

# Pre-Weaned Calves: Housing and Considerations<sup>1</sup>

Curt A. Gooch, P.E.  
Senior Extension Associate  
Department of Agricultural and Biological Engineering  
PRO-DAIRY Program  
Cornell University

## Introduction

Dairy producers know the importance of getting a fresh cow off to a good start for a successful lactation. Considerable effort is needed to ensure that she is given the utmost opportunity to consume feed and water, and that all of her environmental and health care needs are met. Production and profitability can pivot on the first few weeks of her lactation.

Similarly, but not with immediate payback, newborn calves need to be given a good start in life to ensure they will be viable replacements for the herd. Properly raised calves are more apt to be healthy, vigorous, and ready for first calving at the target age and body size for the farm. As cows, they should be able to cope with stressful environmental conditions better than calves raised in less than ideal conditions.

Providing adequate nutrition, health care, animal husbandry, and management are essential. Ensuring a proper environment for each animal is equally important. The type and quality of housing facilities affect all these variables directly or indirectly.

Initial capital, operating, and maintenance and repair cost for the rearing facility are important considerations also. Less permanent confined housing units like greenhouses and fabric-covered structures, collectively given the name alternative housing structures, generally have lower initial cost but higher maintenance and repair costs. Due to the variations in material and structural life between housing options, it is best to determine the total annual cost for each housing system being considered. Difficulty can exist in calculating the exact total annual cost since some of the alternative housing systems offered to the producer are relatively new and the life of the systems are not well established. However, it is well known that plastic cladding only lasts a few years while corrugated aluminum cladding will last 30 years or more.

Labor efficiency for animal housing facilities must also be evaluated. Raising dairy replacements represents between 15 and 20 percent of the total farm costs and labor expense is the second largest expense for the heifer enterprise (Karszes, 1996). The

---

<sup>1</sup> Written for presentation at the Dairy Calves and Heifers: Integrating Biology and Management Conference, January 25 – 27, 2005. Syracuse, NY. NRAES – 175.

method of housing replacements needs to be as labor efficient as possible without any sacrifice to animal health or performance.

All these variables should be considered when developing a management plan.

### **A Management Plan**

Development of a management plan for raising heifers is best accomplished by looking at all related factors: nutrition, health, growth rates, labor efficiency, capital, and operation and maintenance costs. Weighted priorities need to be assigned to each variable in order to decide overall which are most important for a particular farm. Thrifty calves cannot be raised efficiently in poor facilities with inadequate animal husbandry. Great calves, with optimal daily weight gains, can be raised in ideal conditions, but this is not generally economically feasible every day of the year.

The overall management plan for a farm will most likely be different from that of another farm. Existing conditions, site characteristics, employee knowledge, desire and capability, and personal preference are just some of the variables that will influence each management plan.

A primary goal in management plan development is to look for ways to combine replacements with similar characteristics and needs to form management groups. Formation of management groups allows for increased efficiency in meeting the general needs of all group members. However, the individual need(s) of each group member can still be met as required. Management groups are used to help determine the appropriate housing characteristics. The goal of replacement housing facilities is to serve as tools in support of the overall management plan.

### **Management Groups**

When considering rearing dairy replacements three distinct management groups generally can be formed: the newborn group, the transition group, and the adolescent group.

#### Newborn Group

The newborn group consists of calves from birth to about 10 days post-weaning. Retaining a calf in this management group for 10 days post-weaned allows for close observation to ensure the process is complete and is recommended by Morrill (1992).

#### Transition Group

This management group encompasses post-weaned calves up to about 400 lbs. Heifers in this management group transition from a housing system that generally provides individual pens to a small group pen. They also transition from a starter feed diet to forage based feed diet.

#### Adolescent Group

Heifers that have graduated from the transition group are housed in an adolescent management group. If heifers are destined to be housed in a freestall shelter when they are cows, then introducing them to freestalls when they enter this management group is

suggested. Heifers remain in the adolescent management group until they enter the pre-fresh group.

This paper discusses housing options for the newborn management group. Options presented are those that focus on providing a quality calf environment and a high target level of labor efficiency. Two other papers presented at this conference will discuss housing options for the transition and adolescent management groups, respectively.

### **Environmental Basics**

Facilities for rearing newborn calves need to provide the following basic items in order for calves to be comfortable and healthy.

1. A clean, dry, and comfortable resting area
2. Adequate, draft-free ventilation with clean air
3. Ample access to feed and water

Each of these basics is discussed in more detail below.

