Potential alternatives to antimicrobials in pig production based on perceived effectiveness, feasibility and return on investment.

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Abstract
Based on a questionnaire returned by 111 pig health experts from six European countries a list of potential alternatives to antimicrobials was ranked. These alternatives provide input for further studies to find strategies to reduce the widely discussed use of antimicrobials and the potential risk from antimicrobial resistance. Based on their scores for effectiveness, feasibility and return on investment, the most promising alternatives according to the consulted experts are believed to be: improvement of biosecurity measures, increased/improved vaccination, use of zinc/metals, improvement of feed quality and the use of regular diagnostic testing combined with a clear action plan. The MINAPIG consortium will use these results as input for future studies.

Introduction
Reduced antimicrobial usage in livestock is widely discussed and highly promoted in Europe and worldwide as a measure to reduce antimicrobial resistance. However, to guarantee animal health, welfare and economic viability, effective and efficient alternatives are necessary. Pig health experts were asked to provide their perception of the usefulness of different alternatives to antimicrobials. The aim of this study was to distillate a list of potential alternatives that could be used as input for further studies.

Material and Methods
A paper or web-based questionnaire was sent to porcine veterinary experts in Belgium, Denmark, France, Germany, Sweden and Switzerland. The participants were asked to score pre-listed alternatives to antimicrobial usage regarding expected effectiveness, feasibility and return on investment (ROI) between 0= not effective/feasible/economical and 10= highly effective/feasible/economical. The pre-listed alternatives were: Financial/tax (increased price of products), Benchmarking of farmers/veterinarians, Communication/unified advice (improved communication between farmer and veterinarian, all herd advisors promote same strategy), Diagnostics/action plan (herd specific action plan based on diagnostics and historical data), High health/SPF/eradication programs, Genetics, Increased vaccination, Strict euthanasia policy, Increased use of anti-inflammatory products, Improved external biosecurity, Improved internal biosecurity, Age and transfer management (minimized number of movements and at older age), Reduced stocking density, Improved climate/environmental conditions, Improved water quality, Acidification of feed or water, Optimization of feed quality, Use of feed additives and Use of Zinc/metals. The alternatives were provided with a short explanation. The experts were also asked to provide their professional occupation. Data were analyzed using Microsoft Excel 2010 and IBM SPSS version 21.

Results
A total of 111 experts returned the questionnaire, ranking at least 8 out of 19 alternatives (Belgium n=24, Denmark n=30, France n=8, Germany n=17, Sweden n=23, Switzerland n=9). Response rates were minimum 40% and maximum 94%. The majority of respondents were veterinary practitioners (n=53). The other respondents were: professors/teachers (n=13), researchers (n=20), nutritionists (n=6), technical consultants of the pharmaceutical industry (n=8) and other advisors (n=11).
The average scores of all respondents resulted in the following top 5 per scoring parameter:

Top 5 Effectiveness: Improved internal biosecurity (μ=8.21, SD=1.91), improved external biosecurity (μ=7.85, SD=1.83), improved climate/environmental conditions (μ=7.75, SD=1.63), increased vaccination (μ=7.64, SD=1.58) and high health/SPF/disease eradication (μ=7.64, SD=2.13).

Top 5 Feasibility: Increased vaccination (μ=7.32, SD=1.79), increased use anti-inflammatory products (μ=7.30, SD=2.11), improved water quality (μ=7.18, SD=2.10), feed quality/optimization (μ=7.15, SD=1.96) and use of zinc/metals (μ=7.13, SD=2.85).

Top 5 ROI: Improved internal biosecurity (μ=7.61, SD=1.75), use of zinc/metals (μ=6.99, SD=2.39), diagnostics/action plan (μ=6.94, SD=2.07), feed quality/optimization (μ=6.90, SD=2.28) and climate/environmental improvements (μ=6.86, SD=1.96).

Combining the scores for Effectiveness, Feasibility and ROI resulted in the following top 5:
Improved internal biosecurity (μ=7.49), increased vaccination (μ=7.24), use of zinc/metals (μ=7.21), feed quality/optimization (μ=7.20) and diagnostics/action plan (μ=7.04).

On average researchers and professors/teachers preferred diagnostics and action plans as respectively the best or second best alternative related to the overall score of the three scoring parameters. While for example practitioners placed this alternative in sixth position.

Nutritionists and other advisors, such as pig consultants and veterinary managers, saw the use of zinc/metals as the most important alternative. Those experts focused in general more on the alternatives related to feed, water and zootechnical improvements such as climate and environmental, while professors, teachers and consultants from the pharmaceutical industry gave higher rankings to biosecurity measures and increased vaccination.

Financial/tax as an alternative was in the bottom three ranking for all profession categories. Benchmarking of veterinarians and farmers ended up in the middle regions of the ranking for most profession categories, except for the practitioners, they placed this alternative fourth last.

**Discussion**
Response bias might be relevant in this study, although the order of the pre-listed alternatives and the additional explanatory information were carefully designed to minimize this bias risk.

Some countries, such as The Netherlands (SDa, 2013) and Denmark (Alban et al., 2013), already have some benchmarking measures in place, combined with a low or even obligated strict reduction of antimicrobial usage in livestock production. Furthermore some EU countries allow the usage of zinc in weaned piglets. However, use of zinc will or legally might not be implementable in all countries. As a single measure they are unlikely to sufficiently reduce antimicrobial usage without affecting production. Other (combinations of) alternatives, focusing on the production of healthy animals in an optimized environment are necessary. The experts ranked improvement in biosecurity and climate/environment highest in effectiveness, indicating that there is room for improvement in these areas.

For practitioners the average scores vary less, with the lowest maximum average score and highest minimum average score, indicating that they perceive relatively more importance for all proposed alternatives.

Although a limited number of experts from a limited number of EU countries were included in this study, conclusions can be drawn from their perceptions on alternatives to antimicrobial usage.

**Conclusion**
These results provide a first impression on the experts’ opinion on possible alternatives to antimicrobial usage in pig production. Biosecurity improvements, increased vaccination, use of zinc/metals, improvement of feed quality and use of regular diagnostics testing and a clear action plan score high on all criteria. Based on our results, these measures are believed to be the most promising alternatives to antimicrobial usage. The MINAPIG consortium will add complementary information and use these results to design future field studies.


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**References**

SDa, 2013. The Netherlands Veterinary Medicines Authority.