Dairy Housing Management, Volume 2, is the fifteenth in a series of management manuals published by Veepro Holland. In Dairy Housing Management, Volume 1, the basic elements of suitable dairy housing were described. This manual deals mainly with the importance of good ventilation of dairy housing and the manure handling facilities. Through these manuals Veepro Holland aims to provide you with useful management information and assistance in making profitable decisions for your business. Dairy cattle worldwide have to be managed well to utilize their genetic potential to full extent. No single booklet can cover a subject as diverse and complex as dairying. Nor will probably everyone associated with dairying agree on all points covered in one publication. But we of Veepro Holland believe the combination of this manual and other publications on the subject may broaden your practical knowledge about the design of dairy housing and will subsequently contribute to a healthy and highly productive herd.

Veepro Holland is indebted to those who contributed to this manual, particularly, ing. Dolf Smits, housing specialist of the Institute of Agricultural and Environmental Engineering (IMAG-DLO) at Wageningen and ing. Albert Pieters, farm buildings and structures specialist of the Applied Research Station for Animal Husbandry (PR) at Lelystad for their constructive criticism. We would like to thank Rinke Oenema, Head of the Farm Mechanization and Farm Buildings Division of the IPC-Livestock/Dairy Training Centre ‘Friesland’ at Oenkerk for his valuable assistance in the preparation of this manual. Many thanks also to those associations and publishers who permitted us to use various data and illustrations.

VEEPRO HOLLAND
INTRODUCTION

In dairy farming the well-being of livestock plays a significant role in obtaining optimal herd results. Stress-free housing of dairy cattle is, amongst others, one of the main conditions for the realization of this goal. It is important to provide feeding, milking, comfortable resting, cow handling and the environment in a way enabling cows to milk up to their potential.

The well-being of cows is influenced by the housing facility in which they are kept.

The emphasis should be on well-designed and constructed facilities to encourage good management and labour efficiency. Experienced dairy managers have already realized that better housing facilities contribute positively to better milk production performance. Nowadays it is possible that dairies in different climatical zones are able to obtain top milk production levels. Therefore, it is essential to create an ideal environment for your cows.

Hot climatical conditions, especially in the tropics, depress milk production and reproductive performance in dairy cattle worldwide. Reducing heat stress can decrease or even eliminate these losses.

Heat stress occurs when any combination of climatical conditions cause the effective temperature of the environment to be higher than the required thermoneutral (comfort) zone of the animals. Please consult figure 1 on page 4 to determine the degree of heat stress for dairy cows. So let us first discuss a few aspects of good dairy housing, such as the importance of good ventilation for enclosed dairy barns, manure handling and storage, the feeding rack, the handling and treatment facilities, and so on.

GOOD VENTILATION IS A MUST

A proper housing climate is one of the pre-conditions for maintaining an excellent environment within the various housing systems. It has a great effect on the well-being and health status of animals, and on overall performance. Conditions should be created to enhance the animal’s inherent ability to control its own temperature. Therefore, ventilation is essential for the supply of fresh air, with the emphasis on maintaining a suitable air quality under any weather condition over a long period of time.
Adequate ventilation is needed for the removal of harmful gases, such as carbon dioxide and ammonia, avoidance of moisture accumulation and the removal of heat produced by animals (see table 1). It should be kept in mind that a mature cow exhales about 12 litres of water vapour into the air each day. Under-ventilation can, in addition to animal health problems, lead to early deterioration of the building’s structural components. Basically, the aim is to obtain dry surroundings, relatively free of excessive drafts in winter and better ventilation during warmer weather. Enclosed and well-ventilated barns are well-proven dairy housing systems. Cows can withstand low temperatures, providing these barns are dry and free from drafts. The barn temperatures should be kept between -10°C and 20°C to create an ideal environment. The optimum barn temperature is about 10°C. With increasing barn temperatures it becomes more difficult for animals to get rid of their produced heat. In this situation evaporation becomes more important for dissipation of heat. Dairy cows will consume less food in order to decrease their heat production, resulting in lower milk production. Thus the removal of heat plays an important role in ventilation.

