A BAMN Publication

HEIFER GROWTH AND ECONOMICS: TARGET GROWTH

Bovine Alliance on Management & Nutrition

This guide is published by the Bovine Alliance on Management and Nutrition (BAMN), which is comprised of representatives from the American Association of Bovine Practitioners (AABP), American Dairy Science Association (ADSA), American Feed Industry Association (AFIA), and United States Department of Agriculture (USDA). The BAMN group is charged with developing timely information for cattle producers regarding management and nutritional practices.

Intrigued by the possibility of building a better heifer? Want to develop your herd's potential? If you answered yes, your next question probably is, "What will it cost?" Will you really get some bang for your buck, i.e. milk in the tank? Management interventions can make money in three ways – by putting more milk in the tank, by putting milk in the tank sooner, or by any other intervention that returns additional income on the dollars invested. Adjustments to the replacement heifer program on a dairy can potentially make money in all three ways. This is the first in a series of publications focusing on heifer development systems.

When evaluating the heifer-raising enterprise, remember that the return on investment begins as long as 20 or more months after each heifer is born. Many management steps or missteps between the birth of a heifer calf and the birth of her first calf affect the net value realized over her productive life. Looking at the big picture, the two most important factors that determine the economic value of the heifer are (1) at what age she conceived (and therefore at what age she will enter the milking herd) and (2) at what body weight she freshened. How "target growth" can affect age and body weight at calving will be discussed in this fact sheet.

What is target growth?

The application of target growth principles recognizes that nutrient requirements are linked to an animal's rate of gain and current body size *relative to mature size.* To use the target growth system, the steps shown in Figure 1 must be followed. Systematic application of target growth principles allows growing animals to be fed diets that more closely meet their nutrient requirements at different stages of growth and targeted rates of gain. The National Research Council (NRC) publication, Nutrient Requirements for Dairy Cattle (often referred to as the 2001 Dairy NRC; NRC, 2001), incorporates target growth into predicted nutrient requirements for heifers. The following inputs are required to predict nutrient requirements with this system: (1) the expected mature weight of the animal being fed, (2) the desired age at first calving (i.e. acceptable age at insemination), (3) the current weight of the heifer, (4) the current age of the heifer, and (5) the chemical composition of the feeds and dry matter intake of the diet.

Applied properly, target growth can be used to reduce calving age, ensure larger framed heifers at calving, or both. Depending on how heifers were managed previously, application of the target growth system may affect calving age and/or body weight at calving. According to the National Animal Health Monitoring System (NAHMS) dairy survey in 2002 (USDA, 2002), 25.4 months is the average age at first calving in the U.S. dairy herd. Of the 44% of operations that are calving heifers at less than 25 months of age, about 22% are calving heifers at less than 24 months. Altogether 58% of operations calve in heifers younger than 26 months of age, but the 10% that are calving heifers older than 30 months skew the average upward. These 10% are leaving a significant amount of money on the table.

