Heifer Housing Considerations

"Designing Facilities to Enhance Heifer Performance"

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Introduction

There has always been a desire by dairy scientists, agricultural engineers, and producers to optimize the animal environment to allow animals to be as productive as possible. The challenge is to design the animal housing design with due consideration to animal health, feed cost, labor requirements, and the system's environmental impact. To maximize profitability the costs of improving the animal's environment must be realized by the benefits gained in improved animal productivity.

Choosing a particular housing system design is difficult because it is not always known how the system design will affect growth, health, and production of the heifer.
In this discussion a heifer is defined as a dairy replacement that is older than 6 months of age.

The cost of a particular housing system design affects the profitability of the business. The housing system design's impact on the surrounding environment is also becoming a concern that must be considered in the total system design and cost. A review of the variety of systems used in the Midwest and Northeast will help identify some of the important design considerations for productive, profitable, and environmentally friendly heifer raising facilities.

To compare housing systems, there must be some agreement on how to measure heifer performance and its interaction with animal housing. A review of the measurements used in evaluating dairy replacement performance and how these measures can be used to determine the impact of a particular housing system on the animal's productivity will also be discussed.

The Design Process

The design process is necessary and important for developing a functional and economical facility plan. Many times when planning animal facilities the design process is ignored or forgotten. The design process allows the designer to investigate and consider alternatives and evaluate how the different design parameters interact and affect the overall housing system design. The design process is an iterative process. As design features are decided on during the process other design parameters may need to be changed to be compatible with one another. Decisions are made during the process, criteria may change and subsequent decisions will be based on those new criteria. Revaluation of the design criteria and design goals should be included as alternatives are decided on. The design process includes these distinct steps. (Figure 1).

This may seem to be a simplistic way of developing a plan for a heifer barn. Most would just start sketching a barn and placing alleys and pens in a building shell. This process can help identify the real criteria that are being used to develop the plan. It will help focus the decisions to be made on the real needs and not just the physical features and economics.

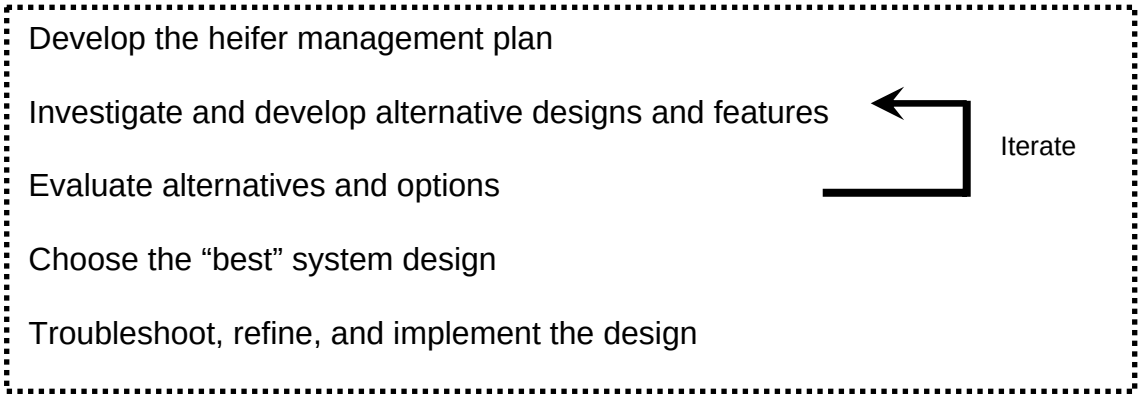

Figure 1. The Design Process

Develop the Heifer Management Plan

The heifer management plan addresses the first step in the design process. (Figure 2) The management plan describes each group's nutritional, health, housing, and environmental needs. With the specific information on each of theses needs the appropriate design parameters for the facility can be determined. The management plan also describes the animal care tasks that need to be performed to care for a particular heifer group. "Raising Dairy Replacements" is an excellent source of information to develop and define the management plan.