Too much ventilation is usually better than too little
Most ventilation systems make use of natural ventilation. Natural air movement is based on the principle that hot air is lighter than cold air. The air within barns is warmed up by the animal’s heat production. The warm air rises to the top of the barn and consequently creates a lower air pressure above the animals. Thus fresh air enters the barn through the air inlets. Draught is usually the result of higher air speeds at a lower air temperature in a specific part of the barn and should be minimized. If draught occurs, the animal’s temperature will suddenly decrease...
substantially, which could affect its health. A healthy barn climate means much ventilation at low barn air speeds. In case of a high degree of ventilation, the difference between the outside and indoor temperatures will be limited. It is essential that enclosed barns have a sufficient air volume per number of animals present to provide a fresh climate.

Good natural ventilation is dependent on the dimensions of the barn, the air inlet and outlet, and the difference in height between the air inlet and outlet. Barns of larger dimensions will more easily provide a constant climate for the animals. Wide and sufficiently high placed ventilation openings prevent high air speeds around the animals. Proper guidance of the air entering the barn by means of long inlet valve structures ensures good mixing of fresh air and the air within the barn. Besides this, cooler air entering the barn does not fall immediately on the animals below the air inlet. New developments include horizontal ventilation with open sidewalls of the barn, which can be closed during colder weather with roll-away windbreak curtains.

**Air outlet**

In case of natural ventilation, an open roof ridge is ideal for the air outlet. The air outlet must be large enough to ensure adequate removal of air mixed with ammonia, carbon dioxide, moisture and heat. The size of the air outlet opening depends, amongst others, on the following factors:

- the heat production per animal;
- the number of animals;
- the difference between indoor and outside temperature.

The heat production per animal is mainly determined by the cow’s level of milk production. The recommended (minimum) amount of air to be ventilated (ventilation capacity) within the barn for different milk production levels is given in table 1. The recommended ridge openings mentioned in table 1 are appropriate for most Western European weather conditions. In these climatical zones (temperate) the wind has a great influence on the ventilation system.

**Table 1** Heat production, ventilation capacity and recommended ridge opening at different production levels at a barn temperature of 20 °C, temperature difference of 5° C between indoors and outside, difference in outlet/inlets heights of 5 meters.

<table>
<thead>
<tr>
<th>milk production (in kg)</th>
<th>heat production (in Watt)</th>
<th>ventilation capacity (m³/hour)</th>
<th>open ridge (cm²/cow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6000</td>
<td>759</td>
<td>460</td>
<td>1080</td>
</tr>
<tr>
<td>8000</td>
<td>865</td>
<td>524</td>
<td>1230</td>
</tr>
<tr>
<td>10000</td>
<td>971</td>
<td>588</td>
<td>1380</td>
</tr>
</tbody>
</table>

**Calculation example**

With the aid of an example, a proper insight is given into the correct size of the ventilation openings. In an enclosed barn with free stalls (2 + 2 rows of free stalls) 100 dairy cows are housed over a total length of 32 meters. Assuming a milk production...
of 10,000 kg, the amount of air ventilated should be 588 m³/hour/cow. The desired open ridge width should then be at least:

$$100 \times \frac{1380}{3200} = 43 \text{ centimeters}$$

100 is number of cows
1380 is the desired ridge opening in cm²/cow
3200 is length of the barn in centimeters

**Air inlet**

The air inlet openings should be large enough for the supply of fresh air. The air inlets and outlets are interrelated. If the air inlets are enlarged, the ventilation process will improve only if the open ridge is enlarged as well. The air inlets should be constructed in the sidewall about 2 meter above the floor level in that part of the barn where animals are housed. They should be about 150% of the air outlet opening. In the above example, this would be: $43 \text{ cm} \times 150\% = 65 \text{ centimeters}$ divided by 2 sidewalls, resulting in a height of 33 centimeters for both sidewall air inlets.

**Slope of the roof**

The desired roof slope of barns should be about 25° to guarantee optimal natural ventilation. This degree of slope facilitates an easier upward air flow to the ridge of the barn. The roof construction should be made strong enough to carry a load of snow in climates where snow may build up on the roof.

