Precision feeding with a decision support tool dealing with daily and individual pigs' body weight

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Monitoring growth of identified and unidentified pigs using data from an automatic weighing system

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In pig farms equipped with frequent body weight (BW) monitoring, such as walking through scales, more than 60,000 BW observations can be collected per batch. So far, farmers were using collected BW information mostly for pig marketing purpose (through a BW sorting system). However, these observations can also be used to alert the farmer about a sudden decline in pigs' growth (at individual or batch level), and to provide current and historical growth statistics for batches. The main obstacle in providing alarms was the fact that most farms are not identifying pigs. An additional difficulty was selection bias caused by the fact that farmers continuously sell the heaviest pigs from a batch as soon as they reach a defined BW threshold. In this study we have developed a tool which can be used to provide growth alarms at individual level (identified pigs) and batch level (identified or unidentified pigs). Moreover, the developed tool can provide current statistics on growth and perform retrospective analyses. The tool was built as a dynamic linear model (DLM). The growth of pigs was described by parameters at batch level representing a quadratic growth function with daily harmonic fluctuations in BW and an autoregressive effect at pig level. In the version for unidentified pigs, we have removed parameters describing individuals. However, we have accounted for the variance in the pig effect by adding it to the random residual. After the first delivery, BW of the remaining pigs was described by a truncated normal distribution. The forecast errors obtained from the DLM were standardized and monitored with a tabular cusum. To test the tool we have used data from 3 batches, 1,058 pigs and 146,926 individual weighings. We have demonstrated that frequent observations of unidentified pigs can provide meaningful alarms on growth deterioration at batch level. Frequent BW information can be useful in informing farmer about unexpected events influencing growth e.g. outbreaks of diseases. The historical information on growth might be valuable in making decisions regarding management.

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Nutritionists, feed companies and equipment manufacturers look for solutions that help farmers to improve sustainability of pig production. Based on experimental results obtained in silico or *in vivo*, a better adequacy between amino acid supplies and requirements increases feed efficiency and farmer's income and reduces the environmental impact of growing pigs, highlighting the interest for precision feeding. Data are collected to characterize daily animal traits (e.g. body weight, BW) and their variation from one day to another (e.g. growth rate, ΔBW). They are used to determine the requirement for maintenance and growth on the next day, respectively. Therefore, adequacy between requirements and supplies depends on these predicted BW and ΔBW. The double exponential smoothing (Holt-Winters) method with a smoothing parameter α=0.6 ($HW_{0.6}$), presents a low sensitivity to the number of latest values used to forecast BW. It seems to allow for a secured prediction of BW soon after the beginning of the growing phase (at least after 4 days). A group of pigs was used in restricted feeding conditions to compare results obtained either with a 2-phase feeding strategy, considered as the control treatment, or a precision feeding strategy based on BW forecasting with the $HW_{0.6}$ method. Pigs allocated to both treatments were group-housed in the same pen, equipped with the decision support system built in the Feed-a-Gene project to manage the data, to determine in real-time the corresponding nutritional requirements, and to adapt the feed characteristics provided to each pig through the blend of two diets (9.75 MJ net energy/kg, 0.5 or 1.0 g of digestible lysine per MJ). Available results from 24 pigs per treatment indicate that overall average growth performance were not influenced by the feeding strategy ($P>0.58$ for both average daily gain and feed conversion ratio) but digestible lysine intake was reduced by 6% (1,774 vs 1,879 g, $P<0.01$) and N output by 7% ($P<0.01$) with precision feeding. Results will be completed by a second group using the same treatments. This study is part of the Feed-a-Gene project and received funding from the European Union's H2020 program under grant agreement no. 633531.