PiPoCooL

Climate change and future pig and poultry production: implications for animal health, welfare, performance, environment and economic consequences

Abstract

Pigs and poultry are predominantly kept in confined livestock buildings in Austria. By modelling the relationship between animals, building, and the ventilation system, the indoor thermal climate, air quality, and airborne emissions will be simulated. For a reference (1985-2010) and the future dataset (2036-2065), the vulnerability of the livestock system will be assessed. For various adaptation strategies, their effectiveness will be evaluated to increase the resilience of livestock husbandry.

Summary

It is anticipated that, in the future, the production of pig and poultry may be severely affected by heat stress. In temperate climate regions like Central Europe these animals are predominantly kept in confined housing systems. Therefore the impact of climate change scenarios on these systems cannot be assessed only by ambient meteorological parameters, as they are modified by the confined livestock building and the livestock itself. There are only few investigations of the impact of climate change on such livestock systems. Most publications deal with ruminants kept outdoor or with climate change mitigation.

This means that the indoor climate, which is the environment relevant for a large share of farm animals, has to be considered by simulation models, describing the interaction between animals which release sensible and latent (water vapour) heat, the insulation of the building to capture the sensible heat, and the ventilation system. The ventilation rate is mostly controlled by the indoor temperature. The ventilation system is the most effective link to the outside, but inevitably differences will occur between climatic conditions outside and inside livestock buildings. The indoor climate will in turn impact on animal health and welfare, productive, reproductive and economic performance and emission of gases such as ammonia and nuisances such as odour from pig and poultry barns.

The project *PiPoCooL* is developed along two main research questions: (1) what is the impact of climate change on livestock husbandry inside confined houses for climate change scenarios, and (2) which adaptation measures are appropriate to reduce the vulnerability of the farms.

Beside the core module of the simulation for the thermal parameters and the air quality inside barn buildings, additional modules will be included to calculate the release of ammonia and odour. Such emission models have to be developed for poultry (broilers, laying hens, and turkeys) as well as for pig production.

An empirical investigation is planned for two areas in Austria with a high density of animal husbandry and different climatic conditions, namely the Northern Alpine Foreland in the provinces Upper Austria/Lower Austria and South-Eastern Styria. These two regions cover

more than 90% of all pigs in Austria and about two thirds of poultry. For both regions a reference climate scenario will be compiled on the basis of representative observational sites, available for the time period 1981-2010. The future climate scenario will be generated for 2036–2065, both on an hourly basis. This time period was selected according to the life expectancy of livestock housing of about 30 to 50 years. Both climate datasets will feed into the simulation of the indoor climate as well as the dispersion of ammonia and odour.

For the two regions, typical confined livestock buildings will be selected with a mechanical ventilation system as it is used for different livestock keeping systems (broilers, laying hens, turkeys), and various pig keeping systems. The system parameters for these selected livestock houses will be the same for both datasets, called Business-as-Usual. The simulated parameters of the indoor climate will be analysed and compared for the two datasets, taking into account animal welfare, health, performance, the environmental impacts, and the resulting economic consequences. It results in an assessment of the impact of climate change for certain livestock housing systems and the adaptive capacity of farmers..

The adaptation measures analysed herein will cover a wide range. Additional air condition features (e.g. heating, evaporative cooling, earth-air tube heat exchange) will be included to simulate adaptive measures which are based on thermodynamic modification of the indoor climate. The management of livestock offers the possibility of control measures like feeding strategies, adaptation of the animal density (reduction of the slaughter weight and/or the number of animals), measures to increase the heat release of animals (evaporation, increased air velocity, cooling of drinking water, floor cooling), modification of the design values for the planning process of livestock buildings (maximum and minimum ventilation flow rate, and insulation of the building), inverting the diurnal pattern (resting during daytime, feeding during night-time), and selecting more adapted breeds (e.g., broilers covering the naked-neck or/and frizzle genes).

