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## Minimising Slurry Pooling in Dairy Housing

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[^0] dermatitis, which is now widespread and costing the UK dairy industry dearly.

# How do we reduce slurry pooling in dairy cow housing, and so combat digital dermatitis? 

A 700 kg cow produces about 0.07 cu m of slurry per day, most of which will be deposited in feed stances and cubicle access passes. A cow will normally defecate and urinate 3 to 5 times a day, but more frequently when excited, or when subjected to changes in routine. Slurry depth is the major influence on digital dermatitis, especially if the slurry depth is consistently above the coronary band of the cow's foot, generally about 25 mm above floor level. Cows standing, walking and lying in slurry will be more predisposed to disease, as they become dirty, with softer hooves. Good cow management depends on a clean environment, and the objective must be to keep floors as clean as is practicably possible, at all times. Prolonged standing in pools or piles of slurry is harmful to cow health, fig I.

The biggest influences on the depth of slurry encountered in dairy units are standing space per cow and frequency of scraping. Feed stance and cubicle access pass dimensions have the greatest influence on limiting slurry depths. Wide feed stances and wide cubicle access passes are tremendous assets in combating digital dermatitis. Farmers who have opted to put in wide passes do not


Fig I A cow standing on a pile of slurry on a badly scraped floor. regret the decision, whilst others struggle to manage cows well in very tight conditions.


Fig 2 A wide feed stance in a single row cubicle unit gives a generous standing space per cow.

The building layout is an important factor. A one row arrangement with a single row of cubicles backing onto the feed stance offers the best layout opportunity to give each cow generous standing space, and ready access to feed, fig 2. A 4 m stance creates nearly 6 sq m of standing area per cow. However this arrangement leads to excess feed face per cow, so it is not as economical a design as a two or three row layout.

A two row cubicle arrangement [two rows of cubicles accessing one feed stance] has more passage space per cow than a three row arrangement [three rows of cubicles accessing one feed stance]. A typical two row arrangement with good access to the parlour is shown in fig 3. A typical three row arrangement is shown in fig 4.


Fig 3 A well designed two row arrangement with wide passes and good access to milking.



Fig 4 A three row cubicle arrangement with good access to feed.

A two row arrangement with a feed stance width of 4 m , and a cubicle access pass of 3 m , has a combined passage area of 5 sq m per cow, including cross passes. This compares with a three row arrangement, with the same passage widths, which has a combined passage area of 3.8 sq m per cow. This represents a $25 \%$ reduction in passage area for the three row arrangement.

The reduction in passage area is even more pronounced if we compare a tight three row arrangement against a generous two row layout. A tight three row arrangement with a 3 m wide feed stance, 2.1 m cubicle access passes, creates an average slurry depth of 24 mm over 24 hours. A generous two row layout with a 5 m wide feed stance, and 4 m wide cubicle access pass, creates an average slurry depth of 11 mm over 24 hours. This is less than half the average slurry depth of the tight three row unit.


Fig 5 A typical building upgrade now outgrown by the cows.

A halving of the average depth of slurry to be handled eases slurry management in generously designed units, compared with tight layouts. A typical tight layout in an upgraded building is shown in fig 5. It is difficult to keep floors clean in such units, especially if the layout is not straightforward.

When designing, or upgrading a layout for dairy cows, be very generous in feed stance and cubicle access pass widths, to ease slurry management, and cow stress levels. Many design variations occur in practice from single row cubicles to banks of six or eight accessing a feed area. It is important not to squeeze too much into the space available, especially when upgrading or extending existing buildings. A short term financial capital gain may contribute to a long term financial loss.

# What are the design and management factors which best contribute to clean and healthy feet? 

Many factors contribute to clean and healthy feet. The following information gives some basis for making rational design and management decisions. It is wide ranging, and provides a useful checklist of those aspects of housing design, which have a direct and indirect influence on cow health, including lameness.

The floor is a direct influence, whilst good ventilation contributing to moisture removal, is an indirect influence. The information concentrates primarily on the design and management needs of dairy cows, but the influence of good design and management for all ages of stock must not be forgotten. This is especially relevant in relation to a problem like digital dermatitis, which needs to be monitored carefully across the whole of the dairy herd, including bought-in replacement stock.

The types of dairy cow housing for which this information is applicable, all have a slurry component. They include bedded lying areas with tractor scraped passes, and cubicles with either tractor scraped passes, flush floor passes, automatically scraped passes, or slatted passes. It is impossible to cover all the housing system variations which occur in practice within one document, but farmers can interpret between the systems shown to suit their own circumstances.

Cows of all breeds continue to increase in size, and designers in the past have been guilty of 'thinking too small'. Inadequate cubicle sizing, over many years, is a good example of this. Farmers using this information, based on 700 kg cows, should link it with other sources, such as legislative and quality assurance requirements, which are specific to their particular needs.

## Overall layout

- Bedded courts: Provide a bedded lying and a scraped standing area of at least 8.5 sq m per cow, including a scraped feed stance. The bedded lying area should be a minimum of 6 sq m per cow. Keep the layout simple, and a good example of a typical bedded court layout with a scraped feed stance is shown in fig 6.
- Cubicles: Provide a lying and standing area of at least 7.5 sq m per cow, on a two-row arrangement. This will be reduced by about $15 \%$, to about 6.5 sq m per cow, on a three-row arrangement. The total standing area, excluding cubicles, should be at least 4 sq m per cow, whatever the cubicle arrangement.
- Feed face: Provide a feed space of 700 mm for large cows, with full access to feed. Reduce this to 400 mm per cow for ad-lib feeding, to ensure that all animals get good access to the feed face. There are less aggressive interactions between cows if there is full feed frontage for all cows.
- Feed barrier location: Locate the feed close to resting areas.


Fig 6 A simple layout for a bedded court system with scraped feed stances. Cows occupy cubicles more if they are near the feed barrier, and subordinate animals can be restricted in their access to feed by dominant cows, especially if their cubicles are not close by, and there is poor access to feed.

- Machinery access: Ensure generous pass widths, with good straight runs and access to all parts of the building, including clear door heights of at least 4 m .
- Group size: Match group size to the system, 80 may be a sensible upper group limit for all cows to interact with one another, but 100 may be a more practical group limit.
- Water troughs: Provide plenty of large water troughs, since high performance cows can drink up to 100 litres of water per day, with big demands post milking and feeding. Two troughs per group are ideal in allowing shy cows access to water at all times. Provide at least I sq m of trough surface area per 60 cows. Trough size should be at least 300 litres, supplying at least IO litres per minute. Flow rate is very important because a high rate stops cows queuing to drink. Fast flowing moderate capacity troughs are also easier to keep clean. Provide ready access to water immediately pre and post milking. Tipping troughs, or troughs with large emptying valves onto cross passes, help keep passes clean. Beware of any
potential frost problems in supply piping.
- Calving/holding pens: Allow at least 12 sq m per cow for small group holding/calving pens, with at least 16 sq m for each individual holding/calving pen.
- Cattle ramps: Maximum slope $15 \%$, for loading only. Avoid steps throughout if possible.
- Convenient waste store: A small, conveniently located area for temporary storage of fibrous waste material such as feed residues, or bedding will help to keep the unit tidy, in addition to any other waste storage facilities.
- Access passes: Provide plenty of 'man access' passes, which are access gaps, about 400 mm clear, between posts. For bio-security a hollow post can house a flexible water hose for washing down boots on exit from feed stances.


## Environment

- Cubic capacity: Provide a generous airspace for cows to aid ventilation, at least 40 cu m per cow for bedded courts, and 35 cu m per cow for cubicles.
- Ventilation: Ensure good natural ventilation throughout the dairy unit, with at least 10 sq m of roof outlet area per 100 cows, and double this amount as inlet area. Design inlets and outlets to avoid wet lying areas in stormy weather. Spaced roofing is an excellent way of providing good natural ventilation, especially in large, multi-span dairy units, fig 7.
- Rooflights: Provide at least I $0 \%$ of the roof area as rooflights over cow accommodation areas, increasing


Fig $\mathbf{7}$ Spaced roof sheeting can provide excellent natural ventilation.


Fig 8 A vented light ridge provides good light and natural ventilation.
this to $20 \%$ over handling and inspection areas, fig 8 .

- Light levels: Aim for an overall light level 50-100 lux. For parlour and close inspection areas, including footbathing, aim for 200 lux, with night light areas 5-10 lux.


## Bedded areas and feed stances

- Feed stance width: Provide an absolute minimum feed stance width of 3.5 m if cows can access the bedded area directly from the feed stance. If the bedded area is shut off from the stance, with access at specific points, cows have to walk behind cows at the feed barrier. The feed stance should be increased to a minimum width of 4 m to allow for good cow space behind feeding animals. Always design for easy escape from feed stances, without trapping animals in dead-ends.
- Access from the bedded area to the feed stance: Some layouts have completely open access from the bedded area to the feed stance. If the bedded area is gated off, allow 0.2 m per cow for a gateway opening to prevent crowding, hence a group of 40 cows need a total opening 8 m wide, say two 4 m wide gates.
- Access from the feed stance to the collecting area: Access and return from the collecting area along the feed stance, not through the bedded area. Cows can be held on this stance after milking pending teat closure.
- Tractor scraped passes: Scrape at least twice a day when cows are at milking, using a good quality, high-capacity scraper. Additional scrapes can be made if cows can be shut back from the feed stance. Provide a slope down the length of the building of at least $1.5 \%$ to minimise the risk of slurry ponding. This slope could be greater at $3 \%$, or even up to $5 \%$, if land levels suit. Provide a small kerb or step to ensure that scraped slurry, or urine run-off, does not enter and soil the bedded area.


