

Group Housing Systems for Calves, Facilities, Equipment, Protocols, and Personnel

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Introduction

I was fortunate to be invited to make a similar presentation to Western Dairy Management Conference in 2013. It is four years later. What have we learned? According to the most recent NAHMS Survey, (USDA, 2017) the majority of calves in the U.S. continue to be raised in some type of individual housing. We have commonly associated individual housing with the ability to control disease better and to more easily monitor and controls calves' appetites. However, recent research and changes within our industry are causing calf growers to reexamine commonly accepted calf feeding practices.

Feeding Management

Feeding management is evolving on many farms from a system that limit fed milk to encourage early weaning. Although this system may have resulted in lower costs per day, there are significant penalties to this practice. Milk or milk replacer intake of less than 1 lb (500 g) of solids per day (one gallon) is frequently inadequate to meet the maintenance requirements, and as a result, there is little energy and protein left to support any weight gain. At 32°F, a 100 lb calf must consume 1.2 gallons of whole milk just to maintain body weight. Even this modest level of intake of milk or milk replacer solids is a problem for

calves during the first 3 weeks of life when starter intake is limited. However, feeding larger quantities of a liquid diet (2+ gallons) twice daily presents challenges for the young calf. Frequently, they will consume the morning feeding but may not be able to consume the evening one. If the milk or milk replacer can be fed in 3 or more equally spaced meals, the calves will gain more weight and height from the same amount of liquid fed twice daily. In addition, there is a reduction in morbidity and mortality. Unfortunately, increasing feeding frequency on most dairy farms is not feasible given the labor situation.

Labor Management

Labor management is and will continue to be a growing challenge on dairy farms. Although hutch housing systems may provide a perceived better environment for calves, these systems are not conducive to labor comfort during inclement hot, cold, or wet weather. Feeding calves their liquid diet individually is a labor intensive practice. Delivery of adequate supplies of clean, fresh water and calf starter grain and cleaning these housing systems is labor intensive and tedious work.

Animal Welfare

Animal welfare is a growing concern in animal agriculture. We, in the dairy industry,

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may believe that individual housing systems provide desirable conditions and comfort for calves, but the consumer seeing the same conditions may have an entirely different interpretation. Research conducted at various universities in North America and Europe have demonstrated distinct behavioral differences in calves housed in groups and individually. Housing calves in groups prior to weaning in well managed systems results in improved nutrient intake throughout the first few months of life and avoids the “post weaning” slump commonly observed in weaned calves when they are first placed in groups.

As a result of these considerations, group housing of preweaned calves is gaining in popularity in the U.S. Successful adoption and management of group housing systems requires:

- An effective colostrum management program such that more than 85% of calves receive adequate colostrum as evidenced by serum proteins above 5.2 g/ 100 mL.
- Accommodations to manage calves individually for the first 3 to 7 days.
- A well ventilated and drained facility to minimize risks of respiratory disease.
- A feeding plan to provide the sufficient nutrients to enable the calf to double its birth weight in 56 days. This allows for differences in breed, genetics within breed, and changing environmental conditions.
- The correct personnel to manage such a system. These are not “calf feeders” but calf managers capable of implementing the desired feeding program and detecting disease early through subtle differences in feeding and animal behavior. They are more data oriented and capable of managing

sophisticated equipment as well as the calves.

Colostrum Management

Given the perceived risks of greater calf-to-calf contact, it is imperative that systems be developed and initiated on the dairy that optimize the likelihood that calves receive adequate colostrum intake. This is achieved by the timely intake of at least 150 g of immunoglobulin G (**IgG**) from colostrum with low levels of bacterial contamination (<100,000 cfu/mL) within the first 6 hours of life. This is achieved when facilities are utilized which make it convenient to maintain a clean calving environment where calving can be observed easily, fresh cows are milked into clean receptacles, and colostrum is fed immediately or cooled immediately. Any delays in colostrum harvest or feeding reduces the chances of success. In some cases, the use of colostrum replacers providing 150 g of IgG should be considered. Routine monitoring of colostrum management through the measurement of serum proteins (>5.2 g/100 mL) is highly recommended.

Transition Calf Management

It is highly recommended that facilities exist to house calves individually during the first 3 to 7 days of life. This may be in calf hutches or individual pens located adjacent to group housing facilities. Provisions should be included to sanitize them between calves and to maintain sufficient bedding and supplemental heat in colder climates. The length of time for housing calves individually is dependent upon the dry cow management program and the success of colostrum management. Housing calves individually for longer periods may help with early detection of disease, but it contributes to labor inefficiency and may present challenges in adopting calves to the group housing system.

