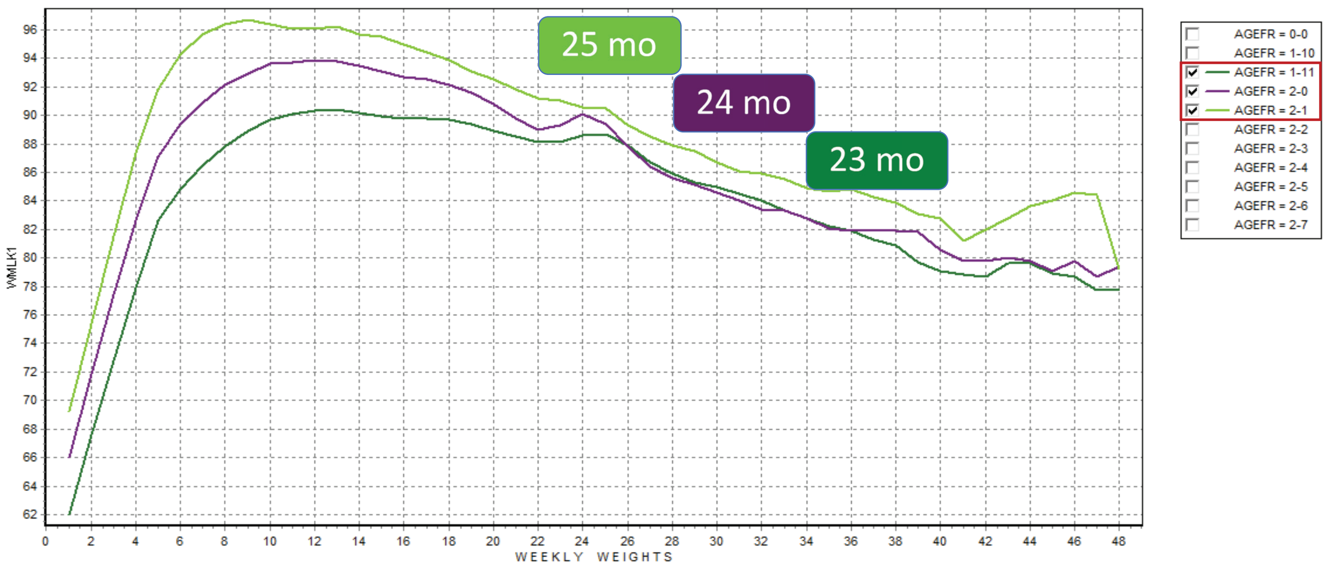


Figure 4. Average annual milk production by age at calving for Lact 1, same dairy as Figure 1.
Notes on Figure 4:
1. Age at calving cohorts are color-coded (dark green, purple, and lime green)
2. The annual number of animals that calved at 23, 24, and 25 months were 737, 360, and 135, respectively; due to the high first-service conception rates of virgin heifers, it is likely that most animals will calve at the youngest age cohort
3. Note that in herds that breed strictly (and somewhat consistently) on size, the Lact 1 age at calving production curves may coincide. This does NOT mean that these animals are mature. The impact of immaturity becomes apparent in Lact 2 production graphs since Lact 1 animals are not bred based on size differences.
4. DairyComp command to generate graph: Plot WMLK1 by AGEFR for LACT=1 AGEFR<30 (then select the 3 most prevalent cohorts from reports)

