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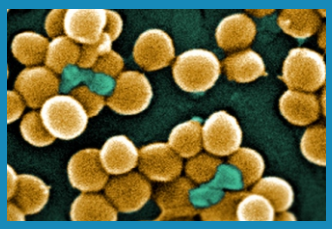
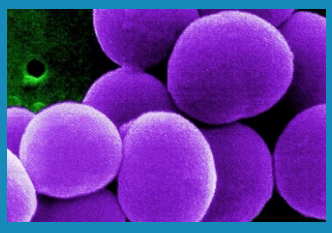
# Technical Report

# An Ecohealth Approach to Develop A Strategy for The Prudent Use of Antimicrobial to Control Antimicrobial Resistance in Human, Animal, and Environmental Health in Indonesia





## Collaborative Work
## Indonesia, China, LAO-PDR, Thailand, Vietnam

2017

# An Ecohealth Approach to Develop a Strategy for the Prudent Use of Antimicrobials to Control Antimicrobial Resistance in Human, Animal, and Environmental Health in Indonesia

A Collaborative Research Project

among

Indonesia, China, Lao PDR, Thailand and Vietnam


Country Team Leaders

| | | |
|---|---|---|
| Drh. M.D. Winda Widyastuti, M.Si (Regional Team Leader) | Indonesia | Center for Indonesian Veterinary Analytical Studies (CIVAS) |
| Dr. Fang Jing | China | Institute for Health Sciences, Kunming Medical University |
| Dr. Boualam Khamlome | Lao PDR | Department of Disease Control, Ministry of health |
| Dr. Suvichai Rojanasthien | Thailand | Faculty of Veterinary Medicine Chiang Mai University |
| Dr. Nguyen Viet Khong | Vietnam | National Institute of Veterinary Research |

## Indonesia Researcher Team

| No. | Name | Afiliation | Expertise |
|---|---|---|---|
| 1 | Maria Digna Winda Widyastuti (DVM, M.Si) | Center for Indonesian Veterinary Analytical Studies (CIVAS) | Veterinary Public Health, Community Engagement |
| 2 | Agus Suwandono (MD, Ph.D, SP.MK) | Professional Consultant; Ministry of Health | Public Health Policy Research Development |
| 3 | Anis Karuniawati (MD, Ph.D, Sp.MK) | Department of Microbiology, Faculty of Medicine, University of Indonesia; The Secretary of National Committee on Antimicrobials Resistance Control and Prevention (KPRA), Ministry of Health | Public Health, Microbiologist |
| 4 | Edi Basuno (Drs, M.Phill, Ph.D) | Professional Consultant; The Center for Agriculture Socio-Economics and Policy Studies (ICASEPS), Ministry of Agriculture | Socio Economic, Agriculture Policy Research, Community Engagement |
| 5 | Anak Agung Gde Putra (DVM, SH, M.Sc, Ph.D) | Professional Consultant; Disease Investigation Center of Denpasar, Ministry of Agriculture | Veterinary Epidemiology, Zoonoses and Economic |
| 6 | Iwan Willyanto (DVM, M.Sc, Ph.D) | Professional Consultant; INI Veterinary Services | Veterinary Public Health, Small Animal Health Services |
| 7 | Hadri Latif (DVM, M.Si, Dr.med.vet) | The Veterinary Medicine Faculty, Bogor Agricultural University; Center for Indonesian Veterinary Analytical Studies (CIVAS) | Veterinary Public Health, Risk Analysis |
| 8 | Imron Suandy (DVM, MPVH) | Directorate of Veterinary Public Health, Directorate General of Livestock and Animal Health Services (DGLS), Ministry of Agriculture | Veterinary Public Health, Veterinary Laboratory for Animal Product Origin |
| 9 | Andri Jatikusumah (DVM, M.Sc) | The Food and Agricultural Organization of the United Nations (FAO); Center for Indonesian Veterinary Analytical Studies (CIVAS) | Veterinary Epidemiology and Economic |
| 10 | Ridvana Dwibawa Darmawan (DVM) | Center for Indonesian Veterinary Analytical Studies (CIVAS) | Veterinary Medicine and Geospatial Information System |
| 11 | Sunandar (DVM) | Center for Indonesian Veterinary Analytical Studies (CIVAS) | Veterinary Medicine and Database Program Development |
| 12 | Riana Aryani Arief (DVM, M.Sc) | Center for Indonesian Veterinary Analytical Studies (CIVAS) | Veterinary Epidemiology |

## Field Team

| No. | Name | Educational Background |
|---|---|---|
| 1 | Dina Wurinaharumah (DVM) | Veterinary Medicine |
| 2 | Patricia Noreva (DVM) | Veterinary Medicine |
| 3 | Asih Tri Hastuti (S.Pt) | Veterinary Medicine |
| 4 | Nenni Septyaningrum (SKM) | Public Health |
| 5 | Aditama Putra Destiyanta (SKM) | Public Health |
| 6 | Ade Nurma Ruditya (SKM) | Public Health |

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# I. Introduction

## 1.1. Background

Antimicrobials, particularly antibiotics have played a very important role in human and veterinary medicine. Antibiotics are used as the main therapy for treating bacterial infections because of its capability to kill or obstruct bacterial growth.

For almost six decades, antibiotics have played a significant role in reducing the burden of infectious diseases in the world; however its effectiveness against pathogenic bacteria is declining in the last two decades. Bacteria have learned to adapt and mutate, and develop resistance against one or more classes of antibiotics. As a result, medication is becoming more difficult, which leads to reduced income and loss of human lives.

Antimicrobial resistance is a now global issue in both human and animal health. Overuse and misuse of antibiotics in both sectors are driving this problem. Only few countries have good policies regulating antibiotic usage. In developing countries such as Indonesia, antibiotic monitoring and law enforcement is weak, resulting in overuse, unsupervised and imprudent sale and use of antibiotics. This is then exarcebated with a lack of public knowledge on how to use antibiotics and poor prescription practices by some medical practicioners.

In animal production, antibiotics are used for growth promotors, preventive measures and therapeutic medication. In Europe, the amount of antibiotics used in animals is 1.5 times of that used in human medicine. Meanwhile in the United States, 70% of all antibiotics are used for growth promotors in animal production. The high usage of antibiotics in non-therapeutic practices in livestock increases the risk of bacteria developing antimicrobial resistance. The presence of resistant bacteria reduces the efficacy of commonly used antibiotics, such as penicillin and tetracycline.

In developing countries, overuse of antibiotics in animal production is suspected to be worse due to poor monitoring, weak law enforcement, limited availability of animal health services, and farmer's lack of knowledge. This problem is present in all types of animal production, particularly in poultry and swine. In these animals, antibiotics are used extensively and unregulated, increasing the risk of resistant bacteria emerging in farms and leaving drug residues in animal products.

This problem could be found particularly in poultry and pig farms where antibiotics are used extensively and often times abused. Poor practices increase the risk of resistant bacteria emerging in farms and drug residues contaminating products. With the current high level of poultry and pork meat consumption, more public health issues could occur due to new emerging zoonotic or food-born diseases related to resistant bacteria.

Antimicrobial resistance is a complex, multi-dimensional and multi-factorial problem which involves various socio-economical levels of the community from farmers, public and private industries, consumers to decision makers at local, regional, and national levels. Therefore, a trans-disciplinary approach and a wide range of stakeholders must be involved to solve this problem. The integration of veterinary science and human public health, epidemiology and socioeconomics are important elements to develop and recommend solutions and strategies.

## 1.2. Goal and Objective

The goal of this project is to explore, develop, and assess the effectiveness of a strategy for the proper use of antimicrobials in humans and animals to control antimicrobial resistance in Indonesia using an ecohealth approach. Specifically, the objectives are:

1. To describe and assess the current AMR situation in veterinary and human medicine.
2. To assess the economic aspect and factors influencing decisions related to antibiotic use in farms.
3. To study the resistance of E. coli against commonly used antibiotics in humans, animals and the environment.

4. To identify, develop, and implement potential intervention strategies for improving health of the public, farmers, and the environment.
5. To provide information and recommendation to policy makers based on results of the study on the importance of prudent use of antibiotics.

## 1.3. Output

This research project is expected to provide the following outputs:

1. Systematic review and stakeholder mapping of the antimicrobial control system in Indonesia.
2. An overview of antibiotic use and accessibility in public and animal health.
3. Assessment of knowledge, attitude and practice of medical personnel, farmers and public regarding antibiotic use and accessibility.
4. Overview of the economic value of antimicrobial use in farms.
5. Overview of antimicrobial resistance in humans, animals, and the environment in studied farms.
6. Identification of factors influencing the use of antimicrobials in farms and the public for the development of potential intervention strategies / program.
7. Recommendation for policies on prudent antimicrobial use with ecohealth approach.

# II. Project/Research Organizational and Methodology

## 2.1. Conceptual Framework and Ecohealth Approach

This project consists of an explorative research and intervention to provide recommendations on policies for regulating antibiotic use in livestock and human with an ecohealth approach. There were five aspects that explored in this project (Figure 1), which are (1) the system (including the legal system, market system, farming system, etc), (2) knowledge, attitude, practices, drug accessibility, and factors influencing use or non-use of antimicrobial agents in the general public and by farmers, (3) socio-economic aspect of antimicrobial use in common practices, (4) engagement of farms as the intervention part of the study, and (5) disseminate the results of the research to policy makers and stakeholders in hopes that the evidence will be used as a basis for policy.

