



**UNIVERSITI PUTRA MALAYSIA**

**STUDY ON ANTIMICROBIAL USAGE AND AWARENESS ON  
ANTIMICROBIAL RESISTANCE AMONG SMALL RUMINANT FARMERS  
IN *LADANG ANGKAT* FARMS, UPM, SELANGOR, MALAYSIA**

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FPV 2017 46**

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FARMERS IN *LADANG ANGKAT* FARMS, UPM, SELANGOR, MALAYSIA**

**SITI FARAHANI BINTI KHALID**

A project paper submitted to the  
Faculty of Veterinary Medicine, Universiti Putra Malaysia

In partial fulfillment of the requirement for the  
DEGREE OF DOCTOR OF VETERINARY MEDICINE

Universiti Putra Malaysia  
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CERTIFICATION

It is hereby certified that we have read this project paper entitled “Study on Antimicrobial Usage and Awareness on Antimicrobial Resistance among Small Ruminant Farmers in *Ladang Angkat* Farms, UPM, Selangor, Malaysia”, by Siti Farahani binti Khalid and in our opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirement for the course

VPD 4999-Project

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## DEDICATIONS

This project paper is dedicated to Allah S.W.T., who had created me and made all things possible throughout this project,

The love of my life,

My father, Allahyarham Khalid bin Tukiman

My mother, Patimah @ Kamisah binti Denin @ Adnan

My siblings, Siti Fairuz, Nur Fadzillah, Nur Khalida, Farahnadira, Ridhwan Hakim

My friends,

My teachers,

&

And to all those who are directly and indirectly involved in completion of this project. Thank you for your continuous support and care.

May this will be your inspiration and motivation for your future endeavours

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In the name of Allah, Most Gracious, Most Merciful.

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Without their supports, I would have never been succeed in achieving this milestone. They had not only given feedback but had given me advice, encouragements, knowledge and strength to carry on with this study until its completion.

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**LIST OF ABBREVIATIONS**

%	Percentage
N	Population size
n	Sample size
$\chi^2$	Chi square statistic
AMs	Antimicrobials
AMR	Antimicrobial resistance
AMU	Antimicrobial use
STEC	Shigatoxin-producing <i>E. coli</i>
MDR	Multi-drug resistance
CIAs	Critically important antibiotics
CDC	Centers for Disease Control and Prevention
FAO	Food and Agriculture Organization
WHO	World Health Organization
SPM	Sijil Pelajaran Malaysia
SPTM	Sijil Tinggi Persekolahan Malaysia

**ABSTRAK**

Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan kursus VPD 4999 –  
Projek

**Kajian Penggunaan Antimikrob dan Tahap Kesedaran Terhadap Ketahanan Antimikrob di Kalangan Penternak Ruminan Kecil, *Program Ladang Angkat*, UPM, Selangor, Malaysia**

**Oleh: Siti Farahani binti Khalid**

**Penyelia: Dr. Rozaihan Mansor**

**Penyelia bersama: Dr. Sharifah Salmah Syed Hussain  
& Dr. Siti Zubaidah Ramanoon**

Trend terkini dalam penggunaan antimikrob telah menjadi satu faktor risiko kepada ketahanan antimikrob dalam industri penternakan ruminan. Permintaan terhadap penggunaan antimikrob dalam industri ternakan boleh dipengaruhi oleh pengetahuan am, sikap dan amalan dalam kalangan penternak. Satu kajian soal selidik keratan rentas yang melibatkan penternak ruminan berskala kecil dalam Program *Ladang Angkat*, UPM, Selangor telah di adakan bertujuan untuk menilai amalan penternak terhadap penggunaan antimikrob; kefahaman dan kesedaran terhadap ketahanan antimikrob. Seramai 13 responden dari sembilan ladang ruminan berskala kecil telah terlibat dalam kajian ini. Borang soal selidik mempunyai lima (5) bahagian:

