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Deep-litter housing for pigs

Ian Kruger
Environmental Engineer
Graeme Taylor and Greg Roese
Livestock Officers Pigs
Intensive Industries Development, Tamworth
Hugh Payne
Senior Technical Officer
Department of Agriculture Western Australia

This Primefact reviews deep-litter housing (DLH), a key technology that has continued to gain momentum in the pork industry.

New batch of weaners on straw

Introduction

Since the mid 1990s, pig production in Australia has been moving towards multi-site production, 'all-in, all-out' management with split-sex and phase feeding systems.

The use of DLH to adopt these systems and in expansion programs has allowed the capital cost of construction to be cut by more than one-half. Shed costs vary considerably but weaner sheds are in the order of $50 to $60 per pig place, grower–finisher sheds at $100 to $120 per pig place and dry sows up to $250 per sow place.

Labour costs may be 20% to 30% higher in DLH systems because bedding needs to be added and spent litter needs to be removed.

Adequate replacement straw should always be available

Benefits of deep-litter housing (DLH)

- Capital costs are reduced by 60% to 70%.
- Construction costs are lower through the use of large group pen kit shelters or converted skillion-style hay sheds.
- DLH caters for increased herd size. The cost of production may be lower than for conventional systems, depending on bedding and feed costs. (The feed conversion ratio (FCR) may be 5% to10% worse than for conventional systems.)
- Animal health is improved through the use of 'all in, all out' (AIAO) management.
- Improved performance results from a higher health status and increased feed intakes.
- Management strategies such as split-sex feeding and phase feeding can be used with DLH systems.
- Automated sort capability.
- DLH is acceptable from an animal welfare perspective.
- There is little or no liquid effluent, and odour is reduced provided adequate litter is used for each batch.
- Used litter is suitable for composting, with the potential to be used as fertiliser or for sale off-farm.

Table 1. Deep-litter housing checklist for building features

Building feature	Check (✓)	Building feature	Check (✓)
Site		**Spray cooling**	
Elevated site with free-draining soils		Automatic control, fine sprays preferable	
Flood-free		Adjust to cool pigs without overwetting litter	
All-weather vehicle access		**Space allowance**	
Drainage away from sheds		Weaners to 10 weeks/35 kg = 0.55 m^2/pig	
No barriers to natural ventilation		Growers to 20 weeks = 1 m^2/pig	
Adequate sealed storage area for used litter		Finishers to 24 weeks/110 kg = 1.15 m^2/pig	
Earthworks completed prior to construction		Dry sows (bedded area) = 2.5–3.5 m^2/pig	
Building orientation		**Bedding material**	
Long axis, east–west where possible		Barley straw preferable	
Building construction		Wheat, oat and triticale straw	
Coverings with 95% to 98% UV protection		Maize stalks, canola residues	
Shade may be necessary at shed ends		Sawdust	
Slope mono-pitch roofs north to south		Rice hulls	
Provide 1 to 1.2 metre wide eaves on north side		**Bedding quantity (guide only)**	
Galvanised frame		Supply sufficient for thermal comfort	
Sidewall blinds and shutters		Barley straw – weaners = 0.3–0.4 kg/pig/day	
Endwall: louvres, blinds or fixed		Barley straw – growers/finishers = 0.6–0.8 kg/pig/day	
Shed supplied in kit or components		Barley straw – dry sows = 1.8 kg/pig/day	
Material transport costs		Wheat straw – growers/finishers = 0.8 kg/pig/day	
Separation distance		Oat straw – growers/finishers = 0.6 kg/pig/day	
Shed spacing end to end, side to side = 5 x height		Maize stalks – growers/finishers = 0.8 kg/pig/day	
Vehicle access for stock loading and cleaning		Hrdwd sawdust – growers/finishers = 1.2 kg/pig/day	
Pad and floor		Pine sawdust – growers/finishers = 0.7 kg/pig/day	
Elevate pad 100 to 300 mm		Pine shavings – growers/finishers = 0.9 kg/pig/day	
Compacted earth floor (impervious)		**Bedding management**	
Concrete floor (preferable)		Aim for 40% floor to be clean and dry	
Feeders		Add and spread bedding as required	
Automatic feed delivery preferable		**Shed management**	
Large range, e.g. tunnel, conventional etc.		‘All in, all out’ with pig age range within 1 week	
Wet/dry feeders		**Health**	
Drinkers		Daily inspection of pigs	
Bowl, cup, pan preferred (avoid spillage)		Separate sick pigs	
Proved 3.0 to 3.5 L/kg feed intake		**Market**	
Water medication		Aim for minimal weight variation between pigs	
Proportioners / header tanks		Sort pigs to achieve max. prime grade	

Savings can be made by running large groups and by using automatic sorter systems. Sorters also increase the number of pigs marketed in the prime weight range.