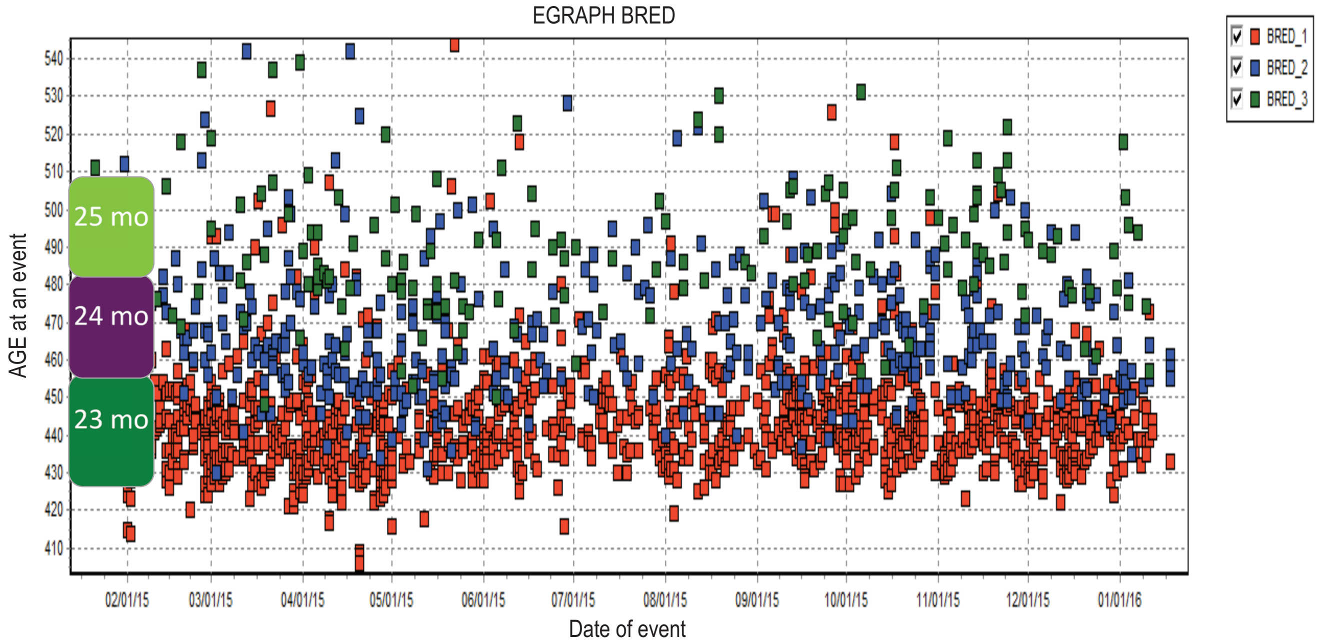


Figure 5. Age at first 3 breeding events for all heifers over a year, same dairy as Figure 1.
Notes on Figure 5:
1. Age at first breeding begins at 425 days (red dots)
2. There are 3 colored boxes on the left of Figure 5 that represent the different cohorts of age at calving discussed above (23, 24, and 25 months); the colored data points (red, blue and green dots) represent breeding events 1-3 and roughly correspond to the age of calving cohort as they are vertically stacked in the figure. Second and third breeding events (blue and green dots) would correspond to the calving cohort at 24 and 25 months.
3. These are mostly rebreeds due to failure to conceive earlier
4. DairyComp command to generate graph: EGRAPH BRED, Select: Lact=0, Select: Scatter graph, Select: Events=1-3

25-month animals, the average milk production of the herd would increase from the current average of 92 lb to 96 lb (41.8 kg to 43.6 kg) (the 25-month average). The difference in maturity of these cohorts is the most reasonable explanation for the production difference because the heifers are bred on age and not size (Figure 5). Note that there was no genomic testing or selection based on genetic pedigree, all heifers in the breeding pen were managed and fed the same.

Is it likely, even reasonable, that the differences in production can be explained by management decisions involving heifer culling? Most virgin heifers that are culled or leave the dairy fall into 2 categories: 1) deaths, mainly early and 2) animals that fail to conceive. Neither category is represented in this graph because animals in these 2 categories never calved.

