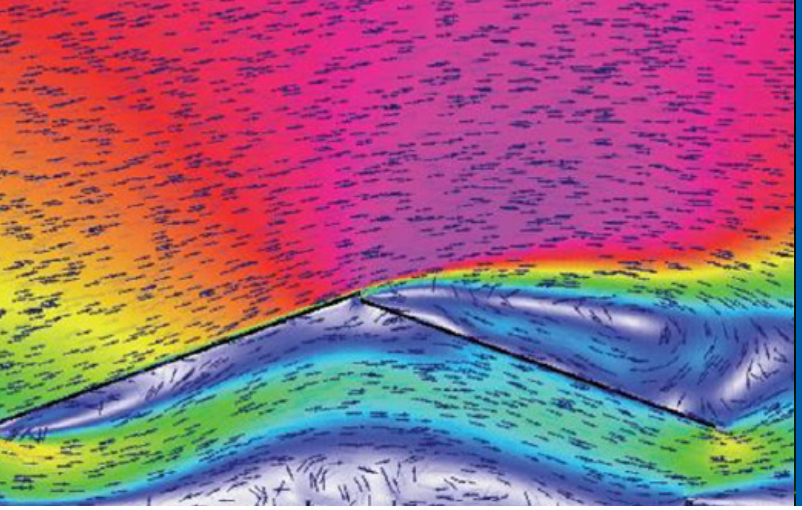


Three column concept for optimizing an environmentally and animal friendly husbandry

Projects

MNVBOYs • Modeling of ventilation rate and flow patterns of naturally ventilated pig barns with outdoor access (Funding: DFG)
https://gepris.dfg.de/gepris/projekt/467000790

BeLuVa • Determination of the air exchange rate at naturally ventilated dairy barns - validation of predictive models (Funding: DFG)
https://gepris.dfg.de/gepris/projekt/397548689

Res4Live • Energy intelligent animal husbandry towards zero fossil fuel consumption. (Funding: EU - H2020)
https://res4live.eu/

Contact
Prof. Dr. Thomas Amon • tamon@atb-potsdam.de
Dr. Sabrina Hempel • shempel@atb-potsdam.de
Dr. David Janke • djanke@atb-potsdam.de
Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB)
Max-Eyth-Allee 100, 14469 Potsdam, Germany

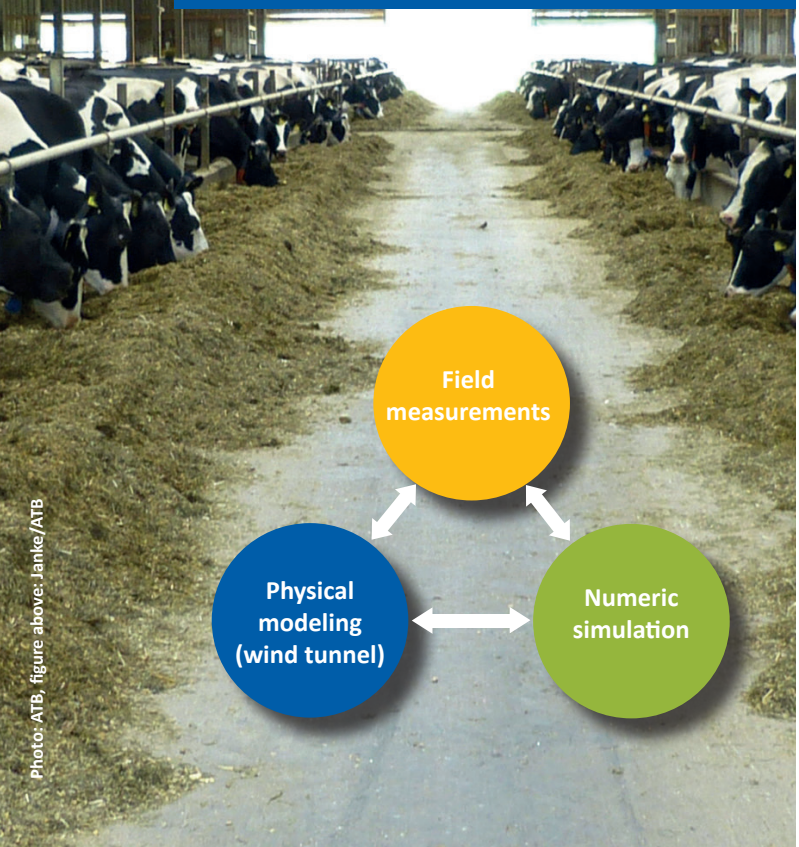


Photo: ATB, figure above: Janke/ATB

The demands placed on modern animal husbandry have risen sharply. Animal husbandry systems should be designed in the sense of sustainability so that they take into account aspects and requirements relating to the health of humans, animals and the environment (OneHealth). This requires a comprehensive understanding of the processes affecting the environment and animals.
To increase the understanding of these processes, scientists at the Leibniz Institute for Agricultural Engineering and Bioeconomy developed a three column concept.