karakteristik demografik, pengurusan am ladang, serta penilaian terhadap pengetahuan dan amalan terhadap penggunaan antimikrob terhadap ketahanan antimikrob. Keputusan dari kajian ini menunjukkan setiap ladang mempunyai sekurang-kurangnya 3 ke 12 jenis antimikrob dengan penicillin (41%) dan tetracyclines (36%) sebagai antibiotik yang paling biasa digunakan. Secara am nya, responden didapati mempunyai pengetahuan yang cukup terhadap sesetengah aspek penggunaan antimikrob namun tidak dalam amalan penggunaan antimikrob. Sebanyak 54% repondan tidak memahami senario sebenar berkenaan ketahanan antimikrob dan kesannya terhadap industri penternakan. Keputusan juga menyarankan terdapat kaitan signifikan antara tahap pendidikan dan jawatan pekerjaan responden dengan kesedaran mereka terhadap ketahanan antimikrob ( $P < 0.05$ ). Keputusan juga menyarankan terdapatnya kekurangan kesedaran terhadap ketahanan antimikrob dalam kalangan penternak berdasarkan kebanyakan mereka tidak sedar terhadap penggunaan antimikrob secara berhemah. Lantas meningkatkan kesedaran terhadap ketahanan antimikrob melalui bimbingan dan pendidikan dalam kalangan mereka amat diperlukan.

**Kata kunci:** antimikrob, ketahanan antimikrob, kesedaran penternak, ruminan berskala kecil

## ABSTRACT

Abstract of the project paper presented to the Faculty of Veterinary Medicine in partial requirement for the course VPD 4999 – Project.

**Study on Antimicrobial Usage and Awareness on Antimicrobial Resistance among Small Ruminant Farmers in *Ladang Angkat* Farms, UPM, Selangor, Malaysia**

**By: Siti Farahani binti Khalid**

**Supervisor: Dr. Rozaihan Mansor**

**Co-supervisors: Dr. Sharifah Salmah Syed Hussain**

**& Dr. Siti Zubaidah Ramanoon**

Recent trends on the use of antimicrobials have become an alarming risk factor for antimicrobial resistance (AMR) in ruminant farming. Demand for antimicrobials usage (AMU) in livestock production can be affected by farmer's knowledge, attitude and practices. A cross-sectional study involving small ruminant farmers in *Ladang Angkat* Programme, UPM, in Selangor area was conducted to assess their practices on antimicrobial usage; as well as to evaluate their understanding and awareness on AMR. A total of 13 respondents, from 9 small ruminant farms were enrolled in this study. Questionnaires comprised of five sections: the demographic characteristics, general management of the farm, assessment on knowledge and practices on AMU

and AMR. Results indicated that these farms acquire 3 to 12 types of antimicrobial drugs with penicillin (41%) and tetracyclines (36%) being the most common antibiotics used. Generally, respondents were found to have sufficient knowledge on certain aspects on antimicrobials usage but not in their practices. About 54% of the respondents did not understand the actual scenario regarding AMR and its impact contributed from the livestock farming. Results were also suggestive that there was an association between the level of education and work position of the respondents and their awareness on AMR ( $P < 0.05$ ). Result suggested that there is lack of awareness on AMR among farmers as majority of them were not aware on the prudent use of antimicrobials, thus increasing awareness on AMR through guidance and education to the farmers are greatly warranted.

**Keywords:** antimicrobials, antimicrobial resistance, farmer awareness, small ruminants

## 1.0 INTRODUCTION

Antimicrobial is defined as agents used to kill micro-organisms, or suppress their multiplication growth and these agents are classified according to the manner in which they adversely affect a microorganism (Saunders Comprehensive Veterinary Dictionary, 1999). Whereas, antimicrobial resistance (AMR) is defined as the ability of a microorganism to resist the effect of an antimicrobial agent (Saunders Comprehensive Veterinary Dictionary, 1999). Resistance may be an intrinsic characteristics or acquired by selection of mutation or by acquisition of a resistance gene from other microorganisms (Saunders Comprehensive Veterinary Dictionary, 1999; Wall *et al.* 2016).

In 1945, in his Nobel Prize lecture for discovering penicillin, Alexander Fleming emphasized that exposing micro-organisms to its non-lethal quantities of the drug as well as under-dosing the infected patient may be resulted in resistance of the infectious agents causing the diseases. His prediction however, proved to be on point as observed by the current trends of AMU and increase in AMR (Fleming A., 1945).

The use of antimicrobials (AMs) in food animal production has been suggested to significantly improve health, productivity and well-being; lowering disease incidence and reducing morbidity and mortality of the livestock animals (Barlow, 2011; Oliver *et al.* 2011). In recent decades however, it has been shown that the usage of AMs for purposes such as therapeutic and non-therapeutic in animal production have led to AMR in bacteria affecting both human and veterinary medicine (Wall *et al.* 2016; McDougall *et al.* 2016). Various studies have shown that consumer's knowledge, attitudes and practices on AMs has become factors affecting the recent

trend of AMU among them (Eng *et al.*, 2003; Nonga *et al.*, 2009; Visschers *et al.*, 2016 & Briyne *et al.*, 2014).

