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Natural ventilation in pig housing

The most important points for south Germany

Insulated housing with fully-slatted flooring is above all recognised as standard in feeding pig units with over 80% of buildings thus equipped. Naturally-ventilated housing supports the requirements for reduced investment and energy input whilst still offering a healthy and welfare-oriented environment for livestock through various function and climate zones as well more pen room. Because of this, the system finds increasing acceptance by farmers as well as by consumers of pork.

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Keywords
Pig, housing systems, outside climate house

The more financial pressure and the demands of animal and environmental protection increase, the greater the number of farmers seeking alternatives to conventional production and marketing of pig meat. The result is increasing interest in naturally-ventilated housing.

Total cost calculations show definite advantages of from 6 to 12% for naturally-ventilated housing in pig feeding units compared with conventional insulated housing with fully slatted flooring. The higher costs of the straw-dung system and of the labour requirements (6 to 15 working minutes per feeding place and year) are more than balanced by a lower investment and energy requirements [3, 8].

Large air openings allow for a high air volume flow which transports dust as carriers of fungi and germs, as well as polluting gases, out of the building so that low concentrations of these result thus reducing associated stress for livestock as well as humans. Because of bad air quality, the incidence of respiratory diseases of pigs as well as farmers has increased strongly in the last years [1, 10].

The welfare-oriented housing environment for livestock, with separate function and climate areas, supports health and performance potential with pigs. Comparisons of naturally-ventilated and other systems thus show similar, or higher, feeding performances in housing systems with physically-separated microclimate areas such as with climate boxes and sloping floors [2,6].

With regard to emissions, first results indicate clearly lower ammonia and methane values in the winter months and emissions comparable to conventional housing in the summer half year. Important with natural ventilation are the lower in-house temperatures which also play a role in smell intensity. On top of this, even before they leave the building odour-flows become strongly-diluted through the high volume air currents. Because of the diffuse emission sources present, higher odour concentrations and influence can be expected in the vicinity of the buildings, but lower concentration and influence from 50 m distance and more.

These positive characteristics of naturally-ventilated housing are affected by the substantial variations in practice, especially in the design and operation of the buildings, which can lead to the positive aspects showing little affect. Very many factors have to be considered in the building and the operation of naturally-ventilated feeding pig housing.

Production systems

The existing production systems described as naturally-ventilated are varied and many. What system is most suitable is decided by the farm situation.

Strawless systems first come into their own when the size of the business increases and the labour capacity starts to reach its limits. For specialised piglet rearing, flat beds with under-floor heating or heated false ceilings for loafing areas have proved successful for group housing systems and will also continue to be very suitable. In feeding and breeding pig production, box pens offer advantages where the pigs are housed in small to medium groups [4, 7] . For those who put less importance in good weather protection for the workforce, verandah systems achieve good feeding results too. These feature detached huts with slatted outside runs as used with growers.

The mostly too limited opportunities for preoccupation on the part of the pigs in strawless pens is just as problematical in a naturally-ventilated housing system as a conventional one. Systems with limited straw bedding are, therefore, better and also suitable for gaining a better price in the system of direct selling to butchers which is widespread is south Germany. Additionally, the investment requirement is lower by from 150 to 250 DM per feeding pig place. Among the available variations, the sloping floor system for feeding and breeding pigs is favoured especially for larger animal numbers because the system can be readily mechanised dunging removal and has a relatively limited straw requirement. On the other hand, deep straw bedding is less advisable because of its high straw requirement and the associated risk of just once landing with a harvesting of bad straw quality (fungus pro-

blems). From the point of view of livestock too, a manure layer can give a too-warm „mattress" on which to lie in spring, summer and autumn and this can be very stressful for the animals if no alternative area is on hand [9]. This can be seen from reduced performance and behavioural changes.

Siting of the housing

The least planning and building permission problems can be expected when the development is to be outside of a built-up area. There, in general, are also the best air flows to be found. In special sites such as those with wind canal effects in valleys or on the edges of woodland the topographical factors have to be especially taken account of. A minimum distance of 20 to 25 m must be observed as a distance to the nearest buildings or closely planted trees. One longitudinal side should be built across the prevailing wind direction.

In that mechanical ventilation or heating is not required, the energy requirement is low and the running of the housing possible without connection to the mains electricity supply. Thus, a building away from housing areas but still without high connection charges is possible. In this way only around 5 to 20% of the energy used in conventional livestock housing is required.

Building design

The ventilation of the naturally-ventilated building takes place mainly at right angles to its axis. For this reason the width of the house should not normally be over 15 m. For the avoidance of trapped heat, the eaves height should be at least 3 m. With strawless housing systems with slurry canals free-standing interior design with a width from 12 to 13 m should be sufficient. Steel frames or square timber bonded constructions are equally suitable. Roundwood constructions can be used too, when enough experience in the process is available. Interior supports must then be fitted as part of the groundplan. Free-standing roofs make a later change of building use much more simple. Using wood offers a good possibility of utilising own-inputs in the form of material and working time. This possibility is gladly taken advantage of, especially in south German.

The air exchange is mainly governed by the wind. For this reason large openings in the side walls are necessary, so that sufficient air exchange is always allowed for. Their design depends on the siting, the livestock husbandry system and the methods by which the microclimate zone is achieved. Diaphragm wall lining, windbreak nets and perforated plastic sheeting can be used.

