EU PiG

EU PiG Innovation Group

Technical Report

Health

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727933.

Challenge: Reduction of antimicrobial medication

1. Introduction

Infectious diseases are still the main cause of economic losses in swine production. For decades, antimicrobials have been the best cost-effective solution chosen by practitioners to contain microbial burden in pig farms. This era is rapidly coming to an end. The excessive and inappropriate use of antimicrobials is leading to an increasing selection of microbial species that are resistant to the effect of several antibiotics. Antimicrobial resistance (AMR) represents not only a threat to human and animal health but also an additional cause of economic losses. Failure of treatments leads to higher veterinary costs and reduced productivity, with consequences for our future global economy that can be detrimental (World Bank Group, 2017). In 2011, the European Commission launched a five-year action plan to tackle AMR and stimulate global awareness towards this topic. Even though a decrease in antibiotic sales, and presumably in animal consumption, of 12% was recorded in 24 European countries between 2011 and 2014, important differences are still present between countries (EMA, 2016). This large variation among European nations has also been observed when reporting methicillin-resistant Staphylococcus aureus (MRSA) species in pigs, with a range varying between 0.5 and 91.4% of positive results (EFSA, 2017). Among the Salmonella species, S. Derby was identified as the most dominant serovar in fattening pigs and 46.9% of these isolates showed resistance to one or more antimicrobials (EFSA, 2017). Resistances to ampicillin, sulphonamides and tetracycline were most frequently detected in Salmonella and E. coli isolates from pigs less than one year of age, while resistant isolates to third-generation cephalosporins were rare (EFSA, 2017). The need for reducing the use of antimicrobials in pig farming is evident. To achieve this goal, three main areas of action have been identified by the experts (EIP-AGRI Focus Group, 2014). Improving health management and welfare is certainly one of them. It´s known, indeed, that ‘non-infectious’ factors like biosecurity, management of the herd and housing system heavily influence pig susceptibility to infectious diseases (van Dixhoorn et al., 2016; Laanen et al., 2013). Environmental enrichment of the housing system allows animals to express their social behaviour, thus increasing general health status and consequently reducing animal susceptibility to infection. Another practical solution is to find new alternatives to antimicrobials and promote the use of the existing ones, such as prebiotics, probiotics (Yang et al., 2015), bacteriophages (Zhang et al., 2015) and organic acids (Suiryanrayna and Ramana, 2015). In general, the overall approach proposed by the European Commission experts is based on preventing rather than treating disease. Therefore, the focus is on implementation of preventive measures, such as developing new vaccination strategies, improving animal nutrition and reducing genetic susceptibility to some pathogens by redefining the breeding system (Burkard et al., 2017; Mellencamp et al., 2008). Moreover, an important aspect is to invest in the education of all the people involved in pig production, including farmers, veterinarians and agri-advisers, in order to correct and meliorate those attitudes and habits that can cause misuse of antimicrobials. Importantly, improving the spread of the information and the communication between different parts is considered crucial in the fight to reduce antimicrobial use in pig farming (EIP-AGRI Focus Group, 2014).

2. Methodology

In order to identify the top five best practices across all the EU PiG regions, a series of criteria has been used, which are able to measure the effectiveness of the collected practices to match the specific challenge.

The following set of criteria has been scored for each practice.

- **Excellence/Technical Quality**
    - Clarity of the practice being proposed
    - Soundness of the concept
    - Knowledge exchange potential from the proposed practice
    - Scientific and/or technical evidence supporting the proposed practice
- **Impact**
    - The extent to which the practice addresses the challenges pointed out by the Regional Pig Innovation Groups (RPIGs)
    - Clear/obvious benefits/relevance to the industry
    - Impact on cost of production on farm and/or provide added value to the farming business or economy
    - The extent to which the proposed practice would result in enhanced technical expertise within the industry, e.g. commercial exploitation, generation of new skills and/or attracting new entrants in to the industry
- **Exploitation/Probability of Success**
    - The relevance of the practice to each Member State (MS) or pig-producing region/system
    - Timeframes for uptake and realisation of benefits from implementation of the proposed practice are reasonable
    - Level of innovation according to the Technology Readiness Level (TRL)
    - The extent to which there are clear opportunities for the industry to implement the practice/innovation
    - Degree of development/adaptation of the practice to production systems of more than one MS

Scores had to be in the range of 0 – 5 (to the nearest full number). When an evaluator identified significant shortcomings, this was reflected by a lower score for the criterion concerned. The guidelines for scoring are shown below (no half scores could be used).

0	The practice cannot be assessed due to missing or incomplete information.
1 – Poor	The practice is inadequately described, or there are serious inherent weaknesses.
2 – Fair	The practice broadly addresses the criterion, but there are significant weaknesses.
3 – Good	The practice addresses the criterion well, but a number of shortcomings are present.
4 – Very Good	The practice addresses the criterion very well, but a small number of shortcomings are present.
5 – Excellent	The practice successfully addresses all relevant aspects of the criterion. Any shortcomings are minor.