Domestic farm animals are important for the economy and social life across the developing countries but also pose as a threat due to the increase exposure to zoonotic infections and food-borne diseases to human population as well as the environment (Katakweba *et al.*, 2012). A study has shown that a number of human pathogens including shigatoxin-producing *E. coli* (STEC), *Salmonella*, and *Campylobacter* can be found in farm animals such as dairy cattle (Barlow, 2011). These milk-producing animals act as reservoir for all these types of bacteria as well as reservoirs for antimicrobial genes in the microbiome that have been shown to cause AMR in humans (Oliver *et al.* 2011). These types of bacteria could be transferred to humans either directly via the food chain or indirectly as a result of spread of animal waste on cropland (Oliver *et al.* 2011).

In 2013, U.S. Department of Health and Human Services: Center for Disease Control and Prevention claimed that livestock producers such as farm animals as high antibiotic consumers with comparison to a considerable levels of avoidable antibiotic use. Uncontrolled use of AMs in the production by either the farmers or veterinarians has the potential to generate cross-resistance to drugs used in human medicine. With that, it is important to propose good farm practices to foster the judicious use of AMs in assuring animal health and productivity (Pereira *et al.* 2014).

The routine exposure of farm animals to low doses of AMs has contributed to the development of resistance in foodborne pathogens which presents a threat to human health and limit the ability to treat human infections with the same classes of drugs used in food animals (Barlow, 2011).

In general, a more thorough understanding on consumer's knowledge, attitude, and practices may improve the clinician-consumer relationship and communication as well as facilitate in the development of strategies to educate them (Eng *et al.*, 2003). Previous study has suggested that educational intervention directed to both clinicians and consumers can increase their knowledge and awareness on the antimicrobials as well as reduce the occurrence of inappropriate antibiotic prescription by the clinicians (Eng *et al.*, 2003).

AMR is becoming a major concern in veterinary practices as it has become one of the top health challenges facing the 21<sup>st</sup> century as reported by the World Health Organization (2015). Moreover, this emerging challenges can be overcome by understanding the attitude pattern and trend of AMU by the farmers. However, studies on awareness of AMR among livestock farmers in developing countries; as well as their role in controlling this problem is still less (Katakweba *et al.*, 2012) The current knowledge on the use of antimicrobial among farmers in Malaysia is scarce and no studies have been conducted to date. Hence, the objectives of this study were:

- i. To assess the practice of AMU among ruminant farmers in Selangor.
- ii. To evaluate the level of understanding on AMR among ruminant farmers in Selangor.

## 2.0 LITRATURE REVIEW

### 2.1. Antimicrobials and antimicrobial resistance in livestock production

Over the last decades, livestock production has seen to developed rapidly and increasingly towards industrialized system where AMs has becoming part of the production. The use of AMs had been widely used in food animals either for growth promotion, prophylaxis or metaphylaxis; (FAO, 2016). Antimicrobial is a term generally used for drugs, chemicals, or other substances that either kill or suspend the growth of microbes such as antibiotics, anti-viral agents, anti-fungal agents, anti-parasitic agents and anti-septic agents (Fridien, *et al.*, 2010).

The emergence of AMR may be driven by the misuse and overuse of these drugs such as antibiotics; and often given without professional oversight (WHO, 2005) which resulted in the ability of a microorganism to resist the effect of antimicrobial agent (Saunders Comprehensive Veterinary Dictionary, 1999). The principle behind the development of resistance is due to different types, concentrations and frequencies of exposure experienced by the bacteria in the guts of humans and animals to antimicrobial agents. In addition, mechanism for the emergence of antimicrobial resistance (AMR) has been known to be either influenced by pathologic mechanisms or behavioural mechanisms (Hwang *et al.*, 2016).

