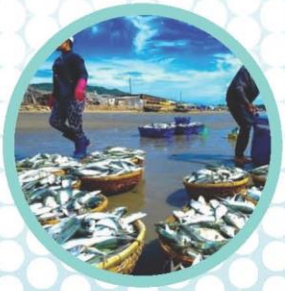

One Health antimicrobial resistance research coordinating workshop

Workshop proceedings

One Health antimicrobial resistance coordinating workshop

Workshop proceedings

7–8 October 2019

Hanoi, Vietnam

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

RESEARCH PROGRAM ON Agriculture for Nutrition and Health
CGIAR
Led by IFPRI

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Welcome message

On behalf of the committee of organizers, we would like to welcome our distinguished guests from Vietnam, Southeast Asia countries and elsewhere to take part in the “One Health antimicrobial resistance (AMR) research coordinating workshop” that is co-organized by International Livestock Research Institute (ILRI), London School of Hygiene and Tropical Medicine (LSHTM) and National Institute of Veterinary Research (NIVR) in Hanoi. We wish good health and happiness to all distinguished guests and participants and wish our workshop a success.

The rise of AMR is a global crisis recognized as one of the greatest threats to human beings today. We are losing our first-line antibiotics. This makes the treatment of a broad range of common infections much more difficult. In fact, AMR is on the rise in every part of the world, especially in low- and middle-income countries where antibiotics are not managed in an effective manner in public health, animal health and environment management.

It is great to see that governments and development partners have put important efforts and resources to combat AMR. However, it is necessary to coordinate these efforts to better synergize and achieve desired impact.

This workshop provides a platform, regionally and locally, to share existing and upcoming initiatives in AMR in Vietnam and Asia and to discuss challenges and opportunities in this area. This will allow us to identify gaps, synergies and overlapping work on AMR research among programs and partners, and discuss collaboration modalities and priorities on AMR research.

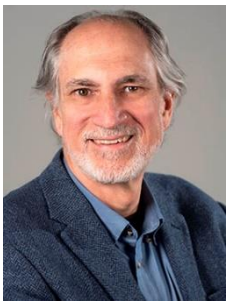
We hope you will have two productive days of interesting discussions. We sincerely wish that this workshop will be a great success not only as a chance to share knowledge and experience in AMR but also as the beginning of a long and fruitful cooperation among partners.

We would like to thank all of you for your participation, in particular those of you who have travelled from far to come to Vietnam. We would like to thank the support of all partners in Vietnam in particular the Ministries, research institutes and universities and donors for the great partnership and support.

On behalf of Committee of Organizers

Hung Nguyen
Regional Representative for East and Southeast Asia
International Livestock Research Institute

Pham Thi Ngoc
Director
National Institute of Veterinary Research



Jeff Waage
Chair, London Centre for Integrative Research on Agriculture and Health and CGIAR A4NH

Acknowledgements

We would like to express sincere appreciation and gratitude to the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH) for the financial support as it enabled the organisation of this workshop.

Big thanks go to the People's Aid Coordinating Committee, Vietnam (PACCOM) for facilitating the organisation of the event.

Appreciation and thanks to the reviewers of abstracts:

- Anders Dalsgaard (University of Copenhagen, Denmark)
- Hung Nguyen (ILRI)
- Johanna Lindahl (ILRI)
- Fred Unger (ILRI)
- Nichola Naylor (LSHTM)

Thanks are also extended to Chi Nguyen, Thanh Nguyen and Hanh Le—ILRI support staff who provided assistance in the workshop preparation, communication, travel and logistic arrangements.

Introduction

Background

Antibiotics and other antimicrobial drugs are among the most important tools available to medical and veterinary professionals for curing human and animal diseases and improving their welfare, yet these drugs are increasingly failing. To tackle antimicrobial resistance (AMR) challenges in low- and middle-income countries and ensure the sustainability of global food and health systems, several initiatives have been developed. At international level, CGIAR Antimicrobial Resistance Hub (CGIAR AMR Hub) and the International Centre for Antimicrobial Resistance Solutions (ICARS) have recently been launched. Fleming Fund has been funding various facilities regionally and nationally to help countries cope with AMR. In addition, AMR is at high-level agenda of development partners such as the United States Agency for International Development (USAID), the World Bank, and United Nations agencies including the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE), and the World Health Organization (WHO).

Objectives

The workshop aims to:

- Share the key international initiatives on AMR research and related programs, and their AMR strategies for Vietnam and Asia;
- Share the AMR national strategy of Vietnam and national programs on addressing AMR in Vietnam and conduct a stakeholder mapping of AMR works;
- Identify gaps, synergies and overlapping works on AMR research among programs and partners, and to discuss collaboration modalities and priorities for collaboration on AMR research;

Date and location

- Location: Pullman Hanoi Hotel, 40 Cat Linh Street, Hanoi
- Date: 7–8 October 2019
- Co-organized by: ILRI, London School of Hygiene and Tropical Medicine and Vietnam National Institute of Veterinary Research
- Funded by: CGIAR Research Program on Agriculture for Nutrition and Health (A4NH)

Workshop program

Time	Activity	Responsibility
Day 1: Monday, 7 October 2019		
08.00 – 08:30	Registration	ILRI
Opening *Moderator: Johanna Lindahl (ILRI)*		
08:30 – 09:15	Welcome remarks • MARD representative • NIVR, Pham Thi Ngoc • LSHTM/A4NH, Jeff Waage • ILRI, Hung Nguyen Stakeholder mapping exercise Group photo	ILRI, Nguyen Viet Hung ILRI, Fred Unger and Johanna Lindahl
Session 1: International initiatives on AMR in Vietnam and Asia *Moderator: Bernard Bett (ILRI), 10 minutes talk and 5 minutes for Q&A each*		
09:15–09:30	CGIAR AMR Hub and AMR research agenda at CGIAR	ILRI, Arshnee Moodley
09:30–09:45	Introduction to the International Centre for Antimicrobial Resistance Solutions (ICARS)	University of Copenhagen (UC), Anders Dalsgaard
09:45–10:00	London-based AMR research London School of Hygiene and Tropical Medicine (LSHTM) and Royal Veterinary College (RVC)	LSHTM, Jeff Waage, Richard Stabler and RVC, Maria Garza
10:0–10:15	Addressing antimicrobial resistance in agriculture in Asia: an overview of the Food and Agriculture Organization (FAO) activities	FAO RAP, Katinka De Balogh
10:15–10:30	Action research in CIRAD: How to promote collective action for antimicrobial use mitigation in South-East Asia	CIRAD, Flavie Goutard
10:30–10:45	Quantification of antimicrobial use and its impact on flock health among small-scale chicken flocks in the Mekong Delta of Vietnam	OUCRU, Nguyen Van Cuong
10:45–11:00	*Coffee*	
Session 2: Key national initiatives on AMR in Vietnam *Moderator: Pham Thi Ngoc (NIVR Director), 10 minutes talk and 5 minutes Q&A each*		
11:00–11:20	Vietnam national action plan on combating AMR in health and agriculture sector	MARD/NIVR, Dang Thi Thanh Son HUPH, Pham Duc Phuc
11:20–11:45	AMR research projects in Vietnam: review	NIHE, Tran Huy Hoang ILRI, Le Trang
11:45–12:30	Panel discussion Vietnam: Future AMR research priorities • Vo Ngan Giang, FHI 360 • Arshnee Moodley, AMR Hub • Pham Thi Ngoc, NIVR • Pham Duc Phuc, Hanoi University of Public Health • Tran Huy Hoang, NIHE • Mattias Larsson, Family Medical Practice	UC, Anders Dalsgaard ILRI, Fred Unger
12:30–13:30	*Lunch*	
Session 3: AMR projects here and there (poster format) *Moderator: Pham Duc Phuc (Hanoi University of Public Heath)*		