Construction sites

Table 1 highlights many of the aspects for consideration when planning and building a deep litter housing system.

Locate buildings with consideration to soil type, drainage, wind and temperature. Construction of shed bases and drainage around sheds are of paramount importance.

Construction of shed bases

Shed bases include uncompacted earthen floors, compacted earthen/aggregate floors and concrete floors.

Uncompacted earthen floors are no longer permitted by regulatory authorities in NSW.

Raised, compacted earthen floors are the minimum requirement for deep litter systems. The maximum permeability required is 1×0^{-9}m/s, which is equivalent to 0.1 mm/day seepage. For earth pad construction, refer to the Queensland Department of Primary Industries & Fisheries (QDPI&F) Note titled *Earth pad preparation requirements for deep litter pig production systems and solid waste stockpile and composting areas*, which is available on their website at: *http://www.dpi.qld.gov.au*.

After years of use, compacted earth floors may break down and require ongoing maintenance due to constant wetting and removal of earth with litter.

Concrete floors are the best option for guaranteeing no seepage, minimising maintenance requirements and easier litter removal. Sheds can be easily disinfected between batches, which is an important hygiene consideration. Also, concrete will eliminate the potential for the leaching of nutrients and pathogens into the soil profile beneath the sheds and into groundwater.

Controlled drainage around sheds

Raised shed bases prevent overland water running into the sheds. This also minimises the potential for nutrients and pathogens to run off to surface water (creeks, rivers, dams) and then leaching to groundwater.

Contain all run-offs from shed roofs and surrounding areas into a controlled drainage area. This includes run-off from shed leachate, spent litter and manure storage areas and carcass-composting areas. The aim is to prevent contaminated water from escaping to surrounding land, streams, freshwater dams, neighbouring properties and native vegetation areas. Bunding (earth diversion banks) can be built around the facility and a catch dam built to collect contaminated water for reuse if necessary.

Avoid any ponding of contaminated water around sheds and facilities to prevent saturation areas which could leach contaminants to groundwater.

Other considerations

When locating a new facility, consider access to water and power supplies. Also, it is important to have all-weather access for feed and stock trucks.

Depending on local wind and climate characteristics, shelters are normally oriented lengthwise along an east–west axis. Side and end blinds are used to maximise ventilation during hot periods.

Construction of sheds will normally require approval from the local council. Depending on the proposed size, a development application or environmental impact assessment may be required. Further information can be found on the Australian Pork Limited (APL) website www.australianpork.com.au/ and click on 'Issues Watch' for environmental requirements.

Internal shed fittings

Design internal fittings for deep litter housing systems to minimise production costs and to keep shelters as clean and dry as possible. Feeders and drinkers are commonly mounted on a raised concrete pad running the length or width of the shed. This assists with keeping the feeding area clean and it reduces litter requirements.

Feeders consist generally of wet and dry competition feeders which feed up to 35 pigs per feeder, or multiple-space dry feeders with drinkers nearby. These are designed to feed large groups of pigs while minimising feed wastage.

Install drinkers that minimise water wastage and spillage. Bowl-type drinkers are commonly used.

Adjustable height drinkers may be required if pigs are kept in shelters for several growth phases.

In many areas **spray cooling** will be required to optimise summer growth. Generally, if conventional sheds require spray cooling, it will also be necessary for deep-litter housing. Pigs in hot weather conditions where there is no spray cooling provided, will often create wallows under drinkers or dung on feed pads. Spray cooling above rest areas provides cooling and will minimise undesirable dunging patterns. However, it is important to manage the timing of spray cooling in order to avoid wet litter.

Shelters located away from mains power have successfully used solar-powered 12 volt systems to produce enough electricity to run a water pump for spray cooling.