In Figure 4, it is apparent that a marked difference in levels of milk production between the age cohorts (23 to 25 months) occurs almost immediately after calving. In other words, Figure 4 shows consistent vertical distribution between milk production curves for these cohorts, and this vertical spacing begins in Week 0 and persists throughout the period of lactation. Animals are rarely culled so early without several test day data, so it is unlikely that culling of Lact 1 animals would create the pattern seen in Figure 4. Furthermore, if biological reasons (i.e. differences in maturity) are not the reason for the differences in milk production between cohorts (differences represented by the spacing between the curves in Figure 4), then how could one create this pattern through culling? One would need to cull higher-producing, younger animals to create the lower milk production curve for younger animals (an irrational idea for any dairy). Furthermore, the pattern of incremental milk production associated with increasing age at calving has been observed in herds across the US, Canada, China, Egypt, Poland, Germany, and the Netherlands. It is improbable that dairies around the world would choose to adopt the same counterproductive, irrational culling strategy. Therefore, the best explanation for the differences in milk production is biological: animals at later age of calving had attained greater body weight than animals in younger age cohorts, had produced more milk, and by our phenotypic definition of maturity, were more mature at calving than animals in younger cohorts.

Observation 4

Observation 4: the age at calving impacts milk production in both Lact 1 AND Lact 2.

The same pattern of increased milk production and supporting rationale for this increase described above for

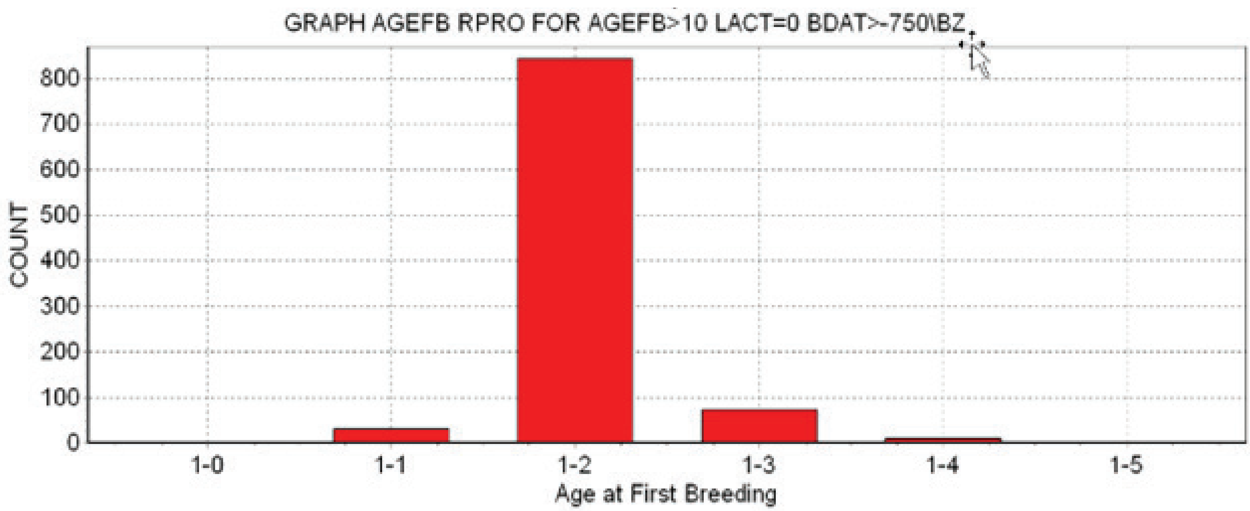


Figure 6. Count of breeding events by age of first breeding, same dairy as Figure 1.

Notes on Figure 6:

1. The age of first breeding shows that the vast majority of animals are bred at 14 months (shown above as “1-2”, meaning 1 year, 2 months or 14 months). This tight clustering around 14 months suggests that animals are bred on age and not size because if they were bred on size, the distribution would be resemble a Bell curve.
2. DairyComp command to generate histogram: GRAPH AGEFB RPRO for AGEFB >10 LACT=0 BDAT>-750\BZ