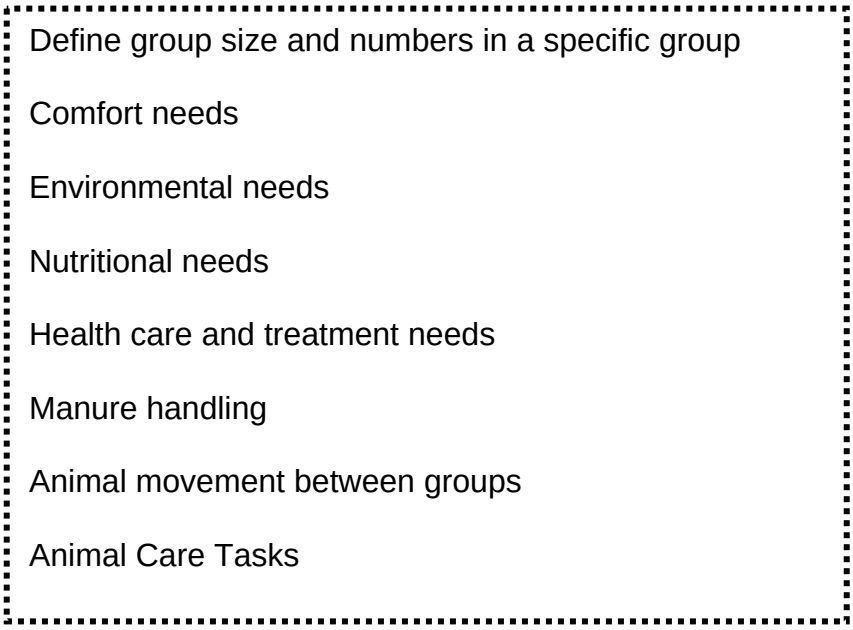

Figure 2. Heifer Management Plan Information

Define the Heifer Management Groups

Each heifer group's age range and the number of animals in the group for a particular farm's management plan needs to be decided. This will define the pen space for a group. Multiple pens of heifer groups will then be integrated into the building layout. The groups are defined based on the normal biological growth and needs of the specific heifer age. Heifer group descriptions, age range, and numbers in each group will vary depending on calving interval, conception rate, culling rate, and other management practices. The number of animals in a group should be considered when planning facilities to avoid overcrowding and competition within a particular group. As herd size increases the age range within a group will be reduced because the total number of animals in an age group range increases. Figure 3 shows the group age range and numbers for each group. Midwest Plan Service (MWPS) has information to determine group sizes for typical age ranges used in group housing. This assumes uniform calving year round, 12-month calving interval, all males sold, and 30% cull rate. The average value is approximately 4% of the herd size for each month age difference. For planning purposes, consider increasing the value 20-25% or approximately 5% per month age

difference to allow flexibility in the design. This allows the system to handle increased group numbers in a particular age range when the calving is not uniform.

Stress on animals

Excessive stresses due to a limitation in the animal's environment will contribute to illness, compromise growth and the genetic potential of the animal. In facility design the goal is to minimize these stresses on the animal. Figure 4 lists the common stresses on animals.

Heifer Age Range (Herd Size of 100 mature cows)	Average Number in Group	Design Number in Group
Birth – weaning (8 weeks)	8	10
3- 5 months	12	15
6-8 months Adolescent Heifers	12	15
9-12 months Adolescent Heifers	16	20
13-15 months Breeding age	12	15
16-21 months Bred Heifers	24	30
22-24 months Springing Heifers	12	15

Figure 3. Heifer groupings for 100 mature cows (MWPS Dairy Handbook, 2000)

Good facility design can minimize some of these stresses, but probably never eliminate them. Stressors are additive. The larger the number of stressors affecting the animal at

any one time the less likely the animal will be able to withstand the next stress that occurs. For example, a heifer may be able to withstand a cold drafty environment, but if it is cold, drafty, and the heifer is hungry, a sick heifer may be the result.