Growers on straw

Supplementary heating in shelters is not usually required as the litter maintains a favourable temperature range. For newly weaned pigs, straw bales can be stacked to form protected creep areas within shelters. After several weeks, the bales can be spread out as extra bedding.

Some producers provide hinged kennel roofs that can be raised when not required.

Auto-weighers or sorters can be equipped with automatic spray markers. Pigs that are underweight can be identified for retention until the next market load.

A continuous sort (see Fig. 6 on page 9) occurs on an ongoing basis and allows sorting of pigs for market, health or different feeding regimens.

Stocking rate and movement

See Table 1 for space allowance requirements for each class of stock.

When moving stock, use boards, inflated rollers, curtains and backing fences to help minimise stress in pigs. Also, for safety it is important to have two staff on hand when moving large numbers of stock.

Weaners, growers and finishers

Many producers report improved weaner performance when pigs are grown on deep litter compared with conventional housing. The main benefit is the disease break achieved by using an 'all in, all out' management system. Improvements in weaner health increase growth rates and improve feed conversion. Litter also provides an ideal insulating material for warmth, which helps minimise post-weaning growth depression.

Weaners are often introduced to deep litter systems at an entry point closest to the feeders. This will reduce the time taken for their first feed in their new accommodation.

Weaners can be moved into shelters at 3–4 weeks of age and can remain for 4–6 weeks before returning to conventional housing. Alternatively, weaners can be moved into shelters and remain until they have reached market weight.

Swing drinkers increase the likelihood of wet patches.

Bowl drinkers minimise spillage.

Drinking trough for dry sows

When growers remain in deep-litter systems until they are ready to be sent to market, variation in weights and backfat thickness will have to be managed carefully. For more information on market weight variability refer to the Primefact 65 *Market weight variation in the pork industry* (see www.agric.nsw.gov.au/reader/pigs).

If growers are moved back into conventional housing at about 60 kg, greater control can be gained over feed intakes, and gilt selection can be easily managed. However, moving pigs back into sheds increases labour requirements and some benefits of 'all in, all out' management systems are lost.

Deep litter shed cleaned out and limed prior to next batch

Weaners on sawdust

Weaners on straw with kennels

Dry sows

It would be unwise for Australian pig producers to invest in new sow accommodation without considering the possible effects of future legislation. Refer to the Australian Pork website at www.australianpork.com.au/ and click on 'Issues watch' for more information on animal health and welfare.

Housing sows on deep litter has become a viable alternative to conventional systems based on stalls. Deep-litter systems are welfare-friendly and construction and maintenance are cheaper than for conventional systems.

The advantages of litter-based shelters for groups of sows include:

- less aggression between sows;
- reduced leg problems and stillbirths;
- the benefits of batch farrowing, if required.

Group housing sows and gilts during gestation reduces or eliminates adverse behaviour often associated with sow stalls. However, there may be

Dry sows on rice hulls

Dry sows on straw

an increase in aggression among recently grouped unfamiliar gilts and sows.

Litter size and farrowing rate are lower when sows are mixed during the first week after mating compared to 28 days after mating. This is due to higher levels of aggression when first introduced to the group. Suggestions to reduce the likelihood of aggression include the following:

- Provide escape areas.
- Group after dark.
- Provide ad lib feed during grouping period.

Sows housed in groups should be fed in a way that minimises competition for feed while managing individual sow feeding requirements. Methods include the use of floor, stall and electronic feeders and self-feeders.

An area of 2.5 m^2/sow is suggested if individual stalls are provided and up to 3.5 m^2/sow if floor feeding is practised.

A shed divided into two groups with a stalled feeding area in the middle (Fig. 5 on page 9) has several advantages. Sows have equal access to food, they can be more easily identified and overall sow management is improved. As only half the sows are being fed at any one time, the concrete feeding area and numbers of feed stalls are halved. Sows quickly learn the daily routine and wait their turn to be fed.

The estimated amount of bedding material required for gestation sows housed in a group varies from about 270 kg/sow to 760 kg/sow. The wide range is due to differences in absorbency of

the products used and the different climatic conditions. Barley is often the preferred option due to its high absorbency and is included at a rate of 360–540 kg/sow.