13:30–15:00	Poster presentations: short format 1 minute for each project followed by poster walk 1. AMR research in Nong Lam University, HCMC (Vo Thi Tra An) 2. Vietnam National Institute of Nutrition's projects (Bui Mai Huong) 3. Evaluating antimicrobial stewardship policy from a One Health perspective: A conceptual framework for quantitative evaluation (Nicholas Naylor) 4. AMR and whole genome sequencing (Richard Stabler) 5. High prevalence of colonisation with carbapenem-resistant Enterobacteriaceae among patients admitted to Vietnamese hospitals: risk factors and burden of disease (Mattias Larsson) 6. Systems-thinking approach to identify hotspots for AMR emergence and selection, and elucidate pathways of human exposure in selected aquaculture systems in Vietnam (L.A. Brunton) 7. AMU in striped catfish aquaculture in Vietnam (Tran Minh Phu) 8. AMU in shrimp and marine fish farming in Vietnam and concerns about the development of AMR (Trinh Kim Chi) 9. Antimicrobial residues, non-typhoidal *Salmonella, Vibrio* spp. and associated microbiological hazards in retail shrimps purchased in Ho Chi Minh city (Nguyen Thi Phuong Yen) 10. Factors influencing antimicrobial use in pig production: an anthropological research in Bac Ninh province, Viet Nam (Tran Minh Hang) 11. Engaging with complexity for improved veterinary antimicrobial stewardship in Thai Nguyen, Vietnam (Tarni Cooper) 12. AMU and colistin-resistant *E. coli* in pigs and pig farm workers in Bac Ninh province, Vietnam (Dang Thi Thanh Son) 13. The use of antibiotics for therapeutic purposes in pig production in Bac Ninh province, Vietnam (Dinh Thi Phuong Hoa 14. FAO AMR Action Plan: an overview of completed projects under the four thematic areas (awareness, governance, evidence and good practices) (Katinka De Balogh) 15. KAP of livestock and aquaculture producers regarding AMU and AMR in Vietnam (Sinh Dang) 16. KAP with livestock and aquaculture producers, veterinarians, animal drug and feed sellers in Vietnam (Nguyen Thuy Hang) 17. Alternative to antibiotic in pig production: A nanosilver use trial (Hung Nguyen) 18. Piloted AMR surveillance programme in livestock production in Vietnam (Nguyen Thuy Hang) 19. Typology of interventions aiming to tackle AMU in aquaculture systems in low and middle-income countries (Maria Garza)	ILRI, Fred Unger

15:00–15:30	*Coffee*	
15:30–16:30	Panel discussion on AMR in Asia including Bangladesh, Cambodia, Laos and Thailand: short statement on AMR works in each country • Md Abdus Samad, Bangladesh Livestock Research Institute, Bangladesh • Sothyra Tum, National Animal Health and Production Research Institute, Cambodia • Vannaphone Phouthana, National University of Laos, Laos • Katinka DeBalogh, FAO RAP, Thailand • Jing Wang, OIE Tokyo	LSHTM, Jeff Waage ILRI, Johanna Lindahl
16:30–18:30	Side meetings	ILRI, Hung Nguyen
19:00–21:00	Workshop dinner We will arrange vans to pick you up from Pullman Hotel at 6.15 p.m. to Sen Restaurant (Add: 60 Ly Thai To Street, Hanoi), and drop you off at Pullman Hotel after dinner.	ILRI, Thanh Nguyen

Day 2: Tuesday, 8 October 2019		
Research interests, gaps and synergies *Moderator: TBC*		
09:00–09:30	Recap day 1 and priority exercise	
09:30–11:00	Group works to identify research gaps, overlapping areas and synergies • Enhance intersectoral collaboration • How to move from: From assessment to interventions Policy to action	
11:00–11:30	*Coffee*	
11:30–12:30	Group presentation and discussion, summary and closure	
12:30–13:30	*Lunch*	
End of common session		

Session 1: International initiatives on AMR in Vietnam and Asia

Introduction to the International Centre for Antimicrobial Resistance Solutions (ICARS)

Anders Dalsgaard, Lisa Bugge-Toft, Mads Kolte-Olsen, Ghada Zoubiane, Kåre Mølbak, Per Henriksen, Robert Leo Skov*

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Despite recent global efforts to mitigate the impact of antimicrobial resistance (AMR), information and evidence on the effects of AMR on health and the economy have so far failed to be translated into actions in many parts of the world, especially in low and middle-income countries (LMICs). The International Centre for Antimicrobial Resistance Solutions—ICARS— is a new partnership that aims to conduct policy relevant applied research at international, national and local level to identify knowledge and evidence-based solutions in close collaboration with countries and key stakeholders. ICARS will support LMICs to conduct applied research relevant to their local challenges and therefore implementing aspects of their AMR National Action Plans (NAPs). It will aim to bridge the gap between science and policy translating national action plans into evidence based practices on the ground. Projects and activities will aim to build local capacity and capability to sustain and scale up the evidence-based solutions identified. Output will be made accessible and where appropriate in open repositories. ICARS will work internationally as a solution development partnership with projects and activities in various locations around the world. Through its work, ICARS will aim to partner with governmental bodies, policymaker and civil society foundations to support the delivery of the United Nations (UN) General Assembly AMR Resolution agreed in September 2016 and fill some of the gaps in the global response highlighted by the recent recommendations of the UN Inter Agency Co-ordination Group (IACG) on AMR in April 2019. ICARS will operate as partnership, coordinated through, and anchored by, hubs in Denmark, the International Livestock Research Institute (ILRI) based in Kenya, and elsewhere as ICARS expands over time. The partnerships will include research, policy, and technical participation from collaborating countries, academic institutions, and national and international organisations.