Change is a stress for animals but gradual and regular changes are not nearly as stressful. Since heifers will be destined for group housing and feeding later in their life, getting them used to competing in a group early makes later transitions much less difficult. Age range and size of animals should be considered in the housing design and the decision of group sizes.

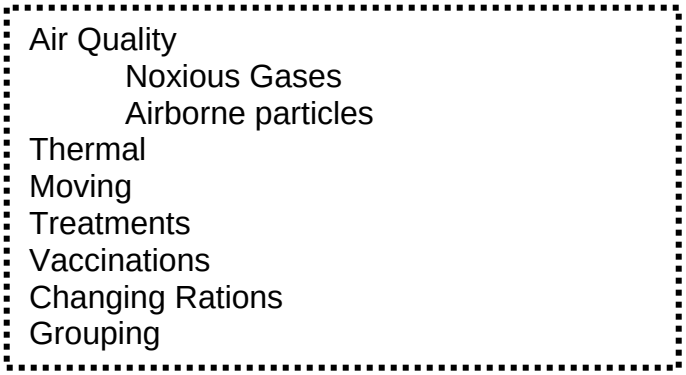

Figure 4. Common Animal Stresses

Heifer Performance Measure

There are two ways to measure heifer performance. The first is quantitative measures of adequate growth of the animal. Hoffman provides up to date measurement goals of Holstein heifers. Several growth benchmarks are reaching puberty weight of 650 lbs. by 6-7 months, reaching breeding weight of 850lbs at age 13 months, and calving at 22-24 months.

The other measure of heifer performance is qualitative and primarily relates to animal health. In the perfect world there would be no incidence of disease or death. In the real world the housing design criteria is to minimize disease and death as much as possible and as reasonably cost effective as possible. Qualitative health measures are listed in Figure 5. These might seem to be obvious and acceptable goals. But it is common to have poor performance in these measures due to budget constraints and compromises made in the building design for economics sake.

Minimal death loss

Minimal respiratory disease

Minimal GI tract disease

Minimal hoof and inter-digital disease

Minimal joint and skeletal abnormalities

Figure 5. Heifer Performance Measurements

Define the Animal Environment

The animal environment includes several areas. The animal's physical environment includes resting space, walking surface, feed and water space. Air temperature, relative humidity (RH), solar radiation, precipitation, and air velocity (natural or artificial) describe the thermal environment. Animal behavior describes how the heifer reacts to the environment, with other animals, and with people. Information describing the animal's environment is used in developing the housing strategy that are dependant on the animal's natural ability to adapt to her environment including competing in a group setting for food, water, and space.

Thermal Environment

Heifers are homeotherms that can maintain a relatively constant body temperature during environment changes. The optimal temperature for calves is approximately 70 F, with a range from 45-80 F. For adult animals the optimal temperature is approximately 50 F with a range of 45-80 F. Heifers will have an optimal temperature within the range of 70F to 50 F.

Temperature extremes are stressful to the animal and the facility design and management should provide the ability to minimize the stress on the animal. Air velocity improves animal cooling through convective and evaporative cooling. At high air temperatures, natural air velocity (wind) is beneficial. When the wind is calm, mechanical means of increasing air velocity to 500 fpm or greater is beneficial.

During low air temperatures, air velocity (draft) should be limited to reduce convective heat loss. As the temperature decreases air velocity contributes to wind chill and associated cold stress. For heifers, a draft at the animal level with an air velocity over 100 fpm should be avoided. As animals get older they can tolerate higher air velocities. Windbreaks in outside lots, or building partitions and hovers are typically used to reduce air velocity at the animal level.

The affect of relative humidity on animals is not well documented or researched. Experience suggests that high relative humidity in a housed environment is usually the result of inadequate moisture removal through ventilation. The combination of high relative humidity and temperature increases the pathogen load and provides aerial transport of the pathogens into the animal's lungs, causing respiratory problems such as pneumonia. This is most often a problem with young animals because of their immature immune systems. High relative humidity in hot temperatures reduces evaporative cooling of the animal. Ammonia production (respiratory system irritant) from manure increases with temperature. Proper ventilation design removes and dilutes the gases produced and the overall pathogen load of the air.