Health and welfare

Daily health checks in deep-litter systems are essential. When checking sheds, move down the shed in a zig-zag pattern ensuring that all pigs move around. Also check that all feeders and drinkers are operational.

Providing adequate space and feeding points will minimise injury, regardless of group size. This is advantageous because productivity is directly related to animal wellbeing.

Refer to the Australian Pork Limited website at *www.australianpork.com.au* and click on 'Issues Watch' for more information on animal health and welfare.

Contract growing

Contract growing pigs offers the benefits of a regular cash flow, without investing heavily in housing or breeding sows. The supplier retains ownership of the pigs. Typically, contractors are paid a fixed rate per pig sold for their labour and management. Bonuses or penalties are applied for feed efficiency and carcase quality. Before entering into a contract it is recommended that you seek legal advice.

Deep litter contract costs are in the range 75c to 80c/pig/week. If litter is not provided at recommended rates, it can result in an increase in shed wet areas, reduced growth rates and increasing health and welfare problems.

Contractors can aim to recover establishment or capital costs in less than 3 years. The construction cost for deep-litter systems is about $120 per pig place, which equates to about 77c/pig/week to cover capital costs.

Litter costs vary considerably. In northern NSW sawdust can be purchased for $25 to $30 per tonne. In most of NSW, cereal straw can be purchased for $80 to $100 per tonne, and in southern NSW rice hulls cost about $35 per tonne.

At the recommended litter rate of about 5 kg/pig/week, litter costs may vary from 15c to 40c/pig/week.

Contract growers operating under a set contract rate will generally not add more litter to achieve better performance for the breeder. Purchasing the extra litter will reduce the contractor's personal income or viability. Also, in drought years there has been an attempt by contractors to use less litter because of higher costs. They maintain their profitability at the expense of pig performance for the breeder.

It is advisable to include litter quantities and the cost in the contractual arrangement with the breeder or supplier.

Litter use

Cheap litter is an essential requirement for successful and profitable management of deep-litter housing systems. Baled cereal stubble is most commonly used but rice hulls and sawdust have also been successful. The amount of straw used varies depending on climate, pig age, penning arrangement, type of litter and other management factors. The quantity can range from 0.3 kg/pig/day to 1.8 kg/pig/day (Table 1).

Large bales are easily moved with a tractor and bale handler. Spent straw is normally cleaned out of shelters using a front-end loader or bobcat.

If rice hulls are used the total volume required for the life of a batch of pigs can be added at the start of the batch. Also, rice hulls are easily worked over by the pigs, resulting in good aeration. Straw, however, generally forms layers and requires topping up on a regular basis. Hence labour costs when using straw can be higher than when using rice hulls.

A guide for bedding requirements is about 50 kg/grower and 15 kg/weaner/batch. All manure and urine is absorbed into the bedding during the batch.

DLH has the added advantage that about 200 kg of wet litter is produced per pig during the growing and finishing phase of production. Spent litter has a high fertiliser value.

Addition of litter to sheds

Well-managed deep-litter sheds emit about half the odour of conventional sheds that have a flushing system. Therefore, deep-litter systems can have reduced odour-separation distances to neighbours. However, odour emissions will greatly increase if litter is allowed to get too wet and decompose anaerobically. This can result in an increase in pig health problems, poor growth rates and reduced overall welfare.

It is important to use fresh litter for each batch of pigs to minimise any health risk and to add sufficient bedding to sheds at the start of a batch in order to absorb manure, spilt feed and water. The pigs' lying areas should be kept dry and any defined dunging areas should be prevented from becoming too wet. Regular addition of fresh litter, particularly towards the end of the batch cycle, may be needed to avoid excessive moisture-related problems. Forty per cent of the shed floor area should be maintained as dry lying area for pigs until the end of the batch.

Shed litter quality can be gauged by the level of visible moisture. There should be no free moisture visible in the litter and no puddles, pools or

wallows. Also, there should be few excessively dirty or wet pigs.

Problems are often worse in winter when less evaporation occurs from the litter. These are exaggerated when floor space per pig is compromised. Producers often design sheds that have inadequate floor space to cater for required pig market weights. Producers also often add too many pigs due to variations in production flow.