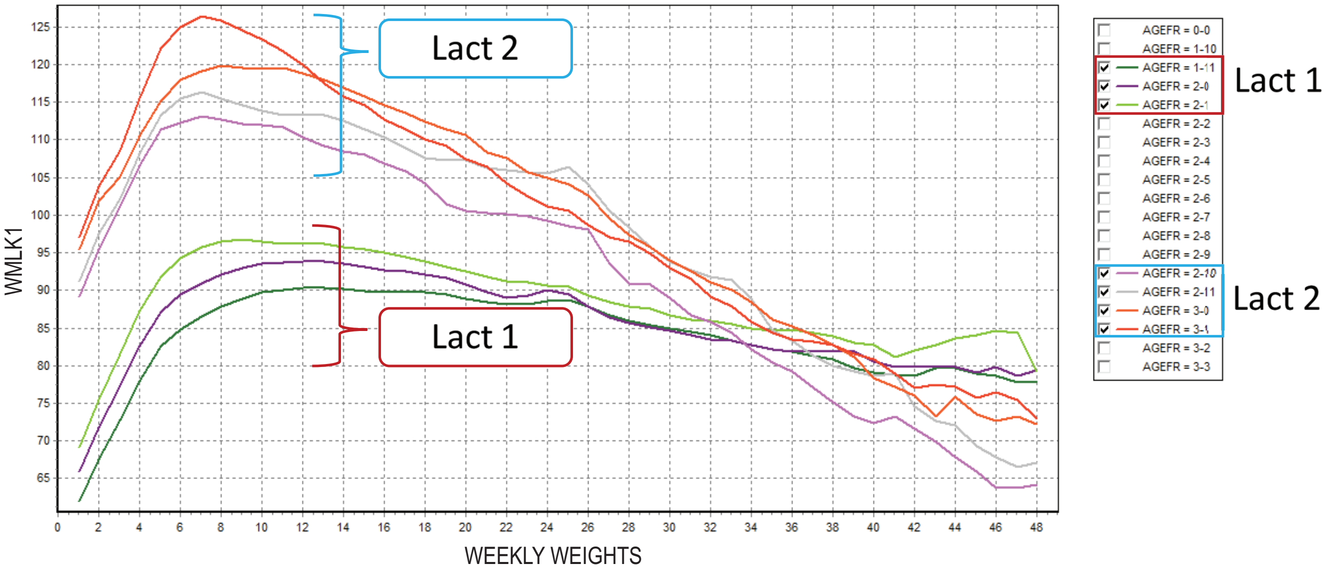


Figure 7. Lact 1 and Lact 2 milk production by age at calving, same dairy as Figure 1.

Notes on Figure 7:

1. There are 4 Lact 2 age-at-calving cohorts (from 34 to 37 months of age, grouped in light blue); the labeling of curves is similar to above: 34 months is represented in the legend as “2-10” meaning 2 years, 10 months which equates to 34 months
2. The lowest-producing cohort of Lact 2 were in the lowest-producing cohort of Lact 1: all animals in the 34-month Lact 2 cohort (pink curve) calved at 23 months (dark green) the year before; similarly most of the 34 and 35-month cohort calved at 23 and 24 months the year before
3. DairyComp command to generate graph: PLOT WMLK1 by AGEFR for Lact=1-2 AGEFR<40. Select the numerically most prevalent cohorts for best representation

Lact 1 animals with increased age at calving (Observation 3) applies for Lact 2 animals. For example, as shown in Figure 7 below, Lact 2 animals that calved at 34 months produced less milk than the subsequent cohorts of animals by age at calving (pink curve labeled “2-10”, meaning 2 years, 10 months). Increased milk is predictably incremental as animals aged.

The average number of lactations in the US is about 2.2. Therefore, the importance and contribution of both Lactations 1 and 2 to overall herd production cannot be overstated. Top producing dairies MUST have outstanding early lactations. There is no "catch up" opportunity. Furthermore, it is ironic that a dairy with immature heifers and outstanding rates of reproductive performance (as is commonly seen with synchronization programs, such as "Double Ovsynch") creates a "toxic mix": such dairies effectively "lock" larger numbers of younger, less mature animals into an under-performing productive life. Indeed, it would arguably be better for such dairies to have lower reproductive performance as this would allow animals more time to achieve greater maturity and thus have a better likelihood of maximizing their full genetic expression of milk production.

The advent of sexed semen created another potential pitfall for dairies – producing large numbers of heifers resulted in younger herds. This situation has corrected somewhat with the increased use of beef semen in dairies, as there are now less heifers coming into the herds and less animals in the younger parities.