Ventilation and Drainage

This factor is probably just as important with individually housed calves as group housed calves, but the impact can be far greater since all calves share the same environment. In poorly designed facilities, one will notice that calves will congregate in a small area, thereby enhancing the ability of calf-to-calf transmission of disease. Producers are highly recommended to seek the advice of experts in designing facilities to provide adequate ventilation and drainage. The Dairyland Initiative website (<https://thedairylandinitiative.vetmed.wisc.edu/>) provides excellent information and offers training sessions each fall on the use of software to aid in developing facilities for young calves and heifers.

Behavior of Group-Housed Calves

Workers in Denmark (Jensen, 2003, 2004, 2005) and Canada (Khan, et al, 2011) have conducted numerous behavioral studies that have enabled the development of recommendations for management of group-housed systems. A common problem observed in calves housed individually is the “post weaning” slump that is apparently related to the adjustment of calves to group housing and the competition for feed. Studies by Chua et al. (2001) found that calves raised in pairs prior to weaning continued to gain weight normally during the week of weaning, while those housed individually experienced the “growth check” commonly observed in traditional calf rearing systems. This suggests that group housing calves prior to weaning promotes development of social skills and reduces fear of interaction with other calves. Another significant concern of group-housed and fed calves is the occurrence of cross sucking. Jensen (2003) found that feeding calves via nipple buckets as opposed to open buckets resulted in a significant reduction

of cross sucking. Cross sucking tends not to be a problem in acidified free choice and calf aut feeder systems as compared to mob feeders. Feeding larger amounts of milk or milk replacer (>2 lb of solids or 2 gallons of liquid) reduces cross sucking. Reductions in flow rate of milk to prolong milk feeding also seems to satisfy the calves urge to suck after completing the liquid feeding meal, particularly when lower amounts of milk are fed daily (<1.5 lb of milk solids or 6 quarts).

A variation of individual calf housing has been the adoption of individual housed calves to paired housing at some time after the first week of age. In such systems, dividers between pens are removed or hutch pens are joined permitting calves to interact with each other without reductions in the resting area allocation per calf. Costa et al. (2015) compared dietary intake and performance of calves housed individually or paired with another calf at 6 or 43 days. All calves were fed 8L of milk for 4 weeks, 6L of milk from 4 to 7 weeks, and weaned at 8 weeks. Intake of calf starter and average daily gains were higher for calves paired at 6 days than other treatments. There was no difference in health. In addition, the growth check commonly observed in calves during weaning was less pronounced for pair housed calves, regardless of the age at pairing.

Feeding Plan

There are several ways to deliver the liquid diet to group housed calves.

- Mob feeding,
- Free choice acidified milk or milk replacer, or
- Computer controlled automatic feeders

Mob feeding of calves is a common practice in grazing dairy farms practicing

seasonal calving. However, conventional dairy farms have also used this method. This practice involves placing larger containers with multiple nipples in the calf pen until all the liquid is consumed, which is generally less than 30 minutes. Sufficient liquid is added to provide the average calf with the desired amount of liquid. Although it encourages labor efficiency, there are some challenges with this system. The most common problem is cross sucking that is a greater problem if the feeder is removed from the pen shortly after calves have finished eating or if lower amounts of milk solids are offered as discussed previously.

More elaborate systems using acidified milk or milk replacer to preserve and limit liquid intake are gaining popularity on some dairy farms. These systems provide a very labor efficient way of feeding calves higher levels of milk or milk replacer solids. Typically, calves are placed in groups of similar age within 3 to 5 days of life. Systems developed in Canada utilize formic acid to decrease the pH of the liquid to approximately 4.2. At this level, the growth of harmful bacteria is inhibited. However, the use of formic acid is illegal in the U.S. Commercial milk replacer powders are available which use organic acids and have proven to be highly successful. The advantage of using a commercial milk replacer is that uniformity of nutrient content and acid level is likely to be more consistent. Users should be aware that acidification of waste milk impedes the growth but does not “kill” pathogenic organisms, such as *Mycobacterium avium paratuberculosis*. Producer experience with these systems has shown the calves will consume as much as 3 gallons daily. Weaning is achieved by limiting the time available to the nipples or the number of nipples available within the group pen. The reader is encouraged to read the publication by Anderson (2008) for further information on free access acidified liquid feeding systems.