Depending on the air temperature, solar radiation can either be beneficial or detrimental. In cold temperatures, solar radiation can be beneficial in drying out bedded areas and alley surfaces. In cold temperatures, if allowed animals will tend to sun them themselves to increase solar gain. In hot temperatures, solar radiation is detrimental and shade is required to reduce solar gain on the animal. In hot temperatures, if allowed, animals will seek out shade. Care must be taken to assure a clean dry resting area be maintained where shade is provided.

In cold temperatures, the animal's clean, dry hair coat provides an insulating blanket to reduce heat loss by conduction and convection. Air velocity, moisture and/or mud on the hair coat will reduce the insulating capacity and increase heat loss, which can be detrimental to the animal. In hot weather, air velocity and wetting the animal's skin below the hair coat can increase heat loss, which is desired to reduce heat stress.

Ventilation

Ventilation is necessary for providing fresh air and removing moisture and excess heat. The majority of newly designed dairy facilities use natural ventilation where wind, the major motive force, and thermal buoyancy (i.e., warm air rises) provide the driving forces for air exchange. Air enters through side wall and eave inlets and exits through the open ridge and downwind sidewalls. Insufficient inlet and outlet openings leads to condensation on cold building surfaces in cold weather and heat build up in hot weather. Naturally ventilated barns are designed to provide shade in the summer and draft control in the winter. Supplemental cooling fans may be used to increase the air velocity and improve cooling in the summer on hot still days.

Physical Environment (Animal comfort)

The animal's physical environment includes the resting and walking surfaces, and its access to feed and water. The building shell design provides for shade and draft control. Heifer comfort is fundamental to the housing design.

Resting Space

A clean and dry hair coat helps insulate the animal against the cold as well as sudden changes in temperature. Bedding in a pack should be dry. A 6" deep layer provides both a cushion and insulation. For heifers, a well-designed free stall platform with bedding is important in encouraging animals to lay in the bed instead of the alley. Freestall partitions, gating, fences, and penning should be designed to withstand animal pressure and prevent injury.

Walk alleys

Freestall or bedded pen group pens should have walk alleys to allow heifers to access feed and water. Alleys are placed between the resting space and the feed/water space. This allows the majority of the manure to accumulate in the alley and reduces the manure accumulation in the resting space. Pen partitions and gates should be hung at a proper height to clear fully bedded pens. Manure scrape alleys should also be laid out for easy manure removal. Gates with the proper swing should be placed at appropriate locations to allow for easily moving animals from one group to another or sorting of individuals from a group. The alley and gate layout should allow a single person to sort and move an individual or group of calves of heifers safely.

Alley surfaces should be made non-skid improve footing and prevent slipping. Alleys should be grooved when the concrete is placed or grooves sawn when the concrete is green. Grooves can also be cut into old concrete alleys to improve footing.

Feed Manger

Easy access to food and water are necessary for optimum growth. Animals cope with environmental changes and stress by compensating in their dry matter intake. The separate heifer age groups are usually fed different rations based on the group's nutritional requirements and thermal environment. Flat feeding floors with a post and rail-feeding fence allow easy access to feed by the heifer. The flat floor also allows easy feed delivery, pushing up of feed, and cleaning by workers. A smooth eating surface can improve dry matter intake. Headlocks are a common option as a feed barrier and can provide for easy restraint for treatment.

Waterers

At least one waterer should be available to each group or individual pen. Two waterers placed at separate locations of a free stall row or bedded group area allows easier access. It also allows submissive animals access to water when a dominant animal commands a single waterer. The water tank should have shallow water depth (i.e., 6 to 8 in.), be mounted at the correct height for the age group, and allow easy cleaning and draining.

Restraint for Treatment

Each management group should have appropriate and convenient access to health care and treatment facilities. Headlocks are a popular restraint option for group pen arrangements. The headlocks are placed at the feed bunk and used consistently by the animals. Animals can be caught and restrained at any time. A squeeze chute, hoof trimming table or surgery table are nice features for any size herd but are becoming very popular for larger herds that have regular herd health checks by a veterinarian. Pens can be designed with a gate swing to funnel an animal towards a head gate to catch and restrain her. These facilities should be easily accessible to the veterinarian truck and vet supply area/office.