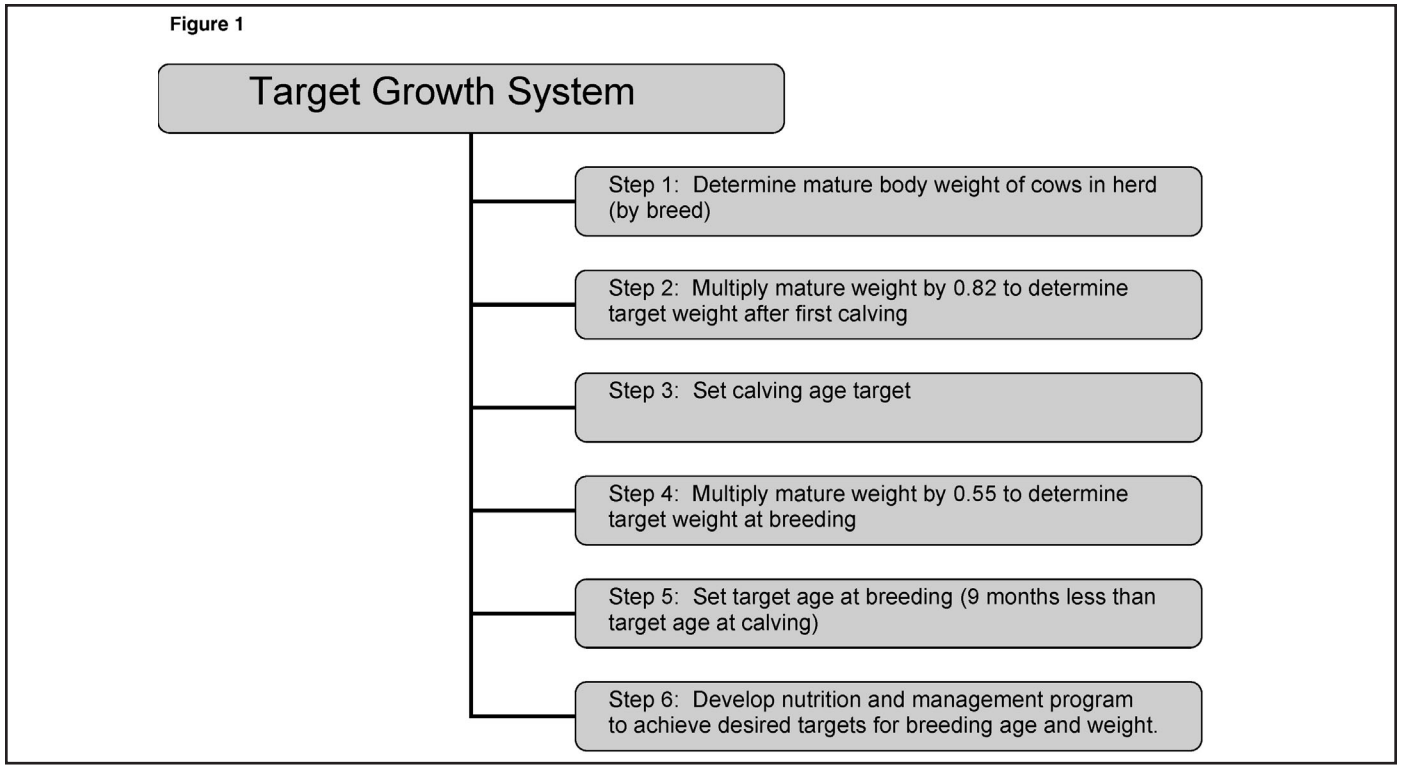


Figure 1. Flow chart for applying the target growth system to a particular group of heifers.

"By reducing their age at first calving, heifers are generating cash sooner and fewer replacements are needed to maintain herd size."

Lower age at first calving is economically advantageous to producers who maintain ownership of their heifers. By modeling discounted income over feed costs at various ages for heifers that calved at different ages, Lormore (2005) showed a cumulative income over feed cost advantage maintained across the first lactation (and herd lifetime) for heifers calving at 22 vs. 24 months of age. Lower calving ages also increase the asset turnover ratio and financial efficiency of the operation since fewer replacements are needed at any given time to meet its internal replacement needs. Reducing age at first calving means (1) heifers are generating cash sooner and (2) fewer replacements are needed to maintain herd size (Lormore, 2005). Calving age is determined primarily by management – at what age are heifers being inseminated? **To reduce age at first calving, managers must be willing to breed younger heifers.**

When should target growth be used?

Heifers have the greatest capacity for frame growth in their first six months of life (Kertz, 1998). Focusing on early nutrition to support the desired rate and composition of body weight gain is important. The target growth system, based on the desired targets for age and weight at calving, primarily influences feeding and management programs prior to puberty. More expensive rations may be called for in younger heifers, but, if the number of days on feed is reduced, the overall costs of feeding replacement heifers may not change significantly. Remember to take body condition into account when measuring body weight and monitoring the outcome of the heifer feeding program. Over-conditioned heifers are hard to inseminate and at greater risk of calving difficulties.

"Remember to record body condition in addition to body weight or frame size when monitoring the heifer feeding program."