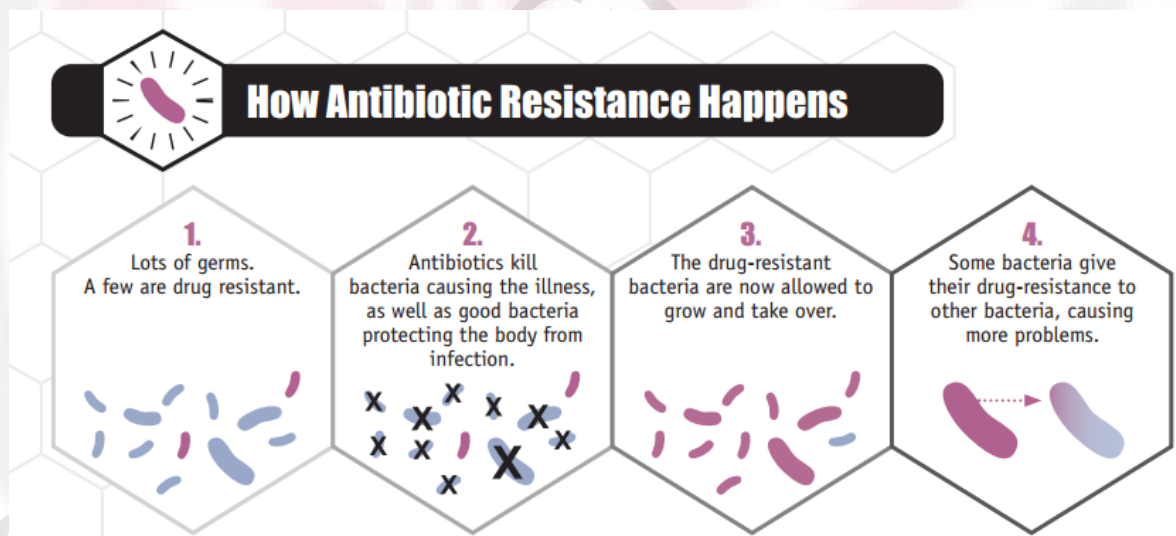
The ability of microorganisms to naturally develop resistance to AMs includes transmission of genetic material, microbial adaptation, and selective pressure from the acts of over-use explained the pathologic mechanism of AMR (Hwang *et al.*, 2016).

As in behavioral mechanism, AMR may occur as a result of overutilization and inappropriate AMU. Knowledge, attitudes and practices on the AMs had becoming the factors affecting the recent trend of AMU (Eng *et al.*, 2003) whilst in livestock

production as an example, the trend of overuse and sub-optimal use of AMs has greatly contributed to the development of AMR (Jones et al., 2014). The emergence and spread of antibiotic resistance causes limitation in the choice of antibiotics used for treatment of infectious diseases; thus further poses a negative impact on patient outcome (Lai et al., 2014).

## 2.2. How AMR happens?

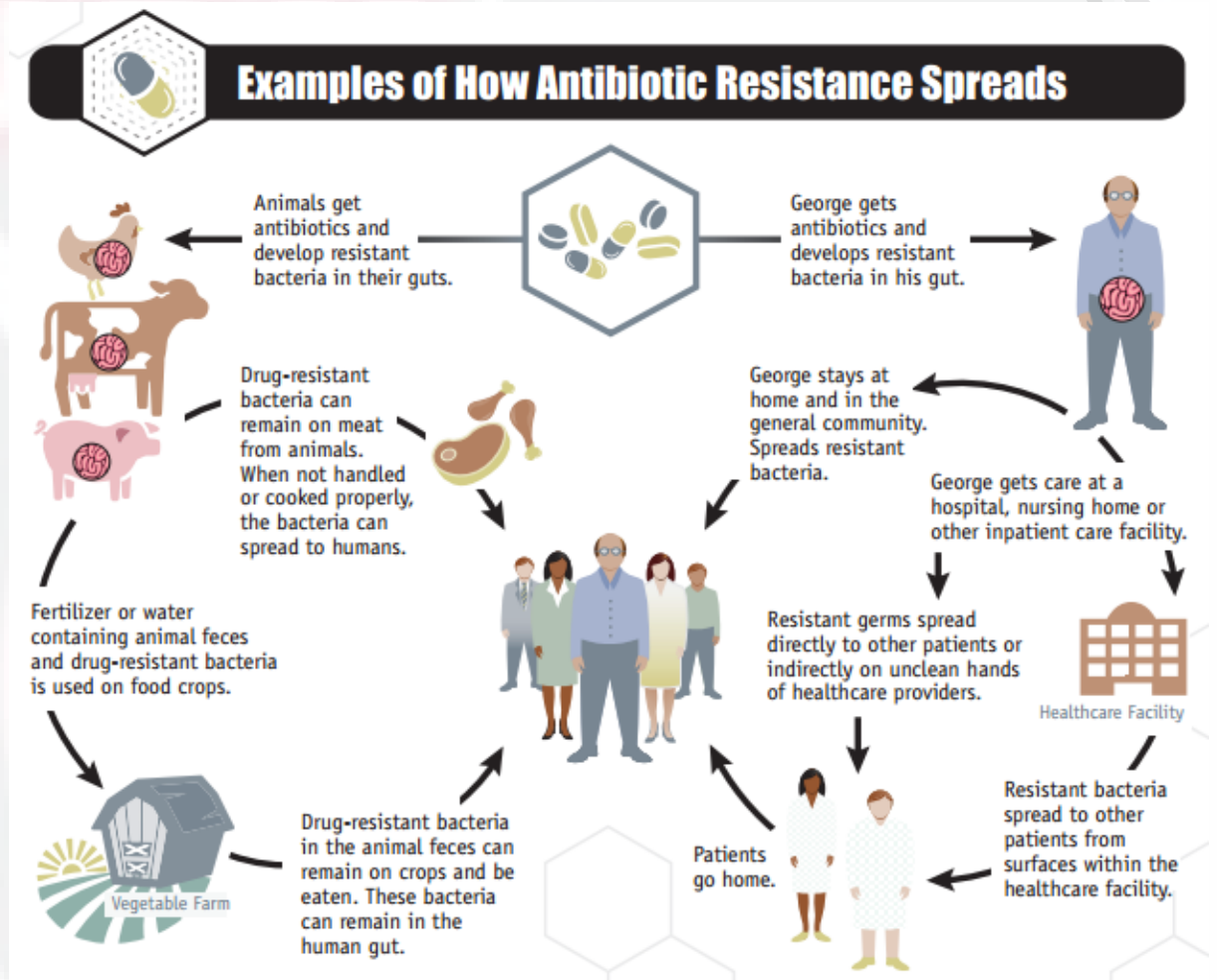
*Antibiotic Resistance Threats in the United States, 2013* by Centers for Disease Control and Prevention (CDC) is a published report that give a snapshot of the complex problem related to current antibiotic resistance issues. This report described in diagrams on how the antibiotic-resistance infection can happen.