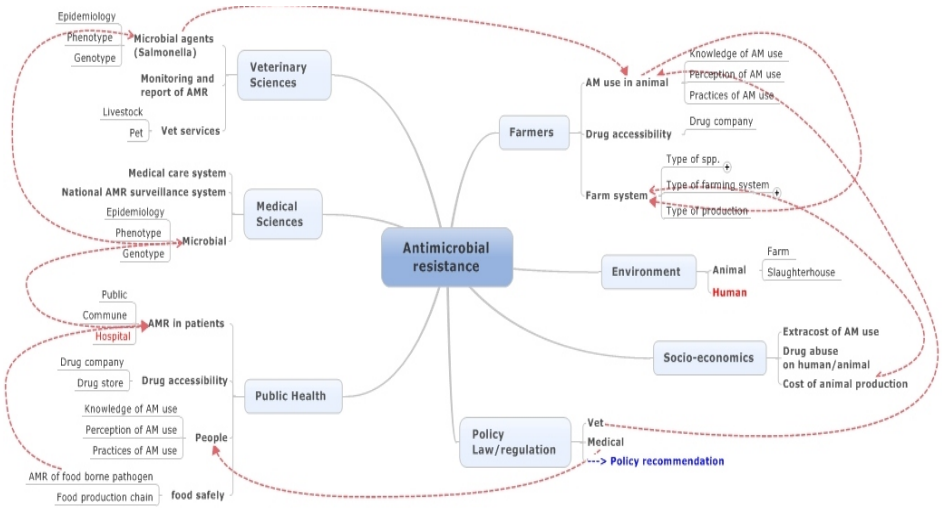



**Figure 1. Conceptual Framework of the Project**

Due to the complexity of the antimicrobial resistance, an ecohealth approach (ecosystem to health) is considered the best approach to help tackle the issue. Six principles of ecohealth are (1) systems thinking, (2) transdisciplinarity, (3) community participation, (4) gender equity, (5) sustainability, and (6) knowledge to action.

## 2.2. Project Design

The research project was divided into 3 phases, which were (1) study phase, (2) intervention phase, and (3) dissemination-advocacy phase (Figure 2). The study phase consisted of desk study and baseline survey on antibiotic regulation, accessibility, and use, and knowledge, attitude and practices of farmers, doctors, and the general public. The intervention phase was built on local specific needs with a bottom-up and top-down method in several pilot targets, and an antibiotic sensitivity survey was also conducted on E. coli bacteria isolates collected from people, animals, and the environment in farms. The third phase was disseminating results of the first and second phase and providing local data to support or provide recommendations for policy makers. Advocating policies requires a step by step, gradual, and continuous process, and is actually conducted since the start of the project at local and national level.

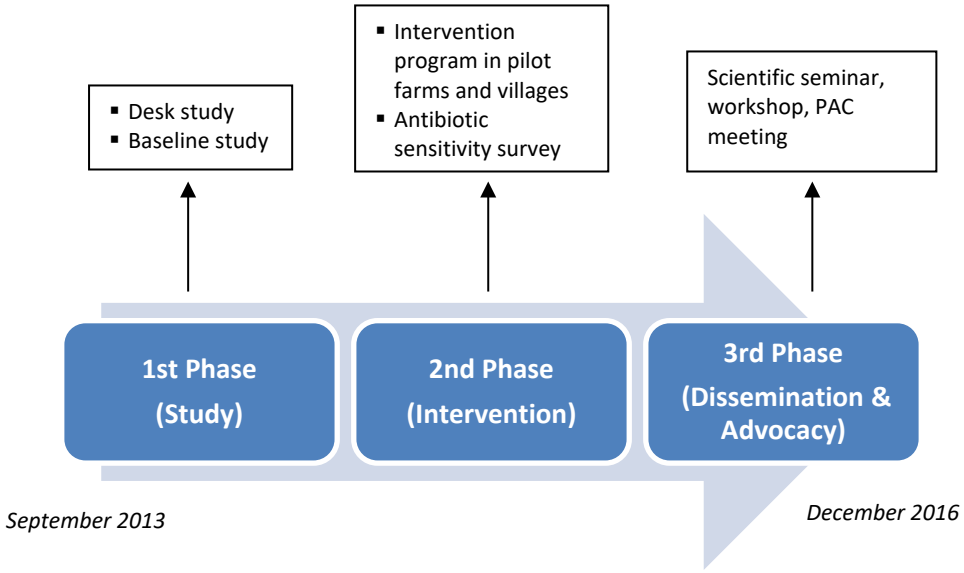



**Figure 2. Phases of Project Activities**

## 2.3. Time, Location, and Target Communities

The project was conducted for 3 years, starting in September 2013 until December 2016, in Sukoharjo, Klaten and Karanganyar districts in Central Java Province. These districts were selected because (1) they have large populations of layer chickens and pigs and farms of all sizes can be found (2) each district has adequate public health facilities in villages and subdistricts; and (3) locations were logistically feasible. Layer chickens and pig production were selected in this project because antibiotic use in both production systems is generally quite high in many Asian countries. Target communities at national level are the Ministry of Agriclture and Ministry of Health. At local level, we worked with layer chicken and pig farmers, people who use public healthcare facilities and animal health and public health personnel at village, subdistrict, and district levels.

## 2.4. Administration and Ethical Clearance

This research project was conducted in collaboration with animal health services and public health services in Central Java Province and the 3 districts. Activity permit for this project was obtained from provincial and district National Unity and Political Agencies of the Ministry of Internal Affairs every 3 months. Ethical clearance for the research was obtained from the Health Research and Development Center of the Ministry of Health on an annual basis.

## 2.5. Methodology

### 2.5.1. Study Phase

#### A. Literature Review

A literature review was conducted to collect information on antibiotic production, use and resistance in Indonesia in both animal and public health sectors. Objectives of this study were:

1. To describe antibiotic production, distribution, and monitoring and surveillance system, and the role of various stakeholders involved
2. To identify strengths, gaps, and opportunities to develop future strategies and capacity strengthening activities for stakeholders

The study was carried out by collecting 3 types of data, which are (1) regulations of antimicrobials, such as laws, directives, manuals, guidelines, standards; (2) local and international research/study results related to antibiotic use and resistance in the last 10 years; and (3) documents, study results, and guildelines on possible intervention strategies for antimicrobial use and resistance. From the information, we conducted stakeholder mapping and a systematic review on antimicrobial regulation. Gap analysis was conducted to evaluate the current situation and identify strengths, gaps and opportunities.

#### B. Baseline Survey

A cross-sectional survey was conducted in layer chicken farms, pig farms, and public medical facilities to collect baseline data on antibiotic use and accessibility in the animal and public health sector. The objectives of the survey were:

1. To describe how antibiotics are used and accessed in animal and public health sectors
2. To identify factors influenceing the decision of using or not using antibiotics in farms and by the general public
3. To measure the economic value of antibiotics in farms
4. To measure knowledge, attitude and practices related to antibiotic use and resistance

A total of 40 layer chicken farms, 40 pig farms, 40 Community Health Centers, and 14 hospitals in all 3 districts were visited in this survey. Farms were randomly selected using Probability Proportional to Size (PPS), while all community health centers and hospitals in the district were included in the study. The interview was conducted by enumerators using a structured questionnaire. Farm owners or managers were interviewed to collect information on farm practices. Meanwhile, for human medical practices we interviewed 54 doctors, 54 patients, and 77 farm workers from both layer and pig farms.

### 2.5.2. Intervention Phase

#### A. Intervention Program in Pilot Farms and Communities

The objective of the action research was to formulate, develop and test applicable strategies for improving prudent use of antibiotics and prevent antimicrobial resistance in animal and public health based on information obtained in the previous phase. Strategies were developed for the intervention program in (1) farms and (2) communities. We selected 15 pilot farms, consisting of 9 pig farms and 6 layer chicken farms, and 4 pilot villages to represent animal health and public health sectors, respectively. Detailed information on the location of pilot farms and villages is shown in Table 1.

**Table 1. Location of Pilot Farms and Villages for the Intervention Program**

| No. | District | Pilot Farm | | Pilot Village |
|---|---|---|---|---|
| | | Pig Farm | Layer Chicken Farm | |
| 1 | Sukoharjo | ▪ 1 farm in Cangkol village, Mojolaban subdistrict<br>▪ 1 farm in Gadingan village, Mojolaban subdistrict | ▪ 1 farms in Polokarto village, Polokarto subdistrict<br>▪ 1 farm in Cangkol village, Mojolaban subdistrict | 1. Cangkol village, Mojolaban subdistrict<br>2. Polokarto village, Polokarto subdistrict |
| 2 | Klaten | ▪ 2 farms in Titang village, Jogonalan subdistrict<br>▪ 3 farms in Somopuro village, Jogonalan subdistrict | 2 farms in Titang village, Jogonalan subdistrict | Somopuro village, Jogonalan subdistrict |
| 3 | Karanganyar | 3 farms in Ngringo village, Jaten subdistrict | 2 farms in Sroyo village, Jaten subdistrict | Sroyo village, Jaten subdistrict |
| **Total** | | 10 | 6 | 4 |

Outcome Mapping (OM) was adopted to plan, develop and evaluate the intervention program. We selected farmers, animal health officers, village health cadres, and public health officers as boundary partners in the intervention program. Boundary partners are local partners with potential to continue the program in the future.

There are 4 steps to the intervention program (Figure 3). The first step uses focus group discussions and interviews with boundary partners to identify specific local issues and build ownership to the program. The second step increases the knowledge and skill of boundary partners. The third step consists of boundary partners conducting activities in the community and providing technical support. The fourth step was monitoring and evaluation to adjust the program if necessary.