Lighting

Lighting is important for animal observation and care. Metal halide and high-pressure sodium lamps are popular energy efficient options for cold areas where they can be mounted 11 ft or higher. Fluorescent lamps with electronic ballasts can start at colder temperatures (down to 0 F). Incandescent, halogen, fluorescent and metal halide lamps have a higher color rendition index (CRI) than high-pressure sodium and mercury vapor lamps. Colors are truer when observed under lamps with higher CRI values. Mercury vapor lamps are not recommended.

Personnel Safety Passes

Personnel safety passes are 12 to 14 inch clear openings placed in the pen partitions to allow easy access from any pen. Safety passes allow a person to escape from an aggressive animal. For small animals spring loaded gates may be mounted across these passes to prevent animals from escaping. Personal passes should be placed in all group pens, usually in or near a gate.

Manure Handling

Animal manure and bedding will be generated wherever heifers are housed (i.e., manure alley or bedded pens). Different housing and bedding choices will require appropriate manure handling system and equipment. Consider manure form, bedding use and storage, manure collection and storage, and the equipment needed. These options can be considered during the design process to develop an overall manure management plan. Consider how manure will be removed while animals occupy the pen.

Animal Care Tasks

While it is important to minimize the stress on the heifer, it is also important to consider the needs of the caretaker. If tasks are easy to do and time efficient they will probably get done. A description of the jobs required to care for each group is helpful in determining the housing system design features. A list of the activities or jobs and what facility

features are needed to get the job done conveniently should be developed for each animal group.

If the chores are difficult to do or take a lot of time, they won't get done or will get rushed and the heifer care will be less than desired. Handling facilities for heifers should be designed into the building to allow easy restraint of animals. Housing design goals for the caretaker are shown in Figure 6.

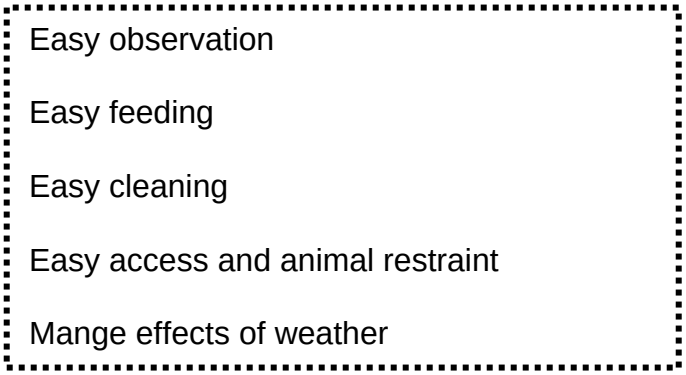

Figure 6. Housing Design Goals for the Caretaker

Decision Making in the Design Process

Identify the required (must have) design features and prioritize the desired (would be nice to have) features. This prioritized list of features helps in making decisions during the design phase. It is especially important when the budget has to be met and some features need to be left out. Required features that are absolutely necessary for animal health and comfort should be retained while other desired features that would be nice can be kept in the design if the budget allows.

Economics

Economical heifer facility management can take on several different meanings. Most often we might think of economical facilities as those that are low capital cost to build. But the total system cost of raising the heifer must be considered when determining economy. Economical heifer facility management must consider the combined cost of facilities or fixed costs, feed costs, variable costs, and labor and management costs. A Wisconsin survey collected cost information for calf and heifer raising on 78 commercial dairy herds. The highest proportion of daily costs for heifer raising was for feed (59%), and variable (16%) costs with lower proportions for labor (13%) and facility (12%) costs (Figure 7). Facility cost per day for heifers was approximately $.20/day). For heifers the potential of reducing feed costs is highest.