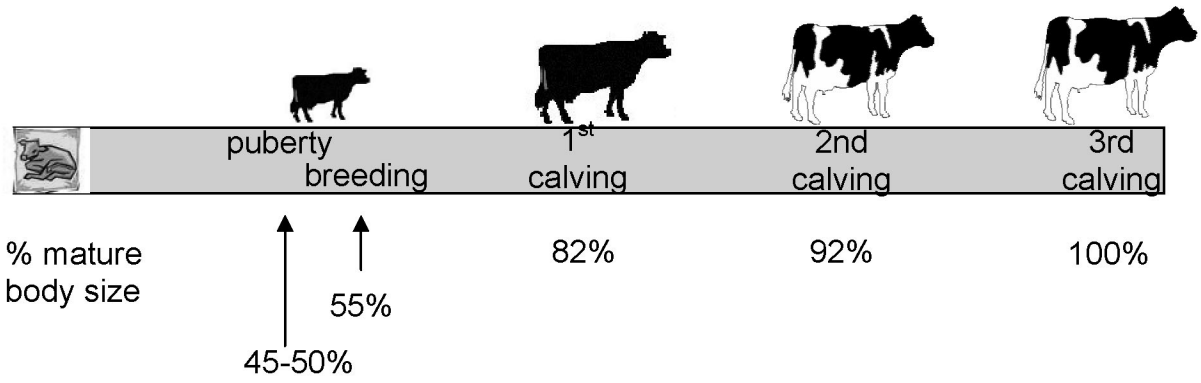
How is mature weight determined?

Cows entering their 3rd lactation have reached approximately 100% of their mature size. Weighing (by scale or by girth tape) cows in their third or greater lactation will provide a reasonable estimate of mature size in a herd. Mature dairy animals have significant fluctuations in their body condition over a lactation, so only mid-lactation animals or those scoring about a 3 (on a scale of 1 to 5) should be included in the estimate.

How is the target age at first calving determined?

The age at first calving is determined by age at conception. To calve in at 22 months, heifers must conceive by 13 months of age. Breeding heifers at 12 months of age is feasible in some systems. More extensive heifer rearing systems may choose to breed older heifers. Many operations have the opportunity to improve the economics of their heifer replacement program by reducing the target age at first calving.

How big should a heifer be at calving (and at breeding)?



Heavier body weights (without over-conditioning) at calving are associated with greater milk production (Hoffman, 1996; Keown, 1986; Lee, 1997) and fewer calving difficulties. In the 2001 Dairy NRC, target weights for breeding and calving are based on percentages of mature size. Heifers should be pregnant by 55% of mature size and calve at 82% of mature size. Puberty usually occurs when heifers have reached 45 to 50% of mature size. Breeding heifers during their third estrus after puberty fits with this system. Based on the authors' experience, delaying breeding after puberty results in over-conditioned heifers which are hard to breed. The following table illustrates breeding and calving weight targets for heifers of differing mature size based on desired age at first calving.

Table 1. Target weights for dairy animals of differing mature size[1]

Mature body weight[2], lb	**1000**	**1400**	**1800**
First bred, 55% mature weight, lb	550	770	990
Post-calving target body weight, lb			
1st calving, 82% mature weight	820	1150	1475
2nd calving, 92% mature weight	920	1290	1655
3rd calving, 100% mature weight	1000	1400	1800

[1]NRC, 2001, p. 238.

[2]NRC presents equations on a shrunk body weight basis, which is 96% of full body weight; Since all weights are affected by this factor, full body weights are shown in this table for simplicity. Weights of third lactation cows can be divided by 0.96 for a more accurate estimate of mature body size. Conceptus weight (lb) can be calculated as (0.665 * (days pregnant - 190)+ 18) * CBW / 99), where CBW is the expected calf birth weight.

When target growth is applied systematically, heifers should achieve the desired size and weight while calving at the target age. Recent data from Cornell University shows that heifers calving at 20 months of age produced as well as heifers calving at 24 months (Van Amburgh, 2004).

How does mature body weight affect nutrient requirements?