The selection of the top five best practices followed the procedure described below:

1. Members of the thematic group (TG) were asked to score all submitted best practices according to the defined guidelines and sent their scoring sheets to the TG leader
2. In addition to the scores, TG members provided brief comments indicating weak points or particular strengths of submitted best practices
3. A conference call was used to discuss the scoring results and select the top five best practices. During this call, the TG agreed to group best practices into different categories. The categories which were considered important and were included in the further selection process were: Benchmarking, Health promoting plan to reduce the use of antimicrobials, Health declaration system, Technical solutions for the administration of antimicrobials. The group agreed to include two best practices from the Benchmarking category and one from the remaining categories. A selection was made during the call
4. A summary of all discussions was sent out after the call to review the decision of the selected five best practices by members

3. Results and Discussion

The following top five best practices within the challenge of optimising the use of antimicrobials have been selected by the thematic group:

Title of best practice	Country
Use of antimicrobials	Finland
QS Antibiotic Monitoring Programme	Germany
Benchmarking antibiotic consumption	Denmark
Use of antibiotic to zero level	Netherlands
Pen level dosing of AM	UK

3.1. Use of antimicrobials

The ‘best practice’ describes a system of health status declaration used in Finnish pig herds. It consists of a voluntary national health and welfare register for swine farms with the goals to manage contagious diseases, to improve welfare and health, as well as to ensure food safety. The system classifies farms into three different categories. A farm starts at the basic level and after it has fulfilled certain criteria, it can be accepted to the national level. A farm at national level has to be free of five diseases: enzootic pneumonia (Mycoplasma hyopneumoniae), swine dysentery (Brachyspira hyodysenteriae), salmonella (all serotypes), atrophic rhinitis (toxigenic Pasteurella multocida) and sarcoptic mange (Sarcoptes scabiei suis). Also, the status of porcine reproductive and respiratory syndrome virus (PRRSV) is monitored. In the case of an outbreak at farm, the disease has to be eradicated. In addition to the aforementioned diseases, all piglets are vaccinated against porcine Circovirus type 2 (PCV2). For controlling diseases regular veterinary visits to farms are required. Every farm at national level is visited four to six times a year and a special documentation form is completed every time. This document is entered into the register. In addition, meat inspection reports can be found online. The data from the online register is not only available for the producer but also for the herd veterinarian and the slaughterhouse.

This health declaration system was considered a very helpful tool to reduce and optimise the use of antimicrobials by the thematic group members. A preventive strategy instead of treatment of clinical disease can effectively reduce the use of antimicrobials. Not only can freedom of bacterial pathogens reduce the use of antimicrobials. Also, freedom and/or control of viral infections like PRRSV or PCV2, which both modulate the immune system and may allow secondary/opportunistic pathogens to establish infections, can be beneficial in regard to antimicrobial use

(Lunney at al., 2016; Segalés and Mateu, 2006).

This best practice was considered as a clear and sound proposal by the thematic group members with a high potential for knowledge exchange and cost reduction. However, it was also discussed that the possibility of dissemination would be limited depending on the availability of high health pigs, the health status and pig density in a certain region. Most likely, only regions or countries with a low pig density might be able to adopt the best practice. Nevertheless, national health classification systems can be used successfully to monitor and eradicate contagious diseases, especially when all parts in primary production (producers, slaughterhouses and veterinarians) are working together.

The fact that no example of a farm using the health declaration system was given was considered as a weak point of the submitted best practice, since the goal of EU PiG is to select farmers to become ambassadors.

3.2. QS Antibiotic Monitoring Programme: optimisation of the use of antibiotics in livestock farming and reducing the danger posed by resistant bacteria

Two benchmarking systems have been selected by the thematic group members for the list of top five best practices. Those two are described and discussed together. Both best practices use an online database for recording the use of antimicrobials in pig farms.

The German QS system is recording applications or deliveries of antibiotics in a central database in order to provide a solid, inter-company data foundation for the pig sector. This system gives farmers and veterinarians the opportunity to assess the actual situation and identify areas where action is needed. The general idea is that proper evaluation creates the necessary transparency for future procedures, from which reduction strategies can then be derived and implemented. Monitoring within a corrective action plan is intended to result in a continuous optimisation of the use of antibiotics in livestock farming and in a reduced risk of resistance to antimicrobials. The data is entered regularly into the antibiotics database by means of input forms or via interfaces. The veterinarian reports every application or delivery of veterinary drugs containing substances with an antimicrobial effect to the antibiotics database and assigns it to the company and, if necessary, to the flock.