The three column model integrates field measurements, physical modeling, and numeric simulation into an overall system. It combines the benefits of the single methods and at the same time evaluates these methods.

Natural ventilation: a specific challenge

Energy saving husbandry systems with natural ventilation place specific requirements on opimisation concepts. The climate inside such stables depends directly on the weather conditions, especially wind, temperature and relative air humidity. Those are, however, constantly changing and a statistic representation via field measurements, for example, needs substantial effort.

The wind field: a crucial impact factor

Indoor climate as well as emissions of naturally ventilated husbandry systems are mainly determined by the air exchange rates and by the distribution of gas, dust, and other particle concentrations. Those, on the other hand, result directly from the wind field inside and around the stable. Even for symmetric buildings a highly heterogenous flow field was found. This indicates that we are dealing with very complex, turbulent processes.

Basis for the design of husbandry facilities

Only the combination of different methods permits a precise representation of the complex flow events in and around naturally ventilated husbandry facilities. This is a crucial prerequisite for the conception of new or the optimisation of existing housing systems.

Info Flyer as PDF:

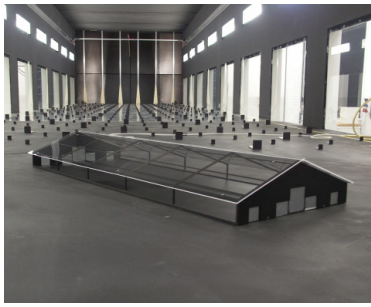
Investigation of wind fields in naturally ventilated animal housings: Three methods – one complex approach

Field measurements provide a mapping of nature, however, only as samples, since the boundary conditions are ever changing and the number of possible sensors is limited. Moreover, in most cases, the building design cannot be changed to study its effect on the flow.
Thus, it is sensible to supplement these data with data from modelling and simulation. Those, however, require a validation of their results.

Field measurements

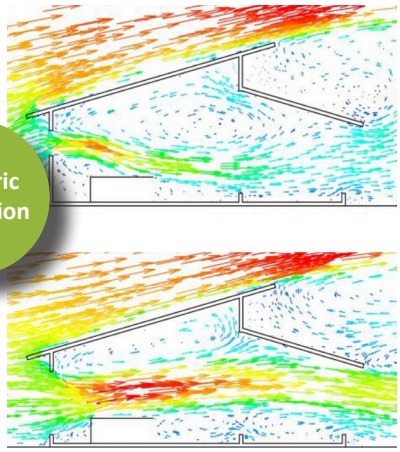
Data from **physical modelling** in the wind tunnel have a high spatial and temporal resolution, are statistically representative, and are measured with a well documented, 3D eddy resolving inflow.
However, it has to be proven that results based on wind tunnel measurements can be assigned with nature. This is typically guaranteed via defined physical parameters which are based on field data.

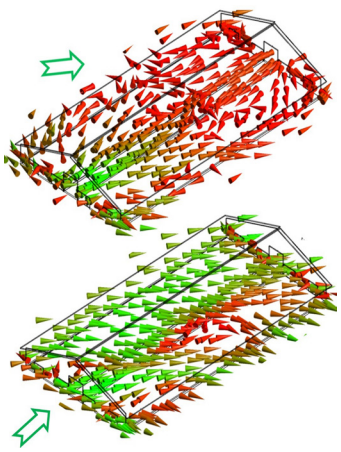
Physical modeling (wind tunnel)



The **numeric simulation** permits an even larger resolution of the flow processes. In addition, modifications of the building design can be investigated rather easily and cost efficiently, and thermal effects can be integrated.
Also numeric models require validation since they rely on simplification related to the solving of the turbulent flow equations or the geometry, for example.

Numeric simulation





The combination of the three methods permits maximal knowledge gain and mutual validation of all results.

At the Leibniz Institute for Agricultural Engineering and Bioeconomy, the three column modell is constantly refined and applied as a standard for optimizing environmentally and animal friendly husbandry.
The three-pillar model is applied in numerous projects, including basic research-oriented projects such as MNVBOY's, BeLuVa & BeLuVa2.0 as well as in the investigation of application-oriented issues, for example in the projects Res4Live and Demonstration Farm LVAT Groß Kreutz - Leibniz Innovationshof.

Figures:
Top: Naturally ventilated barns; where field measurements are carried out. Left: Pig barn in Wehnen (Photo: Yi/ATB). Right: Dairy barn in Dummerstorf (Photo: Stollberg/ATB).
Center: Models for flow measurements in the wind tunnel. Left: Dairy barn (Janke/ATB). Right: pig barn (Yi/ATB).
Bottom: Results of numerical flow simulations. Left: Dairy barn with different wind inflow directions (Doumbia/ATB). Right: naturally ventilated pigsty with two different sized inflow openings (Yi/ATB).

Photo: Foroushani/ATB

ATB
Leibniz-Institut für Agrartechnik und Bioökonomie

www.atb-potsdam.de