#### Resting Area

A clean, dry, and comfortable resting area is important to the health and overall well-being of calves. A generous dry bed of fluffy material such as loose straw, coarse saw dust, or wood shavings benefits the calf by:

1. Helping the calf stay clean
2. Helping maintain a fluffed hair coat for winter protection
3. Acting as a moisture adsorption media
4. Providing a cushioned resting surface

Housing systems that use concrete as a base material require more bedding than those that have a pervious base. The additional bedding material is needed to absorb excreted moisture, spilled liquid feed, and water since they do not appreciatively infiltrate into concrete. Experience has shown that opportunistic pathogen control is difficult in confined housing systems that have pervious bases; it appears to be hard to disinfect granular base material.

#### Ventilation

No matter what housing system is used, it is important that the air used for ventilation is clean and fresh. Newborn calves have little resistance to disease challenge so it is vitally important that the source of air used to ventilate the housing unit be clean and fresh (pathogen free). Newborn calf housing is best located on the windward side of the overall farmstead to minimize passage of airborne pathogens from older cows and heifers. This is especially important on farms that are expanding via purchase of outside cattle or springing heifers. A specialist has indicated that some airborne pathogens, like micro plasma, can be carried by air currents several hundred yards (Welcome, 2000) making it also important to provide substantial separation between newborn and more mature animal housing units.

Given that there is clean air outside the housing structure, a goal is to have air quality within the microenvironment surrounding the calf to be very similar to the air outside the housing structure. With proper ventilation, the relative humidity will be nearly the same in the calf zone as it is outside, and the concentration of manure gases, dust, and pathogens will be very low. Air exchange is required in order to meet these air quality goals. Air exchange is the process of using outside, fresh air to replace the mildly contaminated air within the structure.

Improper ventilation can cause respiratory problems, reduced feed intake and conversion rates, and have long-term effects. Recently, a practicing veterinarian returned to her home farm in Michigan to be the herd replacement manager. During a discussion with her she reported that calves raised on their farm in inadequately ventilated facilities did not cope with summer heat stress during ensuing lactations as well as cows raised as calves off-farm in well-ventilated environments.

Confined housing shelters with large aspect ratios are best oriented with their ridge perpendicular to the summer prevailing winds. This orientation provides better exposure to moving air and benefits the performance of an open peak. Other factors, such as topography, other buildings, manure flow, feed flow, traffic patterns, and expansion also need to be evaluated when determining the location and orientation of a shelter.

#### Access to Feed and Water

Unrestricted access to feed and water is important to effectively achieve optimal daily weight gains. From a newborn calf's perspective, feed and water should be:

1. Readily available and easily accessed without competition
2. Located outside of the pen to a) minimize contamination by urine and manure and b) preclude liquid feed and water from wetting bedding material.

From a calf caretaker's standpoint, feed and water should be:

1. Easy and convenient to deliver
2. Fed from containers that are easy to remove and replace thus increasing proper adherence to cleaning and sanitization protocols

#### **Other Considerations**

Other considerations that should be given when evaluating options to house newborn calves are:

1. Ease of observation; Pre-weaned calves have special needs that sometimes need to be met immediately and/or frequently by the caretaker making ease of observation important.
2. Opportunistic pathogen control; Pre-weaned calves have an

incomplete immune system making them highly susceptible to disease challenge. Materials used for pen construction should allow for easy cleaning and sanitization and not readily support the growth of pathogens. Concrete slabs-on-grade used as pen bases should be hard-traffic (glossy finish) and properly cured and constructed from high strength concrete with a low water to cement ratio (slump less than 4 inches).

3. Separation; It traditionally has been recommended that pre-weaned calves be separated from other calves to prevent calf-to-calf contact in a good calf housing system. Solid pen dividers are sometimes used with mixed results. Observation has shown that newborn calves can be raised successfully in a group housing setting on some farms.
4. Extra space; Extra space is needed to handle surges that inevitably take place in calving frequency. Stone (2000) showed that facilities designed based on uniform calving frequency would be significantly over crowded two to three months of a year based on data collected from 170 northeast dairies. Extra space is also suggested to provide a dormant time between stockings to enhance pathogen control in individual calf pens (Morrill, 1992).

### **Housing Options for the Newborn Management Group**

The next few paragraphs provide an overview of some of the viable housing alternatives that, when properly managed, can provide a suitable environment for rearing newborn calves.