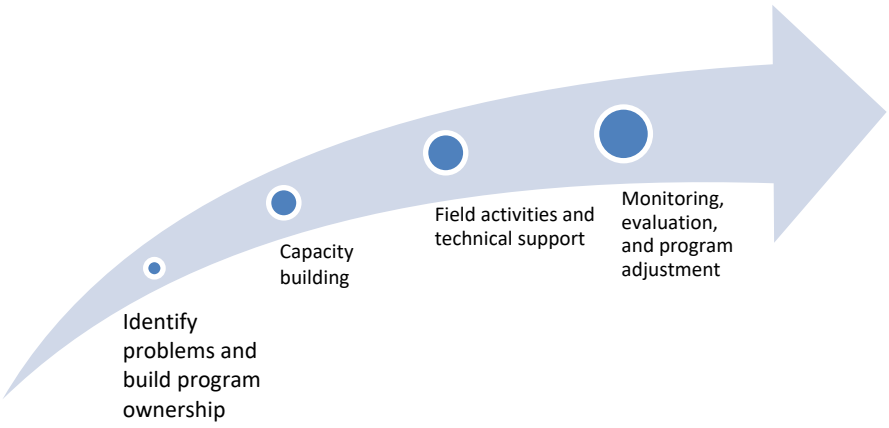



**Figure 3. Steps of the Intervention Program**

## B. Antibiotic Resistance Survey

Samples were collected from 3 districts: Klaten, Sukoharjo and Karanganyar. In each district, 3 villages with the largest small-scale swine and layer chicken population were selected. Three small-scale swine and 3 layer farms were selected from those villages. A small scale pig farm is a farm with

less than 1000 pigs, meanwhile a small scale layer chicken farm is a farm with less than 10,000 layer hens. Fecal samples were collected from animals, farm workers and people living with farm workers. Environmental samples in the form of liquid waste were also collected.

E. coli was isolated and identified from all samples. Phenotypic susceptibility of E. coli isolates against 10 antimicrobial agents was tested with disk diffusion on Muller-Hinton agar, following guidelines in Clinical and Laboratory Standards Institute (CLSI) 2012 and 2013. The list was compiled from a recommended list published by the World Organization for Animal Health after recording the most commonly used antibiotics in farms and humans from our baseline survey (OIE, 2010). The susceptibility level of E. coli isolates was classified into sensitive, intermediate and resistant based on the inhibition diameter, measured according to CLSI guidelines. See Table 2 for the list of antimicrobial agents used for testing antmicrobial susceptibility.

**Table 2. List of Antibiotics Used for Susceptibility Testing Using Disk Diffusion**

| No | Antimicrobial group | Antimicrobial agent | Disc content (µg) | Inhibition Diameter Interpretation Standards (mm) | | | |
|---|---|---|---|---|---|---|---|
| | | | | S* | I* | R* | E. coli ATCC 25922 |
| 1 | β-Lactam | Ampicillin (AMP) | 10 | ≥17 | 14-16 | ≤13 | 16-22 |
| | | Amoxicillin-clav acid | 20/10 | ≥18 | 14-17 | ≤13 | 18-24 |
| 2 | Cephalosphorin | Cephalotin (KF) | 30 | ≥18 | 15-17 | ≤14 | 15-21 |
| | | Ceftriaxone | 30 | ≥21 | 14-20 | ≤13 | 29-35 |
| 3 | Aminoglikosida | Gentamicin (CN) | 10 | ≥15 | 13-14 | ≤12 | 19-26 |
| 4 | Quinolon | Ciprofloxacin | 5 | ≥21 | 16-20 | ≤15 | 32-40 |
| | | Levofloxacin | 5 | ≥17 | 14-16 | ≤13 | 22-28 |
| 5 | Phenicol | Chloramphenicol (C) | 30 | ≥18 | 13-17 | ≤12 | 21-27 |
| 6 | Potentiated Sulfonamides | Trimethoprim-sulfamethoxazole (SXT) | 1.25/ 23.75 | ≥16 | 11-15 | ≤10 | 15-23 |
| 7 | Tetracyclines | Tetracycline (TE) | 30 | ≥19 | 15-18 | ≤14 | 18-25 |

*) S: sensitive; I: intermediate; R: resistant

A total of 16 isolates were later selected for genotyping using PCR. Isolates were tested for resistant genes aadA2, aphA1-lab, blaCMY-2, blaPSE1, blaTEM, oxa2, sul1, strA, TetA(B), Class 1 integron and Class 2 integron.

Susceptibility testing of animal and environmental samples were conducted in Wates Disease Investigation Laboratory in Yogyakarta, meanwhile testing of human samples were conducted in the Microbiology Laboratory of Dr. Muwardi Hospital in Sukoharjo. Further genotyping of isolates was conducted in the Microbiology Laboratory of the Faculty of Medicine, University of Indonesia, Jakarta.

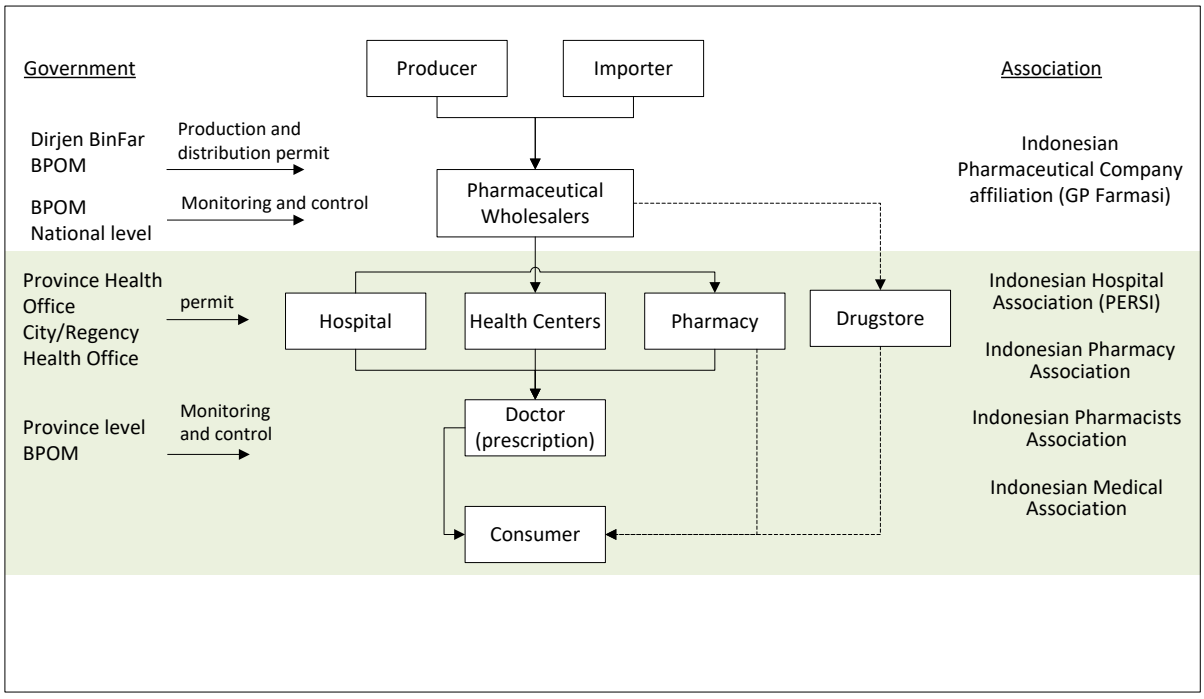
### 2.5.3. Dissemination and Advocacy Phase

The aim of this phase is to increase awareness and encourage behavior change in stakeholders by sharing project results and recommendations. This process was carried out throughout the first and second phase as routine updates were given to the Project Advisory Committee (PAC) and local government stakeholders. A dissemination workshop was also conducted to share project results to all stakeholders involved.

# III. Project Activities and Key Result Findings

## 3.1. Literature Review

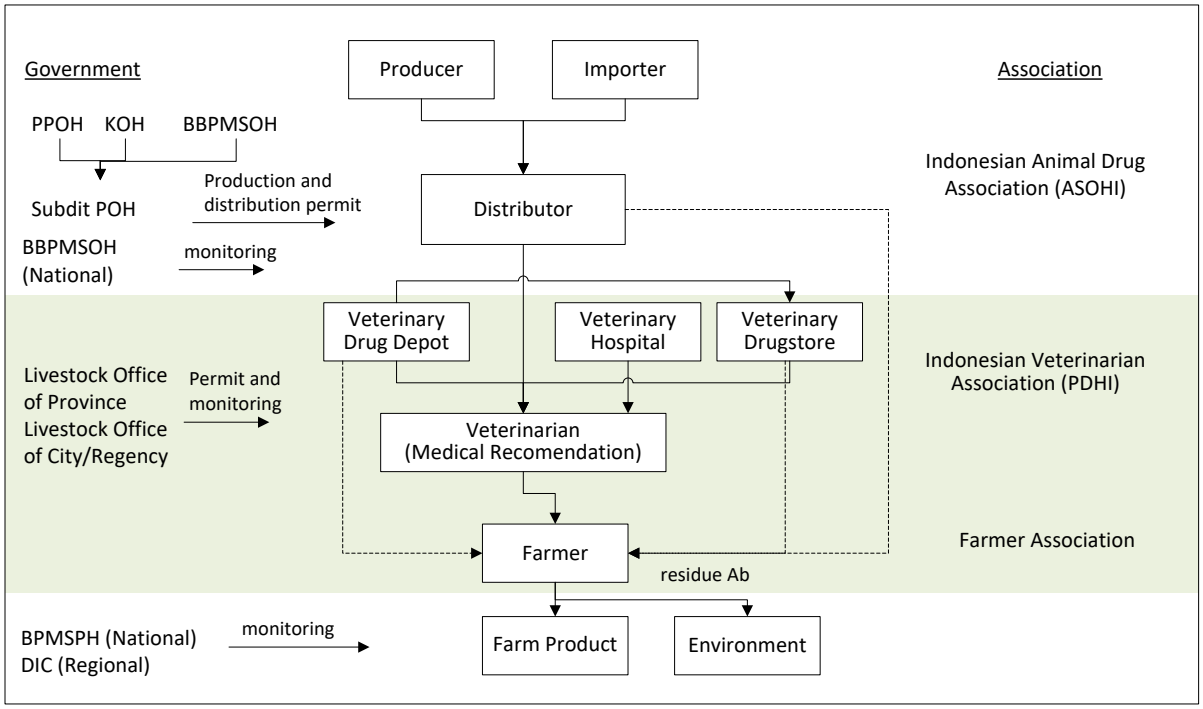
Stakeholders involved in the antibiotic system in human health could be divided into 3 groups, (1) government, (2) private, and (3) associations. Government as legislator holds a central role in managing the system, from creating and placing regulations to monitoring and enforcement. The private sector and associations also hold a pivotal role as players in the system; they can give recommendations and are essential in supporting government programs. Figure 4 below illustrates the system of antibiotics for human health in Indonesia and the stakeholders involved.