**MANURE HANDLING AND STORAGE**

Proper management of manure and waste effluent are essential for the well-being of animals, work force, and the environment within and around the farm. Under no conditions may the slurry penetrate into the groundwater. Hygienic circumstances are a pre-requisite for animal health, milk quality, odour and insect control. Because of the complexity, it is essential to consult waste management specialists. Handling manure and other wastes should be made an integral part of dairy farm management. Furthermore, it is recommended to obtain in-depth advice from the local authorities to comply with the regulations for environmental control at farm level before construction begins.

The emphasis should be on a manure and effluent handling system that provides simple and easy cleaning facilities for cow traffic lanes, milking parlour and exercise yards. The choice of free stall bedding influences the design of the manure handling system. Consider long-term waste storage with minimized odour emission. During the planning stage you should make an objective appraisal of the manure and effluent production and decide whether, and if so, when and where to spread or to sell the manure. Ask yourself if it is worthwhile to utilize manure nutrients in your cropping programme to offset the use of commercial fertilizers. Early planning is crucial, because of the generated on-farm volume of manure and effluent and how to manage it. For the estimation of liquid storage facilities, you should consider that a mature cow
(8,000 kgs of milk) produces about 2 m³ of slurry each month. Another ½ m³ per cow should be added for cleaning and washing the milking parlour facilities. It is recommended to keep your direct rain water run-off from roofs and farm surface water separated from the manure storage. The system should fit in the climatical zone and is divided into a wet or dry method. The dry method is only applicable in dry areas. These methods can include:

**Slatted floors**
Slatted floors are widely and successfully used in collecting manure from dairy housing in conjunction with under-the-barn manure storage. This system is commonly used in the Netherlands and is recommended for temperate and cold climatical zones. It is not recommended for arid and tropical zones. The concrete slats require an excellent design and construction. They must be reinforced to withstand the load of animals and be placed in such a way as to prevent shifting of slats. The slats should taper from top to bottom and, depending on the age of the animals, laid interspaced 3 or 4 centimeters on the surface. The slats should have a slip-resistant top surface for good footing, with rounded edges to prevent foot injuries and to improve cleaning.

**Scraping methods**
A mechanical scraping system on concrete floors can effectively remove solids and liquid manure. This system consists of one or more sets of scraping blades attached to a cable or chain and pulled by a controlled power unit. Some mechanical or hydraulic scrapers are controlled by a timing device. These automatic timers do not eliminate the need for regular observation during periods when the scraper is in operation. There are also self-propelled scrapers available in combination with a specially designed type of floor and a sprinkler system which may use the waste water of the milking parlour. The best results from mechanically scraping systems are achieved when manure is removed frequently. The system should operate on an every-other-hour basis to ensure cleaner traffic lanes and less odour emission. It also prevents manure from freezing to the floor during frost. An advantage of this system is the low ammonia emission. Scraper blades attached to the rear of tractors have a proven record as reliable collection devices. It requires a higher investment and more labour. When planning tractor cleaning it is recommended to have sufficiently wide cow traffic lanes with sufficient space at the end of the lane for tractor turning. Furthermore, the curb of the free stalls must be about 20 centimeters in height to minimize the migration of manure into the bedded area of the stalls during scraping.
Selecting a manure storage system

The choice of the manure storage system depends on the state of the manure to be handled, viz. solid manure, semi-solid slurry or liquid. The addition of bedding or water to the manure is of influence on its conformation for the kind of storage, collection or slurry pumping method, and the selection of equipment therefor. Manure can be stored in pit structures underneath barns with slatted floors, enclosed above-ground storage silos, slurry ponds and lagoons with plastic wall-lining to prevent polluting surface soil and ground water.

For maintaining a homogeneous fluid it is necessary to agitate the slurry. When agitating the manure stored under the barn care should be taken that sufficient ventilation is provided inside the barn, especially in those with slatted floors. Never enter manure storage tanks without a special breathing apparatus, or without a rope attached to your waist and held by another person for emergency. Dangerous methane and hydrogen sulfide gasses can be fatal!