#### ***Individual Calf Hutches***

Individual calf hutches are an excellent housing example for all young stock designs to follow (McFarland, 2004). Much has been written in the past about calf hutches largely due to their success and popularity. Good references include McFarland (1996), Van Horn and Wilcox (1992) and, Davis and Drackley (1998).

Observation has shown that there are many variances between calf hutch systems used by dairy producers. For example, some producers choose to use hog wire panels to contain the calf while others use a tether system. Differences also exist with respect to the feed and water pail locations; some systems are set up to feed calves outside the hutch while others locate feed and water pails in the hutch.

An optimum calf hutch housing system will meet all of the basic needs of calves and be as labor efficient as possible. A calf hutch with an outside feeding and watering station is shown in Figure 1. Its design is based on maintaining all the positive aspects that calf hutches are known for plus maximizing labor efficiency. Specific attributes of this design include:

1. Maximum freedom of choice by the calf. She can choose any of the possible environments offered to her by a calf hutch. This includes in the hutch, outside in the sun, and outside in the shade created by the hutch.
2. Highest labor efficiency of any hutch system. Feed and water are easily delivered by the caretaker. Feed and water pails can be anchored to the feeding station but yet easily removed by the caretaker for cleaning and sanitization. Anchoring the pails means that the caretakers can be most efficient with their job; they will not have to chase or find pails located elsewhere by the calf.

The feeding and watering station is held in place by a plastic collar pipe that is anchored in concrete. The annular stop welded to the steel pipe keeps the feed and water pails positioned at the proper location. A steel pin located in the plastic collar pipe and held in place by the concrete backfill will keep the steel post from rotating in the hole.

When clean up of manure and soiled bedding is performed, the station is easily removed by simply lifting it out of the hole and set aside until cleaning is accomplished. If the feed station is to be moved to another hutch location, then the receiving hole can be protected from debris by placing a plug in the hole.

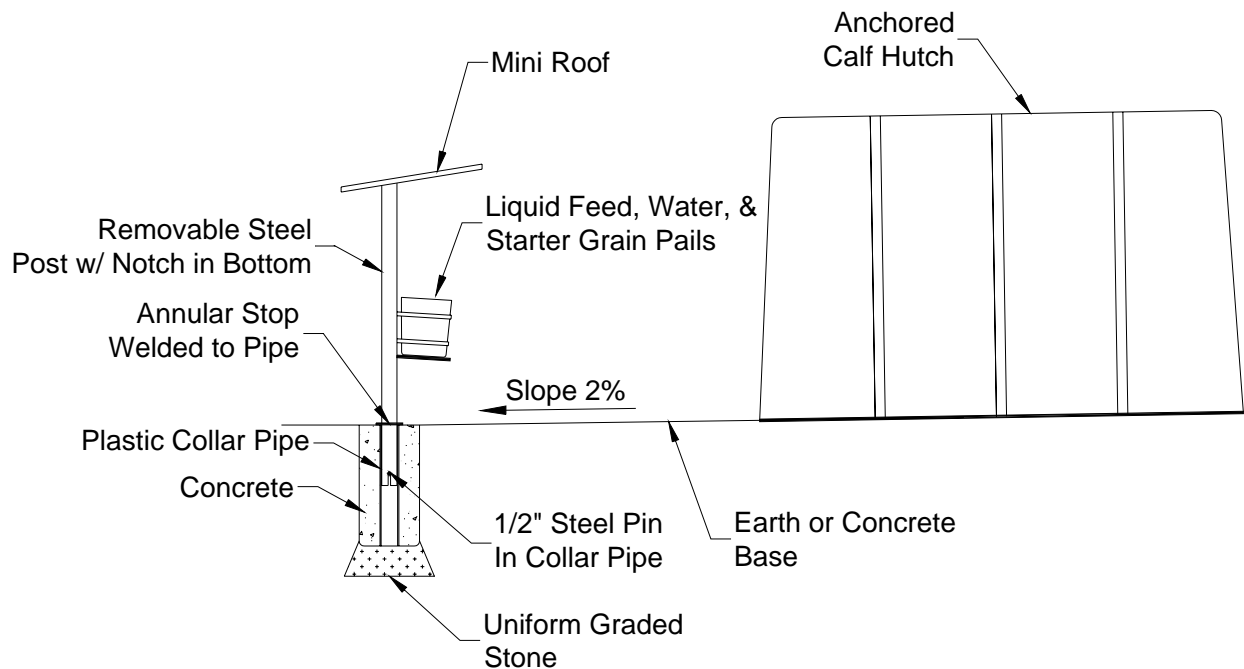
The thought process that lead to the design of the feed and watering station was based on maximizing the labor efficiency for calf hutch systems. Although not currently documented by data, the author believes that labor efficiency will be substantially higher than 9 calves per hour as has been previously reported by Karszes (1996) for other types of calf hutch systems.