London-based AMR research London School of Hygiene and Tropical Medicine (LSHTM) and Royal Veterinary College (RVC)

Jeff Waage[1], Richard Stabler[1] and Maria Garcia[2]

[1] London School of Hygiene and Tropical Medicine, UK,

[2] Royal Veterinary College, UK

The London School of Hygiene and Tropical Medicine is an implementing partner in the CGIAR A4NH programme, contributing public health expertise and experience on AMR in health systems in Asia and Africa to the One Health approach taken by A4NH. In A4NH, our contributions focus particularly on anthropological, economic, policy and genomic research, and link with LSHTM's own interdisciplinary AMR Centre. LSHTM, ILRI and NIVR are developing a genomic-based research project adjunct to existing ILRI projects, involving student and staff exchange plus training and technology transfer. LSTHM collaborates closely with ILRI and with the Royal Veterinary College to deliver its One Health AMR research.

The Royal Veterinary College conducts addresses the AMR challenge adopting an interdisciplinary One Health research approach. RVC leads the GCRF One Health Poultry Hub project, implemented in Vietnam in collaboration with LSHTM and national partners, to address the need to meet rising demand for poultry products while minimising risk to international public health from challenges such as AMR. RVC also leads the AMFORA consortium in collaboration with ILRI, WorldFish, RIA1 and other national partners, aiming to develop a smart approach to investigate human exposure to antibiotic resistance through aquaculture in Vietnam, and to develop a decision-making tool that simulates intervention scenarios to reduce antimicrobial use.

Addressing antimicrobial resistance in agriculture in Asia: an overview of the Food and Agriculture Organization activities

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Countries in Asia have developed their national action plans (NAP) on AMR, based on the Global Action Plan (GAP) on Antimicrobial Resistance (AMR)—the blueprint for tackling AMR developed in 2015 by the World Health Organization (WHO) in coordination with the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE). Countries pledged to strengthen regulation of antimicrobials, improve knowledge and awareness, and promote best practices — as well as foster innovative approaches using alternatives to antimicrobials and new technologies for diagnosis and vaccine development. The collaborative support of UK Fleming Fund (FF) and the United States Agency for International Development (USAID) has been critical in the region and select countries in achieving FAO AMR Action Plan's 4 focus areas which aligns with the WHO's GAP. Activities under each of the thematic areas implemented: 1) Awareness – various AMR awareness campaigns, in partnership with WHO and OIE and government stakeholders from different ministries were implemented and visibility materials produced promoting the prudent use of antimicrobials to preserve their efficacy; 2) Governance - development of multi-sectoral One Health strategies to contain AMR and supported the review of laws and regulations relevant for AMR mitigation through national legal assessments and by identifying areas to be addressed such as regulations on veterinary medicinal products, animal health and production, feed, food safety, pesticides, plant protection, environment, soil and waste, water quality, and institutional coordination, 3) Evidence – in select countries, AMR laboratory capacities were strengthened and pilot projects to generate baseline level data on AMR from bacteria in healthy animals as well reviews on antimicrobial use (livestock, crops, and aquaculture) conducted. Capacity for veterinary drug residues were assessed and harmonized national veterinary drug residue monitoring framework developed and 4) Good practices: a study of producer/veterinarian's knowledge, attitudes and practices on AMU was conducted from which interventions to enhance producer/veterinarian's knowledge through effective communication and practices/support to curb AMU in the countries are enhanced.

Overall, the activities strengthened One Health networks within the country and within the region to collaboratively address AMR. Baseline and preliminary data generated from surveillance, scoping reviews and KAP studies will be used to further improve stewardship of AMU in the animal sector. Data generated, and gaps identified so far could also be used to further inform research to understand the epidemiology of AMR in the region.

Action research in CIRAD: how to promote collective action for antimicrobial use mitigation in South East Asia

F. L. Goutard, M. Bordier, V. Chevalier, C. Ducrot, S. Morand, T.T.H. Pham, F. Roger
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Antibiotic resistance is now a major public health issue, which requires global actions from the international community on governance (states, economic community and international organizations) and from research actors. The Cirad is very well positioned to develop work at the interface between research and surveillance in a typical cross-sectoral approach such as One Health (animal health, human and environment). The Cirad is actually organizing itself through the development of innovative projects in South-east Asia where this problem has become critical.

The major challenge is to rationalize the use of antibiotics in animal husbandry, aquaculture and agriculture to reduce the risk of resistance and the impact on public health. Reducing the use of antibiotics will not systematically result in the reversion of existing resistances because some of them do not entail fitness costs. But on the other hand, this approach is essential to decrease the risk of persistence of certain resistances or the emergence of new ones, and in order to stop the situation worsening.

Objectives are to promote a drastic reduction in the use of antibiotics and, at the same time, to support the implementation of regulatory measures and policies while mitigating the impact of these actions on animal health, farmers' livelihood, public health and biodiversity conservation. This requires the establishment of monitoring and surveillance systems able to assess the effectiveness of these measures from changing practices and emergence of resistance perspectives. Cirad's ambitions are to structure an interdisciplinary research offer at Animal-Environment-Human interfaces - strengthening collaborations with the public health sector - and to propose innovative approaches to support the measures taken by the health authorities.

The support of the different stakeholders will be carried out through research-action projects in collaboration with our partners and, through awareness-raising and training actions on public health issues in the field of antibiotic resistance and reduction of AMU in livestock and agriculture. Methods such as participatory modelling or role-playing approaches will be applied in order to analyze the posture and role of the various players involved in the antibiotic sector (decision makers, agribusiness, salespeople, practitioners, breeders). The aim will be to propose a precise structural analysis of the actors involved, as well as a characterization of the interactions between different sectors and decision-making levels (collaboration mechanisms, communication and decision-making), and to finally identify and the co-develop mutually accepted solutions that can lead to collective action plans.

Quantification of antimicrobial use and its impact on flock health among small-scale chicken flocks in the Mekong Delta of Vietnam

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Background: The Mekong Delta of Vietnam is a hotspot of AMU Small chicken flocks are raised with large quantities of antimicrobials. However, there is a considerable diversity of AMU metrics, and it is not clear how these relate to each other. Furthermore, antimicrobials are often use prophylactically. We performed a longitudinal study on a large cohort of small-scale in the Mekong Delta (Vietnam).