Dirjen BinFar = Directorate General of Pharmaceutical and Medical Devices
BPOM = National Agency of Drug and Food Control

**Figure 4. System Mapping of Antibiotics for Human Health**

In animal health, stakeholders can also be divided into (1) government, (2) private, and (3) associations, and the system consists of 3 major parts: (1) production and distribution of antibiotics at national level, (2) distribution and of antibiotics at regional/local level and (3) surveillance of antibiotic residue. Figure 5 illustrates the system of antibiotics for animal health in Indonesia and the stakeholders involved.




--------- = Illegal pathway

⟶ = Legal pathway

PPOH = Veterinary Drug Assessment Committee
KOH = Veterinary Drug Commission
BBPMSOH = National Veterinary Drug Assay Laboratory
Subdit POH = Subdirectorate of Veterinary Drug Control
BPMSPH = Animal Product Quality and Certification Laboratory
DIC = Disease Investigation Center

**Figure 5. System Mapping of Antibiotics in Animal Health**

Analysis of gaps in the system related to the risk of antibiotic resistance emergence identifies problems to be present in the control structure at the lower levels. Meanwhile, the system for generating production and distributions permits are functioning as mandated by the law. Identified gaps are shown in Table 3.

**Table 3. Gap Analysis Related to Antibiotic Resistance in Indonesia**

| No | Current Situation | Standard | Contributing Factors | Stakeholders Involved |
|---|---|---|---|---|
| **Human Health** | | | | |
| 1. | Improper prescription of antibiotics | Rational prescription of antibiotics | - medical practitioners lack awareness to prescribe antibiotics rationally<br>- pharmaceutical companies give incentives or promotions to use a certain amount of their products | - Directorate General of Pharmaceutical and Medical Devices, Ministry of Health<br>- Indonesian Medical Association (IDI)<br>- Indonesian Hospital Association (PERSI)<br>- Medical Schools<br>- Pharmaceutical companies |
| 2. | Improper consumption of antibiotics by patients | Patients should consume antibiotics according to prescription | - doctors do not educate their patients on the importance of consuming antibiotics according to prescription<br>- many people believe antibiotics are unnecessary once disease symptoms are gone | - Doctors<br>- Health Offices |

| No | Current Situation | Standard | Contributing Factors | Stakeholders Involved |
|---|---|---|---|---|
| **Human Health** | | | | |
| 3. | Antibiotics can be purchased without prescription | Antibiotics should only be purchasable with prescription | - poor supervision over antibiotic sale in pharmacies and drug stores<br>- pharmacists lack awareness<br>- penalty for selling antibiotics without prescription is light<br>- self-medication by patients, people believe all illnesses must be treated by antibiotics | - National Agency of Drug and Food Control (BPOM)<br>- Provincial Center of Drug and Food Control (BBPOM/BPOM)<br>- Pharmacies<br>- Indonesian Pharmacy Association<br>- Indonesian Pharmacists Association<br>- Ministry of Health |
| **Animal Health** | | | | |
| 4. | Excessive use of antibiotics on farm | Rational use of antibiotics on farm | - lack of veterinary services on farm<br>- poor control over antibiotic use in farms<br>- pressure on the marketing division of pharmaceutical companies/distributor to sell products<br>- farmers lack knowledge on rational use of antibiotics and the effects of excessive use on farm<br>- regulations on the type of antibiotics permitted for farm use is still lacking | - Subdirectorate of Veterinary Drug Control, Ministry of Agriculture<br>- Veterinary Drug Control bodies in provincial and district/municipal service offices responsible for livestock and animal health<br>- Farmers<br>- Marketing of pharmaceutical companies/distributors |
| 5. | Animals sold / slaughtered without considering antibiotic withdrawal time | Animals sold / slaughtered after antibiotic withdrawal time has passed to prevent residue in animal products | - farmers lack knowledge and awareness regarding antibiotic residue<br>- poor surveillance over antibiotic residue in farm products<br>- lack of veterinary services on farm | - Provincial and district/municipal service offices responsible for livestock and animal health<br>- Animal Product Quality and Certification Laboratory (BPMSPH)<br>- Veterinarians<br>- Farmers |

## 3.2. Baseline Survey

Layer and pig farms commonly use antibiotics from the β-Lactam, tetracycline, and sulfonamide group. Figure 6 and 7 shows the types of antibiotics used as reported by farm respondents. Majority of layer and swine farms do not have veterinarians on farm. Overall, layer farms use antibiotics for disease treatment (97.5%), disease prevention (50%) and production increase (30%). Meanwhile swine farms use antibiotics only for disease treatment (66.5%) and prevention (77.5%). Twenty percent of layer farms reported they have self-mixed different antibiotics to treat difficult disease incidences. Farms obtain antibiotics mainly from poultry shops (60% layer farms, 72.5% pig farms), technical services of pharmaceutical companies (52.5% layer farms, 12.5% pig farms), and government veterinary officers (12.5% pig farms). Overall, 52.5% of layer farm owners/managers and 72.5% of pig farm owners/managers have poor knowledge on antibiotic use in farms and antimicrobial resistance.

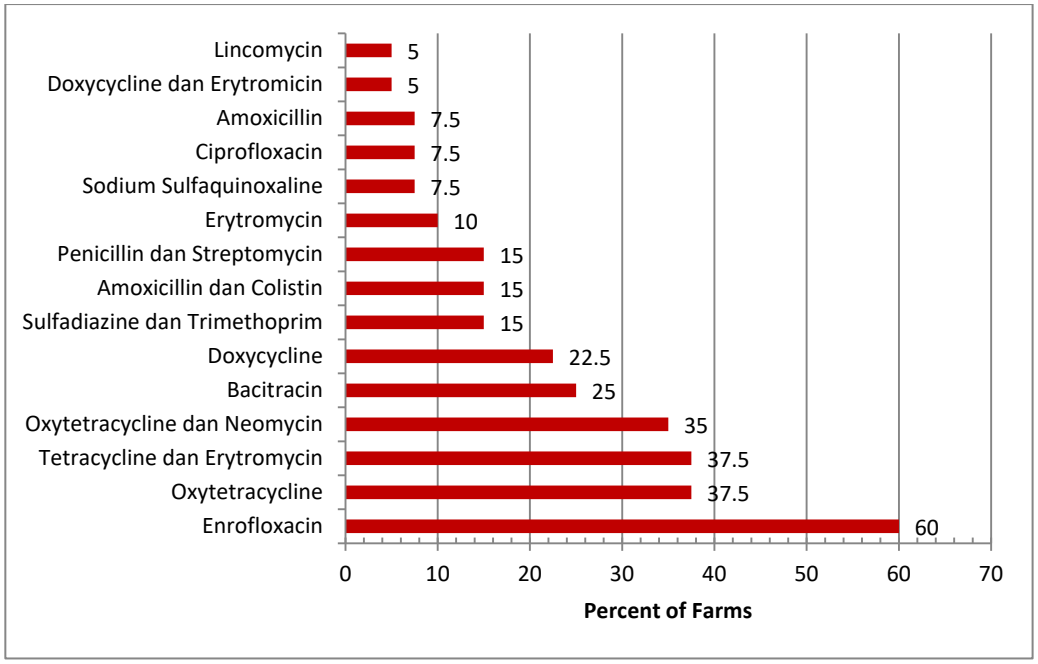



**Figure 6. Antibiotics Used In Layer Farms**

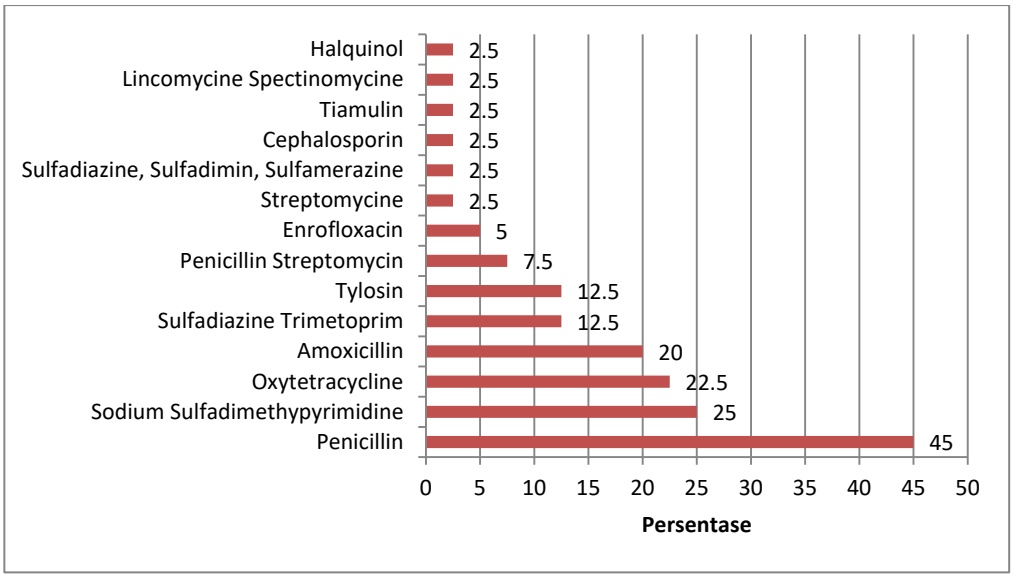



**Figure 7. Antibiotics Used In Pig Farms**

In public health services, Community Health Centers (CHC/Puskesmas) prescribe 14 types of antibiotics while hospitals prescribe up to 82 types of antibiotics. Most commonly prescribed antibiotics in CHCs and Hospitals are shown in Table 4 below.