Skimping on bedding may cost more in the long term through lost production efficiency. Poor management will cause production, health and welfare concerns.

In the future, more producers will purchase or develop machinery to blow litter into shed wet areas.

Storage and treatment of spent litter and composted carcass

Construct storage and treatment areas to prevent ingress of overland run-off and the escape of manure in the run-off. This can be achieved by constructing raised pads or an earth wall bunding and containment, preferably in the controlled drainage area. These areas need to have a compacted base to prevent seepage of manure leachate through the soil to groundwater (less than 0.1 mm/day).

Contain all spent manure, litter, litter composting and carcass composting in sealed and bunded areas to prevent pollutant escape. This will avoid run-off of nutrients and pathogens to surface water (creeks, rivers, dams) and leaching to groundwater.

Composting spent litter will minimise odour problems.

Sustainable spreading and reuse of spent litter

Spreading spent litter can cause an odour nuisance to neighbours. There is also the potential for nutrient and pathogen pollution of soils, surface water and groundwater from unsustainable, that is, high application rates and from spreading near waterways.

Do not spread spent litter close to neighbours and only spread it when the wind is blowing away from them. Do not spread spent litter within 20 m of any intermittent watercourses and not within 50 m of major streams or rivers. A grassed buffer strip between cropping areas and waterways will protect them from manure and nutrient run-off. Spreading manure and litter on cut-and-cart crops (grains or hay) removes eight to ten times more of the applied nutrients compared with a grazed pasture.

Spreading manure and litter at more than 5–8 t/ha every year or 15–25 t/ha every 3 years is likely to overload soils with nutrients. This will also increase the possibility of pollution of surface or groundwater in wet seasons. A guide to equivalent fertiliser rates for used litter is as follows:
30% of nitrogen in 15 t/ha is available in the first year, which equates to 100 kg of urea.

For environmentally friendly deep-litter systems:

- Keep litter and manure as dry as possible so it doesn't cause odour or pig problems.
- Seal bases of sheds and storage areas so they don't seep or leach pollutants.
- Bund and drain all facilities so run-off or leakage won't carry pollutants away.
- Measure and calculate manure/litter quantities and application rates and grow cut-and-cart crops to sustainably and economically use it.

To prove sustainable reuse, it is necessary to keep records of:

- quantity of manure and litter spread each year;
- laboratory nutrient analyses or good nutrient estimates of the litter nutrients to be spread;
- estimated quantity of nutrient to be spread or sold each year from the system;
- crops to be grown and nutrient uptake in the crop;
- land area estimates based on the majority of spread nitrogen and phosphorus, allowing for nitrogen volatilisation losses during spreading and allowable phosphorus sorption in the soil type used.

Table 2 shows a theoretical estimate of nutrients available in spent litter and manure from 1000 grower pigs (1000 SPU) on barley straw deep litter. This is calculated from QDPI&F Piggery Assessment Spreadsheet, Version 10C, June 2004.

If this is applied to a cereal crop yielding 4 t/ha, which removes 80 kg N/ha and 12 kg P/ha, then approximately 100 ha of crop needs to be grown annually to remove the above nutrients in the harvested grain. The spreading rate will be 576 tonnes divided by 100.

Spread manure and litter as evenly as possible at the calibrated rate suited to the specific crop and expected yield.

Dropping manure heaps on small areas of ground and spreading them with a tractor blade to coat the ground with a thick layer of manure is an unsustainable practice. This will apply nutrients at vastly greater rates than crop requirements, in fact more than a hundredfold. There is enormous potential to pollute surface water in run-off, and groundwater through leaching of nutrients.

Table 2. Mass balance for 1000 grower pig deep-litter system.

Nutrients (kg/year)				
Activity	**Total solids**	**Nitrogen**	**Phosphorus**	**Potassium**
Bedding added (DM)	266,500	2,000	200	6,900
Manure added (DM)	110,000	9,000	3,000	2,500
Shed losses (DM)	56,500	1,100	0	0
Out of shed (DM)	320,000	9,900	3,200	9,400
Stockpile losses (DM)	32,000	1,000	0	0
Land applied (DM)	288,000	8,900	3,200	9,400
Land applied (wet)[1]	576,000			
Land applied wet solid %		1.6%	0.6%	1.6%
Equiv. fertiliser value		$8,400[2]	$10,600[2]	$8,600[2]
Total fertiliser value		$27,600[2]		

Notes: [1] Wet solids @ 50% moisture content.