3.1. Benchmarking – antibiotic consumption

In the Danish Vetstat system, all purchased antibiotics from a herd are registered and can be compared with the consumption of antibiotics on other farms with the same production. The Vetstat system was launched by the authorities in 2000 and includes all pig farms in Denmark. The consumption on herd level can be calculated per produced pig/kilogram meat or similar. It is also possible to compare usage before and after disease eradications or implementing different routines to lower the infection pressure. In Denmark, this registration is handled centrally from the pharmacy as all antibiotics used by the farmers are prescribed by their vets to be delivered through the pharmacy. Data can be extracted by everyone, including the farmer or farm adviser. Thus, the system is very transparent. Images depict the possible benchmarking for the herd compared with the average usage in the country. In 2010, the authorities launched the so-called 'Yellow Card' system, where pig farms that use antibiotics above a certain threshold level have to install an action plan that allows the farm to be below this level during the next nine-month period.

The main difference between the two best practices is that the German QS system is a voluntary programme, while the Danish yellow card system is a national programme which has to be put in place on each pig farm. The QS system as a voluntary programme was considered to be more flexible and easier to be introduced to other European countries by the thematic group members. The Danish system on the other hand might have a greater impact on the reduction of the use of antimicrobials since farmers are forced to participate in the programme.

Both best practices were regarded as sound and clear proposals with a high potential of knowledge exchange. Scientific evidence is clearly supporting the fact that higher use of antimicrobials is leading to increased resistance of bacteria against antimicrobials. Therefore, the collection of data from on-farm use of antimicrobials, i.e. the monitoring of antimicrobial use, was considered one of the most important steps towards a targeted and prudent use of antimicrobials by the thematic group members. Data collection is essential for benchmarking and to increase the awareness of farmers and vets towards that important topic.

A weakness of both submitted best practices was the lack of a specific example, i.e. a farm involved in each of the systems, since EU PiG is aiming to select farmers to become ambassadors of best on-farm practices.

3.2. Use of antibiotic to a zero level

SPF farm Van der Meijden located in Spoordonk in the Netherlands is a pig farm with 1000 sows, plus nursery units and some room for finishing pigs in order to test the quality of the piglets produced on farm. The farmer, Kees van der Meijden, started to reduce the use of antimicrobials in 2006 when MRSA became a threat to one of his employees who had to be hospitalised. Back then he began to team up with consulting veterinarians (PorQ) and feed companies and the goal of the whole team became the reduction of the use of antimicrobials on farm and the fight against MRSA. The whole farm was divided into four areas: pregnant sows, rearing area, farrowing and weaner piglets. For each area, special protocols were written in order to inform staff on how to reduce antimicrobials in each area by better animal management. The specific biosecurity plan for the farm includes hygiene measures outside the stables in order to keep out pathogens (separate clean from dirty roads for feed delivery, carcase disposal, etc.; use of a specified fomites entry room; pest elimination; hygiene lock for people entering the farm, with 24 hours down time, shower in, a change of clothing and a visitor log to sign). Internal biosecurity measures include separate clothing and items/instruments with different colours, as well as clarified walking lines between the four different areas of the farm (farrowing, weaner pigs, sows, rearing area) in order to prohibit cross-contamination. In the farrowing, all treatments are done needle-free and pathogen transmission between litters is reduced to a minimum by strict separation of litters during processing and strict separation of age groups within different farrowing rooms. A cooling plate for manure within the farrowing house cools manure to 15 degrees in order to reduce the production of ammonia and improve air quality. After weaning, piglets are moved into the nursery without people walking between the different compartments. Special attention is paid to the water supply and water quality for the piglets; if necessary, water is acidified for newly weaned piglets. In all compartments of the farm, empty facilities are cleaned with detergent and dried before and after disinfection is performed.

All the implemented measures helped to reduce veterinarian costs from €130 to €30 per sow per year with only 16.9% of costs accountable for antimicrobials. This best practice was selected since thematic group members had the feeling that the farmer would be a very good ambassador for EU PiG, who could demonstrate that multiple factors, including strict biosecurity measures and a health promoting plan, are needed in order to reduce the number of antimicrobials used on farm.

3.3. Pen-level dosing of AM into wet feed

An additional system has been 'bolted onto' the normal wet feed delivery system, which comprises a separate small mixer, low diameter lines, pumps and a compressor, plus injectors at each wet feed delivery point. In essence, this allows medication to be delivered to each wet feeder, meaning that animals can be medicated by pen/pairs of pens. The medication is incorporated at the point of delivery. This results in a vast reduction in the use of antimicrobials as individual pens can be targeted, rather than entire buildings or even groups of buildings on the same feed line.

Thematic group members wanted to include a technical solution for the administration of antimicrobials to pigs within the list of top five best practices. The pen-level dosing of antimicrobials into wet feed was chosen over other best practices within this topic since it allows for pen-level treatment, while systems applying medication via drinking water can often be used for complete rooms only.

3.4. Cost-benefit analysis of the EU PiG Ambassador

In order to reduce drastically the use of antibiotics, the farm of Kees van der Meijden has invested in a series of biosecurity measures. For each animal category, separate feed silos are used, which allows the remains of feed at the bottom of the silos to be eliminated. Separate manipulable material is used for each category of animals on the farm, which prevents moving this material from one barn to another. Showers have been installed for visitors and special clothing is used for each separate barn. Innovative as well is the use of a cooling plate to cool the manure to 15 degrees within the farrowing house. This means a clean climate in and outside the farm, healthy pigs and a better working climate for the employees. Certainly, part of this investment also explains the reduced use of antibiotics.