**Table 4. Antibiotics Used in Community Health Centers and Hospitals**

| No | Antibiotic | Facilities Prescribing the Drug (%) | Monthly Use (mg) |
|---|---|---|---|
| **Community Health Center/Puskesmas (40 units)** | | | |
| 1. | Amoxicillin | 100 | 2,650,267 |
| 2. | Trimethoprim-sulfamethoxazole | 85 | 731,102 |
| 3. | Ciprofloxacin | 92.5 | 199,586 |
| 4. | Tetracycline | 72.5 | 161,909 |

| | | | |
|---|---|---|---|
| 5. | Metronidazole | 90 | 139,418 |
| 6. | Cefadroxil | 77.5 | 113,109 |
| 7. | Chloramphenicol | 92.5 | 86,701 |
| 8. | Erytromycin | 82.5 | 83,242 |
| **Hospitals (14 units)** | | | |
| 1. | Ceftriaxone | 71.4 | 1,936,171 |
| 2. | Amoxicillin | 92.9 | 1,862,963 |
| 3. | Cefadroxil | 78.6 | 1,663,536 |
| 4. | Ciprofloxazine | 78.6 | 1,622,033 |
| 5. | Metronidazole | 78.6 | 292,974 |
| 6. | Cefixime | 78.6 | 265,47 |
| 7. | Levofloxacin | 85.7 | 182,441 |
| 8. | Clindasmycin | 71.4 | 88,361 |
| 9. | Chloramphenicol | 71.4 | 75,322 |
| 10. | Erythromycin | 78.6 | 67,963 |
| 11. | Gentamicin | 71.4 | 7,826 |

The knowledge level of respondents on prudent use of antibiotics for humans and antimicrobial resistance is high in doctors and patients visiting healthcare facilities. See Table 5 below. Hospital doctors have better knowledge compared to CHC doctors. However some doctors still prescribe antibiotics for non-pneumonia upper respiratory infections and non-specific diarrhea.

Meanwhile, the knowledge of layer farm workers overall is better than general patients or pig farm workers. About 20-20% of patients and farm workers have bought antibiotics without prescription for self-medication purposes from pharmacies or local stalls. More than 50% non-doctor respondents stopped consuming prescribed antibiotics before it is time and 20% gave leftover antibiotics to treat other people.

**Table 5. Knowledge Level on Prudent use of Antibiotic Use in Human and Antimicrobial Resistance**

| No. | Respondents | Number of Respondents | Knowledge Level (%) | | |
|---|---|---|---|---|---|
| | | | High | Medium | Low |
| 1 | CHC Doctor | 40 | 22.5 | 77.5 | 0 |
| 2 | Hospital Doctor | 14 | 71.4 | 28.6 | 0 |
| 3 | CHC/Hospital Patients | 54 | 7.4 | 31.5 | 61.1 |
| 4 | Layer Farm Worker | 41 | 9.7 | 65.9 | 24.4 |
| 5 | Pig Farm Worker | 36 | 2.8 | 11.1 | 86.1 |

## 3.3. Intervention Program

### 3.3.1. Target for Boundary Partners

Based on results of the literature review and baseline survey, we identified 4 boundary partners for intervention programs in farms and communities, and developed progress markers for outcome mapping (Table 6).

**Table 6. Progress Markers and Objectives for Boundary Partners**

| Boundary Partner | Progress Marker | | | Objective |
|---|---|---|---|---|
| | Expect to See | Like to see | Love to see | |
| **A. Animal Health** | | | | |
| (1) Pilot Farms | a. Attend meetings and trainings.<br>b. Have information on animal health services in their area.<br>c. Recognize antibiotics used in farm. | a. Active participation in meetings, discussions or evaluations.<br>b. Contact or consult with animal health officers regarding veterinary treatment in farm.<br>c. Use antibiotics in farms according to indications. | a. Implement good farming practices to support animal health in farm.<br>b. Encourge other farmers to consult with animal health officers.<br>c. Have a recording of antibiotic use in farm. | a. Improve practices related to antibiotic use in farm<br>b. Improve farm access to veterinary services |
| (2) Animal Health Officer | a. Attend training | a. Respond to farmer consultation requests<br>b. Have knowledge on indication, risk of resistance, and prudent use of antibiotics in farm | a. Actively visit farms to educate farmers on animal health issues<br>b. Educate farmers on antibiotic indictions and resistance | a. Increase health services provided for farms<br>b. Increase officer capacity related to prudent use of antibiotics and antimicrobial resistance |
| **B. Public Health** | | | | |
| (1) Health Cadres in Pilot Villages | a. Attend meetings and trainings.<br>b. Have knowledge on the importance of prudent use of antibiotics and antimicrobial resistance. | a. Share information and educate people on prudent use of antibiotics<br>b. Identify antibiotic misuse and abuse practices in the neighborhood<br>c. Active participation in cadre activities | a. Encourage other people to share information and educate people on prudent use of antibiotics in their neighborhoods<br>b. Take action to correct antibiotic misuse and abuse practices<br>c. Initiate support from the community/village so the program can be sustainable | a. Increase public knowledge on prudent use of antibiotics and antibmicrobial resistance through village cadres<br>b. Increase community participation in preventing and controlling antimicrobial resistance |
| (2) Public Health Officers | a. Attend and actively participate in meetings and trainings.<br>b. Provide education media on antibiotics in waiting or treatment room<br>c. Respond to request form village cadres on information on prudent use of antibiotic and antimicrobial resistance | a. Have knowledge on indication, risk of resistance, and rational use of antibiotics in human health<br>b. Educate patients on prudent use of antibiotics<br>c. Prescribe antibiotics prudently<br>d. Train local health cadres on prudent use of antibiotics and antimicrobial resistance | a. Share information to other health officers and encourage them to practice rational use of antibiotics<br>b. Actively evaluate the use of antibiotics and its effectiveness, and discuss with local health services<br>c. Develop a program for futher antibiotic cadre education and assistance | a. Increase public and patient access to accurate information on antibiotic use and resistance<br>b. Promote rational use of antibiotics |

### 3.3.2. Intervention Activities

To achieve the objectives above, we conducted the following activities during the intervention program:

**1. Training of Facilitators (ToF) for Public Health and Animal Health Officers**

This training was conducted on 23-25 November 2015, in Karanganyar, Klaten and Sukoharjo Districts. The objective is to increase the knowledge of public and animal health officers on antibiotic resistance and prudent use of antibiotics. Both public and animal health officers were invited to the same meeting to build relations and introduce antimicrobial resistance as multi-sector problem. Details on training participants are shown in Table 7 below.

**Table 7. Participants of Training of Facilitators**

| District | Institution | Participant | Invitation | Attendance |
|---|---|---|---|---|
| Karanganyar | CHC Jaten I, Sroyo, Jaten | Doctor | 3 | 1 |
| | | Nurse | 5 | - |
| | | Midwife | 4 | 3 |
| | CHC Jaten II, Sroyo, Jaten | Doctor | 3 | 1 |
| | | Nurse | 4 | - |
| | | Midwife | 5 | 2 |
| | Health Services | | 2 | 2 (Pharmacist) |
| | Livestock and Fishery Services | Veterinarian | 12 | 4 |
| | | Paravet | | 5 |
| | | Education officer | | 2 |
| | ***Total*** | | ***38*** | ***20*** |
| | ***% Attendance*** | | ***53%*** | |
| Klaten | CHC Jogonalan I, Somopuro, Jogonalan | Doctor | 3 | 1 |
| | | Nurse | 3 | 3 |
| | | Midwife | 8 | 5 |
| | CHC Jogonalan II, Somopuro, Jogonalan | Doctor | 1 | 1 (General) + 2 (Dental) |
| | | Nurse | 3 | 1 |
| | | Midwife | 5 | 3 |
| | Health Services | | 2 | 2 (Pharmacist) |
| | Agriculture Services | Veterinarian | 12 | 8 |
| | | Paravet | | 4 |
| | ***Total*** | | ***37*** | ***30*** |
| | ***% Attendance*** | | ***79%*** | |
| Sukoharjo | CHC Polokarto | Doctor | 5 | 3 |
| | | Nurse | 7 | 2 |
| | | Midwife | 15 | 14 |
| | CHC Mojolaban, Cangkol, Mojolaban | Doctor | 5 | 4 |
| | | Nurse | 9 | 3 |
| | | Midwife | 15 | 3 |
| | Health Services | Doctor | 2 | 1 |
| | | Pharmacist | | 2 |
| | | Midwife | | 1 |
| | | Public health | | 1 |
| | Agriculture Services | Veterinarian | 12 | 5 |
| | | Paravet | | 7 |
| | Midwife clinic / Private practice | Doctor | - | 1 |
| | | Midwife | | 6 |
| | ***Total*** | | ***70*** | ***53*** |
| | ***% Attendance*** | | ***76%*** | |


**Figure 8. Photos of Training of Facilitators for Public Health and Animal Health Officers**

**2. Regular Visit and Education of Pilot Farms**

Pilot farms were visited every 2 weeks to 1 month by our field team. At the first visit, farms were profiled to record their initial conditions and identify aspects that need to be improved. Pilot farms were educated on (1) how to improve overall farming practices, (2) how to improve health management, and (3) how to recognize antibiotics used in farms and why is antimicrobial resistance an issue. We also tried to connect farmers with the local animal health officer on duty for that area.

In these activities, we encouraged farmers to develop a proper recording system for livestock production, feed, health events, and drug use. We also provided advice on biosecurity improvement to reduce the rate of disease infection in farms. Key messages on BIJAK (prudent) Antibiotic were shared to increase their knowledge on antibiotic use and resistance in general. Farmers were also provided with booklets on good farming practices and prudent use of antibiotic in farms.