Aims: The aims were: (1) to describe the types and quantities of antimicrobial active ingredients (AAIs) used on flocks; (2) to describe critical time points of AMU; and (3) to compare AMU using different metrics; (3) to investigate the potential impact of prophylactic and therapeutic use of antimicrobials on flock health.

Methods: Data on AMU (qualitative and quantitative), number of chickens in the flock, and clinical signs were weekly collected by chicken farmers using purposefully-designed diaries. A 'prophylactic use' event was defined corresponding with weeks when antimicrobials were used (but not in preceding weeks) and where no clinical signs observed reported in that week or in preceding weeks. A 'therapeutic use' event was defined for weeks when antimicrobials were used (but not in preceding weeks) following the onset of clinical signs. We used regression models and/or ANOVA to estimate of prophylactic/therapeutic use on the outcomes (onset of disease or mortality). We considered the effect of potential confounders including chicken age and AMU during the initial phase (brooding phase) and observation time of clinical signs.

Results: A total of 236 products were used in 102 farms over 203 cycles of production. These contained 42 different antimicrobial active ingredients (AAIs), and 76.2% contained at least one AAI of 'critical importance' according to the World Health Organization. On average, chickens consumed 791.8 (SEM ±16.7) mg/kg at treatment, 323.4 (SEM ±11.3) mg/kg sold, and the treatment incidence was 382.6 (SEM ±5.5) per 1,000 days. AMU was more common early in the production cycle and was highly skewed, with the upper 25% quantile of flocks accounting for 60.7% of total AMU. There was no evidence that prophylactic AMU contributed to a reduction in the subsequent probability of disease in flocks. The impact on therapeutic use on mortality outcomes is under investigation.
Results highlight the high magnitude of AMU in small-scale flocks, and suggest that in these systems AMU reduction efforts should preferentially target the early (brooding) period for prophylactic purposes.

Session 3: AMR projects here and there (poster presentations)

Antimicrobial use in shrimp and marine fish farming in Vietnam and concerns about the development of antimicrobial resistance

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Aquaculture productions are increasing in Vietnam and are important sources of income, employment and food supply in Vietnam. However, diseases problems are hindering sustainable development of the fishery sector and are responsible for overuse of antimicrobials. Antimicrobials are used in aquaculture for both prevention and treatment purposes. Various antimicrobials including human products are used in fish and shrimp culture even for non-therapeutic purposes. The use of antimicrobials in health management of aquaculture farming is of great concern due to possible residues in aquatic products and emergence of antibiotic resistance in pathogenic bacteria. We conducted studies on the use of antimicrobials in shrimp and fish farming and analyzed the quality antimicrobial products. Farmers' knowledge on the use of antimicrobials for their fish and shrimp was also assessed.

Results showed that 20 different antimicrobial products were used for disease prevention and treatment in shrimp and marine fish culture in Northern of Vietnam. Cage fish farmers said they purchased antimicrobial tablets readily available at a local pharmacy and sold for human use. A total of 25 antimicrobial products were obtained from 20 chemical shops to evaluate the quality of antimicrobial products commonly used in white leg shrimp (*Litopenaeus vannamei*) aquaculture in Northern Vietnam. Results revealed that only 1/12 products with a single antimicrobial contained an active substance within ± 10% (accepted level of variation) of the concentration declared on the product label. More than half of the products contained antimicrobial concentrations within < 1.0% to 90% of the declared concentration. The majority of the products provided inadequate or incorrect information on specific diseases to be treated, withdrawal time. The documented poor quality of antimicrobial products and inadequate labeling has negative impacts on effective disease treatment; contribute to development of antimicrobial resistance, and the use of such products is associated with food safety and occupational health hazards. There is an urgent need to strengthen diagnostic services, legislation and control of antimicrobial products in shrimp aquaculture and educate farmers on prudent antimicrobial use practices.

Antibiotic use in striped catfish (*Pangasianodon hypophthalmus*) aquaculture in Vietnam

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Striped Pangasius catfish (*Pangasianodon hypophthalmus*) dominates finfish aquaculture production in Vietnam. Farmed mainly in the provinces of Dong Thap, Can Tho and An Giang in the Mekong Delta, this export oriented industry grew rapidly from 93 thousand tons in 2000 to 1.2 million tons in 2012; a level of production that was maintained in 2018. The combination of intensive production in open farming systems, i.e. influent and effluent water sources are frequently shared and directly used by several adjacent grow-out farms has been linked to frequent disease outbreaks and high mortality rates, mainly of bacterial aetiology. Bacillary Necrosis of Pangasius (BNP) and Motile Aeromonad Septicaemia (MAS) were the most common and economically the most serious diseases experienced by nearly all catfish farmers. Small-scale grow-out farmers reported 1 to 10 episodes per crop whilst large-scale farmers reported 1–5 episodes per crop (mean 3.04). Antimicrobial treatments for 5–7 days are common practice. Amoxicillin, doxycycline, florfenicol and mixture of sulfamethoxazole and trimethoprim are used to treat BNP and MAS.

Thus, innovative approaches include investigating the effectiveness of the mode of application of the vaccine (i.e. immersion instead of manual injection), the alternative replacement of antimicrobials with immune stimulants and the development of fish health management approaches at a regional level (a zonal approach) are needed. In order to enhance the effectiveness of antimicrobials used in disease treatment, antimicrobial therapy for striped catfish should be rationalized. This should be done by evaluating and building up an antimicrobial susceptibility database, and by investigating the pharmacokinetics and pharmacodynamics of common antimicrobials used in striped catfish, e.g. by experimentation and/or by developing modelling approaches that allow extrapolations between different production practices and treatment regimes.

AMR research in Nong Lam University, Ho Chi Minh City

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The impact of AMR on our life is real and very important. Let's have a look at the estimated figure that O'Neill has reported. At present, AMR cause 700,000 deaths per year, more than half of the deaths attributed to traffic accidents. In about the next 30 years, the deaths caused by AMR may increase more than 10-fold at meet the figure of 10 million, even higher than death due to cancer. AMR research contribute to the action plan to provide evidence and raise the awareness for the community to address AMR.

Studies of antimicrobial resistance mainly focus on commensal bacteria and environmental bacteria such as *E. coli, Acinetobacter, Aeromonas, Pseudomonas* and *Stenotrophomonas*. Antimicrobial susceptibility testing was performed from pathogenic bacteria such as *E. coli*, *Salmonella* spp, *Staphylococcus aureus, Pasteurella multocida, Actinobacillus pleuropneumonia, Haemophilus, Ornithobacterium*, and *Clostridium perfringens* isolated from pigs, cows, dogs, chicken or raw material of animal origin (meat, milk).