No differentiation between the bedded and stance area can lead to a wet, dirty feed stance, fig 9 .

- Bedding use: Top up the courts with good quality, dry straw at least once a day. Expect to use at least 1.5 tonnes of straw per cow for a short 120 day winter. This could rise to well over 2 tonnes of straw per cow for a longer 180 day winter. Provide a good foundation of straw immediately after cleaning out.
- Bedding removal: Clean out courts at least every 4 to 6 weeks, more frequently if the bedding becomes sodden or if there are any foot or udder problems.
- Water trough location: Ensure that any water trough spillage is onto the scraped feed stance, and not into the bedded lying area. Keep blown straw out of the trough, and site for easy access to clean.
- Straw storage: Store straw dry and under cover.

Cubicles

- Cubicle numbers: Provide at least one cubicle per cow. Even this may not be enough if some cubicles are so poorly designed and located that they are virtually unacceptable to cows, and hence are rarely used. Do not overstock cows to cubicles.
- Cubicle location: Ensure that all cubicles are draught and rain free, with good, stress-free access for all cows to feed and milking areas.
- Cubicle length, outside wall: For a cubicle against an outside wall, choose a bed length of about 2.7 m , to cater for forward lunging space. Adequate bed length is a critical factor in encouraging cows to readily use cubicles, fig 10 .


Fig 10 Good sized cubicles encourage cows to stand within them keeping back feet clean.

- Cubicle length, inner row: For an inner row providing forward lunging space, choose a bed length of about 2.4 m .
- Cubicle length, double row: For a double row, with shared lunging space, choose a total bed length of about 4.6 m .
- Cubicle width: Provide a minimum 1.15 m width, going up to 1.2 m for very large cows, or for the cubicle at the end of a row against a solid sidewall, where lunging space is restricted.
- Variation in cubicle width: Set out all divisions very carefully, so that there is little variation in cubicle width down any one row. A sensible maximum variation is 50 mm . If cubicles are too wide, cows will turn and dung at the head of the bed.
- Cubicle slope: Provide a slope up from back to front of $5 \%$, approximately 100 mm to 140 mm , to prevent urine ponding in the cubicle, especially for softer beds on an impermeable surface, such as mattresses on concrete.
- Cubicle step: Cows do not like reversing back off a high step, so provide as shallow a step as possible, which prevents scraped or flushed slurry from being forced onto the cubicle bed. The step should not normally exceed 200 mm , including any mat or mattress. For a slatted pass, this step can be reduced to 150 mm or slightly lower. A very shallow step however risks getting cows dirty, as they can lie half-in and half-out of the cubicles. Do not reduce the step below 200 mm for any flushed system because of the risk of flush wash surcharge onto the cubicle bed.
- Cubicle bedding: Choose a soft, comfortable permanent bed, such as a soft mat or mattress, or deep sand bedding. If sawdust, chopped straw, or a similar surface bedded material is used, then bed at least once a day, with at least 0.5 kg per cow per day of dry material. If deep sand is used, then bed at least once a week, with a least 3 kg of dry sand per cow per day. If in doubt, bed to the recommendations and experience of the bedding supplier and other farmers using the same material. Think through the implications of bedding choice for the whole cubicle and waste management system, to include storage, bedding up, containment, cleaning down, utilisation and disposal.
- Cubicle bedding storage: Store bedding dry and under cover, convenient for use for all cubicles. Do not be forced to use poor bedding, which is a health risk, because of a lack of adequate storage.
- Cubicle bedding storage in the cubicle: It is bad practice to store a lot of bedding at the head of the cubicle for cows to drag back. Whilst this bedding may appear clean, it could be highly contaminated, and it is better to bed daily with fresh bedding, to get the maximum benefit in cow comfort.
- Cleaning cubicles: Clean dung pats off cubicle beds at least twice per day. Keep the passage area immediately adjacent to the cubicle step as clean as possible, since the cleanliness and dryness of this area has a major influence on cow cleanliness, fig I I.
- Cubicle heelstone: Avoid any form of narrow rounded kerb or pronounced heelstone at the back of the cubicle, since it will hinder cubicle bed drainage and cleaning, and can cause udder or hock injury. It will also discourage cubicle use if cows have to step over a high heelstone.
- Cubicle division choice: Choose a cubicle division which allows good lunging space to the front and side, with a high headrail, say 1.3 m off the cubicle bed, to encourage a cow to readily use the cubicle, and stand with all four feet on the cubicle bed.


Fig II Always keep the cubicle step area as clean as possible, since this has a major influence on cow cleanliness.

## Access passes between cubicles

- Pass widths: Provide a minimum pass width of 3 m between rows of cubicles, increasing this up to 4.5 m if a generous space is required for very large cows to access, or exit a long run of cubicles.
- Pass levels: As previously stated, slope solid passes at least $1.5 \%$ down the length of the building when automatically scraping, to help prevent widespread slurry ponding. If tractor scraping, then the slope can be increased up to $5 \%$, depending on existing site levels. If flush washing, this slope should be constant at $3 \%$.
- Slatted passes: If the pass is fully slatted, it should be laid flat, or with a very slight slope, down the length of the building, to meet site levels. Slats should be tractor bearing, with heavy weight-bearing slats at cross passes, to cope with feeding equipment. Slatted floors should have a maximum gap size of 40 mm . Slat quality must be good, and slats must be laid carefully without any rocking, or level differences between adjacent panels.
- Sloping passes across the width: Never slope a solid cubicle access pass towards a cubicle step, unless the pass is flush washed to encourage cleaning at this point. Keep the pass level across the width, or with a slope away from the cubicle step towards any central drainage channels, fig 12.


Fig 12 Poor floor levels across a building can lead to serious slurry ponding.

- Cleaning cubicle access passes: Tractor scrape passes thoroughly at least twice a day, when cows are away being milked. Flush wash passes at least 3 times a day, with relatively clean water, not sludge. Automatically scrape passes every 2 hours during active times of the day, say between 4am and I0pm, which is about 10 times per day, to a disposal point, which does not create a build up of dung on cow access passes. The area adjacent to the cubicle step is a key area to keep clean, since this has a major influence on cow cleanliness, including feet.
- Escape routes from cubicles: Avoid 'dead-end' passes, by always offering an alternative escape route from a row of cubicles.
- Cubicle cross passes: Provide a cross pass at least every 24 m run of cubicles, or 20 cubicles, for ease of cow movement, including escape, across the building.
- Cross pass widths: Make intermediate cross passes at least 2.4 wide if there is no water trough. Make end cross passes at least 3.6 m wide, ideally excluding any water trough, or with a very narrow water trough. Make end cross passes at least 4.8 m wide if there is a wide water trough and/or the pass requires tractor scraping. Wide end passes make it easier to locate scraped slurry collection grids and channels on the inside of gable end walls, without them interfering with cow flow across the building.
- Cross pass location: Do not place a cross pass in the middle of the cubicle row without end cross passes, since it then needs to cater for cows coming from four directions. It is better to situate cross passes at the ends of rows, with supplementary passes every 20 cubicles to ease cow movement.
- Cross pass cleaning: It is very important to keep cross passes clean and dry, and profiling a solid pass to shed urine will help. A solid cross pass will quickly become dirty if cleaning is not a twice daily routine, fig 13 . Aids to assist cleaning include tipping troughs, water trough valves, hoses or buckets, and slatted floors, fig 14.


Fig 13 Solid cross passes can soon become very dirty if not cleaned twice per day.


Fig 14 Slats and a tipping trough ease cross pass cleaning.

## Feed stance passes for cubicles

- Feed stance widths: Provide a feed stance width of at least 4 m for large cows, increase this to 4.5 m or over, if the cubicles back onto the feed stance.
- Sloping feed stances: Slope feed stances to the levels previously indicated for cubicle access passes, down the length of the building.
- Slatted feed stances: Design these to meet the requirements as stated, for cubicle access passes.
- Automatic scraper chain, rope, or bar location: For a wide feed stance, it is likely that any central scraper bar, chain or rope will be beyond the back feet of feeding animals, fig 15 . If the stance is narrow, there is a risk of interference with the back feet, fig I6. In narrow passes, the scraper mechanism can be offset to lie between the front and back feet, approximately 1.2 m from the feed barrier.


Fig 15 A wide feed stance keeps the scraper chain or rope beyond the back feet of feeding cows.


Fig 16 A narrow feed stance creates potential injury problems from the scraper mechanism

- Feed space: Provide 700 mm full frontage per cow, 400 mm ad-lib frontage, to ensure that even very shy cows get good access to feed.
- Feed trough level: The base of the feed trough should be $100-150 \mathrm{~mm}$ above front foot level to enable cows to gain maximum reach when feeding. A barrier sloped or set, 20 degrees from the vertical, away from the feed stance, will also assist in this respect. Also the feed trough or trough base should not allow cows to push feed out of reach.
- Feeding step: Within automatically-scraped systems, cows can be disturbed by the scraper when they are eating. A feeding step will reduce the problem by keeping the front feet clear of the scraper blade. A step size approximately $500-600 \mathrm{~mm}$ wide, 100 mm high, with a $3 \%$ slope draining towards the feed stance would suffice, fig 17.The feed trough level should be raised, as previously stated, above the feeding step level, with feed barriers set to suit the new step height.