**Figure 1: How antibiotic resistance happens (picture courtesy of Centers for Disease Control and Prevention)**

Based on Figure 1 above, resistance of antibiotic happened primarily when there is a few drug resistant microorganisms in germ population colonizing the host body. Consumption of antibiotics by the host may kill both bacteria causing the illness and good bacteria protecting the body from infection. The drug resistant

microorganisms are now allowed to grow and take over the colonization in host body. These colonies have the ability to give their drug-resistant to other bacteria causing more problems in the future. Figure 2 below shows the example on how antibiotic resistance happens.



**Figure 2: Examples on how antibiotic resistance happens (picture courtesy of Centers for Disease Control and Prevention)**

### 2.3. Antimicrobial use (AMU) in livestock production

Many studies were done across the countries to assess the AMU among different scales of livestock farming. The main concern related to the use of these drugs by farmers is the risk of development of antimicrobial resistance; therefore

oversight of the volume and class of antimicrobial used is important (Bryan *et al.*, 2016). Many older antibiotics such as penicillins and tetracyclines are cited most frequently as the prescribed classes to treat the main food producing animals such as cattle (Briyne *et al.*, 2014); while tetracyclines and sulphonamides were the most frequently used antimicrobial agents in broiler chicken in Tanzania (Nonga *et al.*, 2009).

Chicken and swine bacterial isolates had been reported to have resistance towards tetracyclines, penicillins and sulphonamides and multi-drug resistance (MDR) were found to be significantly higher in these isolates if compared to those from cattle (FAO, 2016).

**Table 1: Sources of AMR (bacteria and bacterial genes) in animal production setting**

Bacterial species	Antimicrobial resistance pattern	Infections commonly observed in humans	Animal sources of human infection	Other known sources of human infection
<b><i>Campylobacter</i> spp.</b>	Fluoroquinolones	Gastrointestinal (sequelae: <i>Guillain-Barré syndrome</i> )	Food-producing animals (poultry)	Raw unpasteurized milk, water
<b><i>Enterococcus</i> spp.</b>	Aminoglycosides Ampicillin Vancomycin		Food-producing animals (poultry)	
<b><i>Escherichia coli</i></b>	Quinolones Sulphonamides Trimethoprim	Gastrointestinal, UTI, HUS		
<b>LA-MRSA</b>			Food-producing animals (pigs, calves, cows)	
<b><i>Salmonella</i> spp. (non-typhoidal)</b>	Cephalosporins Quinolones Tetracyclines	Gastrointestinal	Food-producing animals (pigs, cows, poultry)	

Legend: HUS - Hemolytic Uremic Syndrome, LA-MRSA - Large Animal Methicillin-resistant *Staphylococcus aureus*, UTI - Urinary Tract Infection  
Source: Adapted from Furuya and Lowy (2006)

The control on the use of AMs in various production settings such as agriculture and health care is critically important because many of the antimicrobial substances licensed for veterinary use belong to antimicrobial classes or groups routinely used in human (FAO, 2016).