### 3. Training of Antibiotic Cadres in Pilot Villages

A number of people from each pilot village was selected and trained to become "BIJAK Antibiotik" Cadres. "Bijak" means prudent. Through these cadres we hope to increase community awareness on prudent use of antibiotics in both human and animals. Majority of the people selected for training were already trained health cadres involved in government community health programs.

During the training, cadres were given basic information on what are antibiotics and why antimicrobial resistance is an important issue in both human and animal health. We also gave hands-on training with assistance from the local CHC on how to identify antibiotic drugs in the household. Cadres were then presented with several likely scenarios of people asking for information or antibiotic misuse events where they had to respond to appropriately.

Educational materials introducing "BIJAK Antibiotik" key messages were provided in the form of posters, stickers, and flipcharts. Cadres were also given guidebooks for reference. After training, cadres were tasked with disseminating this information to their local community and recording any event of antibiotic misuse or abuse observed. If needed, cadres can request assistance or support from the field team and local CHC in their area.

### 4. Training on Good Farming Practices and Health Management for Pig Farms

From the baseline survey and further interaction, it came to attention that pig farmers face difficulties in obtaining information on good management practices. Therefore, training was given to pig farmers in all pilot villages (Table 8). The purpose of this training is to improve production and health management in farms, and help connect farmers to animal health officers in their area.

**Table 8. Participants of Good Farming Practices and Health Management for Pig Farms**

| No. | District | Time | Location | Participant |
|---|---|---|---|---|
| 1 | Sukoharjo | 15 February 2016 | Cangkol Village Hall, Mojolaban Subdistrict | ✓ 2 veterinarians from Sukoharjo Agriculture Services<br>✓ 1 farmer from Cangkol village |
| 2 | Klaten | 14 February 2016 | Somopuro Village Hall, Jogonalan Subdistrict | ✓ 1 veterinarian from Jogonalan Animal Health Center<br>✓ 8 farmers from Titang village<br>✓ 2 farmers from Somopuro villages |
| 3 | Karanganyar | 15 February 2016 | Mr. Temon Mulyono's house (Karangrejo,Ngringo Billage, Jaten Subdistrict) | ✓ 1 veterinarian from Karanganyar Livestock and Fishery Services<br>✓ 2 paravets from Jaten subdistrict<br>✓ 11 farmers from Ngringo village |

### 5. Training on Good Farming Practices and Health Management in Pig Farms for Animal Health Officers

In this intervention program we encouraged farmers to seek advice from their local animal health officers in events of disease or production problems. However, not all officers have sufficient knowledge and skill to address the issue, more specifically in pig production. The objective of this training was to increase the knowledge and technical capacity of animal health officers on good farming practices in pig production, and identification and diagnosis of pig disease.

The training was conducted on October 30-31, 2016 in Kopeng, Semarang District. The first day was theoretical training in a classroom, followed by a field visit on the second day. During

field visit, participants received hands-on practice on pig handling and restrain, tail docking, teeth clipping, and collection of nasal, rectal, and blood samples. The training was attended by animal health officers from Karanganyar, Klaten and Sukoharjo districts (Table 9).

**Table 9. Praticipants of Good Pig Farming Practices and Health Management for Animal Health Officers**

| Institution | Participant | Number of Attendance |
|---|---|---|
| Livestock and Fishery Services of Karanganyar District | Veterinarian | 2 |
| | Paravet | 1 |
| Agriculture Services of Klaten District | Veterinarian | 2 |
| | Paravet | - |
| Agriculture Services of Sukoharjo District | Veterinarian | 2 |
| | Paravet | 1 |
| CIVAS | | 4 |
| | **Total** | **12** |

**Figure 9. Photos of Good Pig Farming Practices and Health Management Training for Animal Health Officers**

**6. Training on Waste Management and Composting for Pig Farms**

Waste management is an important issue for privately owned pig farms in rural areas. The purpose of this training is to transfer knowledge on processing pig farm waste into compost to reduce farm odor and provide additional value to farmers. This training was given by one of the pilot farmers in Klaten, Mr. Sukamto, at his home and pig farm on August 23, 2017. He was selected to become a role model for other pig farmers. Through this training, Mr. Sukamto is also expected to become a role model for encouraging improvement of antibiotic practices in farms. The training was supported by Gondangwinangun Church and Klaten District Agriculture Services and attended by 30 pig farmers from Sukoharjo, Klaten, and Karanganyar districts with good enthusiasm. During the training, Klaten District Agriculture Services also encouraged all participants to form farmer groups in their area so it will be easier for local livestock services to provide development programs and services.

### 3.3.3. "BIJAK Antibiotik" Key Message

Throughout the intervention program, "BIJAK Antibiotik" key messages were delivered to stakeholders in the community and farms at every meeting and every possible opportunity. This message contains easy to remember instructions on how to handle antibiotics appropriately. See

Table 10 for details on "BIJAK Antibiotik" key messages. We also developed taglines "BIJAK (prudent) use of antibiotics, keep livestock healthy and productive" for farmers and "BIJAK (prudent) use of antibiotics, protect our lives" for communities.

**Table 10. "BIJAK Antibiotik" Key Messages (BIJAK = *Prudent*)**

| Community | | | Farmer | | |
|---|---|---|---|---|---|
| **B** | ***Beli*** | Buy with prescription | **B** | ***Beri*** | Use for treatment, not prevention |
| **I** | ***Ikuti*** | Follow the rules when using antibiotics | **I** | ***Ikuti*** | Follow the rules when using antibiotics |
| **J** | ***Jeli dan berani bertanya*** | Be brave and ask your doctors | **J** | ***Jaga masa henti obat*** | Be aware of withdrawl time |
| **A** | ***Awasi*** | Supervise antibiotic usage in your family | **A** | ***Awasi*** | Supervise antibiotic usage in your farm |
| **K** | ***Konsultasi*** | Consult with your doctor when you are sick | **K** | ***Konsultasi*** | Consult with veterinarian / animal health services officers when your animals are sick |

### 3.3.4. Behavior Changes of Boundary Partners

As a result of the intervention program, we observed the following behavior changes in our boundary partners.

**Table 11. Behavior Change in Pilot Farms**

| Progress Marker | | Behavior Change | Evidence |
|---|---|---|---|
| **1. Expect to See** | a. Attend meetings and trainings | 1. More than 50% pig farms attended<br>2. Layer farmers were approached individually | Meeting notes |
| | b. Have information on animal health services in their area | 1. All pig farms have the contact number of subdistrict animal health officers<br>2. All layer farms have the contact number of subdistrict animal health officers and technical services from pharmaceutical companies | Farm visit journal |
| | c. Recognize antibiotics used in farm | 1. 80% of layer farms and 70% of pig farms are more aware of different drugs in the farm<br>2. 30% of layer farms and 40% of pig farms can identify antibiotics used in their farm | Farm visit journal |
| **2. Like to See** | a. Active participation in meetings, discussions or evaluations | 1. Most pig farms asked questions on management tips and disease treatment | Observation during training |
| | b. Contact or consult with animal health officers regarding veterinary treatment in farm | 1. None of the pig or layer farm contacted animal health officers for disease consultation<br>2. One pig farm asked information about veterinary drugs to the officer<br>3. 70% layer farms and 40% pig farms asked information about veterinary drugs to the field team<br>4. 50% layer farms asked about biosecurity measures to the field team | Farm visit journal |
| | c. Use antibiotics in farms according to indications | 1. 30% layer farms and 30% pig farms use antibiotics for treatment<br>2. All layer farms and 80% pig farms claim to | Farm visit journal |

| | | | |
|---|---|---|---|
| | | have used antibiotics according to recommended dose<br>3. 1 pig farm stopped adding antibiotic powder to feed<br>4. All layer farms stopped using drugs 1 to 2 months before hens are sent to slaughter, 20% pig farms become aware about drug withdrawal time | |
| **3. Love to See** | **a.** Have a recording of antibiotic use in farm | 1. 2 of 6 layer farms have recordings on drug/vaccine use before the intervention program, but none in pig farms<br>2. 3 of 4 layer farms and 1 of 9 pig farms who never had recordings, tried to make a health log<br>3. 1 layer farm and 1 pig farm was still maintaining recording until the end of the intervention program | Farm visit journal |
| | **b.** Encourge other farmers to consult with animal health officers | 1. None | Farm visit journal |
| | **c.** Implement good farming practices to support animal health in farm | 1. All farmers support better farming practices<br>2. 1 of 6 layer farms and 2 of 9 pig farms have quite good farming practices<br>3. 1 pig farmer improved sanitation in their farm<br>4. 1 pig farmer often consulted with the field team<br>5. 1 pilot pig farmer collaborated with 2 non-pilot pig farmer to conduct composting of farm waste | Farm visit journal |

Some pilot farms have close relationships with local animal health officers; however it is not related to animal health services and only limited to coordination of government program. Despite routine visits and education from the field team, farmers have limited capacity in learning about antibiotics, particularly when it comes to remembering different names and groups of antiobiotics and the more scientific aspect of antimicrobial resistance.

**Table 12. Behavior Change in Animal Health Officers**

| **Progress Marker** | | **Behavior Change** | **Evidence** |
|---|---|---|---|
| **1. Expect to See** | a. Attend training | All offices invited sent their representatives | Training attendance list |
| **2. Like to See** | a. Respond to farmer consultation requests | 1. None of the farmers asked to consult about animal health services<br>2. One farmer consulted about veterinary drugs and was answered | Interview with officers |
| | b. Have knowledge on indication, risk of resistance, and prudent use of antibiotics in farm | 1. All animal health officers from district services understood the indiction, risk and use of antibiotics in farm<br>2. Animal health officers from the subdistrict level have poorer understanding because majority do not have health-related educational background | Training report<br>Interview with officers |
| **3. Love to** | a. Actively visit | None | Interview with officers |

| | | | |
|---|---|---|---|
| **See** | farms to educate farmers on animal health issues | | |
| | **b.** Educate farmers on antibiotic indictions and resistance | Agriculture services of Sukoharjo district included antibiotic use and resistance as a topic in the district's education program | Interview with officers |

In addition to the behavior changes noted above, Klaten District plans to develop a regional regulation for development of pig farming in the district. Sukoharjo District will also open a new animal health center which covers one of the pilot village with pig farms in it to increase animal health services for thee farmers.