The results of these biosecurity measures are an improvement in the technical performances of the sow and piglet herd. The number of litters per sow increased by 2%, there are 5% less piglets born dead, the pre-weaning mortality is reduced by 20% and the piglet weight at weaning is 5% higher. The daily growth rate in the rearing phase of the piglets rose by 4%. Due to the higher number of piglets born alive, the use of feed per sow increased by 5%.

The most important effect of the biosecurity measures is the reduction of medicines costs of 50% and of veterinary costs of 20%.

The final result is that, due to the biosecurity measures undertaken by this pig farm, the production costs per kg slaughter weight slightly decline, by 1.3%. The reason is that the increase in productivity of the sows and piglets and the strong reduction of medicines costs compensates for the increase in investment costs related to the higher biosecurity level of the farm.

References

1. Adeyi, Olusoji O.; Baris, Enis; Jonas, Olga B.; Irwin, Alec; Berthe, Franck Cesar Jean; Le Gall, Francois G.; Marquez, Patricio V.; Nikolic, Irina Aleksandra; Plante, Caroline Aurelie; Schneidman, Miriam; Shriber, Donald Edward; Thiebaud, Alessia, (2017). *Final report*. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/323311493396993758/final-report

2. Burkard, C., S. G. Lillico, E. Reid, B. Jackson, A. J. Mileham, T. Ait-Ali, C. B. Whitelaw and A. L. Archibald, (2017): *Precision engineering for PRRSV resistance in pigs: Macrophages from genome edited pigs lacking CD163 SRCR5 domain are fully resistant to both PRRSV genotypes while maintaining biological function*. PLoS pathogens, 13, e1006206.

3. EFSA (European Food Safety Authority) and ECDC (European Centre for Disease Prevention and Control), (2017). *The European Union summary report on antimicrobial resistance inzoonotic and indicator bacteria from humans, animals and food in 2015*. EFSA Journal 2017;15(2):4694, 212 pp. doi:10.2903/j.efsa.2017.4694

4. EIP-AGRI Focus Group on Reducing antibiotics in pig farming, (2014): *Final report* https://ec.europa.eu/eip/agriculture/en/publications/eip-agri-focus-group-reducing-antibiotics-pig

5. EMA annual report, (2016): *Sales of veterinary antimicrobial agents in 29 EU/EEA countries in 2014.* http://www.ema.europa.eu/docs/en_GB/document_library/Report/2016/10/WC500214217.pdf

6. Laanen, M., D. Persoons, S. Ribbens, E. De Jong, B. Callens, M. Strubbe, D. Maes and J. Dewulf, (2013): *Relationship between biosecurity and production/antimicrobial treatment characteristics in pig herds*. Veterinary journal, 198, 508-512.

7. Lunney, J. K., Y. Fang, A. Ladinig, N. Chen, Y. Li, B. Rowland, G. J. Renukaradhya, (2016): *Porcine Reproductive and Respiratory Syndrome Virus (PRRSV): Pathogenesis and Interaction with the Immune System*. Annual Review of Animal Biosciences, 4, 129-154.

8. Mellencamp, M. A., L. Galina-Pantoja, C. D. Gladney and M. Torremorell, (2008): *Improving pig health through genomics: a view from the industry*. Developments in biologicals, 132, 35-41.

9. Segalés, J., E. Mateu, (2006): *Immunosuppression as a feature of postweaning multisystemic wasting syndrome*. The Veterinary Journal, 171(3), 396-397.

10. Suiryanrayna, M. V. and J. V. Ramana, (2015): *A review of the effects of dietary organic acids fed to swine*. Journal of animal science and biotechnology, 6, 45.

11. Van Dixhoorn, I. D., I. Reimert, J. Middelkoop, J. E. Bolhuis, H. J. Wisselink, P. W. Groot Koerkamp, B. Kemp and N. Stockhofe-Zurwieden, (2016): *Enriched Housing Reduces Disease Susceptibility to Co-Infection with Porcine Reproductive and Respiratory Virus (PRRSV) and Actinobacillus pleuropneumoniae (A. pleuropneumoniae) in Young Pigs*. PloS one, 11, e0161832.

12. Yang, F., C. Hou, X. Zeng and S. Qiao, (2015): *The use of lactic Acid bacteria as a probiotic in Swine diets.* Pathogens, 4, 34-45.

13. Zhang, J., Z. Li, Z. Cao, L. Wang, X. Li, S. Li and Y. Xu, (2015): *Bacteriophages as antimicrobial agents against major pathogens in swine: a review*. Journal of animal science and biotechnology, 6, 39.