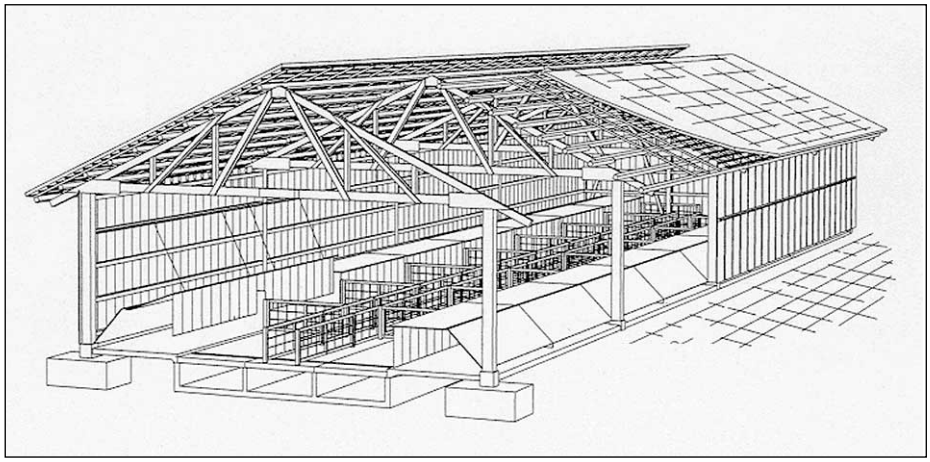

Fig. 1: Strawless naturally-ventilated housing of square timber bonded construction (Landtechnik Weihenstephan construction programme)

With good microclimate zones, the roof doesn't require to be insulated. The high airflow rates allow a quick equalisation of temperatures within the housing. The roofing (roof tiles, concrete tiles, corrugated cement fibre sheets) are used according to the local availablities. The roof slope should be at least 23°. The ridge can be part of the ventilation scheme as an open ridge. Proving itself as best has a saw toothed roof with opening on the lee side. The 30 to 60 cm high opening should be covered with a closable folding screen or a windbreak net.

Pen planning and management

The design of the functional area within the pens for rearing, feeding and breeding pigs is according to the livestock requirements. Envisaged for protection against low temperatures are insulated boxes or similar building components. Even in winter with low temperatures (-5 to -10 °C), even just two hours after introducing piglets to an empty stall , 15 to 20 °C can be reached in the microclimate zones.

Climate control in summer is more problematical. With interior temperatures of 25 °C, the pigs keep the heat in their loafing area microclimate at around the same level through their more or less long occupation of these zones. If the house temperature rises even further, the heat in the microclimate zones increases too and this leads to their occupation rates being reduced, especially where ventilation is bad. In turn, this causes the role of function areas to alter. Here, other factors as well as temperature (stocking rate, age, sex, enterprise management) have an influence. The channelling of air and fitting of showers for the pigs can be applied in this context for active control of animal behaviour within the housing.

For technical reasons, naturally-ventilated housing should only be subdivided in certain situations , and this means that, for hygiene reasons, all-in all-out systems can only apply on a whole-building basis. For continuous-throughput systems in feeding houses, there are therefore limited possibilities for cleaning and disinfecting. To these difficulties can be added the impossibility of wet cleaning during below zero temperatures and the fact that disinfectants are less effective in low temperature conditions.

Literature

[1] *Anonymus*: Gezondheid Varkenshouder aan Risico's Blootgesteld. Rapport 93.001, Boxtel, Heythuysen. SUS (1993), H. 3, S. 58f

[2] *Behninger, S., B. Haidn* und *P. Wagner*: Mast im Kaltstall – Stallklima und Tierleistungen in Außenklimaställen für Mastschweine. Landtechnik 53 (1998), H. 3, S. 154 – 155

[3] *Christel, S.* und *B. Haidn*: Arbeitszeiten in Schweinemastbetrieben. Landtechnik 54 (1999), H. 4, S. 246 – 247

[4] *de Baey-Ernsten, H.* und *B. Haidn*: Außenklimaställe für Mastschweine. – In: Mastschweinehaltung, Baubriefe Landwirtschaft. Hrsg.: Bauförderung Landwirtschaft e.V., H. 40, 1999, S. 100 – 106, Landwirtschaftsverlag GmbH, Münster-Hiltrup

[5] *Gronauer, A., G. Riß, W. Grotz, B. Maier* und *B. Rathmer*: Emissionen aus der Mastschweinehaltung – Schadgase und Gerüche. Mastschweinehaltung, Tagungsband zur Landtechnisch-Baulichen Jahrestagung am 23.11.1999 in Mirskofen. Hrsg.: G. Wendl, Freising, 1999, S. 33 – 56 (Landtechnik-Schrift Nr. 10)

[6] *Haidn, B.* und *N. Hornauer*: Haltung von Mastschweinen in Außenklimaställen – Formen – Kennwerte – Bewertung. Mastschweinehaltung, Tagungsband zur Landtechnisch-Baulichen Jahrestagung am 23.11.1999 in Mirskofen. Hrsg.: G. Wendl, Freising, 1999, S. 83 – 100 (Landtechnik-Schrift Nr. 10)

[7] *Haidn, B.* und *H. de Baey-Ernsten*: Integration bestehender Haltungskonzepte für Zuchtsauen in Außenklimaställen. Tagungsband 4. Internationale Tagung Bau, Technik und Umwelt in der landwirtschaftlichen Nutztierhaltung, Weihenstephan, 9./10. März 1999. Hrsg.: Institut für Landtechnik der TU-München-Weihenstephan, 1999, S. 335 – 340

[8] KTBL: Außenklimaställe für Schweine -Positionspapier. Sonderveröffentlichung 026, Darmstadt, 1998

[9] *Schuch, S.*: Das Verhalten von Mastschweinen in einem Tieflaufstall unter besonderer Berücksichtigung von Stallklimakenndaten und Stallarbeiten. Diplomarbeit. Landtechnik Weihenstephan, 1996

[10] *Zang, Y. et. al*: Acute Respiratory Responses of Human Subjects to Air Quality in a Swine Building. J. agric. Engng Res., 70 (1988), pp. 367 – 373