These studies assess the phenotypic and genotypic resistance, the potential of gene transfer from donor to recipient, the relationship between antibiotic use and level/ risk of resistance. Multi-resistance and mobile elements in spread of resistance genes have also been studied. Factors such as species of animal, type of production were found to influence the level of resistance.

The finance support for research relating to antimicrobial resistance in NLU come from PhD Projects. International organizations from UK, Sweden, USA, The Netherlands also contributed grants for AMR research. National and institutional collaborations also contribute to this issue. Budget from government and institute supported frequently to the researchers but in a limitation.

The research on AMR in Vietnam not only provide information for the proper use of antibiotic in treatment and prevention diseases for animals but also participate to the change in the legislations of the country to meet the regional and international standards.

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Antimicrobial use and colistin-resistant *E. coli* in pigs and pig farm workers in Bac Ninh province, Vietnam

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Antimicrobials seem widely used in Vietnamese pig production and resistance have been reported to a number of antimicrobials. The contribution of antimicrobial resistance (AMR) in pigs and pork to the resistance problems in the human sector is unknown in Vietnam and most other countries. The emergence of colistin resistance in indicator bacteria and bacterial pathogens have been documented in humans and studies have also reported colistin resistance in Vietnamese livestock. The emergence of colistin resistance in Vietnam is of concern because colistin is now a critical antimicrobial used in human medicine, but also because colistin resistance is associated with plasmids which may then transfer to other bacteria, e.g. with other plasmid-associated resistances like ESBL resistance. This study was carried out at 110 pig farms in four districts in Bac Ninh province, Northern Vietnam to understand the current situation of AMU and occurrence of colistin-resistant *E. coli* in pigs and farm workers. About 60% of the 110 interviewed farm workers had inadequate knowledge on AMU, ex. did not recognize AMU and AMR as a potential public health problem. The AMU practices of the farmers were based on their own experiences (56%), advise from local veteterinarians (51%) and veterinary drug sellers (50%). Probably because of experiences with low quality drugs, about a third of the farmers increased the dose of antimicrobials 0.5 to 2 times when treating diseased pigs. A total of 116 pig manure samples and 94 excreta samples from farm workers were collected to determine antimicrobial resistance in *E. coli*. Resistance levels were high for ampicillin (farm workers (72.3%); pig manure (86.2%)); tetracycline (farm workers (72.3%); pig manure (84.5%)); sulfonamides (farm workers (67%); pig manure (82.8%); and trimethoprim (farm workers (64.9%); pig manure (72.4%). Resistance to five or more antimicrobials were seen among 44.7% and 62.1% of the *E. coli* isolates form farm workers and pig manure, respectively. Colistin-resistant *E. coli* was found in 20.2% of farm workers and 45.7% of pig manure samples. Using PCR, the *mcr*-1 colistin resistance gene was found in farm workers (20.6%) and pigs (45.7%). Only one *E. coli* isolated from pig manure carried the *mcr*-3 gene. The *mcr*-2*, mcr*-4 and *mcr*-5 genes were not found. Further molecular studies including whole genome sequencing is needed to determine to what extent pigs and pig farm workers share the same population(s) of colistin-resistant *E. coli*. Studies should also assess how termination of the use of colistin in Vietnamese livestock will impact pig health, farm economy and colistin resistance levels in both the livestock and human sector.

Evaluating antimicrobial stewardship policy from a One Health perspective: a conceptual framework for quantitative evaluation

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Background: Antimicrobial resistance is an issue that requires urgent cross-disciplinary action. Evaluating the full impact of new control measures, such as antimicrobial stewardship (AMS), requires a One Health perspective with multiple angles to account for interacting complexities. To inform the design of future evaluations we performed a literature review to determine what quantitative evaluations for interventions related to cross-sectoral issues, such as climate change, have been utilised previously. Using this evidence, we propose a new framework for the quantitative evaluation of AMS interventions.

Methods: WebofScience, EconLit and Google were searched with combinations of “one health”, “economic”, “evaluation”, “health”, “agriculture” and “climate change”, to collate previous evaluations (date of last search March 2019). Additionally, PubMed was searched with ("one health surveillance economic evaluation” in March 2019), as co-authors were aware of relevant literature in this field. Reference lists were also searched. Literature reviews on AMS impact within human health and agriculture, respectively, were consulted to extract relevant outcomes needed from future AMS evaluations.

Results: 1479 unique abstracts were retrieved from the structured literature search. After two rounds of review (title/abstract and full text), 82 previous evaluations were included directly, alongside 15 previous literature reviews that were included narratively. The most commonly utilised methods included general equilibrium or systems approaches. Proposed outcomes that are useful for AMS-related decision makers include; incidence measures, human morbidity (e.g. disability adjusted life years) and mortality measures, intervention cost to individual sectors and productivity measures (such as impact on Gross Domestic Product). The proposed framework proposes a multi-level-compartmental-model; linking together mathematical epidemiological, microeconomic and macroeconomic impact modelling. This framework allows for the estimation of AMS intervention impact on the aforementioned outcomes.

Conclusion: Quantitative evaluations of AMS policy, utilising the proposed framework, will help stakeholders across the One Health system have the information needed to efficiently tackle the issue of antimicrobial resistance

Systems-thinking approach to identify hotspots for antibiotic resistance emergence and selection, and elucidate pathways of human exposure in selected aquaculture systems in Vietnam

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Aquaculture systems are highly complex, dynamic and interconnected systems influenced by environmental, biological, cultural, socio-economic and human behavioural factors. Intensification of aquaculture production is likely to drive indiscriminate use of antibiotics to treat or prevent disease and increase productivity, often to compensate for management and husbandry deficiencies. Surveillance or monitoring of antibiotic usage (ABU) and antibiotic resistance (ABR) is often lacking or absent. Consequently, there are knowledge gaps for the risk of ABR emergence and human exposure to ABR in these systems and the wider environment. The main aim of this study was to apply participatory systems-thinking approach to map two distinct aquaculture systems in Vietnam – striped catfish and white-leg shrimp –, in order to identify hotspots for emergence and selection of resistance, and human exposure to antibiotics and antibiotic-resistant bacteria, and to compare potential routes of human exposure to antibiotics in these systems. System mapping was conducted by stakeholders at an interdisciplinary workshop in Hanoi, Vietnam during January 2018, and the maps generated were refined until consensus. Subsequently, literature was reviewed to complement and cross-reference information and to validate the final maps. The maps and component interactions with the environment revealed the grow-out phase, where juveniles are cultured to harvest size, to be a key hotspot for emergence of ABR in both systems due to direct and indirect ABU, exposure to water contaminated with antibiotics and antibiotic-resistant bacteria, and duration of this stage. The pathways for human exposure to antibiotics and ABR were characterised as: occupational (at the farm and at different handling points along the value chain), through consumption (of food and water contaminated

with residues and bacteria) and by environmental routes. Further, the participatory mapping process allowed the identification of potential drivers of ABU and interventions associated and of knowledge gaps. By using systems thinking and mapping by stakeholders to identify hotspots we demonstrate the applicability of an integrated, interdisciplinary approach to characterising ABU in aquaculture in order to understand fully the consequences, the relation to emergence and spread of ABR and the public health impact. This work provides a foundation to quantify risks at different points, understand interactions between components, and identify stakeholders who can lead and implement change.