#### **2.4. Awareness on antimicrobial resistance (AMR) among farmers**

Antimicrobial resistance (AMR) is an increasing problem in human and veterinary medicine. This problem can be managed by reducing the usage of AMs in livestock production such as ruminant, poultry and pig farming. In poultry production, AMs were used excessively to overcome flocks' problem related to high level of stress, to treat or prevent occurrence of diseases and poor nutrition (Nonga *et al.*, 2008). In the other livestock production, AMU has resulted in healthier, productive animals with lower disease incidence and lower morbidity and mortality, and production of nutritious, high-quality, and low-cost food for human consumption (Oliver *et al.*, 2011). There are different opinions by the farmers regarding the AMU on contribution to increased AMR.

A study conducted by Visschers *et al.* (2015) among pig farmers showed that farmers are more worried about financial and legal issues around pig farming than AMR. He also found the fact that farmers have low concern about AMR might be due to the immediacy at which farmers experience the problem's consequences such that consequences of AMR will go unnoticed as long as this does not result in therapeutic failure in animals or farmers' health. On the other side, people involved with dairy cattle industry believed that the advantages of AMU in adult dairy cows far outweigh the disadvantages even though they were aware of the emergence of AMR (Oliver *et al.*, 2011). They were more aware with the consequences of banning the use of AMs in the dairy industry and in other food-producing animals (Oliver *et al.*, 2011).

#### **2.5. Fighting back against AMR in livestock production**

Antimicrobial ineffectiveness has become the greatest risk to modern medicine in our generation nowadays because it increases the likelihood of infection during

invasive procedure and chemotherapy for cancer as the resistant bacteria can be transferred from animals to human; and vice versa (The Science and Technology Committee, 2014; Katakweba *et al.*, 2012). The routine exposure of farm animals to low doses of AMs has contributed to the development of resistance in foodborne pathogens which poses a threat to human health and limit the ability to treat human infections with the same classes of drugs used in food animals (Barlow, 2011).

It is believed that the risk of AMR can be alleviated by reducing the use of antimicrobials by both human and veterinary medicine (Visschers *et al.*, 2015). Moreover, investigation of farmer's perception toward AMs, AMR problem in the farms and possible intervention measures should be developed strategically.

In other countries, prudent AMU guidelines have been developed by groups of expertise including Canadian Veterinary Association which addresses strategies that may influence the development of AMR. The guidelines target on establishing veterinary-client-patient relationships and making veterinarians as the primary source of information and guidance for the farmers. Foremost, the guidelines recognized veterinarians as the best positions to evaluate the benefits and risks of AMU in animals with justifying the importance of judicious use of AMs. (<https://www.canadianveterinarians.net/documents/antimicrobial-use-in-animals> & <http://www.canadianveterinarians.net/documents/extra-label-drug-use-eldu>)

### **3.0 MATERIALS AND METHODS**

#### **3.1. Procedure**

A cross sectional study was conducted using a paper pencil survey and structured interview methods. Small ruminant farmers included in this study were from those involved in the *Ladang Angkat* Program, Faculty of Veterinary Medicine, Universiti Putra Malaysia. Farmers were invited by telephone or directly to participate in the study and upon agreement, visitation were conducted and farmers were then interviewed using a set of structured questions. Data collection took place over a period of five weeks (9<sup>th</sup> January to 10<sup>th</sup> February 2017).

#### **3.2. On-farm visit and interview**

Each farm that had agreed to participate in this study were visited. Data and information on handling and storage of AMs were recorded. Respondents were asked to complete eight pages of questionnaire during the farm visit in which structured questionnaire were prepared in English and then translated to Malay language in order to facilitate the interviewing process in the farm. Each questionnaire consisted of 39 main multiple choice and close-ended questions and a few sub-questions that was divided into five sections addressing participant's knowledge, attitudes, and practices regarding usage of AMs and AMR.

#### **3.3. Questionnaire**

The questions only required respondents to answer the questionnaire using simple responses (e.g. 'yes' or 'no') or by choosing the most appropriate answer from multiple choice answers. There were five sections including the demographic

characteristics, general management of the farm, assessment on knowledge and practices on AMU and AMR.