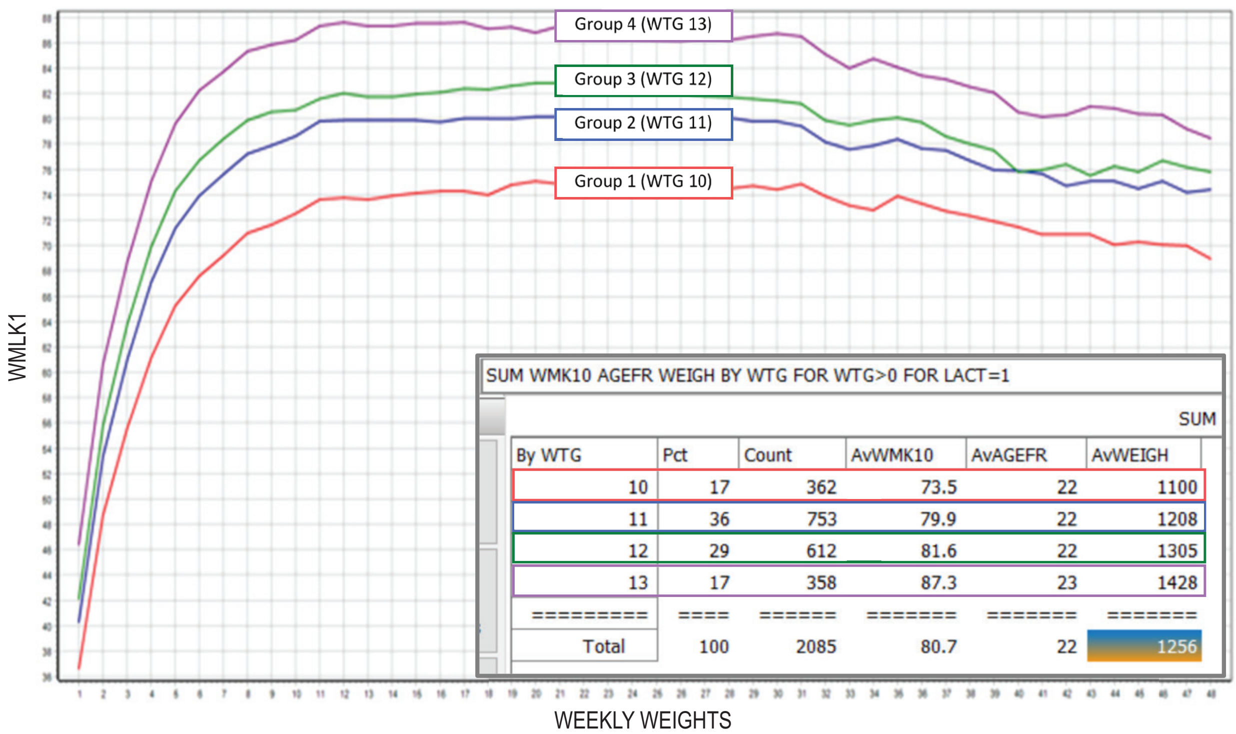
Genomics does not erase immaturity. Even genetically superior animals (as determined by genomic testing) need to be mature to express their full genetic potential. Indeed, it is reasonable to suggest that a dairy should first focus on creating mature heifers before embarking on a genomics program. Evaluating performance records by genetic parameters and age at calving reveals the same patterns that relate milk production to immaturity.

The effect of immaturity on Lact > 2 is less marked than for Lact 1 and Lact 2 because many animals in this group will have reached their mature body weight at this stage. Furthermore, it is relatively less important because there are fewer animals in the Lact > 2 population (often less than or equal to 35% of the herd) and the impact of culling and reproduction on this group will likely be the greatest, mitigating or even concealing the impact of immaturity.

Field Example

This example demonstrates the significant impact of body weight of Lact 1 animals immediately after calving on subsequent milk production. Body weight, as discussed formerly, is a reasonable proxy for maturity.