### ***Open Front Structures with Individual Pens***

Open front structures with individual pens can be either portable or stationary. Both are constructed as wood-framed housing units. Structures should be designed so they can easily be cleaned with a skid-steer loader or small bucket tractor.

These structures require less land space than individual calf hutches and they provide caretaker protection from precipitation and some blowing winter winds. Each individual pen in the shelter is about 3 to 4 feet wide and from 7 to 8 feet deep. In cold weather, a plywood cover can be placed over the rear portion of the pen to minimize drafts and to preserve heat produced by the calf. In warm and hot weather, a removable panel at the rear of the shelter can be opened to provide additional air exchange.

These structures require attention by the caretaker to ensure that the calf environment is maintained properly by adjusting the rear curtain wall. The need for adjustment is not as frequent as with shelters with transparent or translucent coverings. Major adjustments are needed to protect the calf from blowing precipitation and cold winter winds.



**Figure 1. Calf hutch with outside feeding and watering station for a tethered calf.**

### ***Central Drive-Through Feed Delivery Shelters with Individual Pens***

One of the biggest challenges with any confined housing system is management of the calf's environment. Unlike calf hutches, calves housed in confined systems cannot make a choice as to where they are most comfortable. It is incumbent of the calf caretaker to make adjustments to the housing unit's ventilation system in order to manage the microenvironment experienced by the calves. Research has shown that curtains need to be repositioned as many as 7 to 10 times per day during transition weather periods in order to maintain a quality environment (Gooch and Inglis, 2001). This level of adjustments takes a dedicated employee that is trained in the field of ventilation principles and system management. Problems arise when the ventilation system is managed based on human needs and not that of the calves. Remember, calves are in the shelter 24/7 and the caretaker only a portion of that time.

A simple gable truss post-frame construction system can be used to construct a central drive-through calf shelter as shown in Figure 2. Specific attributes of this design include:

1. 32-ft. width; this width provides sufficient space to centrally locate an individual pen on a nominally 11-ft. wide raised concrete platform. This central position provides more protection to the calves and bedding from driving rains when the curtain sidewall is not closed. At the front end of the stall, protection is provided for the feed and water

pails from equipment using the center alley.

2. 2 rows of pens; experience has shown that 2-row newborn calf shelters have a better chance of achieving adequate ventilation than 4-row shelters.
3. Hog wire panels for pen partitions; hog panels do not block air exchange at calf level whereas solid panels can, especially in naturally ventilated shelters when the wind is perpendicular to the solid panels. Solid panels are generally thought to help minimize the spread of disease however ventilation trumps disease spreading since all calves will be compromised when ventilation is not adequate.
4. A natural ventilation system; features of the natural ventilation system are:
  - a. Adjustable sidewall curtains that meet in the middle when the 10 foot sidewall is fully opened.
  - b. Eave openings that are sized based on providing an opening of 1" per every 10' of building width.
  - c. An open peak with upstands (The peak opening is 2" per 10' of building width or 12" (minimum)).
  - d. An automated control system and/or a dedicated caretaker to reposition the curtains as needed.
5. Sloped concrete floors; the concrete slab-on-grade for each row of calf pens is sloped towards the center of the shelter. This facilitates drainage of wash and sanitization water during cleanup operations. The concrete between the outside edge of the pens and the building sidewall is sloped towards the sidewall to drain precipitation away from the bedding. The central alley is counter sloped towards the center of the building again with the goal to facilitate drainage of wash up water and precipitation. The shelter is also ideally sloped 2 to 3 percent longitudinally to allow liquids to run out the building. Buildings constructed following this plan do not need gutters or drain pipes; these have proven a nuisance to keep in service.
6. A large eave; the eave extends horizontally 2.5 feet from the building sidewall to assist in minimizing entry of precipitation. The eave also provides moisture protection for the curtain sidewall system.
7. End wall doors; these doors allow easy access to both the drive through alley and each pen deck. Opening of these doors facilitates easy cleanout of soiled bedding.