In a next step the husbandry conditions will simulated to reveal the effectiveness of adaptation measures (i.e. adaptive capacity), which sums up to livestock and farm vulnerability. Even if some of the adaptation measures are well known, especially in hot climate regions such as in parts of the US, they have to be evaluated whether they will be appropriate for Austrian farmers due do different farm structure, markets, production regulations or climate change impacts. The evaluation will include the direct bio-physical effects on animals and the environment as well as their economic implications, i.e. impacts on production costs and revenues.

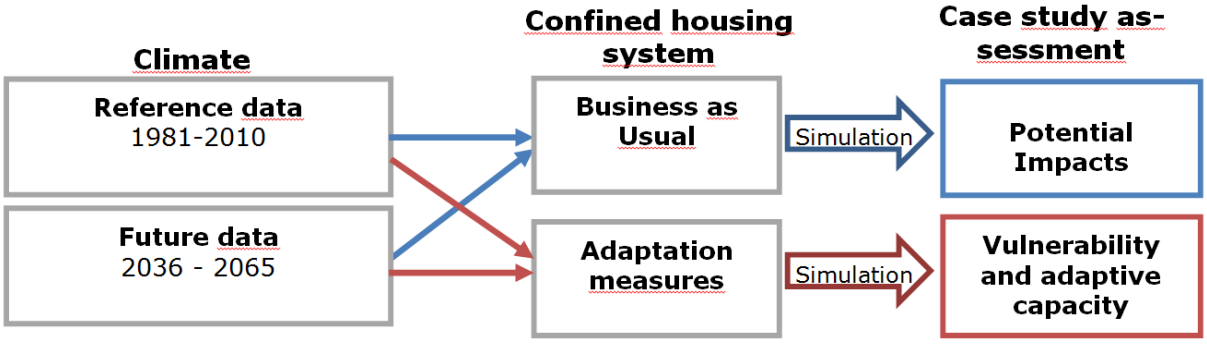

Fig. 1 Structure of the Project *PiPoCooL*

Fig.1 summarizes the work flow to assess the potential impacts and the vulnerability of conventional confined livestock buildings to climate change scenarios and the effectiveness of adaptation measures. These criteria are evaluated by aspects of animal health, welfare, performance, environmental impacts and the resulting economic consequences.

The thermal environment is a major parameter as it directly impacts animal welfare and health. The productivity of farm animals can be investigated by parameters which are sensible to the thermal environment: For fattening pigs and broilers this can be described by daily weight gain and feed conversion, egg production for laying hens and the reproductive performance of sows (litter size, number and body weight of weaned piglets etc.). Furthermore, an increase of the airborne emissions (NH_3, odour) can be anticipated, leading to increased ambient concentrations, a reduced indoor air quality, and increased separation distances to protect the neighbours from odour nuisance.

The project *PiPoCooL* will deliver essential information on the future perspectives of livestock husbandry under global warming. The changing climate will first impose new challenges for maintaining temperate indoor climatic conditions and will possibly lead to an increase of energy demand and thus economic costs. It will furthermore have an effect on the number of animals to be kept within a livestock holding, on the feeding and the handling of manure as well as on the ventilation conditions. The project will enable to quantify these values and the economic outcome. The results from the model calculations will help to evaluate adaptation measures on a scientific basis, which are under discussion currently (e.g. wallow for pigs).

The dissemination of knowledge and the transfer of practical applications will be an important feature of the project. Given a life expectancy of livestock buildings of 30 to 50 years, it is important to consider necessary features in the planning of new livestock buildings for future challenges due to climate change. One of the basic elements of planning are design values for insulation and the ventilation system. The current version of the respective guideline was published in 1983 (ÖKL). An adaptation of these values to future scenarios seems mandatory to make new buildings fit for the future. Adaptation strategies have to be adjusted to the agricultural structure in Austria and the expected future climate change. These concepts should be useful for agricultural and veterinary advisory services. Consequently, stakeholder interaction at various stages of the research process an finally dissemination plays a major role in *PiPoCooL*.

The changing climate will also change environmental effects of livestock husbandry. The likely increase of emissions (odour, ammonia) due to animal activity as well as changing dispersion conditions might affect the separation distances around livestock holdings to prevent the neighbourhood from intensive nuisance. A possible increase in separation distances for the future climate scenario would be considered most relevant as this would have an impact on the size and animal density of livestock farms.

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