Fig 17 A feeding step at the barrier keeps front feed away from the scraper.

- Feeding platform: Recent designs in Sweden have extended the feeding step described above, to a sloped feeding platform about 1.6 m wide, with a rubber-matted floor for additional foot comfort. Cows are encouraged to stand with their tails over a scraped or slatted alley behind, by dividers at the feed face at 800 mm centres. Bullying at the feed face is reduced by the installation of feed dividers, fig 18 . This additional hardware significantly increases costs.
- Feed barrier location: Locate feed barriers as close as possible to resting areas, with easy, stressfree access for all cows.


## Collecting areas and dispersal



Fig 18 A feeding platform keeps cow's feet away from the scraper but increases building costs.

- Collecting area size: Large cows need about 1.5 sq m each of standing space in the collecting area, which ideally should be suited to group sizes such that no cows have to stay for longer than one hour waiting to be milked.
- Collecting area drinking water: Access to a water trough is recommended, especially if cows have to wait for long periods.
- Collecting area slope: A significant slope up towards the parlour of about $5 \%$ will assist in orientating cows prior to milking, as well as easing cleaning down the collecting area after milking, fig I9. If such a steep slope is not thought necessary, then the slope up to the parlour should be at least $1.5 \%$ for solid floors to avoid slurry ponding. Avoid steps wherever possible at parlour access and exit points, they slow down cows, are difficult to clean, and can cause foot injuries, fig 20.


Fig 19 A significant slope up to the parlour prevents slurry ponding whilst orientating cows towards the parlour entry


Fig $\mathbf{2 0}$ Steps slow down cows and are an injury risk at the parlour.

Collecting area cleaning: The whole of the collecting area should be designed for easy, thorough cleaning after each milking.

- Collecting area shape: A long narrow area the width of the parlour, with open access and sight of the parlour will assist cow collection, including the installation of a backing gate if required.
- Collecting area light levels: Light levels must be good, with at least I0\%, up to $20 \%$ natural rooflighting, and good artificial light.
- Collecting area ventilation: Good ventilation is essential throughout the collecting area to assist in keeping cows healthy, clean and dry. This is best achieved by generous ridge openings to release stale air.
Fly control: This can be a problem which is difficult to solve, but air movement boosted by fans may help.


## Handling and treatment areas

- Handling areas and treatment facilities: Design and integrate these into the layout at the outset to suit individual circumstances. Sharp turns and narrow passes must be avoided, with single file passes at least 900 mm clear width, and double passes at least 1800 mm clear width. A rounded rump rail in passes, approximately 900 mm from the floor and 100 mm off the wall will help protect cows from injury, and assist in keeping walls clean.
- Footbaths: Exit pre-wash baths and footbaths should be located far enough away from any parlour to prevent disrupting cow exit. For example, allow at least one whole side, and preferably both sides, of a herringbone parlour, to fully exit the parlour, prior to pre-washing and footbathing. Alternatively pre-washing and footbath facilities can be located prior to cow collection, and integrated fully into the cow collection routine. Keep footbath areas light and well ventilated.
- Dispersal of cows to a clean standing area: All cows after milking should be dispersed to a clean standing area, such as a cleaned feed stance, whilst teat closure takes place. Access to drinking water on dispersal is recommended.
- Stray voltage: Beware stray voltage affecting cows, particularly in the vicinity of the parlour, and take steps accordingly to provide a common earth.


## Floor design and maintenance

- Floor slipperiness: Avoid slippery floors by surface treatment, grooving or applying a surface material such as sand. Swedish research confirms that slurry covered floors are much more slippery than dry. For example, slip distances for rough tamped concrete are 29 mm when dry, 40 mm when slurry covered. Slip distances for grooved concrete are 36 mm when dry, and 54 mm when slurry covered. Slip distances for smooth concrete are 41 mm when dry, and 81 mm when slurry covered. Spilt sand when used as bedding can smooth off concrete floor surfaces, and surface retexturing will be required more frequently when cubicles are bedded with sand. Conversely spreading a surface with sand when conditions are icy will help prevent cows slipping.
- Floor types and finishes: Many variations are possible, but grooved slotted or grooved squared profiles should ideally not exceed 40 mm apart, so ensuring that the pressure points of a cow's foot will always land on a groove. One American recommendation is to have grooves at 95 mm centres, 13 mm wide and 10 mm deep, as a diamond pattern, but it seems sensible to space grooves at closer centres than this. To avoid the harsh surface that caused by rough tamping, one approach is to finish off rough concrete with a stiff brush texture, and groove later as the surface smoothes off. A very abrasive tamped surface can increase the wear on hooves to a degree that can be detrimental to hoof health. Stamped patterns into wet floors can create cambered bulges between the grooves. This creates a slippery floor, as feet slip into the grooves, causing claw damage.
- Rubber mats for floors: A range of products is now available for solid and slatted floors. Hard rubber mats with no surface texture will become slippery. Textured mats, designed specifically for cattle housing, allow the animal's foot to sink in several millimetres to create some grip. Preferred location of mats is the feed stance. Purpose-designed mats also interlock for lateral stability, and only products specifically recommended for cattle housing should be used. Cost may be a limiting factor at about $£ 25.00$ per sq m supplied, plus about $£ 4.00$ per sq m for fitting. A 4 m wide stance, 700 mm feed face, gives a feed stance area of 2.8 sq m per cow, costing approximately $£ 80$ per cow place, for textured rubber matting.
- Floor slopes to drains: Ensure that ponding is avoided even on very small areas by sloping floors about $2 \%$ to convenient gullies, drains or slatted panels. Small link areas are often forgotten but can be damaging to feet if trafficked regularly by cows.
- Slatted floors: High quality slats must be used with a maximum slat gap of 40 mm . Very slippery slats should be grooved, or rubber coated, or replaced. Poor slats, with broken edges, should be replaced as quickly as possible. Sharp differences in level between adjacent slats must be remedied, as must any rocking of slats caused by uneven support.
- Floor maintenance: A high standard of floor maintenance throughout any dairy unit is essential in avoiding cow foot problems, fig 21 . Pitted, holed floors pond slurry and cause injury, fig 22. A floor inspection and repair programme should be carried out rigorously every year, preferably in the summer months, when there is the best opportunity to carry out remedial work.


Fig 21 An ideal solid pass is wide, well-maintained with a significant slope.


Fig 22 A badly pitted floor in urgent need of repair.

- Cow access roads and tracks: These should be of the highest standard, bearing in mind that cow foot health is an all-year-round responsibility. Loose sharp stones and chippings are the main danger to foot health.
- Cleaning out: All floors, walls and cubicle beds should be thoroughly cleaned and washed down once a year.


# How can this information best be used to design and manage dairy cow housing? 

## Bedded lying areas with tractor scraped passes

The easiest way to avoid slurry ponding on the feed stance is to run the stance to a slope, say $3 \%$ down the length of the building. The feed stance should be flat across its width to avoid slurry channelling, and for ease of scraping thoroughly. The tractor and scraper take the slurry directly out of the building to a nearby store. A small kerb, 150 mm high, prevents slurry being scraped into the bedded area, fig 23. It also prevents any water trough spillage from entering the bedded area, when cows drink whilst standing on the scraped feed stance.

Cow access, and return from the parlour collecting area, should be via the scraped feed stance, where cows can be held for teat closure after milking. Gated access to the bedded area must be non-restrictive, fig 24. Cows on the feed stance should easily pass behind feeding animals. The building is well ventilated, with good natural lighting, and plenty of access height for feeding and bedding machinery.

## Cubicles with tractor scraped passes

A workable cubicle layout for tractor and scraper access is shown previously in fig 3. The building is laid to a slope of $3 \%$ down its length, to prevent ponding of slurry in the passes. All feed and cubicle access passes are wide enough to allow ready access by the tractor and scraper. A slurry store reception pit convenient to the scraped passes helps to cut down on scraping time. It is a simple design, easily worked.

Cross passes can be difficult to access by tractor but a wide cross pass and curved corner will help, fig 25.


Fig 23 A kerb differentiates the bedded area from the scraped feed stance.


Fig 24 Non-restrictive access from the bedded area to the feed stance is important. It is very important when tractor scraping, to do the job thoroughly and not leave slurry residues, especially at the cubicle step area, fig 26 . This slurry will inevitably be dragged onto the cubicle bed, causing dirty feet, tails and udders.


Fig 25 Rounded corners ease tractor scraping.


Fig 26 Careless scraping at the cubicle step will lead to dirty feet, tails and udders.

Ponding immediately adjacent to the cubicle step must be avoided, because this area significantly influences cow cleanliness. Any flat passage will lead to ponding, fig 27 . One possibility is to create a slight fall of $2 \%$ towards the centre of the cubicle access passage. This will move liquids away from the cubicle step area. It may affect the ability of the tractor to fully clean the passage, but two scrape runs down a wide access pass would remove all liquids.

The most effective design for tractor scraping is undoubtedly creating a significant slope down the


Fig 27 Leaving any passage flat will lead to slurry ponding. length of the building. Leave plenty of room for manoeuvre at cross passes and end passes, for an efficient, thorough scrape. A generous building height, with good ventilation, will ease machinery access and assist in the rapid removal of stale air and tractor fumes.