Alternative structural systems, like fabric or plastic covered metal arch buildings, can also serve as calf confinement shelters. These structural systems should have the same

attributes as listed above so a suitable environment for calves is provided. Well-managed sidewall, endwall, and peak openings are especially needed to maintain air quality within structures that have transparent or translucent cladding. Basic heat transfer theory and data shows that transmission of radiant energy from the sun through the plastic will quickly warm the air within the structure (Gooch and Inglis, 2001). The degree of warming is highly dependent on the amount of energy transmitted; clear plastic coverings transmit about 87 percent of incident light while white plastic coverings transmit approximately 30 percent. Warming of the interior air results in:

1. Additional evaporation of free moisture
2. Increased production of manure gases
3. Increased air moisture from animal respiration

Consequently, confined housing systems that have transparent or translucent cladding will require more ventilation on any given day compared to systems with opaque cladding.

### ***Warm Barns***

Cold winter weather in New York State, New England, and the upper Midwest can cause uncomfortable conditions for some calf caretakers and reduce calf caretaker labor efficiency for most others as well. Because of this, some producers express interest in a warm barn to raise their newborn calves. The use of warm barns for newborn calf housing has been tried in the past with generally less than favorable results. Failure of such systems is generally for two reasons: 1) improper design of the mechanical ventilation system, and 2) inappropriate management.

### **Mechanical Ventilation**

Mechanical ventilation systems incorporate the use of exhaust fans and planned air inlets. Mechanical ventilation systems for newborn calf facilities can be designed by following one of two methods: the room volume air exchange method or the per animal head method. The room design method is based on providing 1, ½, 1/5, and 1/10 room volumes of air exchange per minute for summer, warm, mild, and cold periods, respectively. Design information for both methods is summarized in Table 1. It is recommended that a ventilation system designer investigate both design methods and employ the one that results in the higher air exchange rates.

**Table 1. Suggested minimum ventilation rates for mechanically ventilated warm newborn calf barns.**

Weather Condition <sup>(1)</sup>	Room Volume Design Method (room volume air exchanges per hour)	Per Animal Design Method (cfm/hd)
Summer	60	100
Warm	30	65
Mild	12	30
Cold	6	15

<sup>(1)</sup>A four tiered weather condition design approach is recommended by McFarland (2001).