Section A questions were pertaining to the demographic characteristics of the respondents, including farm's location, gender, age, education, position held in the farm and years of experience in farming sector. Section B questions were on general management practiced by the farm such as the species of animal kept, type of management system practiced, purposes of livestock farming and herd sizes. Descriptive analysis were performed to summarize the data in these sections.

In section C, D and E, formulated questions were developed towards assessing the respondent's knowledge and attitude on AMU and AMR. A standard set of questions were used based on a survey conducted by WHO in 2015 on current public awareness and common behaviors related to antibiotics in a range of countries.

For questions 38 and 39, participants were asked to respond according to the following 5-point Likert scale: 1=strongly disagree, 2=slightly disagree, 3=neither agree nor disagree, 4=slightly agree, and 5=strongly agree. Those who answered "strongly agree" or "slightly agree" to the AMR knowledge questions will be classified as knowledgeable on the issue while those who answered "strongly disagree" or "slightly disagree" would be considered as otherwise.

### **3.4. Statistical analysis**

Data were entered into Microsoft Excel and analysed using SPSS Statistics Version 22 (IBM Corp.). Chi Square ( $X^2$ ) test was performed to determine if there were any association between variables ( $P < 0.05$ ).

## 4.0 RESULTS

### 4.1. Demographic characteristics

A total of 13 respondents (N=13) from 9 out of 14 actively available small ruminant farms in *Ladang Angkat* Program, UPM participated in this study.

As shown in Table 2, all respondents were male and mostly were within the age group of 31-49 years old (62%). Out of these 13 respondents, 39% of them (n=5/13) did not complete their secondary school education while the rest represents proportion of those getting formal high education up to post-graduate program (23%). Six of them (46%) were working as general workers, 4 were farm owners (31%) and the rest were either working as a manager or veterinary supports. Their working experience ranges from less than 3 years (31%, n=4/13), 3 to 7 years (23%, n=3/13) and more than 7 years (46%, n=6/13).

**Table 2: Descriptive statistics of demographic characteristics of 13 respondents**

Demographic characteristics (N=13)	n	(%)
Gender		
• Male	13	100
• Female	0	0
Age (years)		
• <30	2	15.4
• 31-49	8	61.5
• ≥50	3	23.1
Education group		
• Less than secondary school	5	38.5
• SPM	2	15.4
• STPM/Diploma	2	15.4
• Under-graduate	1	7.7
• Post-graduate	3	23.1
Position in the farm		
• General worker	6	46.1
• Manager	1	7.7
• Owner/Director	4	30.8
• Veterinarian	1	7.7
• Veterinary assistant	1	7.7

Year(s) of experience in ruminant farming		
• Less than 3 years	4	30.8
• 3 to 7 years	3	23.1
• More than 7 years	6	46.2

## 4.2. General management

In this study, a total of 9 farms were visited. As shown in Table 3, all farms involved had a mixed of sheep and goats and were managed mostly with intensive (67%) and semi-intensive (33%) farming systems. Four farms managed for meat production (44%), 2 farms for milk (22%) and the rest were for multi-purposes such as breeding, research and teaching (33%). Herd size ranges from less than 50 heads of animals (11%, n=1/9), 50 to 100 heads of animals (33%, n=3/9), 101 to 150 heads of animals (11%, n=1/9) and majority of the farms had  $\geq 150$  heads of animals (44%, n=4/9).

**Table 3: Descriptive statistic of general management of 9 farms**

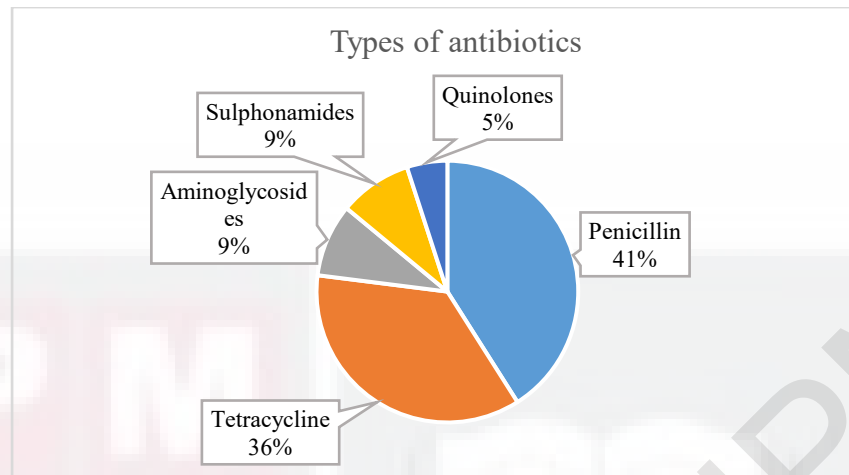
<b>General management (N=9)</b>	<b>n</b>	<b>(%)</b>
Species of ruminants available in the farm		
• Sheep only	0	0
• Goats only	0	0
• Sheep and goats	9	100
Type of management system		
• Intensive farming	6	66.7
• Semi-intensive farming	3	33.3
• Extensive farming	0	0
• Integrated farming	0	0
Purposes of farming		
• Meat	4	44.4
• Milk	2	22.2
• Multi-purpose/others (breeding, research and education, etc.)	3	33.3
Herd/flock sizes		
• <50 heads	1	11.1
• 50-100 heads	3	33.3
• 101-150 heads	1	11.1
• >150 heads	4	44.4