Annualized Capital Costs of Housing Systems

The cost of the housing options shown in Figure 8 were estimated from construction data, builder and farmer input. The capital cost was annualized for a 10-year life and 10% interest. The annualized cost was then divided by the appropriate number of housing days for an animal group including a 2 week cleaning and rest period for a pen to determine a cost per day per heifer for each housing system. The annualized facility costs are only a part of the total annual cost to raise a heifer. This is an important economic consideration in trying to reduce costs. For example an attempt to reduce facility costs by choosing a low capital cost system may increase other costs such as daily feed and labor costs by more than the cost savings achieved in a low capital cost system. Where is it more likely to be successful to reduce the daily cost of raising a heifer by $.05/day? $.05 a day is equivalent to 25% of the housing costs but only 5% of the feed costs?

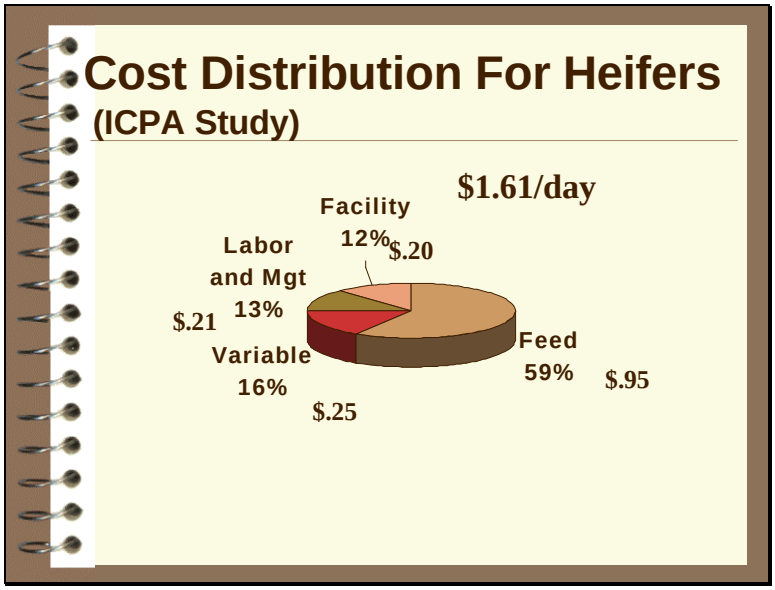

Figure 7. Daily Cost Proportions for Raising Heifers.

Housing System for a Management Group

Each heifer management group is defined as having similar needs for growth environment and production goals. For small herd sizes the age range within a group may be rather large. The tendency may be to combine small age range groups to increase the group size. This may be detrimental to individual animals within the group. The number of animals in a group should be adjusted to compensate for differences of the wide age range of individual animals and to ensure the individual animal's needs are being met within the group. As herd size increases the age range of a group will be smaller and also provide for the needs of the individual animals. In practice the group size can be increased based on management experience. The overall goal should be to base group size on meeting similar animal needs.

There continues to be interest by producers to explore housing options at both ends of the capital cost spectrum. Low capital cost facilities such as pasture and open lots is one direction that large growers are moving to especially for heifers older than 12 months. Managed use of designed areas such as lots, mounds, windbreaks, concrete, packs, and pasture or sacrificial paddocks can minimize environmental effects on the animal. However, higher capital cost systems are also being constructed. These systems are intended to minimize the environmental effects on the heifer, increase growth rate, reduce labor costs, and environmental risk and costs to clean lot runoff. Specific design of these options is beyond the scope of this discussion. There are several good references to develop specific design parameters for the housing systems discussed below. MWPS and NRAES have handbooks and proceedings that show plans and specifications for various housing options.