Post-calving weights (days-in-milk "DIM" <7) from a Holstein herd were collected and recorded in DairyComp. Animals were coded in 4 groups based on these weights (see insert table with grey dash border in Figure 8 below). Altogether 2,085 Lact 1 animals were weighed and assigned to groups based on weight. These average weights were 1,100, 1,208, 1,305, and 1,428 lb (500, 549, 593, and 649 kg), respectively.



By WTG	Pct	Count	AvWMK10	AvAGEFR	AvWEIGH
10	17	362	73.5	22	1100
11	36	753	79.9	22	1208
12	29	612	81.6	22	1305
13	17	358	87.3	23	1428
=========	====	======	=======	=======	=======
Total	100	2085	80.7	22	1256

Figure 8. Lactation curves vary by weight groups for Lact 1 animals.
Notes on Figure 8:
1. The 4 weight groups differ by approximately 100 lb (45.4 kg) post-calving (see "AvWEIGH" column)
2. Animals in this herd calved at a similar age (22 to 23 months)

The lactation production graphs were plotted after a year (see Figure 8 below). Notice the clear pattern of incrementally greater milk production with increasing body weight. There is also a 14 lb (6.4 kg) difference in milk production at Week 10 between animals in Groups 10 and 13 (see insert table), indicating that increased maturity of Lact 1 animals would predictably and substantially increase overall herd milk production.

Discussion and Recommendations

It is eminently apparent that heifer immaturity has a profound and far-reaching impact on herd production. The recent trend to breed heifers earlier has exacerbated the negative impact of immaturity on many herds. While there are many economic benefits associated with calving animals earlier (including decreased heifer inventory, decreased heifer raising costs, and earlier entry into milk production), these benefits should be balanced against the long-term negative effects of suppressing the full genetic potential of immature animals. It is important to consider that every additional lb of milk produced by a mature Lact 1 cow translates to a similar increase in per-day herd production in the long-term.

All animals will eventually reach mature body weight. The question is whether the dairy will attain the required growth on a (cheaper) heifer ration or a (more expensive) lactating ration. Furthermore, since the ADG of heifers at breeding (~2 lb [0.9 kg]/day) far outpaces that attained during lactation (~0.3 lb [0.13 kg]/day), it will take approximately 7 times longer to attain the same growth in body weight during lactation versus pre-calving. Every lb of growth requires 2.3 MCal of energy. Given that a lb of milk requires 0.3 MCal, it follows that each "missing" lb of body weight will cost ~8 lb (3.6 kg) of milk production as the animal's body will prioritize energy and metabolic resources to growth rather than milk production. This could be thought of as "heifer shrink" (akin to "feed shrink").

The impact of immaturity on later lactations, especially Lact 2 (the so-called "sophomore slump") is frequently not recognized on dairies. Lact 1 and Lact 2 milk production by age of calving should be graphed on every dairy to more fully evaluate the impact of immaturity. The notion that Lact 1 animals "catch up" growth in some faster, compensatory fashion after calving, supposedly correcting the inadequacies of the past, is blatantly false. There is no "factory reset button" for immature Lact 1 animals. Instead, immaturity persists through later lactations in a predictable fashion.

Objective criteria to monitor progress during heifer raising is not commonly used. Also, unless the mature body weight of the herd is known it is impossible to know what the goal at breeding should be. In fact, this 2-year process might be the most expensive aspect of the dairy industry that lacks an objective quality control. For example, animals are often bred when they look "big enough," etc. This approach is itself not enough. Regular, strategic, objective measurements need to be made to monitor the process and make necessary corrections. Weight (using a scale), is the best practical approach and can be used as a proxy for body frame and maturity. With the caveat that attention is paid to body condition score, so as not to over-condition animals which can lead to unfavorable outcomes. Heifer rations can easily create fat rather than frame.

Girth tapes can be used in place of scale weights, but the safety of the operator needs to be considered. If a procedure is risky or awkward, it is less likely to be sustainable. Weights should be used to develop a breeding program that will ensure that heifers are bred at 55% of mature body weight of the herd. This requires a knowledge of the mature body weight of the herd and ADG (based on weights and age) so that expected ideal age at first breeding can be calculated. The average can be generalized for the setting of goals for the group of heifers being bred. In making adjustments to achieve the target breeding weight, a month of growth can be approximated as 60 lb (27.3 kg) increase in weight.