Challenge: Bio-security

4. Introduction

Biosecurity has been defined as: “The implementation of measures that reduce the risk of the introduction and spread of disease agents; it requires the adoption of a set of attitudes and behaviours by people to reduce risk in all activities involving domestic, captive/exotic and wild animals and their products” (FAO/OIE/World Bank, 2008). Biosecurity measures can be distinguished between those that aim at preventing pathogens from entering into a herd (external biosecurity) and those that limit the dissemination of the pathogen between different animal groups within the herd (internal biosecurity). In the attempt to reduce antimicrobial use in pig farming, the implementation of biosecurity has been pointed out as a notable tool to improve animal health (Laanen et al., 2013). Overall, the three main concepts of biosecurity have been identified as segregation, cleaning and disinfection (FAO and OIE, 2010). Segregation is the main element in biosecurity and has the purpose of minimising the possibility of interaction between infected and uninfected animals. External biosecurity can be established by avoiding possible interactions between vehicles coming from outside and personnel working inside the farm, using fences in case there is risk of contact with wild animals and assigning a separate loading area for moving animals from/to the farm. Internal biosecurity includes measures such as observation of a clear separation between animals of different age groups, isolation of sick animals, storage of dead animals in a separate area and strict separation between dirty and clean areas inside the farm (FAO and OIE, 2010). Cleaning is the second most effective step in biosecurity and the effect of disinfection strictly depends on its strength: only after a proper removal of the organic matter can the disinfectant act effectively. Other biosecurity measures include removal of manure, routine checking of drinking water quality and control of vermin such as rodents and flies (http://www.thepigsite.com/pighealth/article/462/biosecurity/). Observing a period of quarantine before the introduction of new pigs and applying all-in, all-out practice is recommended. Moreover, the physical position of the herd should be designed in a way that a minimal distance from neighbouring herds and frequently used public roads is respected (FAO and OIE, 2010). To assess the biosecurity status of a herd, a risk-based scoring tool, the Biocheck.ugent® (www.biocheck.ugent.be), is available for farmers and practitioners. By using this tool, the biosecurity status of several farrow-to-finish pig herds in Sweden, France, Belgium and Germany has been evaluated in a cross-sectional study; this study revealed that there are significant differences in biosecurity status between European pig herds (Postma et al., 2016). A recent review describes transmission routes of important pig diseases and how biosecurity measures may prevent or reduce transmission between and within pig herds (Filippitzi et al., 2017). Also, the level of implementation of biosecurity measures in different European countries, including Belgium, Denmark, France, Germany, the Netherlands and Sweden, was compared (Filippitzi et al., 2017).

Environmental factors and the size and the structure of a herd have a strong impact on the application of biosecurity measures. Small-scale keepers are likely to be less informed about the legislation and therefore less prone to apply biosecurity measures (Correia-Gomes et al., 2017; Limon et al., 2014). Furthermore, farmers seem to be more interested in implementing preventive measures after they have been educated about the positive consequences on farm performance (Casal et al., 2007; Laanen et al., 2014). Therefore, informing farmers about the positive effect of biosecurity on animal health, welfare and productivity is the first step to improve herd management.

5. Methodology

In order to identify the top five best practices across all the EU PiG regions, a series of criteria has been used, which is able to measure the effectiveness of the collected practices to match the specific challenge.

The following set of criteria has been scored for each practice.

- **Excellence/Technical Quality**
    - Clarity of the practice being proposed
    - Soundness of the concept
    - Knowledge exchange potential from the proposed practice
    - Scientific and/or technical evidence supporting the proposed practice

- **Impact**
    - The extent to which the practice addresses the challenges pointed out by the R- PIGs
    - Clear/obvious benefits/relevance to the industry
    - Impact on cost of production on farm and/or provide added value to the farming business or economy
    - The extent to which the proposed practice would result in enhanced technical expertise within the industry, e.g. commercial exploitation, generation of new skills and/or attracting new entrants in to the industry

- **Exploitation/Probability of Success**
    - The relevance of the practice to each Member State (MS) or pig-producing region/system

- Timeframes for uptake and realisation of benefits from implementation of the proposed practice are reasonable
- Level of innovation according to the Technology Readiness Level (TRL)
- The extent to which there are clear opportunities for the industry to implement the practice/innovation
- Degree of development/adaptation of the practice to production systems of more than one MS

Scores had to be in the range of 0 – 5 (to the nearest full number). When an evaluator identified significant shortcomings, this was reflected by a lower score for the criterion concerned. The guidelines for scoring are shown below (no half scores could be used).

0	The practice cannot be assessed due to missing or incomplete information.
1 – Poor	The practice is inadequately described, or there are serious inherent weaknesses.
2 – Fair	The practice broadly addresses the criterion, but there are significant weaknesses.
3 – Good	The practice addresses the criterion well, but a number of shortcomings are present.
4 – Very Good	The practice addresses the criterion very well, but a small number of shortcomings are present.
5 – Excellent	The practice successfully addresses all relevant aspects of the criterion. Any shortcomings are minor.