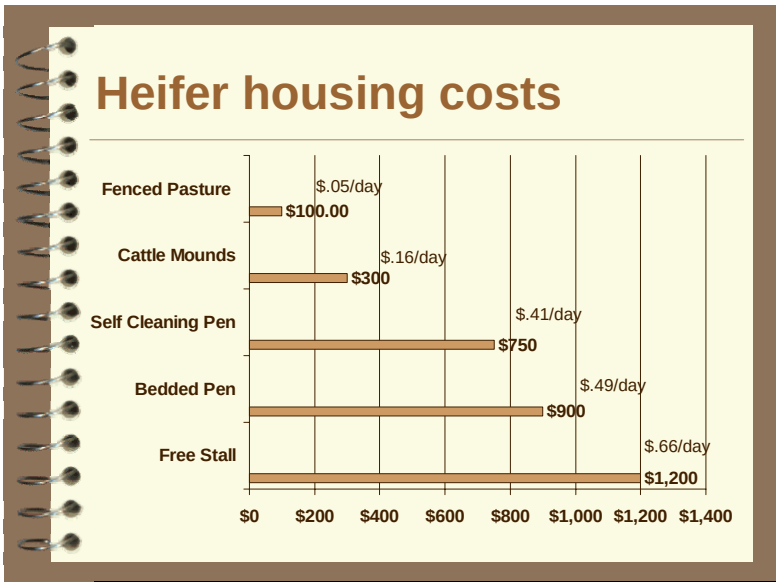

Figure 8. Housing Options and Costs for Heifers

Pasture

Pasture is an area that is stocked at an animal density that maintains vegetative growth throughout the growing season. Excessive use of a pasture can result in a muddy lot, which is not recommended. Pasture in the summer and sacrificial paddocks in the winter are one of the lowest capital costs systems. Natural or man made windbreaks and shade may be incorporated into the layout. Cattle mounds and bedded outdoor packs can help keep animals dry and reduce mud. Fencing and water systems are designed to provide easy animal movement and adequate access to water in each paddock.

Outside dirt lots/ mounds

As the outside space per head decreases the ability to maintain vegetative cover decreases. A dirt lot usually does not have vegetative growth and should have limited access by the animals depending on the weather. A dirt lot should not be used when it is

muddy. A fence and gate should be used to limit animal access to the dirt lot at appropriate times. The outdoor dirt lots may become muddy during some times of the year which require the need to provide high areas (cattle mounds) within the space to allow cattle to move out of the muddy areas. Giving heifers access to dirt lots or pasture is desired by some producers as a way to improve foot health. Heifer facilities can be designed to allow limited access to open lots depending on the weather. Muddy conditions can be limited by using geo-textile fabrics in a designed all-weather surface. More information is available in AED-45, Using all-weather geo-textile pads and lanes (MPWS, 1999). Lot runoff from dirt or concrete lots needs to be handled properly, according to local and state regulations to prevent pollution. Concrete lots can also be developed to provide an improved surface for the cattle that can be used when muddy conditions occur on the dirt lots.

Bedded Pen (Pack) System

The bedded pack should be sized to provide the correct resting area per animal depending on size. This resting space does not include the feed bunk alley and scrape alley used for accessing feed and water. Bedding needs to be added regularly to provide a clean and dry place for animals to lie. The pen arrangement should allow easy bedding addition and manure pack removal with a skid steer or front-end loader. Properly placed gates allow alleys and resting areas to be cleaned easily and without mingling cattle groups. Well-designed facilities are convenient to use and reduce labor requirements. The bedded pen system does allow management flexibility as the dairy business grows and the herd size increases. The manger has several options of increasing building capacity. Pens can be overstocked above design recommendations effectively decreasing the space per animal. Increasing bedding amounts and frequency may be required to keep animals similarly clean and comfortable. If pens designed to provide the minimal space per animal this option may not be available. In that case increasing animal numbers will require the construction of additional space.

Self Cleaning Bedded Pen system

The bedded self cleaning floor space has a slope of at least 1:12 to allow bedding to move down slope of the resting area into the adjacent alley. This alley is scraped daily to remove manure to a collection area. The space per animal should be adequate to allow resting space and still allow foot traffic of the animals to move manure and bedding down slope. The resting space does not include the adjacent alley and feeding areas. The self cleaning bedded pen system also allows management flexibility as the dairy business grows and the herd size increases. The manger has several options of increasing building capacity. Pens can be overstocked above design recommendations effectively decreasing the space per animal. Increasing bedding amounts and frequency may be required to keep animals similarly clean and comfortable. If pens designed to provide the minimal space per animal this option may not be available. In that case increasing animal numbers will require the construction of additional space.