In the target growth system, size-scaling from a standard reference point is used to estimate body composition at any given stage of growth. Post-natally, a growing animal can be thought of as being somewhere along the continuum of development from birth to mature size. Body composition at the endpoints, birth and maturity, is predictable and not dependent on mature body size. In beef cattle, the standard reference weight is based on an animal with 28% fat (NRC, 1996). Animals of different breeds and genetic lines may reach the standard body composition at very different body weights. For example, the mature size of a Holstein cow varies from about 1400 to 1800 pounds. Therefore, two growing animals at the same age or body weight may be at very different stages relative to their mature size and, therefore, differ in their body composition and composition of gain. Figure 2 illustrates this relationship between body weight and body composition for heifers with genetically determined mature body weight potentials of 1400 and 1800 pounds. Nutrient requirements depend primarily on current body weight of the animal and desired rate of gain. However, nutrient requirements are also affected by composition of gain, which is dependent on physiological maturity. Both rate of gain and composition of gain are accounted for by target growth systems.

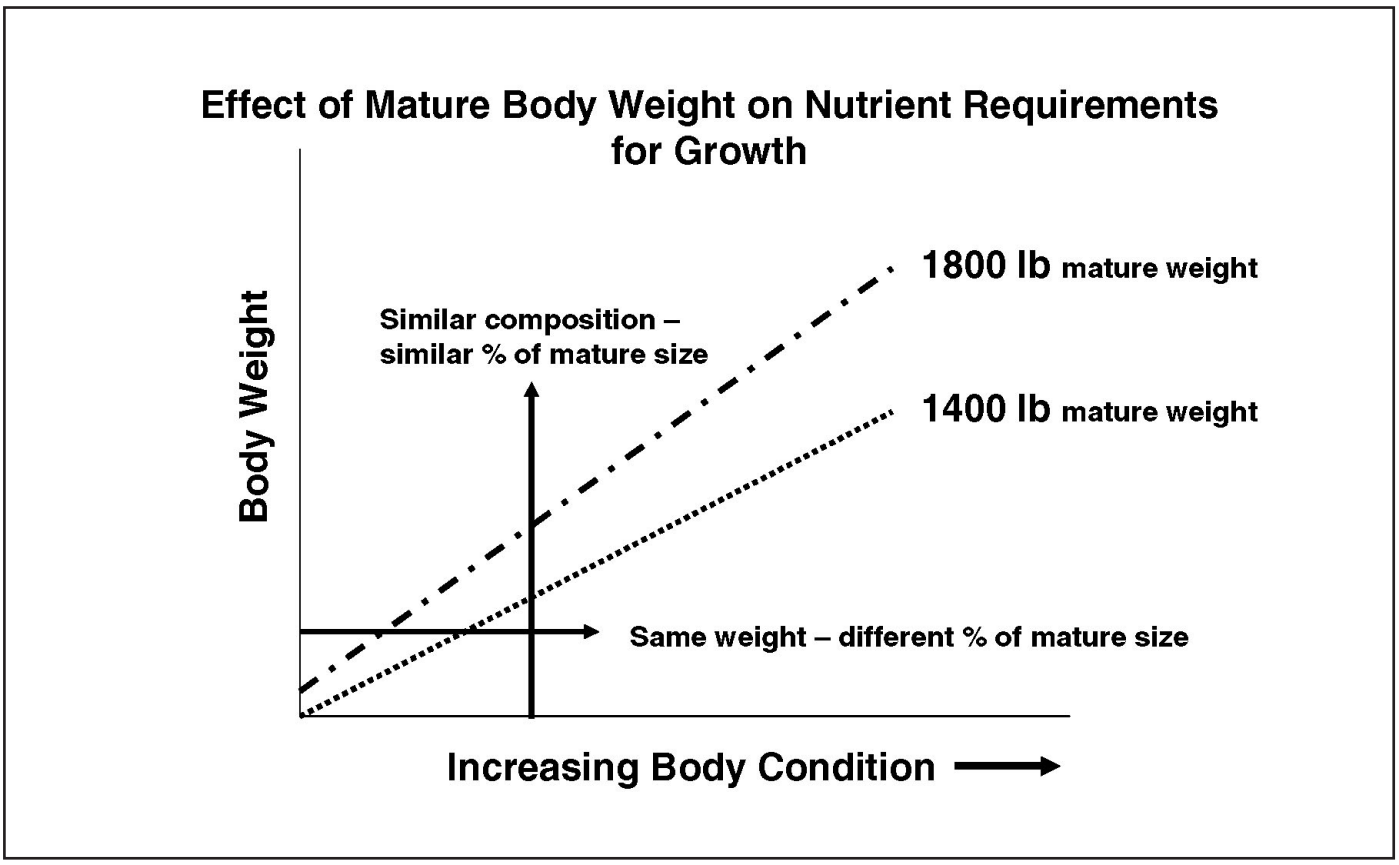


Figure 2. The effect of different mature body size on composition of the animal at similar stages of growth. (Used with permission from Van Amburgh and Meyer, 2005.)