Depending on climatic conditions and existing environmental laws, it is desirable to have storage facilities which can hold at least 6 months’ manure production. This flexibility allows for awaiting the growing season for field application to minimize soil compaction and to maximize nutrient benefits for grazing or for cropping purpose.

The capital investment in equipment, maintenance, fuel and electricity, and the running cost should be considered when comparing the annual costs of the various manure handling systems.

THE FEEDING RACK

Optimal feeding requires that animals receive the correct amount of feeds for their respective milk production. Installation of lock-in stanchions with head gates at the feed table allows for capturing and restraining the animals. Rations can be fed more accurately without cows expressing their social dominance. In dairy herds the stanchions have different valuable uses also for other management practices, such as vaccinations, treatment, artificial insemination, pregnancy checking, and so on. They save time and at the same time reduce the risks of injury to animals. The feeding racks can be divided into two systems:

- self-locking stanchions;
- diagonal stanchions.

The self-locking stanchions are usually installed for dairy cows and enable the farmer to quickly fasten and release cows. Furthermore, the system has the advantage that animals can be un-locked individually or groupwise. The recommended feeding space width for mature cows should be 65 to 75 centimeters, depending on the size of the animals.
In hotter climates it is recommended to use a spacing of 75 centimeters for mature cows to ease dissipation of body heat. The feeding rack of the diagonal type is often used for younger stock. The feed table is an integral part of the feed driveway and should be about 10 centimeters above the barn floor level, thus causing less physical load on the cow’s front part when eating. Cows prefer to eat in a natural grazing-like position. It is recommended to have a 75 centimeters wide flat feed table in front of the feeding rack. The feed driveway should have a width of about 5.50 meters between the two feeding racks for easy driving through of feed mixer wagons.

It should be kept in mind that some feedstuffs (ensiled foddercrops) contain acids that tend to etch the concrete surface and may affect the feed table. Therefore, the surface quality of the concrete, on which the feeds are provided, should be of a high standard. To reduce deterioration of the concrete, the feed table should be lined with an acid-resistant material to increase lifespan, such as:
- ceramic tiles;
- synthetic material;
- polyester concrete.

**HANDLING AND TREATMENT FACILITIES**

Through proper herd health control, premature culling of cows can be kept at an acceptable level. Therefore, sound facilities for sick cows and calving cows are essential. They should be draft-free, dry and well ventilated. The pens should have separate water bowls for drinking. The most appropriate location for the pens is along the exit lane of the milking parlour to facilitate separation of cows from the herd after milking. Bringing them into the herd again takes little time. Another advantage of this location is that cows remain in visual contact with herdmates, which prevents social isolation and stress. The number of pens needed per herd depend on the total number of cows. For optimal care three types of pens are needed, whereby the percentages mentioned below may serve as a guideline:
- separation pen 4%
- maternity pen 3%
- treatment pen 3%

**Separation pen**

The separation pen may be used for cows in heat, pregnancy diagnosis, artificial insemination, taking cows’ temperatures and for cows needing short-time treatment. The cows in need of attention should be taken directly to the separation pen after milking and be returned quickly to the herd after treatment. This results in saving on labour and prevents disturbance of the herd.
Maternity pen
A well-equipped maternity pen is a must. A few days before the expected calving date the cow should be taken to the maternity pen to get used to its new environment. Cows near calving should have visual contact with herdmates, as this significantly contributes to a smoother birth process. It is recommended to locate the maternity pen at the feeding lane and close to the milking parlour. In view of the short distance the cow can be milked easily in the parlour after calving. For larger dairies it is recommended to have separate milking facilities. The cows should stay in the maternity pen for about 24 hours after the release of the afterbirth. After recovery they can be brought into the herd again. After each calving, the maternity pen should be cleaned and disinfected thoroughly. The recommended dimensions of the maternity pen should be at least 4.0 x 3.0 metres in order to have sufficient space behind the cow during calving in case assistance is needed.