The selection of the top five best practices followed the procedure described below:

1. Members of the thematic group (TG) were asked to score all submitted best practices according to the defined guidelines and sent their scoring sheets to the TG leader
2. In addition to the scores, TG members provided brief comments indicating weak points or particular strengths of submitted best practices
3. A conference call was used to discuss the scoring results and select the top five best practices. During this call, the TG agreed to group best practices into different categories. The categories which were considered important and were included in the further selection process were: Animal health information/classification; Pig loading; Rodent and Insect control; Technology and data; Truck sanitation; Pig flow/batch farrowing/separation clean-dirty; ‘BioCheck’ biosecurity assessment tool
4. During the conference call, TG members agreed to continue the process of selecting the top five best practices by voting again, keeping the different categories in mind. TG members ranked the most important categories and selected the top five best practices, representing those most important categories

5. A summary of the ranking of the top five best practices was prepared by the TG leader and sent to TG members. Based on this ranking and the feedback of the TG members, the top five best practices were selected

The following top five best practices within the challenge of biosecurity have been selected by the thematic group:

Title of best practice	**Country**
Health management	Finland
All-in all-out production 7 - 120 kg pigs	Denmark
Strict hygiene management	Belgium
Adoption of Biosecurity Tool	Ireland
Truck disinfection DRYSIST	Spain

6. Results and discussion

6.1. Health management

The Finnish way towards 'Health management': the Sikava register for health classification

To implement health management in the Finnish swine production system, some slaughterhouse companies created Sikava, a health classification register for swineherds. This is a national voluntary register available online (www.sikava.fi), where most of the pig farm owners in Finland share information about their farm health status. The system identifies three different categories of farms based on the fulfilment of specific health and biosecurity criteria: a basic level, a national level and a so-called 'special level', reserved for breeding farms. To reach the national level, the farm needs to prove to be free of enzootic pneumonia (Mycoplasma hyopneumoniae), mange (Sarcoptes scabies), swine dysentery (Brachyspira hyodysenteriae), atrophic rhinitis (toxic Pasteurella multocida) and salmonella (all serotypes). Once the farm meets the selection criteria, it has to maintain its health status. This can be achieved only if a veterinarian visits the farm and performs a control four to six times a year. If, for some reasons, the vet delays the visit for more than seven weeks, an alarm informs the health classification officer, who immediately downgrades the farm to the basic level. The veterinarian makes use of a special form provided by the system to assess the health status at each visit. This form has the purpose of evaluating the animal welfare conditions, freedom from the above-mentioned infectious diseases, presence of clinical symptoms, mortality in different age groups and body conditions scores. Once a year, the health plan of the farm needs to be checked. As a part of the check, the fulfilment of biosecurity procedures is evaluated. Also, the euthanasia methods applied, carcase disposal and routine procedures, such as castration, are evaluated. Additionally, this system allows a good control of the medication usage at the farm: every time the vet medicates animals, he/she can send the data to Sikava via the internet. Most important, the slaughterhouses transfer their meat inspection data to Sikava, making them available for producers. In this way, a direct connection and an efficient data sharing are possible between pig producers and slaughterhouses (https://www.sikava.fi/PublicContent/IntroductionInEnglish).

Costs and benefits: The system showed several successful results. It improved the average daily weight gain by 50 – 70 g. Ivermectin use, mass medication in finishing farms, mycoplasma and PRRS vaccination could be reduced to zero. A reduced pig stress level was observed and, consequently, the possibility of enhancing long-tail pig production increased. Overall, this system encourages the use of preventive health care instead of clinical disease treatments.

Transnational impact: By implementing the health management, a lower antimicrobial usage is needed.

6.2. All-in, all-out production

All-in, all-out production in Denmark

All-in-All-out (AIAO) replacement system in pig production improves pig performance, reduces disease transmission and facilitates the management of the farm (http://www.thepigsite.com/articles/4011/scheduling-allin-allout-swine-production/). AIAO is a measure where the efficacy is based on grouping animals and moving every group into a new empty and disinfected area. Ideally, AIAO should be performed by site; this is not always the case in practice. In Denmark, the Seges Pig Research Centre applies AIAO as follows (www.seges.dk). After farrowing, piglets of 7 kg enter each section and stay in the same pen until slaughter. Pigs are introduced into the pens at one-week intervals. There is no more than two weeks age difference between the pigs in each pen. After the stable is full, no other pigs enter the pens. The pens are emptied over a five-week period. All pigs of the same pen are slaughtered no later than 20 weeks after the first entering in the stable. After emptying of the stable, the entire section undertakes a process of sanitation that implies washing, disinfection and drying. This biosecurity measure has several advantages. Firstly, disease outbreaks can be limited to one section, thus breaking the chain of disease transmission within the farm. Secondly, since animals of the same group have similar nutritional and environmental requirements, this system results in easier management of the animals. Keeping records of feed intake, pig performance and clinical symptoms is easier when grouping the animals.