Younger animals have the capacity to deposit more lean tissue per unit gain. From an energetic standpoint, a pound of fat contains 1.6 times as many calories as a pound of lean tissue, on a dry weight basis. Yet, lean tissue

(which can be thought of as muscle) carries 3.6 times as much water as protein, so depositing protein is associated with more efficient weight gain (Van Amburgh 2004). As animals approach maturity, they deposit more fat than lean tissue per unit gain. This change in the composition of gain with maturity is similar despite differences in mature size.

How do these targets translate into an appropriate ration?

The desired rate of gain is calculated by knowing the current weight of the heifer, the target weight at breeding, and the time period over which the weight gain must be achieved. The nutrient requirements to support the desired rate of gain in heifers of a given mature body size can be calculated using program such as that provided with the 2001 Dairy NRC. On a particular farm, in order for the heifer development system to be successful, the nutrient requirements must be met in the package of feed that the heifers actually consume. Either ad libitum or restricted feed systems can be employed to meet the target gains and avoid over-conditioning. Shortening the time to calving requires more intensive management of the feeding and breeding systems in the heifer operation. Feed composition, actual dry matter intakes, and heifer body condition must be monitored regularly and sources of variation must be minimized.

Examples shown in Table 2 illustrate the results of setting up targets in three different scenarios. **These examples are hypothetical and may not reflect the goals of any particular dairy.** To make this work in a specific situation, the herd's goals and management must be taken into account. Age targets are a management decision that should be made while keeping the biology of the developing heifer in mind.

Table 2. Application of target growth system under different management scenarios. Pre-pubertal growth rate is calculated based on animal factors and target age at first calving (AFC).

Mature body weight, lb	AFC, mo	Current age, mo	Current weight, lb	Target wt, post-calving, lb	Target wt, breeding, lb	Target age at breeding, mo	Target growth rate, lb/day
1000	22	4	210	820	550	13	1.2
1400	22	4	275	1150	770	13	1.8
1800	24	4	350	1475	990	15	1.9

Understanding the composition of gain has practical implications for formulating rations. The heifer with a larger mature size has a greater protein requirement for growth at the same body weight as a heifer with smaller mature size. Because it is "younger" physiologically, the one with a larger mature size is depositing more lean than fat per unit of gain. If these two heifers are fed the same ration that is formulated for an "average" heifer, the one with a larger mature size will tend to become over-conditioned because its requirement for protein is not being met relative to the energy in the diet. This effect is also seen in calves fed greater amounts of milk replacer containing only 20 or 22% crude protein because they do not consume enough protein relative to their capacity for lean tissue gain. Growing animals must be fed to support their protein and energy requirements per pound of growth.

What are the benefits of using the target growth system to formulate rations?

Expected economic benefits from applying target growth principles include increased throughput of the heifer enterprise, accelerated internal herd expansion, earlier income from milk production, and potentially increased income from sale of heifers. Since fewer replacements would be needed to maintain herd size, in some cases both crowding stress in heifer facilities and number of acres required by nutrient management planning would be reduced.

To sum up, there is not a one size fits all heifer raising system. Diets must provide the protein and energy required for gain at the heifers' particular stage of growth, i.e. percentage of mature body size. More rapidly growing heifers and heifers with greater mature size require greater amounts of protein in their diets, especially at younger ages. The target growth system provides a biological framework for formulating heifer rations and may yield economic rewards as well.

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This publication was written by Julie Smith, DVM, PhD, University of Vermont Extension Dairy Specialist, Department of Animal Science, Burlington, VT.

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Publication Date 2007
Printed in U.S.A.
01030606