Treatment pen
The treatment pen is used for sick cows who must be kept separated from the herd for a longer period of time. Combining individual treatment stalls with the maternity pens allows for versatility and convenience for veterinary services. The construction of walls and floors should allow for easy cleaning and disinfecting to maintain the highest possible hygienic standards.

PROVISION OF LIGHT
In enclosed barn systems higher demands are made in regard to the provision of natural light than those in open free stall housing systems. Windows in the sidewalls and light openings in the roof structure are preferred for the provision of daylight. In enclosed barn systems the recommended window surface should be about 1/20 of the floor surface area and as a rule of thumb the artificial lighting should be about 60 watts of fluorescent lighting per 5 mature cows.

PROVISION OF WATER
A dependable water source plays a vital role in supplying fresh water to cattle. Ample fresh water supply is essential and its quality must be good and without any flavour. Your water supply may look and taste good, but the only way to be sure of its quality is through a complete analysis and regular quality monitoring. It may contain impurities which could hamper effective cleaning or even present a health hazard. It is recommended to...
provide watering troughs in pens for every 30 to 40 cows. It is necessary to check the capacities and requirements of all equipment as well as the needs for potable water and cleaning purposes. Your estimated water use depends for example on:

- consumption by cows, heifers and calves;
- cleaning of milking parlour pipeline milking systems;
- group spray washers in holding areas, udder washing and cleaning;
- washing of milking parlour, holding areas;
- evaporative cooling systems in hot climates.

**HOLDING AREA**

The holding pen should be a separate but an integral part of the milking facilities and designed to hold, guide and prepare cows for entering the parlour. The holding area can be equipped with gates that open to return lanes and treatment facilities, and can also be used for sorting and grouping of cows. For larger herds a holding area in front of the milking parlour is essential for obtaining an increased parlour capacity. Group sizes should be kept in multiples of the number of stalls on one side of the parlour. In parallel and herringbone configuration, sizing of groups in this manner will eliminate the need for blocking off a section of the stalls to milk partial groups.

The size of the holding area should be based on the number of cows to be milked and the number of milking sessions per day. Ideal would be to keep a group of cows no longer than 1 to 1½ hours at each milking in the holding area. The sizing of the holding area should be based on a floorspace of about 1½ m² per cow for larger breeds. The length of the holding pen should be about twice its width for easy funneling of cows into the parlour. Udder washing facilities (mushroom washers) can be incorporated in the holding area to obtain cleaner udders. Installing a crowd gate in the holding area encourages the cows to advance voluntarily into the milking parlour. The use of a crowd gate helps in maximizing parlour output. The crowd gate can be automatically advanced by pushbutton operation to guide the cows towards the parlour entrance. Besides this, it keeps the available space for cows in the holding area relatively constant and allows for continuous milking, because a second group of cows can be moved into the holding pen behind the crowd gate, when about two-thirds of the cows from the first group have been milked. After milking, the cows should be enabled to drink water and afterwards walk straight to the feeding area and remain standing for about an hour to allow the teat sphincter to close sufficiently and the teat dip to act to prevent bacteria from entering the udder. For this purpose a self-locking feeding rack is very useful.

Fresh and good-quality water is essential for dairy cattle under all circumstances.
SUMMARY

A well-designed housing system for dairy cattle should be the basis, with the emphasis on cow comfort and manageability. Thorough study of the manure handling and storage opportunities makes the management job easier and more desirable and promotes efficiency.

The general guidelines for proper dairy housing design are:

1. constructing building facilities to increase comfort and manageability of cows;
2. optimising labour efficiency by providing desirable working conditions;
3. planning with the emphasis on logistical lines for cow traffic patterns;
4. maintaining adequate ventilation in enclosed barns under all weather circumstances;
5. planning an appropriate manure handling and storage system, which complies with legal requirements for environmental control;
6. providing sufficient space per cow at the feeding rack;
7. keeping apart maternity and separation pens to provide hygienic circumstances;
8. having sufficient natural or artificial lighting available;
9. providing sufficient drinking space for all animals;
10. keeping holding area separate from free stall area.
FURTHER REFERENCES

- The housing of Dairy Cows and Young Stock; Lecture notes of IPC-Livestock/DTC Friesland.
- Various Articles about Dairy Housing published in the Hoard’s Dairyman magazine.