**Table 13. Behavior Change in Cadres in Pilot Villages**

| Progress Marker | | Behavior Change | Evidence |
|---|---|---|---|
| **1. Expect to See** | **a.** Attend meetings and trainings | 1. 88 cadres from 4 pilot villages attended training<br>2. 5 additional participants from non-pilot villages also requested to attend training | Training attendance list |
| | **b.** Have knowledge on the importance of prudent use of antibiotics and antimicrobial resistance | 1. Cadres can identify antibiotic drugs<br>2. Cadres understand the impact of antimicrobial resistance | Observation during cadre training<br>Interview with cadres and supervising health officers |
| **2. Like to See** | a. Share information and educate people on prudent use of antibiotics | Cadres have spread information about prudent use of antibiotic to their family and community, both through personal communication or social meetings | Cadre logbook<br>Interview with cadres and supervising health officers |
| | b. Identify antibiotic misuse and abuse practices in the neighborhood | Cadres have identified practices of antibiotic misuse and abuse in their communities, such as fanatic use of Supertetra (tetracycline product); free sale of antibiotic in pharmacies, drug stores, and general stalls; the sale of drug packets that contain antibiotics | Cadre logbook<br>Interview with cadres and supervising health officers |
| | **c.** Active participation in cadre activities | Cadres have active discussions with each others and the village midwifes as their supervising officer | Cadre logbook<br>Interview with cadres and supervising health officers |
| **3. Love to See** | a. Encourage other people to share information and educate people on prudent use of antibiotics in their neighborhoods | 1. Cadres encourage their families, neighbors, and people at social meetings to share the information with others<br>2. Cadres also encourage their colleagues who are less active or still awkward | Interview with cadres and supervising health officers |

| | | | |
|---|---|---|---|
| | | | |
| | b. Take action to correct antibiotic misuse and abuse practices | 1. A cadre in 1 pilot village once freely sold antibiotics and drug packets containing antibiotics, but stopped after receiving training<br>2. Cadres report to village officials if they find cases of antibiotic misuse or abuse<br>3. Cadres put up eduational posters in their community | Interview with cadres and supervising health officers |
| | c. Initiate support from the community /village so the program can be sustainable | 1. 2 of 4 pilot villages recommend village officials to publish a village decree for cadres<br>2. All 4 pilot villages suggest regular evaluation from supervising CHCs | Interview with cadres and supervising health officers |

Most cadres are also cadres for other government health programs, such as Posyandu, healthy village, and mother and child health. Village officials were very open and supportive to the establishment of antibiotic cadres in their village, especially after several practices of medicine misuse or abuse was identified, such as wrong use of medicine or using medicine over the recommended dose.

**Table 14. Behavior Change in Public Health Officers**

| Progress Marker | | Behavior Change | Evidence |
|---|---|---|---|
| **1. Expect to See** | a. Attend and actively participate in meetings and trainings. | 1. Doctors, midwives, and even the head of the local Community Health Center attended meetings/trainings<br>2. 2 officers from a neighboring CHC also requested to attend training<br>3. Most participants were active in asking questions, sharing experience, or giving comments | Training attendance list<br>Observation during training |
| | b. Provide education media on antibiotics in waiting or treatment room | 1. Health officers in 2 pilot villages have set up the educational poster and brochure provided in the CHC, village clinic and Posyandu<br>2. Health officers in 1 of 4 village copied and gave out education materials to patients visiting the CHC | Interview with officers |
| | c. Respond to request form village cadres on information on prudent use of antibiotic and antimicrobial resistance | When asked, health officers (in particular village midwife) actively responded to requests for information or assistance from cadres | Interview with officers |
| **2. Like to See** | a. Have knowledge on indication, risk of resistance, and | Health officers already understand about rational use of antibiotics, there is also program from the | Interview with officers |

| | | | |
|---|---|---|---|
| | rational use of antibiotics in human health | government regarding this issue | |
| | b. Educate patients on prudent use of antibiotics | Education is given to patients visiting the health facility | Interview with officers |
| | c. Prescribe antibiotics prudently | Health officers become more careful when prescribing antibiotics, they follow guidelines on rational use of antibiotics from the government more closely | Interview with officers |
| | d. Train local health cadres on prudent use of antibiotics and antimicrobial resistance | None | Interview with officers |
| **3. Love to See** | a. Share information to other health officers and encourage them to practice rational use of antibiotics | Some officers have informally shared the information to other officers in the CHC who did not attend any training or meeting | Interview with officers |
| | b. Actively evaluate the use of antibiotics and its effectiveness, and discuss with local health services | None | Interview with officers |
| | c. Develop a program for futher antibiotic cadre education and assistance | There are plans to share the information with other CHCs, and include antibiotic cadres in their regular health cadre evaluation every 3 months. | Interview with officers |

## 3.4. Antibiotic Resistance Survey

For the survey on antibiotic resistance in E. coli isolated from animals, people, and the environment in layer chicken and pig farms, we collected a total of 725 samples. See Table 15 for details on the number of samples collected.

**Table 15. Samples Collected from E. coli Antibiotic Resistance Survey in Pig and Layer Farms**

| No | Sampel | Karanganyar | | Sukoharjo | | Klaten | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Pig | Layer | Pig | Layer | Pig | Layer | |
| 1 | Farm worker or family | 25 | 18 | 24 | 24 | 20 | 23 | 134 |
| 2 | Babi | 45 | - | 42 | | 39 | - | 126 |
| 3 | Layer chickens | - | 135 | - | 135 | - | 135 | 405 |
| 4 | Environment | 15 | - | 20 | - | 15 | 10 | 60 |
| **TOTAL** | | | | | | | | **725** |

Results of the antibiotic susceptibility tests of samples collected can be seen in Figure 10 and 11 below. High resistance was found against antibiotics ampicillin (AMP), tetracycline (TCY), and Trimethoprim-sulphamethoxazole (SXT) in isolates from animals, humans, and the environment in pig and layer farms. In pig farms, resistance was also found against antibiotic chloramphenicol (CHL). Meanwhile in E. coli isolates from humans in both pig and layer farms, there is resistance and intermediate reaction against antibiotic cephalotin (CEP) of the cephalosporin group. This trend also spillovers to E. coli isolates from pigs and the environment in pig farms. E. coli isolates from layer chickens and pigs are observed to start develop resistance against fluoroquinolone antibiotics ciprofloxacin (CIP) and levofloxacin (LVX). Overall, the pattern of antibiotic resistance in E. coli isolates obtained from animal, human, and the environment is quite similar in pig farms; this indicates there might be transfer of resistance bacteria or resistance genes in these different hosts.

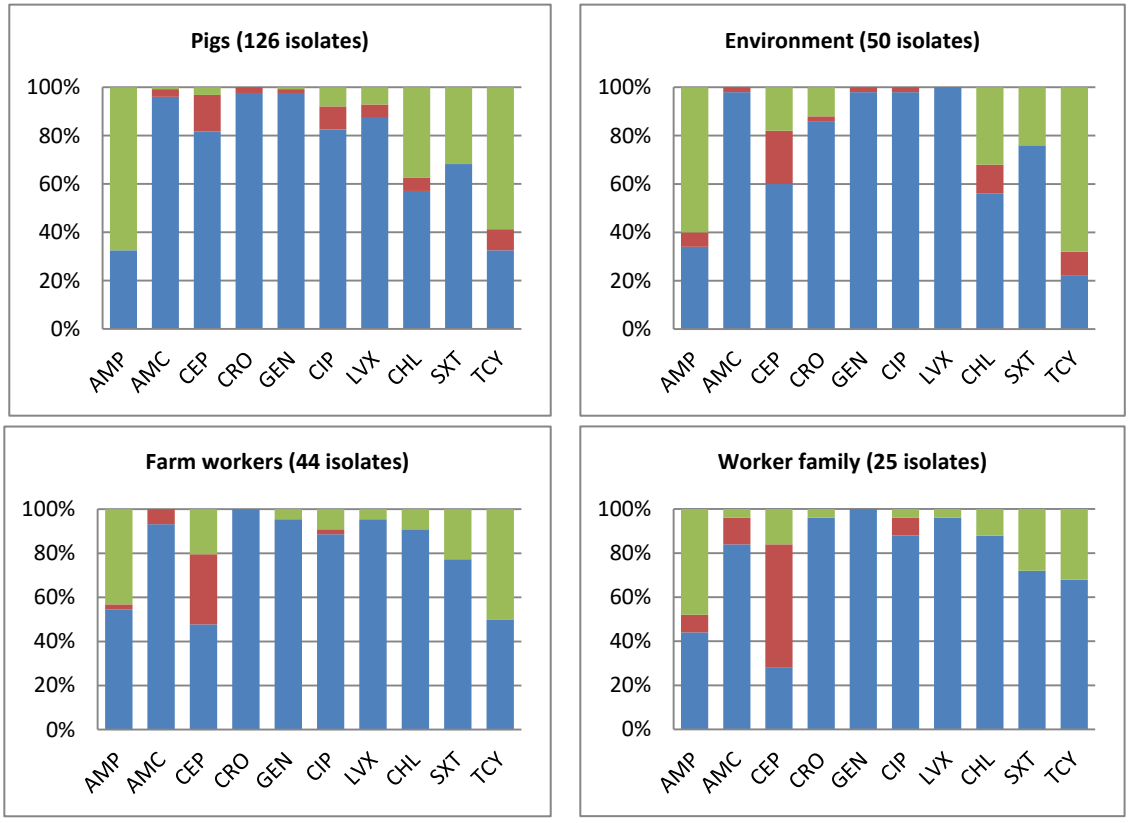



**Figure 10. Antibiotic Susceptibility of E. coli Isolated from Animals, Humans, and the Environment of Pig Farms; green=resistant, red=intermediate, blue=susceptible**


**Figure 11. Antibiotic Susceptibility of E. coli Isolated from Animals, Humans, and the Environment of Layer Chicken Farms; green=resistant, red=intermediate, blue=susceptible**

Phenotypic resistance as well as the presence of resistance genes were noted in 16 E. coli isolates selected for genotypic testing (Table 16, 17, 18). Of the three sources examined, the frequency of resistance gene detection was the highest among the human isolates. Bla TEM was the most frequently encountered resistance gene followed by aadA2 (Table 17). Out of 4 beta lactamase examined, blaTEM gene was found in 68.75% of the *E coli* isolates. All the 8 human isolates originated from farm workers of pig and layer farms and the family members of the farm workers showed the presence of blaTEM gene. In addition three isolates originating from swine and environment of swine farm also showed the presence of blaTEM gene. Other beta lactamase genes (blaCMY-2, blaPSE1 and oxa2) were however absent in all isolates.