Costs and benefits: Health herd status has a strong impact on the financial balance of a farm. It is estimated that production value is increased by 20 DKK per produced pig by introducing all-in, all-out in this system. This is related to increased average daily weight gain and improved feed conversion ratio. The cost of establishing AIAO is mainly due to extra costs for materials in order to maintain the barriers between sections.

Transnational impact: AIAO at either section or herd level is possible in all finisher herds in the majority of rearing (7 – 30 kg) herds in Europe.

6.3. Strict hygiene management

Strict hygiene management in Belgium

Among the biosecurity measures defined by 'Good practices for biosecurity in the pig sector' (FAO and OIE, 2010), segregation is considered as the first step to prevent most contamination and disease transmission. Agrafiek foundation (http://agrafiek.be/) awarded a Belgian farmer for the efficient hygiene management in his pig farm. In this farm, a strict separation between the clean and dirty area is maintained. Before entering the farm, workers and visitors need to pass through a hygiene lock. Different footwear and clothes for each animal category are provided. The fattening pigs are delivered in a separate room. In the farrowing pen a container, which can be filled from the inside and emptied from the outside, refrigerates the carcasses and placentas.

Costs and benefits: Strict hygiene management is essential to reduce risk of disease transmission. This results in low morality rate and reduced antimicrobial use.

6.4. Adoption of BioCheck Biosecurity Scoring Tool

Adoption of BioCheck Biosecurity Scoring Tool in Ireland

The Irish Agriculture and Food Development Authority (Teagasc) has adopted the University of Ghent Biosecurity Scoring Tool, the Biocheck.ugent® (www.biocheck.ugent.be), as part of its Advisory Services package to enable farmers to review biosecurity on their farms (https://www.teagasc.ie/media/website/publications/2014/Biosecurity_scoring_of_Irish_farms.pdf). The Biocheck.ugent® scoring system is a science-based questionnaire that can be filled in online and assesses if the adopted biosecurity measures are appropriate.

The questions cover both external and internal biosecurity. The calculation of the score and the associated report are adapted to the herd type. It has been observed that pig farms with a higher score in external and internal biosecurity were also associated with better production and lower antimicrobial usage (Laanen et al., 2013). The questionnaire is organised in a way that every single question is explained in detail, to make sure that the reader is informed about the purpose of the question and, therefore, can give an appropriate answer. Questions on the external biosecurity evaluate the purchase of piglets; transport of animals, removal of manure and carcases; feed, water and material supply; vermin control; and geographical location. Questions on internal biosecurity assess health management; farrowing and suckling period; respect of segregation and compartmentalisation; cleaning and disinfection.

Biocheck.ugent® helps the farmer to gain awareness about the biosecurity status of their pig farm and to identify possible areas of improvement. So far, the Biocheck.ugent® scoring has been carried out for 73 farms (25% of Irish farms) and these farms have been able to identify areas they need to improve on their farms. This will help improve biosecurity and thus pig health and performance, while reducing costs.

Costs and benefits: Improved biosecurity enables improvements in pig health and performance, while reducing veterinarian costs and antimicrobial usage.

Transnational impact: Biocheck.ugent® is a useful tool that can be used to evaluate the biosecurity status of every herd type. It has been used already in several countries, showing international applicability across different farming systems. Making farmers aware of what they can do to implement the biosecurity measures in their farms is the first step to improving pig farming. By applying the appropriate measures, the farmer can ameliorate the health status of the herd and save money on medical costs.

6.5. Increasing external biosecurity by dry truck disinfection DRYSIST

Increasing external biosecurity by dry truck disinfection DRYSIST in Spain

The development of the DRYSIST for truck disinfection results from the collaboration of OPP Group together with CASTAÑE and other pig companies. The DRYSIST technology consists of a heat system that allows truck disinfection without the use of any chemicals, using only dry/heat turbines. Trucks are subjected to a temperature of 37°C for 30 minutes or 75°C for 15 minutes. The most challenging part is to ensure that the heat can reach all the corners of the truck cabin. DRYSIST technology overcame this problem by using previously acquired expertise in bodyworks for farm animal transportation vehicle manufacturing to design a system that transforms the truck cabin into an oven with equal distribution of the steam all over the truck's inner surface. Nine temperature sensors, placed in all corners of the trucks, control the efficiency of the process. Software supervises the process and takes a picture of the truck's licence plate to assign a certificate of disinfection. The company assures that DRYSIST is 100% effective and chemical free (https://globalfoodsafetyresource.com/truck- disinfection-process/).

Costs and benefits: Truck movements can be one of the most important causes of pathogen entry into a farm. For this reason, it is necessary to consider the importance of performing an efficient cleaning and disinfection of vehicles entering the farm. Investment on innovative vehicle sanitation systems that reduce the use of water and time spent by personnel has obvious benefits on increasing biosecurity and, therefore, reducing the risk of disease outbreaks.