Typology of interventions aiming to tackle antimicrobial use in aquaculture systems in low and middle-income countries

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Aquaculture is the fastest growing food sector in low- and middle-income countries (LMICs). Increased production has been achieved through intensification of aquaculture systems while neglecting aquatic health management. As a consequence, indiscriminate antimicrobial use (AMU) to treat or prevent disease and increase productivity is common, and often compensates for management and husbandry deficiencies. Regulation and enforcement for the responsible use of antimicrobials is often inefficient or absent. Further, there is a lack of a comprehensive framework to understand existing interventions to reduce AMU in the sector. The objectives of this study were to conduct a typology analysis of past, current, and planned strategies and interventions to tackle AMU in selected study countries and to provide an overview of the policy landscape in regard to AMU, focusing on aquaculture systems in LMICs. Initially, scoping discussions with stakeholders informed the selection of countries based on the aquaculture development stage, role of the sector, perceived AMU, initiatives against AMR and access of information, to obtain a good spectrum of representation and representation of aquaculture systems. Individuals with knowledge and/or experience in the design and implementation of interventions in LMICs, in Asia and Africa, were interviewed to (a) gather documentation on the policy and strategy landscape, (b) obtain information to identify suitable elements that inform grouping and categories for the typology analysis, and (c) obtain specific data on strategies to inform the analysis. The typology was framed according to the main purposes of the interventions, namely, (i) reducing AMU, (ii) providing alternatives to AM, and (iii) removing the original cause of the problem, e.g., addressing animal health management. Further, the specific objectives of the strategy or intervention were associated to different drivers of AMU. Additional elements for the analysis included the nature of the intervention (policy, capacity development, behaviour change, market incentives, etc.), key implementers and designers, time frame, geographic and production system scope, strength of intervention, etc. Analysis of the policy landscape revealed differences in policies across the different countries while poor enforcement seems to be common in the cases studied, restricted to market oriented commodities.

In this study, we characterise existing strategies and interventions in aquaculture systems in LMICs to provide preliminary evidence on the effectiveness of strategies and interventions applied in aquaculture. Further, we propose an assessment framework to inform the design and implementation of future interventions, including definition of indicators to monitor impact of interventions.

Antimicrobial residues, nontyphoidal Salmonella, Vibrio spp. and associated microbiological hazards in retail shrimps purchased in Ho Chi Minh City

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Vietnam currently ranks as one of the largest shrimp producers worldwide. However, the presence of associated microbiological hazards such as non-typhoidal Salmonella (NTS), Vibrio spp., virulence genes, and ESBL (Extended Spectrum Beta-Lactamases) as well as their associated antimicrobial resistance but also presence of antimicrobial residues, is largely unknown.

We investigated 40 batches of retails shrimps in different retail sites (including street markets and supermarkets) in Ho Chi Minh City, Vietnam. The presence of antimicrobial residues in shrimp muscle tissue was investigated by Premitest, Charm II and Ultra - High Performance Liquid Chromatography tandem Mass Spectrometry (LC-MS/MS) following a hierarchical approach. A mix of the shrimps' heads and shells was cultured for NTS using ISO 6579-1:2017 and Vibrio spp. following ISO/TS 21872-1:2007. Phenotypic antimicrobial susceptibility was investigated using Vitek (NTS, 34 antimicrobials) and disk diffusion (Vibrio spp., 12 antimicrobials).

A total of 9 (22.5%) samples contained antimicrobial residue, including tetracyclines, fluoroquinolones, and macrolides (in 7.5%, 7.5%, 2.5% and 2.5% of samples, respectively). Shrimp samples from supermarkets had a higher prevalence of antimicrobial residue than those purchased in street markets (50% vs. 13.3%) ($p = 0.049$). A total of 30 (75%) samples were contaminated with NTS. All samples contained Vibrio spp., with V. parahaemolyticus being most common (87.5% samples). A total of 58.9% NTS isolates were multidrug resistant. With regards to the highest priority, critically important antimicrobials, the highest resistance corresponded to quinolones (14.4–47.8%), followed by 3rd and 4th generation cephalosporins (3.3–7.8%). Vibrio spp. isolates were characterized by their high resistance against ampicillin (82.7%) and 3rd generation cephalosporins (8.3–16.5%). ESBL activity was detected in 28.1% V. parahaemolyticus isolates. Half of ESBL-positive V. parahaemolyticus strains harboured $bla_{CTX\text{-}M1}$. We found an association between the presence of residues and the number of resistances for NTS ($p = 0.075$) and Vibrio spp. isolates ($p = 0.093$) from the same sample.

These findings suggest that the presence of residues may contribute to the selection of AMR in foodborne pathogens in shrimps. Authorities should strengthen policies aiming at restricting inappropriate antimicrobial usage in shrimp farms, and step up monitoring of antimicrobial residues and food-borne pathogens at retail in Vietnam.

Engaging with complexity for improved veterinary antimicrobial stewardship in Thai Nguyen, Vietnam

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Objective: Towards finding context-appropriate solutions for antimicrobial stewardship (AMS) in Vietnam, this research aimed firstly, to identify the ways in which livelihood capitals influence AMS in smallholder livestock systems in Vietnam. Secondly, using a participatory approach, it aimed to identify leverage points for intervention for improved AMS.

Materials and methods: Firstly, participatory group interviews identified stakeholders involved in AMS in cases of smallholder pig disease. These findings were used to develop and implement a cross-sectional survey of 82 animal healthcare workers and 210 smallholder farmers in Phu Binh District, Thai Nguyen Province, where smallholders comprise approximately 86% of households. This study aimed to describe how livelihood capitals influence AMS behaviours related to examination, diagnosis, treatment, prophylaxis and animal husbandry. Subsequently, a longitudinal survey followed pig and chicken disease case management on 110 farms for five months. Finally, in September 2018 these data were presented in a series of participatory stakeholder workshops aiming to, first as individual groups and then in a multi-stakeholder workshop, identify leverage points for intervention.