The E coli isolates when tested for the presence of three genes rendering resistance against aminoglycosides, 1 isolate originating from human worker at layer farm and another 2 isolates from swine and the environment of swine farm showed the presence of aadA2 gene. In total 18.75% of the isolates showed the presence of aadA2 gene. In addition to aadA2 gene, strA gene was also identified in *E coli* isolated from the swine farm environment. None of the 16 isolates tested however showed the presence of aphA1-lab gene.

One layer farm worker isolate was found to contain gene conferring resistance to sulphonamides (sul1) while another isolate from swine farm worker was found to contain TetA(B) gene that contributes the resistance against tetracycline. Class one integron was found in two human isolates (12.5%) originating from workers in layer farm and swine farm. It was however absent from the animal and animal farm isolates. On contrary, class two integron was not recovered from any of the isolates.

Only one out of 10 isolates showing phenotypic resistance to tetracycline showed the presence of tetA(B) gene indicating that other genes might have been responsible for the resistance

against tetracycline. Likewise, of the six isolates showing resistance against Trimethoprim-Sulphamethoxazole, sul1 gene was only encountered in one isolate. This is indicative of the role of other resistance genes and mechanisms. Likewise of 5 isolates showing resistance against gentamicin, only one isolated confirmed the presence of aadA2 gene.

**Table 16. Phenotypic Resistance of the E. coli Isolates Selected for Genotypic Testing**

| Antimicrobial agents | Number of Resistant Isolates (Intermediate Resistant Isolates) | | | |
|---|---|---|---|---|
| | Human isolates | Animal Isolates | Environment Isolates | Total |
| Ampicillin | 5 | 4 (1) | 1 | 10 (1) |
| Amoxycillin | 2 (2) | 1 | 0 | 3 (2) |
| Cephalotin | 7 (3) | 4 | 1 | 12 (3) |
| Ceftriaxone | 0 | 2 | 1 | 3 |
| Ciprofloxacin | 3 | 2 (2) | 0 | 5 (2) |
| Levofloxacin | 2(1) | 2 (2) | 0 | 4 (3) |
| Chloramphenicol | 3 | 2 | 1 | 6 |
| Gentamicin | 2 | 3 (1) | 0 | 5 (1) |
| Trimethoprim-Sulphamethoxazole | 4 | 2 | 0 | 6 |
| Tetracycline | 5 | 4 (1) | 1 | 10 (1) |

**Table 17. Presence of Antimicrobial Resistance Genes in E coli Isolates**

| Resistance genes | Number of resistant isolates | | | |
|---|---|---|---|---|
| | Human isolates | Animal isolates | Farm environment isolates | Total (%) |
| blaCMY-2 | 0 | 0 | 0 | 0 |
| blaPSE1 | 0 | 0 | 0 | 0 |
| blaTEM | 8 | 2 | 1 | 11 (68.8) |
| oxa2 | 0 | 0 | 0 | 0 |
| aadA2 | 1 | 1 | 1 | 3 (18.8) |
| aphA1-lab | 0 | 0 | 0 | 0 |
| strA | 0 | 0 | 1 | 1 (6.3) |
| sul1 | 1 | 0 | 0 | 1 (6.3) |
| TetA(B) | 1 | 0 | 0 | 1 (6.3) |
| Class 1 integron | 2 | 0 | 0 | 2 (12.5) |
| Class 2 integron | 0 | 0 | 0 | 0 |

**Table 18. Comparison of Phenotypic Resistance with Presence of Resistance Genes in E coli Isolates**

| Antimicrobial resistance genes tested | Number of resistant genes found among phenotypically resistant isolates | | | |
|---|---|---|---|---|
| | Ampicillin n=10 (1) | Amoxycillin n=3 (2) | Cephalotin n=13 (3) | Ceftriaxone n=3 |
| blaTEM gene | 7 | 0 | 9 | 1 |

## 3.5. Dissemination and Advocacy

The Project Advisory Committee (PAC) was developed in 2014 with representatives from the Steering Committee (SC) of APEIR in Indonesia and various government institutions. Meetings with the PAC were conducted 3 times at 20 October 2014, 2 November 2015, and 21 November 2016. In each meeting, we gave the PAC an update on the development of the project. Members of the PAC are:

a. SC APEIR – Prof. dr. Amin Soebandrio, Ph.D, Sp.MK
b. Badan Pengujian Obat dan Makanan (BPOM)
c. Direktorat Jenderal Bina Upaya Kesehatan, Kementerian Kesehatan (c.q. BUKR)
d. Direktorat Jenderal Bina Kefarmasian dan Alat Kesehatan, Kementerian Kesehatan
e. Direktorat Jenderal Peternakan dan Kesehatan Hewan (c.q. Direktorat Kesehatan Hewan, Direktorat Kesehatan Masyarakat Veteriner)

On 14 November 2016, we conducted a dissemination workshop to share project results with various stakehodlers. The workshop was attended by 45 participants from the Ministry of Agriculture, Ministry of Health, Wates Disease Investigation Laboratory, Dr. Muwardi Hospital, Central Java Province Livestock Services, Health Services and agencies responsible for livestock services in Karanganyar, Sukoharjo and Klaten Districts, FAO, academicians, and ASOHI (Indonesia Veterinary Drug Assoication).

# IV. Recommendations

From this project, we propose the following recommendations to all stakeholders.

**General Recommendations**

1. Strengthen existin regulations and develop new regulation to increase monitoring and control of antibiotics distribution and use, and limit the use of antibiotic for growth promotors in farms and prophylactic treatment in humans.

2. Improve antimicrobial resistance monitoring and surveillance programs in primary healthcare facilities, communities and farms to provide information for developing policies in animal and public health sectors.

3. Engage communities to support antimicrobial resistance control program through risk communication and introduction of good practices on prudent and responsible use of antibiotics and disease prevention.

**Specific Recommendations**

1. Require all drug producers for both animal and human use to put prescribed drug and antibiotic drug label on every drug strips.

2. Add antibiotic susceptibility testing in primary healthcare facilities as a requirement for facility accreditation.

3. Establish support from local government offices or independent community funding to sustain antibiotic cadre activities into the future.

4. Ensure a strict reporting system is in place for all businesses involved in the importation, distribution, sale, and prescription of antibiotics for animal and human use.

5. Develop national guidelines for prudent and responsible use of antibiotics in livestock.

6. Similarities in antibiotic resistant patterns of E. coli isolated from animals, human and the environment indicates the need to conduct a more comprehensive research on the impact of using similar antibiotics in animal and public health, and the likely risk of sharing resistant bacteria or genes in a farm environment.

# V. Project's Outputs

During the project, we published 3 types of documents, which are activity reports, scientific manuscripts, and advocacy materials. See Table 19 for details.

**Table 19. List of Project Outputs**

| No. | Receiver | Document | Time Period |
|---|---|---|---|
| 1 | IDRC | First 6 Month Progress Report for Year 1 | September 2013 – February 2014 |
| | | Second 6 Month Progress Report for Year 1 | March – August 2014 |
| | | Annual Project Report for Year 1 | September 2013 – August 2014 |
| | | First 6 Month Progress Report for Year 2 | September 2014 – February 2015 |
| | | Second 6 Month Progress Report for Year 2 | March – August 2015 |
| | | Annual Project Report for Year 1 & 2 | September 2013 – August 2015 |
| | | Literature Review Report | 2014 |
| 2 | Health Services and Livestock Services of Central Java Province | Progress Report for Year 1 | September 2013 – August 2014 |
| | | Reports of Literature Review and Baseline Survey | 2015 |
| | | Project Summary | 2013-2015 |
| 3 | National Seminar on Veterinary Innovation in Research and Industry to Answer Market Challenges | Manuscript on Baseline Data of Antibiotic Use in Layer Chicken and Pig Farms | 19 September 2015 in Yogyakarta |
| 4 | The 14th National Veterinary Science Conference in Indonesia | Oral presentation on Antibiotic Use in Layer Chicken Farms in Central Java Province<br>Oral presentation on Antibitoc Use in Pig Farms in Central Java Province | 23-24 September in Tangerang |
| 5 | The 4th International One Health Congress & The 6th Biennal Conference of the International Association for Ecology and Health | Oral presentation on An Ecohealth Approach to Mitigating Antimicrobial Resistance: Assessment of Doctor KAP and Programs in Health Facilities in Central Java Province, Indonesia<br>Oral presentation on An Ecohealth Approach to Mitigating Antimicrobial Resistance: Antibiotic Use in Layer Farms in Central Java Province, Indonesia<br>Poster presentation on "BIJAK-Antibiotik" Cadres: A Community Participation Model for Antimicrobial Resistance Prevention Program in Central Java Province, Indonesia<br>Poster presentation on An Ecohealth Approach: Antibiotic Usage and Accessibility in Swine Fars in Central Java Province, Indonesia | 4-7 December 2016 in Melbourne, Australia |