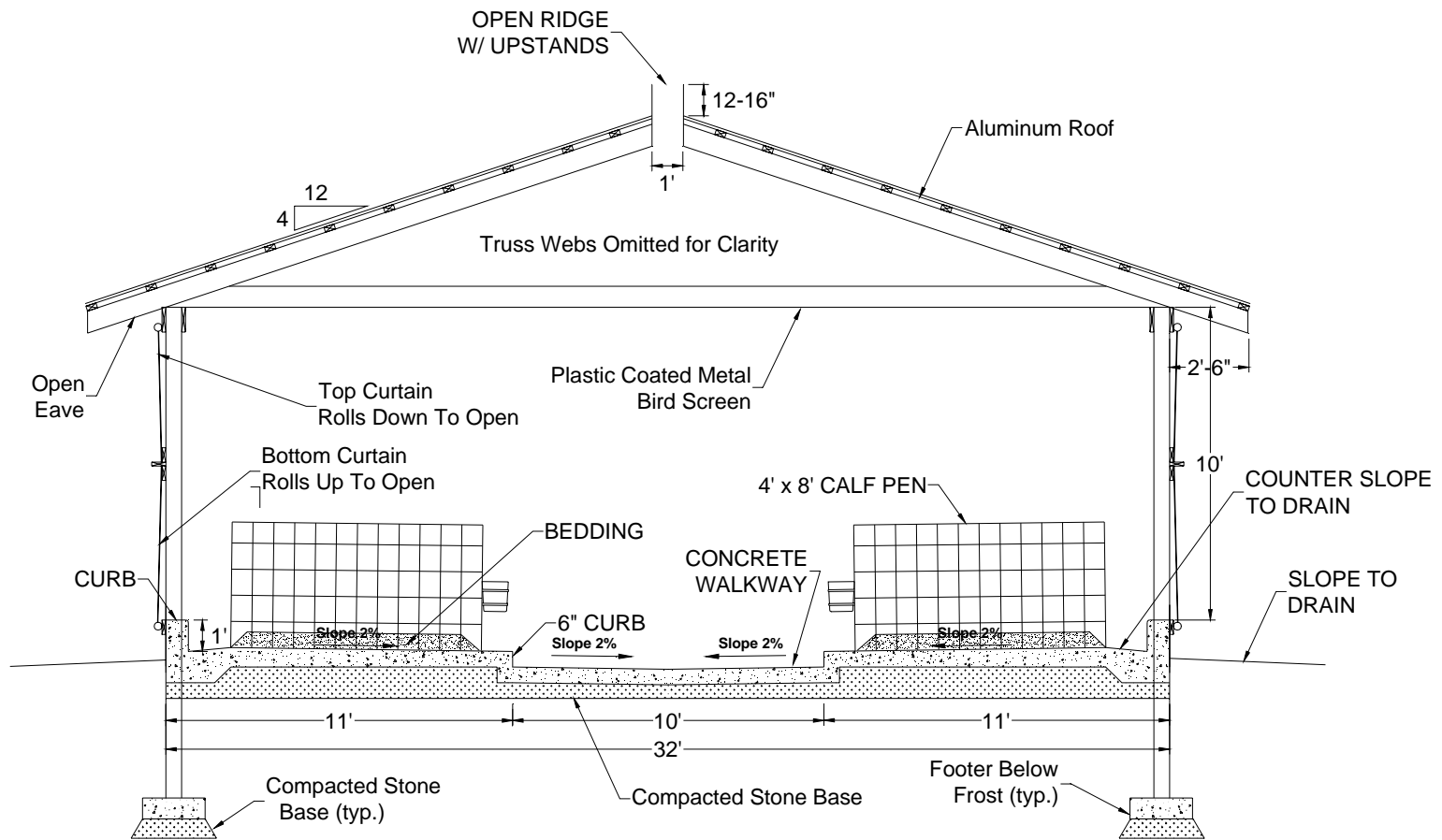


Figure 2. Naturally ventilated cold drive through calf shelter with 2-rows of individual pens.

## Management

Warm calf barns require particular attention to detail by management and caretakers alike to be successful. Ventilation systems need to be managed to provide the air exchange rates shown in Table 1 to be successful. These air exchange rates require large amounts of heat to substantially maintain room temperatures higher than ambient during cold conditions since heated air is not recirculated as part of the heating process. An engineer can perform calculations to predict the amount of heat needed for a warm barn and the operational costs.

In addition to proper ventilation, adherence to a strict sanitization protocol is needed to keep opportunistic pathogens under control. Organic matter should be removed by the elbow grease method as apposed to the using high pressure washers. The high impact velocity of high pressure washwater will cause pathogens to become airborne resulting in easy spreading to neighboring pens or housing units. Stubborn dried organic matter can be removed with high pressure washing as needed after dosing with sanitizing chemicals.

## **References**

- Davis, C.L. and J.K. Drackley. 1998. *The Development, Nutrition, and Management of the Young Calf*. Iowa State University Press, Ames, Iowa 50014
- Gooch, C.A. and S.F. Inglis. 2001. Environmental Conditions in Plastic Film Covered Calf Facilities. Presented at the Six International Livestock Environment Symposium in Louisville, Kentucky. *Livestock Environment VI*. The American Society of Agricultural Engineers. St. Joseph, MI.
- Karszes, J. 1996. Economic Impacts of Heifer Housing. Proceedings from the Calves, Heifers, and Dairy Profitability National Conference. NRAES-74. Formally the Northeast Regional Agricultural Engineering Service. Cornell University, Ithaca, New York.
- McFarland, D.F. 2001. Personal Communication. Extension Agricultural Engineer. Penn State Cooperative Extension. York, Pennsylvania.
- McFarland, D.F. 2004. Every Calf Needs a Box. *Hoard's Dairyman*. May 25, 2004 Issue, pg. 359.
- McFarland, D.F. 1996. Housing Calves: Birth to Two Months. Proceedings from the Calves, Heifers, and Dairy Profitability National Conference. NRAES-74. Formally the Northeast Regional Agricultural Engineering Service. Cornell University, Ithaca, New York.
- Morrill, J.L. 1992. The calf: birth to 12 weeks. Chapter 41 in *Large Dairy Herd Management*, edited by H. H. Van Horn and C. J. Wilcox, 401-410. Champaign, IL: American Dairy Science Association.
- Stone, W.C. 2000. Defining and Managing Special Cows. Proceedings from the Dairy Housing and Equipment Systems Conference. NRAES-129. Natural Resource, Agriculture, and Engineering Service. Cornell University, Ithaca, New York.
- Van Horn, H.H. and C.J. Wilcox. 1992. *Large Dairy Herd Management*. American Dairy Science Association. Champaign, Illinois 61820

Welcome, F. 2000. Personal Communication. Cornell Diagnostic Laboratory, Cornell University, Ithaca, New York.