Results: Throughout the research farmers and animal healthcare workers (AHWs) emphasized the significant roles smallholders played in disease management, largely attributed to their human capital and variably, to barriers in engaging with veterinary services. Farmer motivations for using antimicrobials in healthy animals overwhelmingly pertained to disease prevention. Knowledge of stewardship principles was lacking in all stakeholder groups. Over 5 months, 66 cases of chicken disease and 50 pig cases were recorded (individual cases included single or multiple animals with the same signs). Animals were examined by an AHW in fewer than one percent of cases. In cases where antimicrobials were sought, farmers' descriptions of clinical signs were most commonly used by an AHW to make a presumptive diagnosis and recommend treatment. From the final workshops, suggested leverage points spanned disease prevention, diagnosis and treatment and involved different scales and stakeholders. Participants in the workshops were encouraged and surprised at some suggestions of other stakeholder groups (farmers, AHWs and AHWs with a government role) for improving AMS, due to their synergy and at times, replication.

Conclusions: This iterative approach aided a more nuanced, multi-perspective understanding of local constraints and opportunities for AMS. While the ultimate goal may be for all animal healthcare systems to adhere to global AMS standards, our research addresses the question of

how we might support smallholder farmers and animal healthcare workers to make better stewardship decisions within their current livelihoods context.

Key words: Antimicrobial stewardship, livestock, Vietnam, context-appropriate solutions, mixed methods

Food and Agriculture Organization antimicrobial resistance action plan: an overview of completed projects under the four thematic areas (awareness, governance, evidence and good practices)

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The objective of this poster is to describe the activities (research and projects) in Viet Nam relevant to the four thematic areas of the Food and Agriculture Organization's (FAO) Antimicrobial Resistance (AMR) Action Plan (2016–2020), the project objectives and key findings in Viet Nam and in other countries in South East Asia.

Awareness: The FAO Regional Office for Asia and the Pacific developed a toolkit for AMR awareness campaigns. This is updated each year for the World Antibiotic Awareness Week celebrations and ongoing country and regional awareness and advocacy campaigns.

Evidence: AMR surveillance, Antimicrobial Usage (AMU) survey, veterinary drug quality and residue monitoring were piloted in Viet Nam. In brief, antimicrobial susceptibility testing of *Escherichia coli* isolates detected high levels of resistance to aminoglycosides, macrolides, penicillins quinolones/fluoroquinolones, and sulfonamides but relatively lower levels of resistance to cephalosporins, carbapenems and polymixins. These findings appear to coincide with the AMU data collected (same classes), but the top ranking antimicrobial classes reportedly sold for use in livestock were: penicillins, tetracyclines, polypeptides and lincosamides. For the detection of residues (from 720 samples, 6 provinces), depending on the antimicrobial tested, there were inter-provincial and inter-species variations in the proportion of samples that tested positive on ELISA. However, the spectrum of chemical residues tested was limited (3 classes). In chickens tetracycline was the most frequently detected residue, whereas in pork, sulfonamide was the most frequently detected. Quantitative analysis of antibiotics collected from veterinary drug stores shown that 14 out of 144 samples (9.7%) did not have the quantity of active ingredients shown on the labels.

Governance: Viet Nam has completed the review of legislation relevant to AMU and AMR. Specifically, for veterinary medicinal products, the review found that regulations are required to enhance veterinary oversight on AMU (require prescription) and reporting of importation data.

Good practices: A study of the knowledge, attitudes and practices (KAP) indicated that more than half of the producers reportedly use antimicrobials primarily for the treatment of infections. However, there were also preventative uses when the farmers observed clinical signs, changes in environmental conditions and disease situations in adjacent farms. Only one-fifth of producers demonstrated favorable attitudes towards antibiotic use, preventing antibiotic resistance and administering antibiotics remained the preferred countermeasure directly applied by farmers at the first indication of disease.

In other low- and middle-income countries that conducted similar studies, findings on AMU and AMR were relatively similar and gaps in the regulation of VMPs and key drivers of AMU and AMR, likewise, needed to be addressed. These studies serve as a baseline for further work on AMR mitigation in Viet Nam, inform further research to better understand the epidemiology of AMR in the human-animal-environment interface, provide a basis for the necessary regulatory changes in AMU and to further strengthen surveillance and monitoring capacities for AMR, AMU and veterinary drug residues.

Factors influencing antimicrobial use in pig production: an anthropological research in Bac Ninh province, Viet Nam

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Introduction: In Vietnam the use of antimicrobials in livestock general and in pig production in particular has been perceived as not well regulated and practiced. This leads to the over-use of antimicrobials and would contribute to the antimicrobial resistance (AMR) in animals, human and the environment. While many studies have focused on quantification of antimicrobial use (AMU) and AMR profiles resistance in livestock production, much less has been known on how farmers and other actors on the social aspect of the AMU, meaning the drivers and decision leading to the AMU.

Objectives: Our aimed to understand how and why antimicrobials are used in pig production and identify factors that influence the AMU in raising pigs in Vietnam. This study is part of the "Health and Antibiotics in Vietnamese Pig Production" (VIDA-PIG Project), funded by the Danish International Development Agency (DANIDA that addresses the major health issues affecting Vietnamese pig farms.

Methods: The research was conducted in Bac Ninh province, located in the Red River Delta of Vietnam, about 30 kilometers from Ha Noi during the year of 2018 and 2019. The research team conducted 74 in-depth interviews with pig producers, local veterinarians, local authorities, leaders of department of health, veterinarian drug shops, feed shops, veterinarian drug companies, feed companies, organic food stores; 9 focus group discussions with farmers in different farm scale sizes namely small (<20 pigs), medium (<200 pigs), and large farm sizes (>200 pigs). Researchers also had 7 farm stay observations where they stayed 5–7 days in each farm to observe daily pig production activities and pig disease treatments.

Results and conclusions: Our research shows that feeds used in medium and large farms were mainly industrial bran whereas small farms used a mixed feed of leftover food from restaurants and households, proceed feeds by farmer and industrial feeds. Farmers in small farms treated (injection) sick pigs themselves but also used local veterinarians' services when their pigs had serious illnesses. Farmers from medium farms treated sick pigs themselves only. Large farms had their own veterinarians who took care of the herd health.

AMU in pig production was driven by multiple and complex factors such as profits of farmers, profits of veterinary drug shops and companies, meat market price, mass media and policy regulations. Veterinarian played important roles in AMU. The decision over whether or not to prescribe an antimicrobial was influenced by numerous factors relating to the veterinarians' experience, the clinical situation presented, and the profit they may earn from selling veterinary drugs.