## Cubicles with flush floor passes

The flush floor system relies on using flush wash water to clean feed and access passes, and is relatively new technology in the UK, compared with more established systems. It is very effective in cleaning down passes provided fairly clean wash water is used. Flush water is recycled and can become thicker with slurry over time. Thicker washings are less effective, so it is important to keep these thin by careful management, including the provision to renew the water supply on a regular basis, possibly every 4 weeks as a guide. Flushing should take place at least 3 times a day. Flush when cows are held elsewhere in the unit, not when there are a lot of cows standing in the passes affecting the


Fig $\mathbf{2 8}$ Valve location is important to get maximum flushing effect, without leaving a dirty area behind the valve requiring cleaning. force and effectiveness of the wash. Locate water entry valves for maximum flushing power for all passes and aprons, including the collecting area, after each milking, fig 28.


The system demands a lot of water, since water flows from each flush valve at a rate of over 20 cu m per minute, albeit only for a few seconds. Each flush pass will use about 9 cu m of water. It is recommended that the farm has a plentiful free water supply, which is never vulnerable to prolonged dry spells. There is considerable technology in the system, including flush tanks, intermediate tanks, pumps, possible settlement tanks, a separator, and a main storage tank. This technology is kept away from the cow's feet, so there are foot health attractions in a system which does not create the injury risk of mechanical scraping, fig 29. This system has significant capital and running costs, which must be fully considered at the outset.

Choose a suitable sloping site on a constant slope $3 \%$, not variable, to maintain the momentum of the flush wash. Make the cubicle access step 200 mm , to avoid any risk of flood wash surcharging onto the cubicles. Keep passes flat across the slope for an even flush, full width. If there is any slope across the pass it should be higher in the middle to keep flush levels good at the kerbs, where deposits are most likely. When cleaning off dung pats from cubicle beds, it is easier for flushing if these can be deposited towards the middle of the pass and not left at the edges.

Finish off floors with a hard brush finish, not a rough tamped surface, since this may affect flow. If the finish becomes slippery, concrete grooving can remedy the problem. An initial grooved finish down the length of the flush direction will help to create a less slippery surface for cows, but it does not appear to increase cleaning effectiveness.

Contain the flush wash water within a cross channel across the full width of the inside of the building, prior to transfer back for recycling. This is a receiving gutter, and it must be dimensioned to best suit the flush volume and velocity. Keep the receiving gutter open and railed away from cow flow, rather than gridding the top, which could block up.

Have a contingency plan to tractor scrape, in case of power, or other system failure. A flat profile across the width of each passage aids both effective tractor scraping, and flush washing. Ventilate buildings well because the flush wash creates a lot of moisture within the building, with ammonia emissions as the passes dry out.

## Cubicles with automatically scraped passes

Automatic scrapers are very convenient to use, have a minimum labour requirement and can be activated to scrape at frequent intervals. However they pose a threat to cow foot health by creating a slurry tide when scraping. They also have the potential to injure cows' feet, either because of the blade itself, or because of the chain or hydraulic bar [ropes are kinder to feet]. Cows in the passes cannot escape a slurry tide, and the consequences are dirty feet, with slurry deposits sometimes well above the coronary band.

## How can we minimise the slurry tide?

The influence of the slurry tide can be reduced by the following design and management initiatives:

- Sloping passes: A constant slope down the pass length helps prevent ponding by allowing some liquids to run off between scrapes, which would otherwise add to the slurry tide. The design requirement is $1.5 \%$ minimum, with a steeper slope [3\%] more effective in running off liquids.
- Scrape often: A guideline is every 2 hours, but with little or no scraping overnight, so that cows are not unduly disturbed.

- Clean out returned slurry: Do not allow a build-up of returned slurry at the top end of the scrape, fig 30. One solution is to provide a slatted or gridded tank at the return scraper location. If the scraped passes cannot be sloped and are laid flat then a 'squeegie scraper' scraping backwards and forwards could keep passes clean, minimising the slurry tide, especially with the help of intermediate passes.
- Wide passes: A wide pass creates less slurry build up, and less injury risk to the cows, especially at the feed stance, since back feet remain clear of the scraper chain or bar.
- Limit building length: Very long buildings create automatic scraping problems. Shorter buildings designed as multi-spans are easier to scrape.
- Minimise water trough wastage: Water trough spillage adds to the slurry tide.
- Minimise feed and bedding wastage: Feed wastage at the barrier, and bedding spillage at the cubicle step, add to the slurry tide. Provide a small convenient storage pad for these fibrous residues.
- Overstocking: Do not stock beyond one cow per cubicle, to help avoid crowded, dirty passes.
- Provide frequent slatted cross passes: A break in the length of scrape with frequent slatted cross passes will help to control the slurry tide build-up, say every 20 cubicles, fig 31 . This is illustrated in layout drawing fig 32.
- Additional scraper blades: Extra scraper blades can be installed if there are cross passes to deposit the scraped material, such as a cross pass halfway down a building. Two scrapers on the chain pull the slurry, one to halfway and the other beyond halfway to the end. Slurry tide build-up during scraping is halved, and loading on individual scrapers is eased. A layout with a tank halfway is shown in fig 33. However this layout has too few access passes between banks of cubicles to work effectively.


Fig 33 A building layout with a central cross pass and double bladed scraper, but there are insufficient cross passes for ready cow access to feed.

- Keep scrapers well maintained and working: Regular checks on a monthly basis of chains, ropes, hydraulic bars and motors will help prevent failure problems, and assist in running scrapers regularly, with no major slurry tides following a breakdown. Even a short period of scraper inactivity due to a breakdown can cause considerable problems of slurry build-up.
- Narrow slatted or slotted channels down the pass length: Standard panel slats can be laid lengthwise down the centre of the pass, above a transfer channel, fig 34. A slight passage cross fall towards the slat will help drain off liquids when not scraping. A fall down the length of the building of $3 \%$ will prevent slurry ponding. A slurry channel below can function as a continuous overflow channel. This involves designing a flat-bottomed channel with steps and overflow lips, to continually drain slurry down the length of the building, following the natural angle of repose of slurry [2-3\%]. A single slotted drain could similarly drain off liquids, but this may require flush washing, or a mechanical means of emptying.
- Winged scraper blades for narrow central channels: For a narrow central slatted, or slotted, channel as shown in fig 34. A winged scraper blade would better capture and concentrate the slurry over the channel when scraping, and so assist in capturing the slurry tide.
- A step at the feed stance: Feeding cows are often disturbed by the scraper blade. A step for the front feet helps to minimise disturbance, by keeping the front feet out the path of the blade. Recommended step dimensions are approximately $500-600 \mathrm{~mm}$ wide, 100 mm step, with a $3 \%$ slope up towards the feed pass, shows a step up to an internal trough. For external feeding at the side of a building, this step can accommodate the building stanchions, (fig 35) making it easy to mechanically clean up feed residues outside the building, and scrape the inside feed stance.


Fig 34 A slatted panel in a solid floor will help minimise the slurry tide.


Fig 35 A feeding step keeps front feet away from the scraper blade.

- A feeding platform at the feed stance: This Swedish innovation claims better hygiene, with a clear reduction in hoof diseases. Automatic scrapers can be run continuously behind the feed platform without disturbing eating animals. The sloping platform is shown in fig 18.
- Herringbone prefabricated drained floor:This Danish concept for flat passes uses prefabricated, profiled concrete panels form the building alleyways, fig 36. Slurry is drained via herringbone grooves, to a slotted drainage channel, placed down the middle of the panels. The floor slopes between $1 \%$ and $2 \%$ towards the drainage channel. A cleaning flap fixed to the automatic scraper blade slots into the drainage channel, and cleans it out as the scraper progresses down the building. The slot width is 40 mm wide, the same as the maximum void gap for conventional slats.
- Longitudinal prefabricated drained floor: This Danish variation integrates a scraper designed with 'fingers', which fit into the slots, as the scraper moves down the length of the building, figs 37 \& 38. Installation, on a sand bed, must be very precise. A series of surface grooves in the panel,
 both longitudinal and transverse, direct slurry liquids to an under panel drainage pipe. The floor surface looks excellent, but there may be a risk under dry conditions, particularly with fibrous materials in the pass, that the drainage system could clog up. This pipe runs the full length of the building to an external storage channel at one gable end. Both these designs are presently being installed on commercial dairy units in Denmark, and are being evaluated by staff at The National Centre for Building and Technique.


Fig 37 A precast drained floor set onto a sand base


Fig 38 A scraper with 'fingers' into a prefabricated drained floor.

## How can we minimise slurry build up at the end of the scrape?

Slurry build-up on grids or slats within buildings, at the end of the scrape, is a common problem. Cows track through this piled up dung. Their feet get dirty and infected. The deposits need to be regularly washed or scraped away, preferably daily and this is a constant management chore. The main problem is at the end of cubicle access passes, where cubicle bedding spillage is rolled into a thick paste by the automatic scraper at the end of the scrape.