Computer controlled automatic calf feeding systems are gaining rapidly in popularity as a means of accurately delivering the liquid diet while controlling meal size, daily allotment, and frequency of feeding. More sophisticated systems provide valuable management information to enable the calf manager to monitor diet consumption by individual calves and make timely intervention for calves becoming ill.

Calf autofeeders consist of the basic components (Figure 1; Biotic Industries, Bell Buckle, TN). These systems vary widely in sophistication and price ranging from systems that record minimal data and have simple feeding programs to more involved systems with extensive capabilities to program different feeding plans for individual calves in a group and monitor calf performance. The essential features of autofeeders include a feeding stall and feed box that contain a device enabling electronic identification of calves. Most new systems utilize the radio-frequency identification (**RFID**) ear tags. The nipple is connected via a flexible tube to a mixing bowl where defined amounts of powder and water are mixed as prescribed by the system. Calf meals are limited by meal size, number of meals per day, and time intervals between meals. Additional features of systems will be described later in this manuscript.

The work conducted by Jensen (2004, 2005) and von Keyserlingk et al. (2004) has resulted in the recommendations for stocking rates given by major manufacturers of calf autofeeder systems. General relationships are what would be expected in group housing situations. More calves per feeder results in greater competition for the nipple and an increased rate of intake. A second important factor governing autofeeder management recommendations is the milk allowance per day and per feeding. When calves are limit-fed

milk (less than 1.5 lb of solids per day) calves spent more time in the feeder without being rewarded with additional milk. Similarly, when milk allowances per feeding session are small (one pint or less) calves remain in the stall longer without being rewarded.

General recommendations and features of calf autfeeder systems

(Note to reader: Many of the autfeeder systems are manufactured in Europe and use the metric system).

- Age when calves are introduced to the autfeeder system is strongly dependent upon fresh cow and newborn calf management. Aggressive colostrum management programs are essential to successful adaptation to the autfeeder system. Consider routine monitoring of serum proteins during the first week to assess success of the colostrum program. Most farms house calves in individual housing systems for at least the first 5 days to ensure that the calf is eating well. Provide sufficient facilities to house young calves for 5 to 7 days during a heavy calving season.
- Calves are trained to feeders by gently leading them to the nipple when they are moved into the group housing. Eliminating the morning feeding the day that calves are moved into the autfeeder group encourages adaptation to the system. Research by Svennson and Liberg (2006) and Jensen (2008) shows that moving calves onto the feeder at less than 6 days requires more effort to train calves to the feeder. Research by Jensen (2006) has shown that calves introduced to feeders at day 14 required less training time. Calves introduced to the feeder at day 6 spent less time in the feeder after ingesting milk and ingested less milk. They were less successful in competing for milk feeder access, particularly when there is a wider range in age of calves in the pen and with higher stocking rates per feeding station (>25). There also appears to be less risk of respiratory disease when entrance into the feeder is delayed until 10 to 14 days of age. However, experience by most autfeeder system users has shown that moving calves to the autfeeder group is feasible within 7 days of age, particularly when the range of age of calves in the pen is relatively uniform (< 14 days) and there is an effective colostrum management program and excellent newborn calf care.
- Stocking rates of no more than 25 calves per nipple are advised.
- Daily milk allowances range from 1.5 to as much as 2.7 lb (680 to 1225 g) of milk solids per calf per day. On a volume basis, this amounts to 1.4 to 2.6 gallons (5.3 to 10 L) of liquid per day. Higher milk or milk replacer solids levels are recommended.
- Meal sizes vary from 1 pint to 2.6 quarts (0.5 to 3.0 L) each. In many systems, calves must earn enough credits to be able to receive milk or milk replacer from the feeder. As an example, if a calf is allocated 8 liters of “milk” per day, they will earn about 0.33-liter allocation for each hour of the day. They must accrue enough “credits” to achieve their minimum meal size specified by the system that might be 1.5 L. This would mean that there must be a minimum of about 5 hours between feedings. The feeder mixes milk replacer or delivers milk in 0.5 L increments until reaching the maximum meal size. Should the calf wait longer before visiting the feeder, they would be allowed to consume more milk until reaching the maximum meal size limit specified. Typically, maximum meal sizes increase from 2 to as much as 3.5 L as calves age.