Freestall Systems

Freestalls can be used to provide a clean and dry place for the heifer to lie down. They should be sized to prevent injury as heifers get up and down. They also should be easily accessible from walk alleys. A freestall platform should have the correct width and length depending on animal size. The brisket board and neck rail should be the correct distance from the rear curb. NRAES and MWPS have information on stall dimensions. Alleys and feed bunk space should adjacent to and be convenient to the freestall platforms. Properly placed gates and swing directions should allow groups of cattle to be moved to the adjacent alley while the other alleys are cleaned. Freestall pens are slightly less flexible as the herd size increases and the number of heifers increases. Since freestall platforms are designed for specific sizes of animals a pen will only hold a certain number of animals. Overstocking pens can be an option up to a point assuming the same size animal is housed in the pen. Housing an animal in an incorrectly sized freestall platform will increase labor to keep animals clean in too large a stall or create an uncomfortable platform and possible injury to an animal in a stall that is too small.

Develop alternative designs

Use the required and desired design features and the information in Figure 2 and 6 to come up with creative housing ideas and options. Visit other farms, look through popular press articles, and visit with allied professionals to obtain ideas for grouping, housing and managing calves and heifers. Sift through the ideas to find those that fit best into your management plan. Use Mid West Plan Service (MWPS), Natural Resource, Agriculture, and Engineering Service (NRAES), and Extension publications for design recommendations for the specific designs discussed above.

Choose the “best” system design

There are many alternative types of housing systems. Choosing the right one for your farm depends on the capital, labor and management resources available. Making the best use of those resources to provide a healthy environment for the heifer is what it takes to be successful. It is also the main challenge in designing a system for a specific farm

There is no single “best” design. Every design involves a trade-off. The difficult task is to incorporate as many of the design criteria desired into a functional, practical, and easily constructed plan. Some design principles may have to be compromised slightly to be part of the overall design. If the design principles have been prioritized, the job of deciding which features to keep or eliminate for whatever reason can be made more easily because the decision process is already in place. Well-designed heifer facilities will fit the management plan, provide comfort and care, be convenient and safe for workers, and economical.

Assess the trade-off of each design option. Try to determine which combination of design choices provides the most balanced design. The “best” solution should meet all of the required criteria set forth in the management plan and building specifications, and most

of the highest ranked desired features. The overall layout should be somewhat "better" than the other alternatives.

Implement the design

Develop a scaled building plan for bidding or construction purposes. The plan helps define the space and conveys the specifications of what is to be built to the builder and to others involved. The specifications of the building will describe the facility in terms that a builder or contractor can understand. A complete plan will help the builder and other contractors to build the facility the way you planned it.

The scaled plan can be used to evaluate the overall design and its impact on all aspects of the management plan. The dairy design team can review and critique the design. The herd manager and other employees can consider how they will perform their assigned tasks.

Retrofitting Existing Facilities

In some cases, existing facilities can be used to house and manage ar heifer group defined in the management plan. Evaluate the existing facility to determine its function in the plan. If the space can meet the needs described in a reasonable fashion with cost-effective modifications then it may be a viable alternative. If the retrofit does not meet the functional design, then it may not be a good decision even if it is a very low cost modification.

Summary

Facility design is an iterative process involving give and take. It is easy to lose sight of the original intent along the way. Design the facility to implement the heifer management plan for each group. Consider and select each of the design features to develop a comprehensive facility design. Keep the lists (i.e. Figures 2 and 6) developed during the design process and use them as a guide when considering design changes during construction.

A heifer facility should be designed and built to implement the chosen management plan and provide a clean, dry environment with plenty of fresh air and feed and water for the animals. A well-designed facility should also be labor efficient, economical, safe for both workers and calves and heifers, and environmentally friendly.

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