## Initiatives to deal with this problem have included:

- Concrete slats: Conventional slats do not provide sufficient gap space or angle of slope away from the gap to cope with scraped dung which contains feed or bedding residues. Laying slats with the gap across the width of the scraped pass, or diagonal slats, provide the best opportunity to remove dung, but the maximum recommended gap size of 40 mm is a limiting factor, fig 39.
- Metal grids: Grids are more effective than slats, especially if the sharp edge of the 'L' shaped grid is set to create maximum gap by facing the scraper blade. However the 40 mm gap is insufficient to remove all dung, fig 40 . Any increase in gap size will risk foot injury. Cows dislike walking over metal grids, especially if slippery, but stray voltage could also be a problem.


Fig 39 Concrete slats do not have sufficient gap to remove solid deposits.


Fig 40 Metal grids cannot cope with solid deposits, especially cubicle bed spillage.

Wide slots in the floor: A full passage width 200 mm cross slot will remove dung but it poses a serious injury risk to cows, fig 41. It is possible to locate a removable board over the slot and the scraper blade which allows cows to step across, but this must be carefully monitored to ensure that legs are not trapped by the automatic scraper blade, fig 42.


Fig 41 A wide slot is an injury risk for cows.


Fig 42 A protected slot could allow cows to step over the gap.

Lifting lids: These solid metal lids are lifted by a shoe on the automatic scraper, but tend to stick open with dried dung, and as such pose an injury risk to stock, fig 43. They can be made to work by very attentive management, and do have the potential to keep passes clean, but tend to create more problems than they solve.

- Cross scrapers: Linking a cross scraper to effectively take scraped dung from a series of passes down the building length is very difficult. The scraper must co-ordinate scraping times, scraper positions and drive mechanisms, otherwise slurry residues are left. It is an over-complicated system since it attempts to move slurry mechanically in two directions.
- Deposit at the inner face of the gable wall: If cross passes are wide then cows will not need to walk near at the inner face of the gable end wall, fig 44. The scraper simply deposits slurry in a tank away from cow traffic. Safety rails at 600 mm high and 1100 mm high, prevent cow access. The deposition point is 500 mm wide, and gridded. Any surface deposits can be quickly pushed down manually into the storage tank. It is a simple and effective Danish design, which could be further adapted by locating a water trough over the cross channel access point, in place of safety rails.
- Scrape beyond the building: Slurry deposits in the vicinity of cows can be prevented by scraping slurry directly outside the building. An opening under a gable end door, or wall lintel, enables the scraper to deposit slurry directly outside the building, away from cows'


Fig 43 Lifting lids often stick partly open due to dung residues.


Fig 44 A slurry slot adjacent to the gable end wall is away from cow flow areas. feet. Deposition to a solid concrete wedge eases dung lifting with a tractor and bucket, by creating a lip, fig 45 . Alternatively slurry can be deposited directly onto outside slats, draining off the liquid, leaving solids to be mechanically lifted, fig 46 . Neither system looks tidy, but each is very effective at getting slurry deposits away from cow traffic. A neater solution is to build an external channel open channel to contain dung, fig 47 . If rainwater dilution of the slurry is a problem, the channel can be solid covered, with scraper access to deposit dung via a letterbox opening.


Fig 45 Scraping beyond the building with a concrete wedge to ease the lifting of dung.


Fig 46 Scraping beyond the building to a scraped, slatted pad.


Fig 47 Scraping beyond the building to an external channel, which can have a letterbox cover.

Fully slatted passes are not subject to the same ponding risks as solid or part-solid floors. Ponding occurs in slatted units where solid floor levels do not complement slatted floor levels. Slatted floors are generally laid flat, and the tendency is to make adjacent solid floors flat. The solid area then dams up with slurry, fig 48. Solid floors should drain towards slats, at about $2 \%$ slope, to minimise ponding risk.

Solid cross passes between rows of slats can get very dirty, and are a nuisance to clean. The only advantage of a solid area like this is to flood it and use it for a


Fig 48 Slurry ponding because of poor floor levels. purpose, such as a footbath or footwash area, draining into the slatted tank. Slatted cross passes are easy to clean, especially when adjacent to a tipping water trough.

Good slurry management on slats is essential at the cubicle step. Some farmers hand brush this area back to allow the dung to be trampled through the slats, fig 49 . Small ride-on machines are now available to mechanically clean this area and the dung pats from the back of the cubicle bed, fig 50 . Taking the slat gap right to the cubicle step will help keep this area clean. This is best done by a removable kerb laid at the heel of the cubicle, fig 51 .


Fig 49 Dung hand brushed from the cubicle step area will be trampled through the slats.


Fig 50 Mechanical assistance in bedding, cleaning and dung removal.

The time spent tractor scraping on slats is much reduced compared with solid passes, because the bulk of the slurry goes immediately through the slats. Wherever possible, tractors should access all cross passes, as well as feed stance and cubicle passes. Automatic scraping on top of slats guarantees clean floors, but this comes at a price. A dairy unit with this system is shown in fig 52. It has a floor wash system attached to the moving scrapers. The lightweight 'squeegie' scraper works well, cleaning the floor on both the downward


Fig $5 \mathbf{I}$ The slat gap extends right to the cubicle step which is a removable kerb.


Fig 52 A new dairy unit with slotted floor panels, scraped and washed on top.
and return journey. The flooring system is slotted, grooved panels, fig 53.

Floor maintenance is very important and farmers should carry out regular maintenance checks on all slatted flooring, replacing damaged slats immediately. Cows are very uncomfortable walking on slatted floors where there is a change in floor level between adjacent slats, due to poor laying, uneven bowing or poor manufacture. Rubber slotted mats are an option for upgrading poor slats, but check with the supplier and other users that these do not become too slippery


Fig 53 Slotted panels, grooved to help prevent slipping. because of surface oils and slurry.

Slatted buildings must be well ventilated, especially those with deep storage tanks requiring periodic mixing, which can release dangerous gases.

# What are the approximate capital and running costs of each system? 

Dairy farmers need to look very carefully at capital and running costs, and get the best value for money that they can, whether it be a new system or upgrade. Only systems which have a slurry component are included, since the basis of the work is slurry management to help combat digital dermatitis. Fully bedded courts, open bedded or wood chip corral systems are excluded.

Capital and equipment costs are compared in Table I for seven variations of the housing systems highlighted in this report. They are no more than very general indications of comparative costs, since many factors can influence the cost of a building project. The figures are based on broad costs per sq m from The SAC Farm Building Cost Guide, and SAC Farm Management Handbook, with additional information from trade suppliers. They are for dairy cow accommodation and slurry storage only, not including the parlour, dairy, and collecting area, which are regarded as common elements for all the housing systems.

A typical 100 cow building is used as the basis for the cost comparisons, sized to meet the stated design and management requirements. The building system ranges from a bedded court with scraped feed stances and a drive through feed passage, to a conventional cubicle house, with a drive through feed passage. The building dimensions are 40 m long by 28.5 m wide, with 5 months slurry or dung storage. Initial capital costs also include for dedicated equipment and machinery, such as automatic scrapers, pumps and tractors. Initial capital costs are expressed as a percentage increase over the cheapest system, which is a tractor scraped bedded court, at approximately $£ 210,000$ for 100 dairy cows. This is shown as $100 \%$ in Table I. The building systems compared are:
I. Bedded courts with tractor scraped feed stance to dung store.
2. Cubicles with tractor scraped passes to a dung store.
3. Cubicles with tractor scraped passes, partially slatted and slurry store.
4. Cubicles with automatically scraped passes, partially slatted and slurry store.
5. Cubicles with fully slatted passes, with slurry storage.
6. Cubicles with automatically scraped fully slatted passes, with slurry storage.
7. Cubicles with flush floors, a separator and slurry store.

Table I. Building and equipment capital costs for seven housing systems


The most expensive system to capitalise is number 6 at $138 \%$, followed by numbers 5 and 7 , each at $132 \%$. Partially slatted systems 3 and 4 are $116 \%$ and $120 \%$ respectively, with the tractor scraped system on solid floors at I03\%, only slightly more expensive than the bedded court system, used as a baseline.

Capital and equipment costs are only half the story. Running costs are highly significant in systems choice, and these include labour, equipment maintenance and depreciation and fuel. They do not include bedding costs, because these are so variable, depending on location. The cost of bedding can be a highly significant factor in running costs, especially for example, if straw is not available locally for a bedded system.

Running costs, associated with slurry transfer and storage, are cheaper for fully slatted floors than for any other system, at approximately $£ 5$ per cow per year for mixing and pumping. A cheap tractor and mounted scraper costs just less than $£ 30$ per cow per year. Similarly an automatic scraper system costs just less than $£ 30$ per cow per year. The most expensive system to run is the flush floor system with a separator at nearly $£ \mid 30$ per cow per year, excluding water costs. This is significantly higher than the next most expensive system to run, which is an automatic scraper system over a fully slatted floor at over $£ 35$ per cow place.

The cheapest system to capitalise and run over a significant period of time is bedded courts with scraped feed stances, provided bedding costs are not taken into account. This is closely followed by tractor scraping between cubicles to a dung store. Hybrid systems, involving a significant area of slats and solid scraped areas, involve both capital and running costs, to the extent that in the long term, they are not much cheaper than fully slatted systems. The most expensive system to capitalise and run, in the long term, is the flush floor system, with a separator.