- When milk replacer is used, powder is diluted with water to approximately 13 to 15% solids. Caution is advised when specifying dilution as most autofeeding systems express the grams of milk replacer to add to each liter of water. Therefore, 150 g added to a liter of water is not 15% solids but 13% (1,000 ml of water + 150 g of powder = 1150 final weight). Therefore, 150 g of powder/1150 g of total weight = 13% solids).
- Number of meals per day varies by the system. Some basic calf autofeeders have a small mixing bowl and provide meals of 1 pint per visit. In these systems, milk allowances exceeding 1 to 1.5 gallons daily require numerous daily visits to obtain the daily allowance (>12). In other systems, calves are limited to a maximum amount per visit, and the feeder will mix multiple batches of liquid up to the maximum. Typically, calves nursing from systems that are more sophisticated consume ~4 to 5 meals per day.
- Feeding programs vary considerably depending upon the system. The basic systems are frequently programmed to provide all calves with similar meal sizes and daily allowances, regardless of their age. However, the more sophisticated systems enable feeding a defined feeding program in which milk allowance is gradually increased over several days and then decreases to accomplish a “soft” weaning, which reduces the stress of weaning. An example of such a feeding program is shown in Figure 2. (Courtesy: T.J. Earleywine, Land O Lakes Animal Milk, Shoreview, MN). In more sophisticated systems, multiple feeding programs can be in effect within one pen so that smaller calves or those of a different breed are accommodated.

Systems that are more sophisticated also enable use of pasteurized waste milk in addition to milk replacer. A system utilized by one autofeeder manufacturer enables the calf to consume milk or milk replacer ad libitum for a specified period in the group pen (usually 28 days). Then the liquid diet daily allocation is reduced to 8 L/day to stimulate starter grain consumption. Allocation is held constant until gradual weaning over 7 to 10 days at approximately 42 days.

- Systems that are more sophisticated enable dispensing additives in either the liquid or the dry form to calves. This enables the manager to administer additional electrolytes, antibiotics, or other therapies on an individual basis.
- Sanitation of the autofeeder is automatic in some systems and manual in others.
- More advanced computer controlled stations will also deliver calf starter grain through a separate feeding stall. These systems will trigger “soft” weaning from liquids when calf starter grain intake reaches levels indicated by the computer. However, experiences on dairy farms has shown that these systems do not encourage intake and many users provide small open feed bunks with free choice calf starter.

Several field studies have been conducted in herds that utilized automatic calf feeder systems (Machado et al., 2012; Dietrich et al., 2015; Jorgensen et al., 2015; Knauer et al., 2017). As expected, there are a wide variety of installations and management practices. Maintenance of equipment to follow manufacturer’s recommendations is necessary to maintain low levels of microbial growth and delivery of liquid diets with desired solids level and temperature. These studies

have shown a higher treatment rate for calves housed in autfeeder systems as compared to individual calf feeding systems. This appears to be related to earlier detection of disease that was predominantly diarrhea and was treated with electrolytes. Mortality was less than 1.5% in these field studies that may be due to more timely treatment.

It appears that drinking speed, which is calculated by some systems, is a useful tool for predicting onset of digestive disease but not respiratory disease. Calves frequently will consume their daily allocation of liquid while they are becoming ill, but at a slower rate. Research is ongoing to develop algorithms that might be used to “flag” calves, which would require further closer evaluation.

Risk Factors for Disease in Autfeeder Systems (Endres and James, 2017)

- Farms with greater numbers of calves per group have poorer health scores. It is suggested that average group size be limited to 15 calves. Herds practicing all-in all-out strategies were more successful with larger group sizes. Larger group sizes can be successful if ventilation, drainage, and maintenance of bedding is optimal.
- Space per calf. The minimum space per calf is 35 sq. ft. Herds with 45 to 50 sq. ft. of bedded resting space have better health scores.
- Time to reach peak milk allowance. Herds that are too slow (>14 days) in increasing the liquid diet to maximum levels have poorer health scores. Calves may have looser manure but higher milk intake earlier promotes better gains and health.
- Herds without positive pressure ventilation systems are associated with much higher incidence in morbidity. The investment in engineering advice and installation of these ventilation systems is essential for success.
- Strict adherence to recommended sanitation of the system is essential. Routinely scheduling automatic cleaning of the internal surfaces 4 X per day is associated with lower microbial growth. Once daily circuit cleaning of all surfaces and the feeding nipple is recommended. Use of recommended sanitizers and detergents which are designed for use at lower temperatures found in autfeeder systems is also critical.
- Milk replacers must be formulated to mix at the lower temperatures utilized in autfeeders (~105°F). Utilization of milk replacers requiring higher mixing temperatures will not work well in autfeeder systems!
- Machines that are more sophisticated handle waste milk in addition to milk replacer. This creates a new set of management challenges as waste milk should be pasteurized, cooled for storage, and then warmed again prior to feeding. Some systems, given the known solids content, will automatically add milk replacer powder and water to achieve the desired final solids level in the diet. Given the variable supply of waste milk and the variable solids content of waste milk, it is challenging to maintain consistency in the feeding program and to successfully sanitize the equipment.
- Dairy producers interested in adopting this technology should have the proper management mindset. These individuals should have the following skills and management behaviors:

