Dairy heifers represent a large expense of resources including feed, buildings, and labor; yet return no money to the dairy farm until they calve. Thus our overall objective must be to minimize costs while maximizing the returns on those costs incurred. Our overall management of these heifers must be handled in a manner that yields the best quality heifer, with the highest potential to be productive, profitable, with a minimal cost to the farm and the environment.

Feed represents the largest component to the cost of heifer production and is such a large proportion that it clearly represents the major way to control heifer costs. We are often reminded of the importance of feed efficiency (lb milk/lb feed) for lactating dairy cows; yet the concept is seldom mentioned for the growing heifer. However, dairy animals spend over half of their life on most farms as a calf or heifer, which means that their feed efficiency is critical as well. There are many factors that can impact feed efficiency in the dairy heifer, including: genetics, forage quality (fiber and dry matter digestibility), feed intake level, growth rate or stage of growth, body condition or change in body composition, gestation, heat or cold stress (environmental stresses), and exercise level. Precision feeding heifers is really only about feed efficiency and utilizing the principles of feed efficiency to grow heifers at the rates that we need and desire.

Diet type and amount fed can be large factors that affect feed efficiency and are the major aspects that we use in precision feeding heifers. Forage and ration digestibility are also obviously important. The more digestible the feedstuffs used in the ration, the more efficient the heifer will be. In addition, the greater the dry matter intake fed as a percent of body weight, the lower will be the feed efficiency.

There has been a great deal of research done about precision feeding heifers, and virtually all since 2000. Much of the research has been done looking at precision feeding highly digestible diets to dairy heifers for improving feed efficiency and reducing nutrient waste. Feeding dairy heifers a balanced diet is always important. In the case of precision feeding, no additional free choice forages are fed, and the balanced diet is likely fed in the form of a TMR or mixture of forage and grain, fed once daily. Based on current published research for precision-fed dairy heifers, nutrient specifications as currently understood are as follows:

**Protein:** Balance primarily for crude and soluble protein.
- 14 to 15% CP for pre-pubertal heifers based on 2.15% BW DMI/d.
- 13 to 14% CP for post pubertal heifers based on 1.65% BW DMI/d.
- Maintain at least 30 to 35% soluble CP in the rations at all times.
- Rumen undegradable CP levels in excess of 25 to 30% are not required; use only standard feed sources based on price and availability and not feeds specifically designed for high bypass protein.

Heifers require a specific amount of crude protein daily, and for heifers total protein has been shown to be equally as important as the various protein fractions. Research has shown that added rumen undegradable protein (RUP) is of limited value to the heifer beyond what is found in common feedstuffs. In situations where high RUP feedstuffs are more economical than lower RUP feeds, they may be used; however they should not be used for the added RUP. Soluble (SP) and rumen degradable crude protein (RDP) are efficiently utilized by dairy heifers. In studies with SP added as urea, improved nitrogen retention in rations with SP approaching 40% has been observed. It appears that nitrogen utilization in the precision-fed dairy heifer is efficient, allowing for efficient rumen microbial protein production throughout the day despite feed access being limited to a few hours. In various published research trials, maximum protein efficiency has been demonstrated when heifers are fed diets containing 14 to 14.5% CP.
Energy: The energy requirement of the heifer will be influenced by the size, growth rate, and environment of the heifer. There are two feeding strategies to meet the energy requirements of growing dairy heifers. First, diets can be formulated at variable energy densities and fed ad-libitum to allow the heifer to select her energy consumption. In the second strategy, heifers’ diets can be formulated at a fixed (generally higher) energy content and precision-fed to specifically meet the heifers’ energy requirement. Regardless of feeding strategy, heifers should be fed energy to allow 1.75 to 2.00 pounds of average daily gain or approximately 130 kcal of metabolizable energy per pound of metabolic body weight (BW^{0.75}).

Fiber (NDF or ADF): The current NRC levels for fiber for dairy heifers may not be warranted based on recent precision-feeding experiments. Traditionally, high levels of fiber or low quality forage are fed to dairy heifers to control dietary energy; however precision feeding high concentrate, low fiber diets effectively accomplishes the same goal. Economics and the mix of forages available to a farm usually drive the forage level to feed. Much of our recent precision feeding work has been done with 70 to 90% forage diets.

Vitamins and minerals: In precision feeding systems balance for current NRC specifications. At present there are no data to suggest vitamin and mineral requirements are altered when heifers are precision-fed diets.

Monitor Heifer Weight
Weighing heifers is a relatively simple means to monitor animal performance, and this practice is a must for precision feeding dairy heifers successfully. Weighing heifers is increasingly important when precision feeding dairy heifers since an inappropriate level of diet restriction can lead to rapid gains and fat heifers or gains lower than desired. Electronic scales can be placed in alleys or some other easy to handle location to make heifer weighing less of a chore. Basically any time a heifer is handled, she should be weighed. With a precision feeding system heifers must be weighed to allow you know what amount of feeding is required, while maintaining the growth rates needed for breeding at a given age or for calving at a given body weight.

Recommendations:
• Weigh heifers at the same time of day (relative to feeding), otherwise alterations in gut fill can impact ADG calculations.
• Weighing heifers once per month is best, but once your system is stable, less frequent weights can work as long as you at least observe body condition.
• It is best to weigh all heifers; however, on some farms it may not be realistic, as heifer numbers may be labor prohibitive. In this case, weighing a representative group of heifers in a pen each time will suffice. It is important to be sure that this group is representative of the entire group and that the same heifers are weighed each time.
• Monitor individual heifer and group gains against benchmark weights, and alter management, specifically feed intake strategies, as needed.