## What are the main findings of the study?

The background work for this booklet has been extensive, including visits to over 30 co-operative farmers on dairy units UK wide. It involved discussions with a number of researchers, consultants, and suppliers of equipment, for which the authors are grateful. A brief summary of the main findings is as follows:

- Slurry ponding is widespread: This was found on 23 of the 30 farms visited, ranging from significant areas to localised dished areas needing repair. Poor site levels, poor link levels, inadequate slopes, and a lack of maintenance, are the main causes of slurry ponding.
- Inadequate slopes are a common problem: Many buildings are built too flat, especially those with automatic scrapers installed. Discounting buildings with slats between cubicles, which are expected to be fairly flat, only 8 out of 23 of the remaining buildings assessed meet the minimum lengthwise slope requirement of $1.5 \%$.
- Sloping passes gets rid of ponding: Providing a significant, consistent slope down the length of a building is the easiest and cheapest way to avoid slurry ponding. The slope should be a minimum of $1.5 \%$, but slopes of 2-3\% are more effective, going up to $5 \%$ if this suits site levels. Flush floor units should be $3 \%$ slope. Fully slatted floors must be laid level, or near level to ease cow movement.
- Slurry build-up is a major problem: Slurry deposits at the ends of automatically scraped passes are a widespread problem, particularly at cubicle access passes. The simplest way to deal with this is to scrape slurry out of the building to a pad or external tank, or to locate a collection point right on the inside wall of the gable end, away from cow flow areas.
- Many buildings do not have adequate cow space: Half of the buildings visited do not meet the minimum stated area requirements per cow. This causes problems with slurry build-up, cow flow and access for scraping. Some farmers are overstocking cows to cubicles. This occurred on nearly $20 \%$ of the farms visited. Some are understocking cows to cubicles, especially when space is extremely tight. Those farmers with wide passes are very appreciative of the extra space this gives their cows, with easier slurry management.
- Cubicle bed comfort is generally good but cubicle size can be a problem: The majority of farms visited have a high degree of bed comfort using mattresses, soft mats, or sand. Cubicle width is usually adequate, but many cubicles are not long enough, particularly ones adjacent to an inner wall, requiring significant forward lunging space.
- There is scope for ventilation improvement: 17 out of 30 farms rate only poor to average indicating scope for improvement, invariably due to inadequate outlet area at the building ridge.
- There is scope for apron and cow track improvement: 16 out of 30 farms rate only poor to average on this vital aspect, which is fundamental to cow foot health.
- There is scope for better prewashing and footbathing facilities: Only 3 farms have prewash footbaths, and 18 out of 28 farms rate poor to average for their footbath facilities. Regular, effective foot treatment, including footbathing is a vital component in controlling the levels of digital dermatitis in a dairy herd.
- Routine maintenance is a must, especially for floors: Whilst half the units rate good to excellent for floor maintenance, half rate only poor to average, usually because of potholes, worn out surfacing, or slippery surfaces. A regular inspection and appropriate repair or treatment is recommended. Ignoring maintenance is a false economy in view of the cost of lameness due to poor floors.
- Technology costs money: The most expensive system to capitalise and run is the flush floor system for cubicles. Hybrid systems involving both slurry scraping and slurry containment under slats are also relatively high cost systems to finance, especially if the slatted area extends throughout the feed and cubicle access passes. Fully slatted floored units with cubicles have the highest initial capital cost but are comparatively cheap to run. The lowest capital and running cost systems are bedded courts, or cubicles, with tractor scraped passes, based on straightforward dung handling and storage.
- The farmers visited have a high commitment to getting daily management right: The farmers selected and visited represent 'good practice farmers', hence management scores are generally good, over a wide range of working practices and types of premises. Newer units may be easier to work, and less expensive to maintain, but the selected farmers in less sophisticated premises are attending to the same routine tasks in relation to cow care, with the same discipline and determination.
- There is scope for improvement: Every unit visited, and every dairy unit in the UK, has the potential for some improvement. There are many well-managed enterprises, but no matter how good the dairy unit, there is always some aspect which can be improved, sometimes at very little, or no extra cost.


## How does your dairy unit shape up?

- Do you meet the design and management recommendations?
- Do you have buildings which avoid slurry ponding and allow cows to keep clean and healthy?
- Is your slurry and bedding management regime good enough?
- How much scope is there for improvement?
- How do you compare with other units operating a similar system?


## Assessment forms

To measure your dairy unit against the standards stated, and against other dairy units, fill in the assessment form[s] which best matches your enterprise. The assessments cover the following building systems:

- Bedded courts with tractor scraped feed stances.
- Cubicles with tractor scraped passes.
- Cubicles with flush floor passes.
- Cubicles with automatically scraped passes.
- Cubicles with slatted passes.

An honest appraisal of your buildings and daily routines will assist in identifying areas where there is scope for improvement, as well as confirming aspects which are satisfactory. The appraisal may prompt design, construction and management initiatives which improve cow health, performance and profitability of the enterprise.

## Bedded courts with tractor scraped feed stances

Be totally honest throughout and give yourself a score of one for 'yes', zero for 'no'.
For questions requiring an answer ranging from excellent to poor, give yourself a score three for 'excellent', score two for 'good', score one for 'average' and zero for 'poor'.
This is summarised as: Yes $=1, \quad$ No $=0$, Excellent $=3, \quad$ Good $=2$, Average $=1, \quad$ Poor $=0$.
Three farms scored 47, 39 and 33. Of these total scores, the management scores [in the final section] were 13,12 and 11 respectively. An assessment score of 45 or over is indicative of a good layout and management regime. A new unit, or substantially upgraded premises, should aim for a score of 55 or over, striving towards a maximum possible score of 65.

| Overall layout and environment |  |
| :--- | :--- |
|  | Is this building either - a complete dairy unit erected with significant recent extensions or modifications? |
|  | - an older unit without any significant recent upgrades? |

Yes $=1, \quad$ No $=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$

| Dimensions of bedded courts and feed stances |  |
| :--- | :--- |
| Is the bedded lying area at least 6 sq $m$ per cow? |  |
| Are the feed stances at least 3.5 m wide if there is full access to the bedded area? |  |
| Are the feed stances at least 4 m wide if the bedded area is partly gated off? |  |
| Can all cows readily, quickly and conveniently access the feed stance? |  |
| Can the feed stance be easily shut off from the bedded court? |  |
| Is there sufficient feed face per cow to avoid stress/competition at the feed barrier? |  |
| Are the feed stances sloped at least $1.5 \%$, to help prevent slurry ponding? |  |
| Is slurry prevented from flowing into the bedded area when the pass is scraped? |  |
| Are scraped feed stances non-slip throughout? |  |
| Can a tractor get full and easy access to scrape all feed passes? |  |
| Can cows easily exit the parlour and return, directly to the feed stance? | Total |


| Management of bedded courts and feed stances |  |
| :--- | :--- |
| Is straw stored dry and under cover? |  |
| Does straw usage meet, or exceed, I.5 tonnes per cow over the housing period? |  |
| Are the lying areas bedded at least once a day with fresh straw? |  |
| Are the feed stances scraped out at least twice per day? |  |
| Is there a store close by for fibrous waste materials, such as feed residues? |  |
| Are the bedded courts cleaned out at least every 4 to 6 weeks? |  |
| Is the effectiveness of the scraper blade excellent, good, average or poor? |  |
| Is the reliability of the tractor and scraper excellent, good, average or poor? |  |
| At appraisal time is passage cleanliness excellent, good, average or poor? |  |
| At appraisal time is cow cleanliness excellent, good, average or poor? | Total |

$\square$

## Cubicles with tractor scraped passes

Be totally honest throughout and give yourself a score of one for 'yes', zero for 'no'.
For questions requiring an answer ranging from excellent to poor, give yourself a score three for 'excellent', score two for 'good', score one for 'average' and zero for 'poor'.

This is summarised as: Yes $=1, \quad$ No $=0$, Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$.

Seven farms scored $50,42,42,33,32,32$, and 29. Management scores [in the final section] were consistent, ranging from 10 to 13 , indicating similar levels of commitment to good cow management. The units with lower scores are older premises which are generally tight for space, and not straightforward in layout. The higher scorers are larger, newer units with wide feed passes and good access for scraping. Anyone building or upgrading a tractor scraped dairy unit should be aiming to score over 50, and preferably over 60, heading towards a maximum score goal of 74.

| Overall layout and environment |
| :---: |
| Is this building either - a complete dairy unit erected within the past ten years? |
| - a unit with significant recent extensions or modifications? |
| - an older unit without any significant recent upgrades? |
| Is the overall layout simple, with good straight runs throughout? |
| Is slurry ponding avoided throughout the whole unit? |
| Does the layout allow for easy grouping of cows into required husbandry groups? |
| Does the layout allow for easy observation of all cows from central points? |
| Can all milking cows quickly and easily access the feed area? |
| Do milking cows have access to an additional loafing area? |
| Does each cow have at least 7.5 sq m standing and lying area [2 row cubicle unit]? |
| Does each cow have at least 6.5 sq m standing and lying area [ 3 row cubicle unit]? |
| Is the building volume at least 35 cu m per cow? |
| Can scraped slurry be readily transferred to store without long scraping runs? |
| Is the parlour conveniently sited, close to all milking cows? |
| Is cow flow to and from the parlour straightforward for all milking groups? |
| Is the collecting area straightforward, and large enough to suit cow numbers? |
| Can the collecting area be readily accessed and cleaned down? |
| Can cows be easily and routinely held on a clean standing area after milking? |
| Are cow handling facilities ideally situated? |
| Are there any prewashing facilities before footbathing or treatment? |
| Are footbathing arrangements excellent, good, average or poor? |
| Is building ventilation excellent, good, average or poor? |
| Is natural lighting excellent, good, average or poor? |
| Is water provision excellent, good, average or poor? |
| Is overall building maintenance excellent, good, average or poor? |
| Is floor maintenance, including surface finishes, excellent, good, average or poor? |
| Are all outside aprons and cow tracks excellent, good, average or poor? |
| Total |