- o They are data oriented and should evaluate the intake and other management information provided each morning and periodically throughout the day.
 - o Calf managers should “walk” the pens periodically to evaluate calf behavior and detect illnesses prior to viewing computer reports of calf feeding behavior.
 - o There is an opportunity for improved labor efficiency with aut feeder systems. However, many producers note that time formerly spent feeding and cleaning buckets or bottles is spent reviewing reports, walking pens, and maintaining the feeder.
- Calf behavior is dramatically different for group-housed calves. When calves are fed twice daily in individual pens, they respond to people entering the barn through increased activity and vocalization. Calves fed via an aut feeder system will not respond to people entering the pen as much. If a calf does so, it usually means that they may not have trained to the feeder or there is an equipment malfunction.

Conclusions

Group housing systems have been successfully adapted on many dairy facilities. The choice of what system will depend upon herd size, financial resources, and management preferences. Use of mob feeders tend to be more successful in smaller herds. Acidified free choice systems have been successful in a variety of herd sizes. Aut feeders are a proven technology that offers some attributes that are very positive for calf nutrition and management but are probably more appealing to herds of at least 200 cows or more when the fixed costs of the system can be spread over more animal units. More frequent

feeding is probably less stressful for the calf and appears to promote more efficient feed utilization. It is easier to feed more without added labor or stressing the calf with large meal sizes or higher percentages of milk solids required for intensive feeding systems limited to twice a day feeding in buckets or bottles. The field studies of farms using aut feeders emphasizes the need for well-designed facilities and routine monitoring of temperature, solids delivery calibration, and sanitation. Although they are marketed for their labor saving, field studies have indicated that although routine labor is reduced, increased emphasis is placed on monitoring the equipment, evaluating calf consumption, sanitation, and in monitoring calf health.

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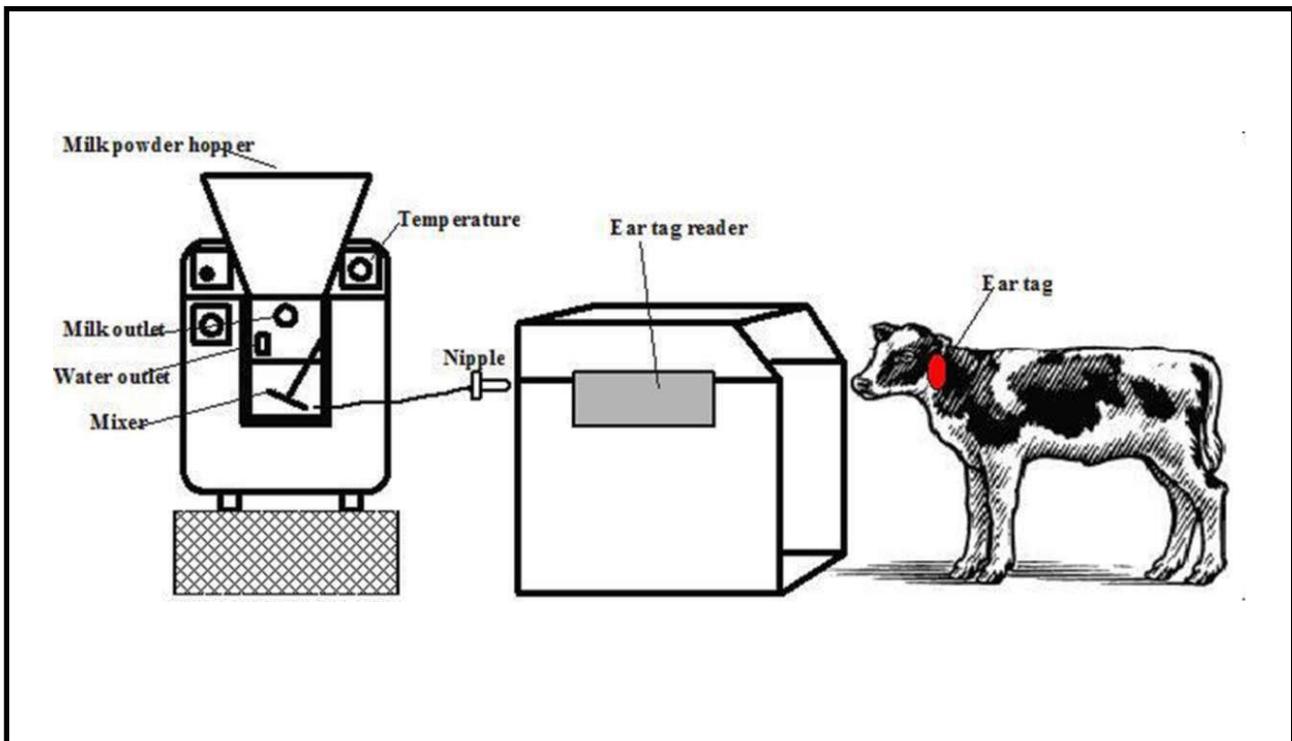