[2] Fertiliser values used: urea $430/t; superphosphate $290/t; muruiate of potash $460/t.

Some producers compost spent litter to eliminate weed seed contamination and to provide an improved fertiliser product for off-farm sale.

Agronomic value of deep litter

Pig shed deep litter is best applied to high value crops such as canola. It would also be valuable to spread litter on cereal and legume crops.

Spent litter is a valuable resource at $27,600 per 1000 SPU per year (see Table 2).

If in doubt about the suitability of spreading spent litter on any specific crop, obtain a nutrient analysis of the litter and consult an agronomist prior to application.

Concluding comments

Although deep-litter housing has been widely adopted, the recent drought caused the price of straw and feed to increase significantly. The high cost of feed in association with higher feed conversion ratios experienced in shelters has increased the cost of production in shelters, making them less attractive. Additionally, some of the early shelters were built with inexpensive materials and these now require considerable maintenance. The logistics of handling large quantities of straw and manure has also caused some producers to question the long-term viability of shelters.

Interest rates are now much lower than they were ten years ago when many producers made decisions to build shelters rather than conventional buildings. This may make it easier to borrow and service the additional capital required for conventional buildings.

However, many smaller producers have neither the capacity to borrow the capital required nor confidence in the long-term future of the pig industry to invest in conventional buildings that must be depreciated over a longer period; instead, smaller producers prefer the low-cost option of shelters.

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Examples of deep-litter housing floor plans

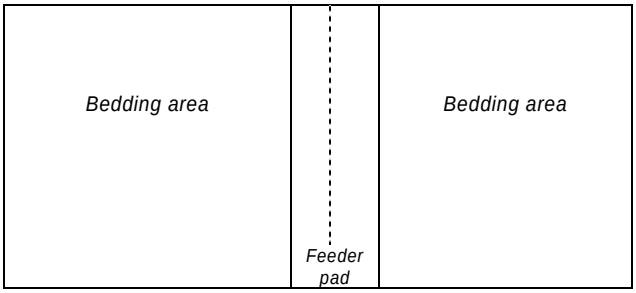

Fig 1. DLH floor plan with centre feed pad and shed divided into two sections (not to scale). This design is preferred by many producers due to excellent delineation between dunging, feeding and lying areas.

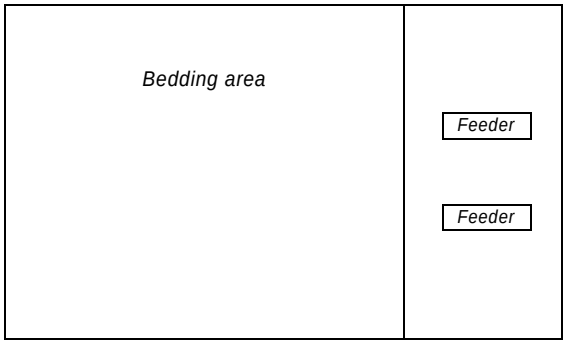

Fig 2. DLH floor plan with bulk multi-space dry feeders generally at the eastern end (not to scale).

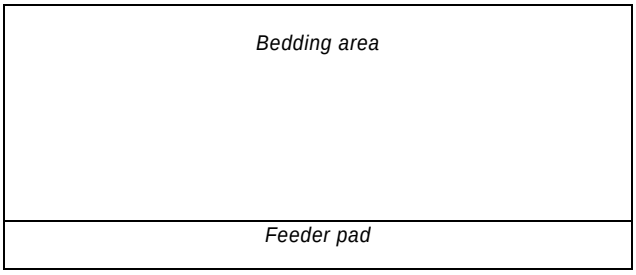

Fig 3. DLH floor plan with feeder pad along the southern wall is often used for very large groups (not to scale). It has less defined dunging and lying areas. It is also difficult to add litter to central areas if they become wet during a batch.