Yes = 1, $\quad$ No $=0, \quad$ Excellent $=3, \quad G o o d=2, \quad$ Average $=1, \quad$ Poor $=0$

| Dimensions of cubicles, passes and feed stances |  |
| :--- | :--- |
| Is there at least one cubicle for every milking cow? |  |
| Is there a cross pass, at least every 20 cubicles, to assist cow flow or escape? |  |
| Is there always an alternative escape route for cows without any dead end passes? |  |
| Are all, or the majority of cubicles, at least I.I5m wide? |  |
| Are all, or the majority of outer cubicles against a solid wall, 2.7m long? |  |
| Are all, or the majority of inner cubicles, 2.4 m long? |  |
| Are all, or the majority of double row cubicles, 4.6 m long? | Are all, or the majority of cubicle access passes, at least 3 m wide? |
| Is the cubicle step a maximum of 200 mm from the scraped pass, including matting? |  |
| Do the cubicle beds slope $5 \%$ [I00mm] front to back to prevent urine ponding? |  |
| Overall, is the bed comfort level of the cubicles excellent, good, average or poor? |  |
| Are all tractor scraped passes sloped at least I.5\%, to help prevent slurry ponding? |  |
| Are all, or the majority of feed stance passes, 4 m wide? |  |
| Can the tractor easily access all passes, including cross passes? |  |
| Is there sufficient feed face per cow to avoid the risk of bullying at the feed barrier? | Total |


| Management of cubicles, passes and feed stances |  |
| :--- | :--- |
| Is cubicle bedding stored dry and under cover? |  |
| Are cubicles bedded at least once a day with sawdust, or a similar type of bedding? |  |
| Are cubicles bedded at least once a week with deep sand bedding? |  |
| Is at least 0.5 kg of sawdust, or a similar type of bedding used, per cow per day? |  |
| Is at least 3 kg of dry sand bedding used, per cow per day? |  |
| Are dung pats cleaned off cubicle beds at least twice a day? |  |
| Are all cross passes cleaned down at least twice a day? | Are all cubicle and feed stance passes, tractor scraped at least twice per day? |
| Is there a store close by for feed and bedding residues, to encourage tidiness? |  |
| Is the effectiveness of the scraper blade excellent, good, average or poor? |  |
| Is the reliability of the tractor and scraper excellent, good, average or poor? |  |
| At the time of the visit, was passage cleanliness excellent, good, average or poor? |  |
| At the time of the visit, was cow cleanliness excellent, good, average or poor? | Total |

$\square$

## Cubicles with flush floor passes

Be totally honest throughout and give yourself a score of one for 'yes', zero for 'no'.
For questions requiring an answer ranging from excellent to poor, give yourself a score three for 'excellent', score two for 'good', score one for 'average' and zero for 'poor'.

This is summarised as:Yes $=1, \quad$ No $=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$.

Two dairy units scored 57 and 44 respectively, with a management score of 15 for the former and 9 for the latter. The higher scoring farm is a new purpose-built unit, and the lower score relates to a refurbished building, sited within an existing complex. A new flush floor, or substantially upgraded unit, should aim to attain a score of 60 , striving towards a maximum score of 69 .

| Overall layout and environment |  |
| :---: | :---: |
| Is this building either - a complete dairy unit erected within the past ten years? |  |
|  | - a unit with significant recent extensions or modifications? |
|  | - an older unit without any significant recent upgrades? |
| Is the overall layout simple, with good straight runs throughout? |  |
| Is slurry ponding avoided throughout the whole unit? |  |
| Does the layout allow for easy grouping of cows into required husbandry groups? |  |
| Does the layout allow for easy observation of all cows from central points? |  |
| Can all milking cows quickly and easily access the feed area? |  |
| Do milking cows have access to an additional loafing area? |  |
| Does each cow have at least 7.5 sq m standing and lying area [2 row cubicle unit]? |  |
| Does each cow have at least 6.5 sq m standing and lying area [3 row cubicle unit]? |  |
| Is the building volume at least 35 cu m per cow? |  |
| Are flush wash collection arrangements within the building excellent? |  |
| Is the parlour conveniently sited, close to all milking cows? |  |
| Is cow flow to and from the parlour straightforward for all milking groups? |  |
| Is the collecting area straightforward, and large enough to suit cow numbers? |  |
| Can the collecting area be readily accessed and cleaned down? |  |
| Can cows be easily and routinely held on a clean standing area after milking? |  |
| Are cow handling facilities ideally situated? |  |
| Are there any prewashing facilities before footbathing or treatment? |  |
| Are footbathing arrangements excellent, good, average or poor? |  |
| Is building ventilation excellent, good, average or poor? |  |
| Is natural lighting excellent, good, average or poor? |  |
| Is water provision excellent, good, average or poor? |  |
| Is overall building maintenance excellent, good, average or poor? |  |
| Is floor maintenance, including surface finishes, excellent, good, average or poor? |  |
| Are all outside aprons and cow tracks excellent, good, average or poor? |  |
|  | Total |

Yes =1, $\quad$ No $=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$

| Dimensions of cubicles, passes and feed stances |  |
| :--- | :--- |
| Is there at least one cubicle for every milking cow? |  |
| Is there a cross pass, at least every 20 cubicles, to assist cow flow or escape? |  |
| Is there always an alternative escape route for cows without any dead end passes? |  |
| Are all, or the majority of cubicles, at least I.I5m wide? |  |
| Are all, or the majority of outer cubicles against a solid wall, 2.7m long? |  |
| Are all, or the majority of inner cubicles, 2.4m long? | Are all, or the majority of double row cubicles, 4.6 m long? |
| Are all, or the majority of cubicle access passes, at least 3 m wide? |  |
| Is the cubicle step at least 200 mm high, excluding matting? | Do the cubicle beds slope $5 \%$ [I00mm] front to back to prevent urine ponding? |
| Overall, is the bed comfort level of the cubicles excellent, good, average or poor? |  |
| Are all passes sloped at least $3 \%$, for maximum flushing effect? |  |
| Are all inlet valves well located, for effective wash down of all aprons and passes? |  |
| Are all, or the majority of feed stance passes, at least 4 m wide? |  |
| Can the tractor easily access all passes, if the flush wash fails? |  |
| Is there sufficient feed face per cow to avoid the risk of bullying at the feed barrier? |  |


| Management of cubicles, passes and feed stances |  |
| :--- | :--- |
| Is cubicle bedding stored dry and under cover? |  |
| Are cubicles bedded at least once a day with sawdust, or a similar type of bedding? |  |
| Are cubicles bedded at least once a week with deep sand bedding? |  |
| Is at least 0.5 kg of sawdust, or a similar type of bedding used, per cow per day? |  |
| Is at least 3 kg of dry sand bedding used, per cow per day? |  |
| Are dung pats cleaned off cubicle beds at least twice a day? |  |
| Are all cross passes cleaned down at least twice a day? |  |
| Is there a store close by for solid fibrous waste, such as feed or bedding residues? |  |
| Are all cubicle and feed stance passes, flush washed at least three times a day? | Is the flush water changed on a regular basis, at least every month? |
| Is the reliability of the total system excellent, good, average or poor? | At appraisal time is passage cleanliness excellent, good, average or poor? |
| At appraisal time is cow cleanliness excellent, good, average or poor? | Total |

Grand Total $\square$

## Cubicles with automatically scraped passes

Be totally honest throughout and give yourself a score of one for 'yes', zero for 'no'. For questions requiring an answer ranging from excellent to poor, give yourself a score three for 'excellent', score two for 'good', score one for 'average' and zero for 'poor'.
This is summarised as: Yes $=1, \quad$ No $=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$.

Eleven farms scored $52,51,47,47,46,45,43,42,33,32$, and 29 . Management scores [in the final section] were reasonably consistent ranging from 14 to 11 , averaging 13 . This shows a high standard of commitment by farmers to cow care, across a range of buildings, from old to new. The higher scoring farms have new buildings, or are substantially improved existing premises, with wide feed and cubicle access passes. A substantially upgraded dairy unit should aim to exceed 55 as a target score. A new dairy unit should aim to exceed 60 as an assessment goal, striving towards a maximum score of 76 .
$\left.\begin{array}{|l|l|}\hline \text { Overall layout and environment } & \\ \hline & \text { Is this building either - a complete dairy unit erected within the past ten years? } \\ & \text { - an older unit without any significant recent upgrades? }\end{array}\right]$.