Figure 1. Basic components of a calf autofeeder.

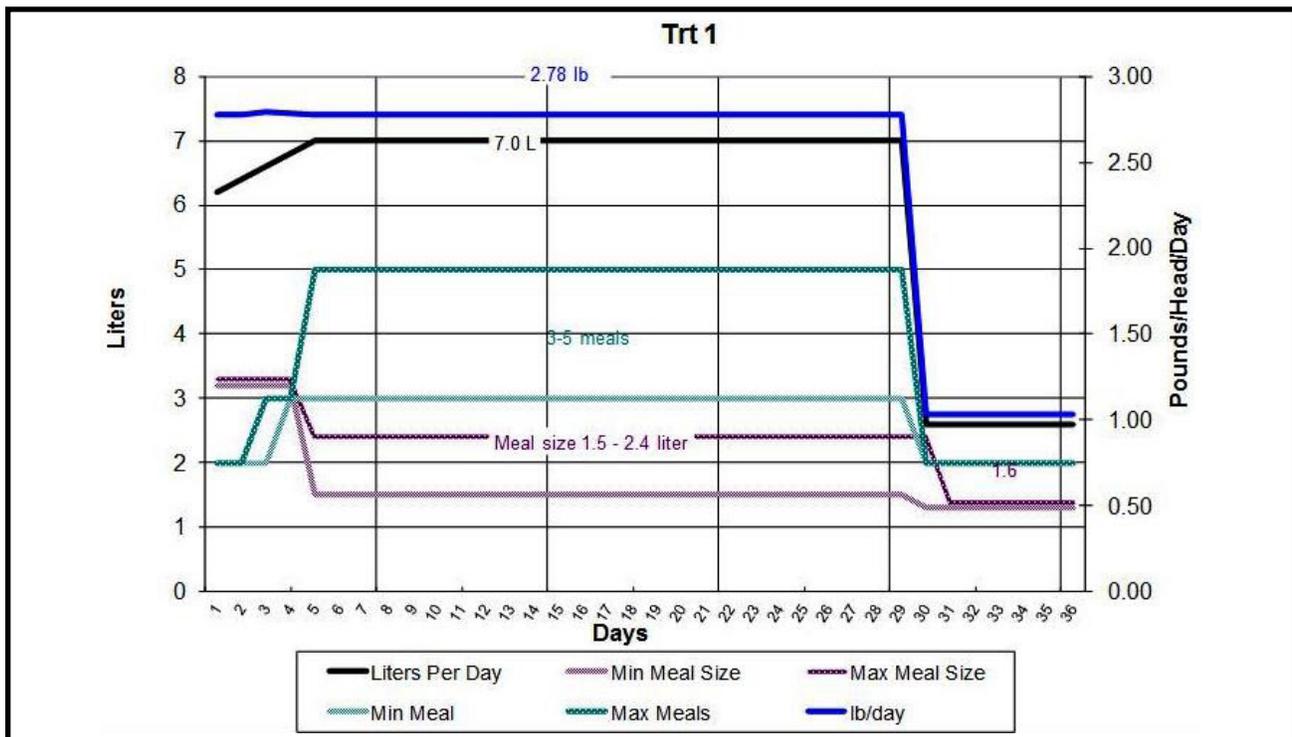


Figure 2. Example of a feeding program with calf auto feeders that permit gradual increases in milk allowance and then decreases milk allowance to prepare for weaning.