This study described the practices of feeding and pig health management in different size farms and examined the factors that influenced the AMU practices and decision of AMU of multiple actors in pig production. The profits of different actors along the value chain is key to AMU.

Key words: AMU, factors influencing AMU, pig production, anthropological research, decision making, Bac Ninh, Viet Nam.

Alternative to antibiotic in pig production: a nanosilver use trial

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Introduction: In Vietnam antimicrobial use (AMU) in livestock production is not well managed. 80% of pork is produced by smallholder farmers where antibiotics used for disease prevention and growth promotion is popular due to its low cost of antimicrobials and lack of farmer's knowledge on the AMU. It was estimated that the AMU for overall consumption of in-feed antimicrobials (for pigs and chicken) was 1,024 tons per year. To reduce the AMU and move forward to a long-term goal of reducing AMU in livestock, an appropriate approach with a clear identification on benefit for farmers when reducing AMU is essential. The objective of this study was to test an intervention at farm level to reduce the AMU and AMR by replacing antimicrobials by nanosilver that is an anti-microbial chemical.

Methods: Six small pig farms from Lap Thach and Tam Duong district, Vinh Phuc province were selected. Sixty 35 days old piglets from Vinh Phuc pig breeding center were obtained for this study. In each farm, 10 piglets randomly divided into two groups of five were raised in two pig housing plots. Both groups were fed with the same quantity of pig feed produced by Tan Viet company. In the control group, feed was added with Amoxicillin at 300ppm which reflected the business as usual of pig production in Vietnam. In the intervention group, feed was antibiotic-free but added with nanosilver (Sinavet 01 (Nano-san plus) commercialised product in the market) at 0.3% per kg of feed. Pigs were raised for 4 months from August to December 2018. We measured the pig weight at the experiment start (T0), after 1 month (T1), 2 months (T2) and 4 months (T4) to calculate the Average Daily Gain (ADG). 124 pooled pig fecal and floor samples (from 3 individual samples each) were taken from 6 farms monthly to analyse the resistance profile of E. coli. Antibiotic residues in 12 pork carcasses at sale were analysed. Quantity of feed use, price and body weight of pigs at sale were recorded. Farmers were asked to manage and record pig health (sickness, treatment) as they practice normally without any influence of research team.

Results and conclusions: The pig weight varied from 11.3 to 11.8, 22.8 to 28.6, 43 to 59, 84 to 111.6 kg/pig at T0, T1, T2 and T4. No significant difference in ADG was observed between the control and intervention group at all times of measurement ($p>0.05$). Prevalence of E. coli in both fecal and floor samples was 100%. Testing susceptibility with 10 commonly used antibiotics in Vietnam revealed high resistance rates of 100% to Vancomycin and Penicillin G, followed by Colistin (97.6%), Ampicillin (97.4%), Trimethoprim (93.0%), Tetracycline (92.1%), Florfenicol (88.9%) Doxycycline (86.0%) and Neomycin (75.4%). There was no significant difference in AMR profile of E. coli between the control and intervention group. No antibiotic residue was found in pork from the intervention group. One (out of six) pork sample of the control group was detected to have Amoxicillin at 26.3 µg/kg (vs. 50 µg/kg as MRL for Amoxicillin in pork) for a withholding period of seven days.
In conclusion, the use of nanosilver as replacement of antibiotic added to the feed showed no difference in ADG, nor in AMR profile of E. coli in a small-scale pig production. These trial results are encouraging to potentially offer an alternative to antibiotic use in pig production to reduce AMU and AMR. An environmental impact assessment of nanosilver is needed before scaling up this use

Key words: AMU, AMR, alternative, pig production, nanosilver, trial

The use of antibiotics for therapeutic purposes in pig production in Bac Ninh province, Vietnam

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Introduction: Antibiotics (AB) are currently threatened by the emergence of antibiotic resistance (ABR), leading to a lack of options to treat infectious diseases in people, livestock and aquaculture. Thus, it jeopardizes human health, animal health as well as food and nutrition security. In Vietnam, the pig sector contributes a considerable part to the overall amount of AB used (ABU) in food animal productions, leading to AB residue in pork and an increased risk of ABR. This study aimed at understanding the practices of using antibiotics in pig farms for disease treatment in Vietnam.

Methods: The research was conducted in Bac Ninh province in 2018 and 2019. We selected 110 pig farms from different farm scale sizes namely small (<20 pigs), medium (<200 pigs), and large farm (>200 pigs). Data on household socioeconomics, pig production system, farm management and the use of antibiotic, knowledge, attitude and practice of ABR and ABU and were collected by questionnaire to the owner or worker of these pig farms. Farmers were also interviewed on pig health management (diagnose and treatment) with antibiotic. A record system was set up with 110 record books on ABU for therapeutic use at pig farms where farmers are trained and asked to record the quantity, purpose, duration of the use and the type of antibiotics during 4 months from September to December 2018.

Results and conclusions: The survey shows that the majority (82%) of farmers did not know about the banned antibiotics. 50.9 % of them did not know the overuse of antibiotics in pig production can affect human health. 34.5 % of farmers said they followed the instruction of the drug use, 34.5% did not while 30.9% of farmers followed the veterinarian advices. When using antibiotics to treat sick pigs, 30.9% indicated that they increased the dose while 3.4% decreased the dose. 80% of farmers bought antibiotics at vet drug stores; 38.2% took antibiotics from local veterinarians or para-vets whereas 8.2% purchased antibiotics from marketing staff of vet drug companies. Educational level, working experiences were identified as factors to be significantly associated with knowledge of farmers while influencing factors of practices were gender and knowledge ($P<0.05$).

The findings from the records book revealed that antibiotics were used for therapeutic purpose at 77 farms (70%). Of those 77 farms, 53.2% were shown to have correct practices and 46.8% incorrect practices in using antibiotics for treating sick pigs. During the observation, antibiotics were used 97 times, including 45 different types of antibiotics divided into 9 groups of antibiotics. Of those 97 times, increased the doses were recorded 43 times (44.3%) and decreased the doses were seen 2 times (2.6%). However, we did not know whether the use of AB of pig farmers for therapeutic purpose were necessary or not.

Our study shows that the use of antibiotics for therapeutic purpose in pig production was common in Bac Ninh. Most of the use was not appropriate as farmers increased the doses, treated sick pig themselves without diagnose or without seeking help from a veterinarian. These results would be useful to plan trainings and interventions to improve farmers' KAP on AB use in pig production.

Key words: Antibiotic use, Bac Ninh province, pig farms, therapeutic purpose, Vietnam.

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