Yes $=1, \quad$ No $=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$

| Dimensions of cubicles, passes and feed stances |  |
| :--- | :--- |
| Is there at least one cubicle for every milking cow? |  |
| Is there a cross pass, at least every 20 cubicles, to assist cow flow or escape? |  |
| Is there always an alternative escape route for cows without any dead end passes? |  |
| Are all, or the majority of cubicles, at least I.I 5 m wide? |  |
| Are all, or the majority of outer cubicles against a solid wall, 2.7m long? |  |
| Are all, or the majority of inner cubicles, 2.4 m long? | Are all, or the majority of double row cubicles, 4.6m long? |
| Are all, or the majority of cubicle access passes, at least 3 m wide? |  |
| Is the cubicle step a maximum of 200 mm from the scraped pass, including matting? |  |
| Do the cubicle beds slope $5 \%$ [I00mm] front to back to prevent urine ponding? |  |
| Overall, is the bed comfort level of the cubicles excellent, good, average or poor? |  |
| Are all auto-scraped passes sloped at least I.5\%, to help prevent slurry ponding? |  |
| Do the auto-scrapers take slurry right to the outer walls, or beyond? |  |
| Is there a store close by for fibrous solid waste, such as solid deposits, feed waste? |  |
| Is there a slatted cross pass every 24 m or less to prevent a large slurry tide forming? |  |
| Are there lengthways slots or channels to drain the liquids off scraped slurry? |  |
| Are all, or the majority of feed stance passes, $4 m$ wide? | Is there sufficient feed face per cow to avoid the risk of bullying at the feed barrier? |


| Management of cubicles, passes and feed stances |  |
| :--- | :--- |
| Is cubicle bedding stored dry and under cover? |  |
| Are cubicles bedded at least once a day with sawdust, or a similar type of bedding? |  |
| Are cubicles bedded at least once a week with deep sand bedding? |  |
| Is at least 0.5 kg of sawdust, or a similar type of bedding used, per cow per day? |  |
| Is at least 3 kg of dry sand bedding used, per cow per day? |  |
| Are dung pats cleaned off cubicle beds at least twice a day? |  |
| Are all cross passes cleaned down at least twice a day? | Are all cubicle and feed stance passes, auto-scraped every 2 hours? |
| Is routine maintenance/servicing of the auto-scrapers carried out each month? |  |
| Is the effectiveness of the auto-scrapers excellent, good, average or poor? | Is the reliability of the auto-scrapers excellent, good, average or poor? |
| At appraisal time is passage cleanliness excellent, good, average or poor? |  |
| At appraisal time is cow cleanliness excellent, good, average or poor? | Total |

Grand Total $\square$

## Cubicles with slatted passes

Be totally honest throughout and give yourself a score of one for 'yes', zero for 'no'.
For questions requiring an answer ranging from excellent to poor, give yourself a score three for 'excellent', score two for 'good', score one for 'average' and zero for 'poor'.
This is summarised as: Yes $=1, \quad \mathrm{No}=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$.

Seven farms scored $56,51,38,37,34,34$, and 33 . The two highest scoring units are relatively large, recently built, purpose-designed buildings, which are generous in cow space, with good cow flows. The other units are older buildings, or upgrades of existing buildings, which are generally tight for space. Some have poor cow flow arrangements, and restrictive access for feeding and bedding. Despite a large variation in total scores, management, passage and cow cleanliness scores are very similar, indicating a high commitment to this aspect.
Anyone upgrading an older unit should aim to score at least 45. A new unit should aim to score at least 60 , from a possible total of 68 points.

| Overall layout and environment |
| :---: |
| Is this building either - a complete dairy unit erected within the past ten years? |
| - a unit with significant recent extensions or modifications? |
| - an older unit without any significant recent upgrades? |
| Is the overall layout simple, with good straight runs throughout? |
| Is slurry ponding avoided throughout the whole unit? |
| Does the layout allow for easy grouping of cows into required husbandry groups? |
| Does the layout allow for easy observation of all cows from central points? |
| Can all milking cows quickly and easily access the feed area? |
| Do milking cows have access to an additional loafing area? |
| Does each cow have at least 7.5 sq m standing and lying area [2 row cubicle unit]? |
| Does each cow have at least 6.5 sq m standing and lying area [ 3 row cubicle unit]? |
| Is the building volume at least $35 \mathrm{cu} \mathrm{m} \mathrm{per} \mathrm{cow?}$ |
| Is the parlour conveniently sited, close to all milking cows? |
| Is cow flow to and from the parlour straightforward for all milking groups? |
| Is the collecting area straightforward, and large enough to suit cow numbers? |
| Can the collecting area be readily accessed and cleaned down? |
| Can cows be easily and routinely held on a clean standing area after milking? |
| Are cow handling facilities ideally situated? |
| Are there any prewashing facilities before footbathing or treatment? |
| Are footbathing arrangements excellent, good, average or poor? |
| Is building ventilation excellent, good, average or poor? |
| Is natural lighting excellent, good, average or poor? |
| Is water provision excellent, good, average or poor? |
| Is overall building maintenance excellent, good, average or poor? |
| Is floor maintenance, including surface finishes, excellent, good, average or poor? |
| Are all outside aprons and cow tracks excellent, good, average or poor? |
| Total |

Yes =1, $\quad$ No $=0, \quad$ Excellent $=3, \quad$ Good $=2, \quad$ Average $=1, \quad$ Poor $=0$

| Dimensions of cubicles, slatted passes and feed stances |  |
| :--- | :--- |
| Is there at least one cubicle for every milking cow? |  |
| Is there a cross pass, at least every 20 cubicles, to assist cow flow or escape? |  |
| Is there always an alternative escape route for cows without any dead end passes? |  |
| Are all, or the majority of cubicles, at least I. I 5 m wide? |  |
| Are all, or the majority of outer cubicles against a solid wall, 2.7m long? |  |
| Are all, or the majority of inner cubicles, 2.4 m long? | Are all, or the majority of double row cubicles, 4.6 m long? |
| Are all, or the majority of cubicle access passes, at least 3m wide? | Is the cubicle step a maximum of I50mm from the scraped pass, including matting? |
| Do the cubicle beds slope $5 \%$ [I00mm] front to back to prevent urine ponding? |  |
| Overall, is the bed comfort level of the cubicles excellent, good, average or poor? |  |
| Are all slatted floors set level, or near level to, ease cow walking? |  |
| Are all panels laid to avoid any level changes between adjacent panels or slats? |  |
| Are all slats in good condition without any cracked or broken edges? | Is 40 mm the maximum gap size between slats? |
| Are all, or the majority of feed stance passes, 4m wide? |  |
| Is there sufficient feed face per cow to avoid the risk of bullying at the feed barrier? | Total |


| Management of cubicles, slatted passes and feed stances |  |
| :--- | :--- |
| Is cubicle bedding stored dry and under cover? |  |
| Are cubicles bedded at least once a day with sawdust, or a similar type of bedding? |  |
| Is at least 0.5 kg of sawdust, or a similar type of bedding used, per cow per day? |  |
| Are dung pats cleaned off cubicle beds at least twice a day? |  |
| Is cubicle spillage hand scraped daily, away from the step up for tramping through? |  |
| Are all cross passes cleaned down at least twice a day? |  |
| Are all slatted passes automatically or tractor scraped on a daily basis? |  |
| Is there a store close by for feed and bedding residues, to encourage tidiness? |  |
| At appraisal time is passage cleanliness excellent, good, average or poor? |  |
| At appraisal time is cow cleanliness excellent, good, average or poor? $\quad$ Total |  |

$\square$

## Glossary

Access pass: a gap to enable a stock person to readily enter or exit livestock areas.
Automatic scrapers: scraper blades on a time switch, moved by hydraulic bars, chains or ropes.
Bedded Court: a straw yard for loose housing cattle.
Concrete apron: the outside area at the end of a building which permits access and turning on a solid base.
Coronary band: the area at the top of the hoof where the hoof wall is formed.
Cross scrapers: automatic scrapers, running across the building, which gather slurry from scrapers running down the length of a building.
Cubic capacity: the amount of air within a building.
Cubicle access pass: the passage running between rows of cubicles allowing cows access to the cubicles
Cubicle cross pass: a link pass between the feed stance and the cubicle access pass.
Cubicle step: the step up to the cubicle from the cubicle access pass.
Double row of cubicles: cubicles which are 'head-to-head,' with a shared lunging space for the cows.
Feed face: the space for an animal to feed at the feed barrier.
Feed stance: the dairy cow standing area adjacent to the feed barrier.
Feeding platform: a raised feed stance on which a cow can stand with front and back feet.
Feeding step: a raised plinth in the feed stance, for the front feet of feeding cows.
Flush floors: passes and stances cleaned periodically by flushed water.
Gable wall: the wall at the end of a building, normally with doors, or gates, to access the feed stance and cubicle access passes.

Lux: a measurement of the intensity of light within a building.
Prefabricated drained floors: factory made floor panels, with drainage provision, laid on site.
Winged scraper blades: automatic scraper blades shaped like a ' $v$ ' which concentrate the slurry collection at the central juncture of the blades.

Notes

Notes

Slurry Management Techniques to Reduce Pooling in Dairy Cattle Housing, published September 2005. Based on the findings of a project team led by Dr Mike Kelly, Livestock Building Design Consultant, supported by Dave Howat, Waste Management Specialist, David Webster, retired Farm Manager and SAC Veterinary Staff.

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[^0]:    This advisory package of information for dairy farmers deals primarily with combating slurry pooling in dairy cow housing. Dirty floors, ponded areas of urine, mounds of slurry and slurry tides are all detrimental to cow health. These factors all contribute to foot problems, especially digital