Wither heights can be measured to help assess the growth of body frame. However, the safety of the operator must be evaluated if measuring occurs alongside the animal. An alternative practical approach is to place a tape on the poles supporting headlocks, set at some cutoff height (such as 50 inches). When animals reach this height, they are then eligible for breeding. The problem with this approach, however, is that it is easier to make a measurement mistake – height is easily affected by a shaggy hair coat or an uneven alley floor due to the accumulation of manure debris.

So, why the Reference to Peter Pan in the Subtitle?

The timeless Disney character is portrayed as never growing up, locked in some kind of perpetual childhood. Dairies that raise immature heifers suffer a similar fate, since their animals perennially under-perform for a substantial part of their productive life. In essence, the dairy becomes a sort of "Neverland" where cows experience a delayed growing up, a "Peter Pan" dairy.

Heifer raising needs to have the guiding hand of objective parameters, such as weights. But what are the weight goals? Industry standards (such as those set out by the Dairy Calf and Heifer Association) suggest heifer conception at 55% of mature body weight. As mentioned earlier, this requires knowledge of mature body weights and breeding heifer weights. Mature body weights are approached by animals in the third and fourth lactations, and the best time to measure this is at 80 to 120 DIM. Ideally as many animals as possible (but at least 50) should be weighed to determine target body weight. The MBW is NOT the average of cull cow weights.

A current industry challenge to achieving maturity is that heifer raisers are not incentivized to attain heifer maturity goals. Since most heifers are raised on a per diem basis, there is little or no focus on achieving growth goals. This creates a dilemma. If the goal is to ensure that animals achieve particular maturity milestones there are only 2 options: 1) increase the ADG or 2) delay breeding of heifers. The goal should always be to breed a mature heifer as early as possible. Should this not be attainable, then the fallback position is to delay breeding. At least in California, the prevailing ADG's would suggest an appropriate age at first breeding of 420 days. Provided reproduction performance is good, this should result in most animals calving at 23 to 24 months. Calving in mature heifers at 22 months should also be attainable.

Why did the widespread breeding of heifers early lead to lower milk production outcomes seen on many dairies that implemented the policy? In short, the necessary increased ADG required to achieve maturity at an earlier calving age did not happen.

When discussing heifer raising, much focus is on calf health, such as pre-weaning deaths and disease. But a pre-weaning mortality rate casts little light on the ultimate product 2 years later. If there are weights, they are likely to be birth and weaning weights, and maybe trailer weights when calves return home. This could be valuable, but the data collection should not end there: heifers should not disappear into a "black hole" from the hutches until breeding. Heifers need to be weighed regularly: at 4 months, when heifers return to the dairy (to assess the transition through weaning); at 12 months as the heifers approach breeding (to confirm that the weights are "on track" to reach the goal of 55% MBW at conception); and then at pre-calving (close ups, DCC>260, goal of 95% MBW, to assess the last year of growth). If weights immediately post-calving (DIM<7) are used, a goal of 85% MBW should be used.

The above discussion has focused entirely on productive outcomes of immaturity, but there is evidence (published and anecdotal) that immature animals also experience higher dystocia and stillbirths, poorer transitions, and higher culling in the first 60 days of lactation. Certainly, milk production is protective (from culling) and it is not surprising, therefore, that immature animals have a greater likelihood of being culled. Immaturity is more costly than just lost milk.

The days of excess heifers raised by "Darwinian Theory" are over and the heifer of tomorrow needs to be 1) healthy (especially with regards to lung health), 2) have superior genetics (likely a product of sexed semen and genomic testing), and 3) be physically mature. This animal is most likely to remain productive for a lot longer than the US average of 2.2 lactations. Mature heifers will set the stage for lengthened productive life on dairies.

Endnote

[a]DairyComp Herd Management Software, "DairyComp"