Earlier publications:

- Reproduction Management
- Young Stock Management
- Foot Care Management
- Feeding Management, Volume 1
- Feeding Management, Volume 2
- Milking Machine Management, Volume 1
- Milking Machine Management, Volume 2
- Proper Milking Management
- Udder Health Management
- Forage Management
- Fresh Cow Management
- Dairy Herd Administration Management
- Successful Artificial Insemination Management
- Dairy Housing Management, Volume 1
Dairy Training Centre Friesland (DTC-Friesland) is part of IPC Livestock. It is established by various Dutch farmers’ organisations and controlled by the Ministry of Agriculture, Nature Management and Fisheries. The Centre conducts a variety of international training programmes and courses. We also provide consultancy and management services.

All courses have a strong practice-oriented character based on the training concept of **learning by doing**. The practical training is very intensive; one instructor deals with groups of six students and for subjects like milking even with three students only. DTC-Friesland offers training in the following subjects:

- **Dairy Husbandry**
  - machine- and handmilking, milking machines, milk hygiene
  - feeding, ration calculation, feedplans, quality of feedstuffs
  - fertility management, heat detection
  - breeding, use of A.I., culling, body conformation
  - housing, tying/cubicle systems, hygiene
  - health, mastitis control, hoofcare
  - calf rearing
  - farm economics
  - farm administration

- **Forage production**
  - pasture management
  - fodder crops
  - silage making
  - farm machinery

- **Milk processing**
  - manufacture of cheese, butter, yoghurt, ice-cream, etc.
  - milk collection and payment systems
  - marketing
  - management of a dairy unit

- **Sheep husbandry**
- **Dairy goat husbandry**
- **Intensive beef production**
- **Horse keeping and animal traction**
- **Teaching methodology**

Visits to farmers’ organisations, A.I.-stations, Health and Extension service etc. are integrated in the courses to provide a good picture of the dairy sector in the Netherlands.

**AD HOC COURSES**

Our major activity is the organisation of ad hoc courses on request. These training programmes are tailor-made and completely designed according to the requirements of
the client. The courses deal with one or more of the earlier mentioned subjects. Duration of the courses varies from 1 week to several months. The courses are conducted in English. For some special subjects training can be provided in French, Spanish or German. If facilities are available locally, our staff is prepared to conduct courses abroad as well.

**SIX-WEEKS COURSE: MODERN DAIRY FARM MANAGEMENT**

This course is especially designed for persons in charge of a large-scale dairy enterprise, and includes all aspects involved in managing a dairy herd. The course offers a good opportunity to refresh one’s knowledge and learn about recent developments in dairy farm management.

**SIX-WEEKS COURSE: MILK PROCESSING**

The course is designed for (assistant) managers of small to medium-sized dairy plants and future staff of new dairy enterprises; i.e. on-farm milk processing. Both six-weeks courses are conducted annually in September. However, for groups of at least six persons it can be organised at any time during the year.

**TRAINING FACILITIES AND STAFF**

The centre has three farms, each with a different management system. One farm is especially equipped for international courses. The total stock at the three farms includes 240 dairy cows, 50 fattening-bulls, 45 dairy goats, 85 sheep and 12 Friesian horses. Additionally, the centre maintains close relations with twenty neighbouring farms which are used for practical training.

Our staff consists of fifty dedicated and well-qualified trainers. All have up-to-date knowledge of modern dairy farm management, and over 70 man-years experience is present in various dairy development projects throughout the world.

**ACCOMMODATION**

A modern hostel provides full board and lodging in single or double bedrooms. An international kitchen and many recreational facilities are present. Social excursions are organised during the weekends to enable the students to get acquainted with the Dutch culture.

For more detailed information on our activities, please contact:

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Knowledge of dairy housing contributes significantly to the overall performance of dairy cows.