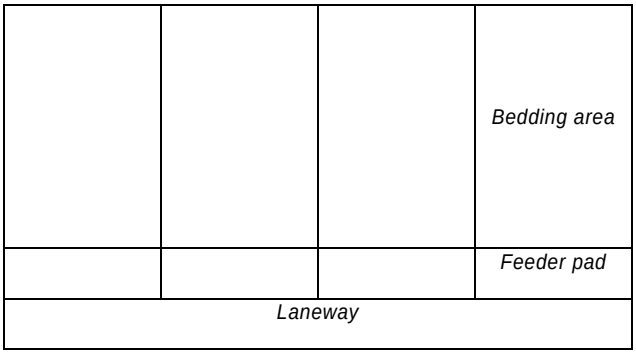

Fig 4. DLH floor plan with feeder pad along the southern wall and divided into smaller pens plus an access laneway (not to scale).

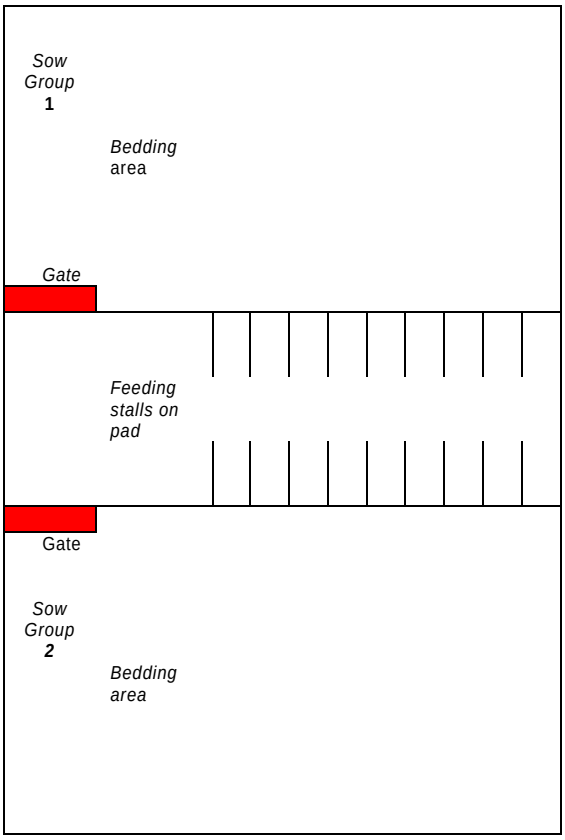

Fig 5. DLH floor plan for dry sow accommodation

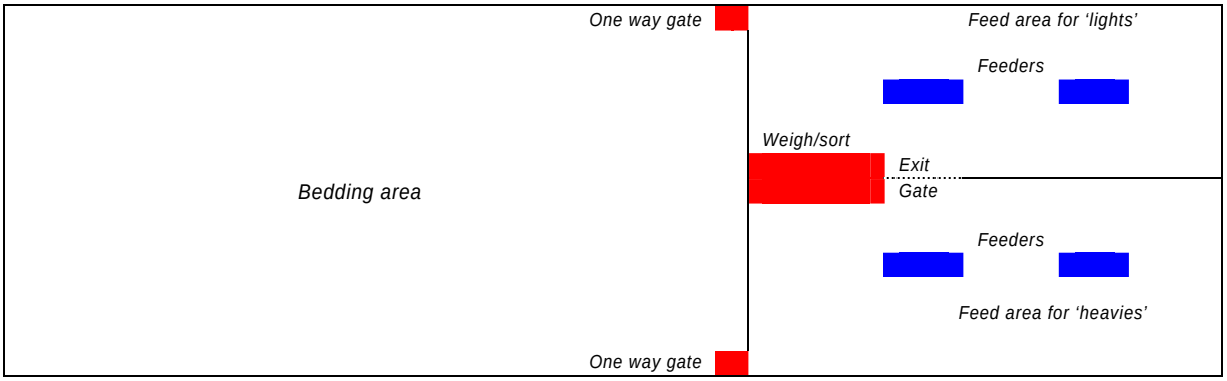

Fig 6. DLH floorplan for a continuous automatic sorting for large groups (VIDO Swine Technical Group, 2004). Not to scale. This design is popular with the use of bulk feeders as there is good delineation between dunging, feeding and lying areas.

Note: Multi-space wet & dry competition feeders cater for up to 30 pigs/feeder with extra drinkers placed on the feed pad or at the open dunging end.