Group Sizes
In any group-housed heifer facility minimizing variation in size and age of heifers in each group is important, and it remains important in precision feeding system management. Typically, beyond 4 months of age, heifers should be housed with other heifers as close to the same age as possible and always in groups with less than 200 pounds (90 kg) of weight variation within the group. Often this means having groups with 2 to 4 months of age variation at the most. Post breeding, this number can be increased to 300 pounds (136 kg) weight spread between animals within a group.

Feed Bunk Space
In precision feeding systems, heifers will need 14 to 24 inches of feed bunk space per heifer as they progress from 4 months of age to pre-calving or 22 months of age.

Precision-fed heifers will not have access to feed at all times of day, thus all heifers in a pen must have access to the feed bunk. Overly aggressive and timid heifers are very susceptible to over- or under-nutrition when feed bunk space is limited.

There are three strategies that can be used when feed bunk space is limited. The first is clearly grouping animals with peers having similar body weight. The second strategy is to have impediments to free motion at the feed bunk, such as headlocks or closely placed divider posts. This will likely be effective to some degree, but not completely. The third is to feed
twice daily at close intervals. For example, feed two-thirds of the daily allotment at 7 a.m. and the remaining third at 9 a.m.; in this way the larger animals can eat more freely at the early feeding and the more timid animals at the second feeding.

**Hungry, But Growing**

At the initial implementation of the precision feeding protocol, the heifers will likely vocalize immediately prior to feeding, with the frequency and magnitude increasing toward the next feeding. Research experiences are that this behavior will diminish and virtually disappear by between 10 and 14 days after the implementation of the precision feeding strategy. This is due to a moderate reduction in rumen and gut size needed to accommodate a reduced digestive load, which is one of the reasons for the improved efficiency in precision-fed heifers.

The transition to precision feeding requires time and commitment in a manner similar to the time it takes to increase gut capacity after calving. As long as the heifers are growing according to the ADG goals of your operation and receiving a correctly balanced ration, they are adequately fed.

**Transition to Pre-freshening and Post-freshening Diets**

Precision feeding should be discontinued and heifers adapted to normal pre-freshening diets 30 to 45 days before calving. Precision feeding heifers until 30 to 45 days before calving has had no adverse effects on calf birth weight, dystocia, metabolic problems, early lactation intakes, or first lactation milk production, as has been reported in several peer-reviewed journal publications. Changes in rumen and gut volume have been shown to occur rapidly and do not limit postpartum dry matter intake.

**Nutrient Specifications**

Listed below are some of the nutrient recommendations that have been determined under experimental and practical situations. It should be noted that both high forage and high concentrate rations contributed to these recommendations, both types of diets were precision-fed to produce a level of growth to meet ADG objectives. Precision feeding highly digestible, high concentrate diets is still under development for dairy heifers, and knowledge is still incomplete. But this information can serve as a starting point for those interested in precision feeding dairy heifers. The final determination for the success of a precision feeding program is the animal herself, and careful and frequent monitoring of heifer progress is the key to successful application of this nutritional approach.

A strategy for practical ration balancing is to formulate a least-cost diet based on the feeds available, meeting the required specifications, and then feed an amount of dry matter to meet the nutrient requirements. That is, assuming energy is most limiting for growth, determine the ME required by a heifer for a specific rate of gain (from the NRC, for instance) and divide the requirement by the formulated ration energy density (Mcal/d ÷ Mcal/pound DMI).

| Age, Body Weight, DMI, ME, CP, NDF, |  |
|---|---|---|---|---|
| Age, mo | Body Weight, pounds | DMI, pounds/d | ME, Mcal/d | CP, pounds/d | NDF, % |
| 4 | 250 | 5.72 | 7.8 | 0.9 | 23 |
| 6 | 350 | 7.45 | 10.1 | 1.1 | 24 |
| 7 | 450 | 9.07 | 12.2 | 1.4 | 26 |
| 9 | 550 | 10.62 | 14.1 | 1.6 | 27 |
| 11 | 650 | 12.11 | 16.0 | 1.8 | 28 |
| 13 | 750 | 13.55 | 17.9 | 2.0 | 29 |
| 14 | 850 | 14.95 | 19.6 | 2.2 | 30 |
| 16 | 950 | 16.32 | 21.3 | 2.4 | 30 |
| 18 | 1050 | 17.65 | 23.0 | 2.6 | 31 |
| 20 | 1150 | 18.96 | 24.6 | 2.8 | 32 |
| 21 | 1250 | 20.24 | 26.2 | 2.9 | 32 |
| 23 | 1350 | 21.51 | 27.7 | 3.1 | 33 |

Feed efficiency in the dairy heifer can therefore be optimized by selecting animals that have the genetic propensity for high dry matter intake in first lactation and have the ability to grow at uniform rates to meet the body size requirements for calving at 22 to 24 months of age. Maintaining optimal body size during the growing phase is important to minimize heifer maintenance requirements. Finally, feeding precise amounts of highly digestible and perhaps higher concentrate rations will minimize energy and protein requirements of the heifer as the heifer will efficiently digest and utilize the feeds that she is fed.