Transnational impact: The technology can be easily implemented in other countries. Biosecurity is an important issue on a global scale. For long journeys of transportation, biosecurity is challenged on several occasions. The above-mentioned system can perform a 100% efficient disinfection and deliver a certificate for it, ensuring that all trucks that undertake the disinfection are free of certain pathogens. During periods of disease outbreaks, this system will allow truck companies to prove that they are pathogen-free, thus giving them the opportunity to use their resources for all kinds of livestock since they could lower the contamination risk between species or loads to zero.

6.6. Cost-benefit analysis of the EU PiG Ambassador

The Biocheck Biosecurity Tool, developed by the University of Ghent, has been promoted by the Teagasc Development Department and been adopted by 73 farms in Ireland. With this tool, the pig farms are able to identify the areas, where improvements concerning biosecurity are needed.

An Irish pig farm has been selected which has implemented a series of improvements related to biosecurity. The farm raises 325 sows and produces annually 4,170 fattening pigs.

Some areas were identified as critical (footbaths, filter zones, handwashing facilities, etc). Improvements have also been made in the flow of the animals. This farm had animals in the farrowing house for five weeks: weaners first stage for four weeks, weaners second stage three to four weeks and 12 weeks in the finisher house. The pigs in the first stage were close to the density limit, thus it was decided to build an extra second stage house and move the pigs one week earlier from first to second stage. That removed some pressure from the pigs and performance has improved significantly.

The farmer also did a couple of management changes, such as a decrease in in-feed antibiotics and the removal of ZnO. The reduction in antibiotics and ZnO had consequences in performance initially, but the farm recovered rapidly. For the antibiotics, the animals had eight weeks of in-feed antibiotics (first and second stage weaners) and now is only one or two weeks depending on the time of year.

The results of these biosecurity measures include an improvement in sow performance (pigs sold per sow) by 3.5%, due to more litters per sow (2.75%), and a reduction of pre-weaning mortality (-0.85%). A significant reduction has been achieved in rearing mortality (-13.6%).

As far as the fattening phase is concerned, this pig farm achieved a reduction of finishing mortality of 30.3%, an increase of daily live weight gain of 5.5% and an improvement of the feed conversion rate of 4.9%. The reduction of the use of antibiotics and ZnO further contributed to the better economic performance of this pig farm.

The final result is that, due to the biosecurity measures undertaken by this pig farm, the production costs per kg slaughter weight dropped from €1.66/kg to €1.50/kg which corresponds to a decrease of 9.3%.

References

1. Casal, J., A. De Manuel, E. Mateu and M. Martin, (2007): *Biosecurity measures on swine farms in Spain: perceptions by farmers and their relationship to current on-farm measures*. Preventive veterinary medicine, 82, 138-150.

2. Correia-Gomes, C., M. K. Henry, H. K. Auty and G. J. Gunn, (2017): *Exploring the role of small-scale livestock keepers for national biosecurity-The pig case*. Preventive veterinary medicine, 145, 7-15.

3. FAO/OIE/World Bank, (2008). *Biosecurity for highly pathogenic avian influenza. Issues and options*. Rome. 73 pp.

4. FAO and OIE, (2010). *Good practices for biosecurity in the pig sector. Issues and options in developing and transition countries*. FAO Animal Production and Health. Paper No. 169.

5. Filippitzi, M., A. Brinch Kruse, M. Postma, S. Sarrazin, D. Maes, L. Alban, L. R. Nielsen, J. Dewulf, (2017): *Review of transmission routes of 24 infectious diseases preventable by biosecurity measures and comparison of the implementation of these measures in pig herds in six European countries*. Transboundry and Emerging Diseases, doi: 10.1111/tbed.12758.

6. Laanen, M., D. Maes, C. Hendriksen, P. Gelaude, S. De Vliegher, Y. Rosseel and J. Dewulf, (2014): *Pig, cattle and poultry farmers with a known interest in research have comparable perspectives on disease prevention and on-farm biosecurity*. Preventive veterinary medicine, 115, 1-9.

7. Laanen, M., D. Persoons, S. Ribbens, E. De Jong, B. Callens, M. Strubbe, D. Maes and J. Dewulf, (2013): *Relationship between biosecurity and production/antimicrobial treatment characteristics in pig herds*. Veterinary journal, 198, 508-512.

8. Limon, G., E. G. Lewis, Y. M. Chang, H. Ruiz, M. E. Balanza and J. Guitian, (2014): *Using mixed methods to investigate factors influencing reporting of livestock diseases: a case study among smallholders in Bolivia*. Preventive veterinary medicine, 113, 185-196.

9. Postma, M., A. Backhans, L.Collineau, S. Loesken, M. Sjolund, C. Belloc, U. Emanuelson, E. Grosse Beilage, K. D. Stark, J. Dewulf and M. Consortium, (2016): *The biosecurity status and its associations with production and management characteristics in farrow-to-finish pig herds*. Animal: an international journal of animal bioscience, 10, 478-489.