### 4.3. Storage facilities and antimicrobials available in the farm

During the farm visit, the storage facilities and types of AMs available in the farm were identified and recorded. One of these farms did not have any storage facilities or own any stock of AMs. Drugs were mostly kept in refrigerator (for vaccines), locker and boxes (refer to Table 6). It was observed that all these drugs were kept away from sunlight. Table 4 shows the list and type of AMs kept in these farms.

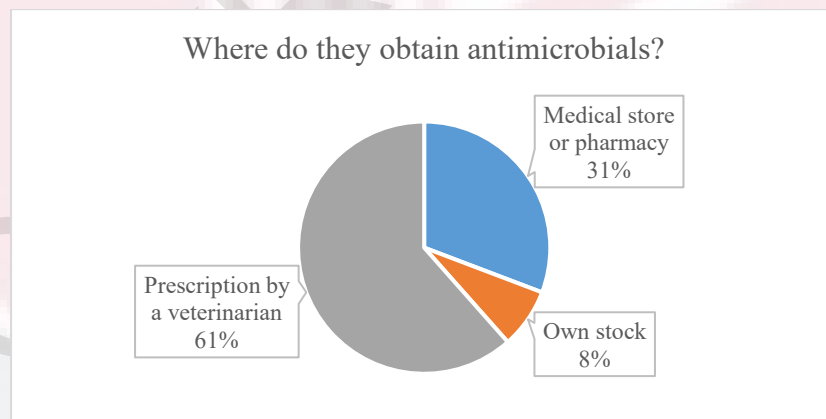
**Table 4: Types of antimicrobials available in the farms**

<b>Antibiotic groups</b>	<b>Frequency (N=22)</b>	<b>Percentages (%)</b>
Penicillins:		
a) Amoxicillin	3	13.6
b) Benacillin	2	9.1
c) Ampicillin	1	4.5
Tetracyclines:		
a) Oxytetracyclines	4	18.2
b) Terramycin	4	18.2
Aminoglycosides:		
a) Streptomycin	1	4.5
b) Gentamycin	1	4.5
Sulphonamides:		
a) Sulfadimidine	2	9.1
Quinolones:		
a) Enrofloxacin	1	4.5
Combination:		
a) Penicillin-streptomycin	2	9.1
b) Penicillin-kenamycin	1	4.5
<b>Antiparasitic agents</b>	<b>Frequency (N=18)</b>	<b>Percentages (%)</b>
1. Fenbendazole	2	11.1
2. Albendazole	2	11.1
3. Thiobendazole	1	5.6
4. Ivermectin	6	33.3
5. Amitraz	2	11.1
6. Doramectin	2	11.1
7. Diminazine aceturate	1	5.6
8. Levamisole	1	5.6
9. Asuntol	1	5.6



**Figure 3: Percentages of types of antibiotics used in the farms**

From the result, antimicrobial frequencies were calculated for each farm as shown above in Figure 3. The most frequent types of antibiotics found among 8 small ruminant farms were penicillins (41%, n=9/22) and tetracyclines (36%, n=8/22). As for antiparasitic, the most frequently used drug was ivermectin (33%, n=6/18). Figure 2 shows where the farms obtained their AMs.



**Figure 4: Sources of antimicrobials obtained from 8 farms**

#### 4.4. Knowledge about antimicrobials

Third section (Section C) of questionnaire was generated to assess respondents' knowledge about AMs. In short, 69% of respondents (n=9/13) had sufficient knowledge on certain aspects on AMU. This was made based on the total

marks obtained by each respondents for this section. There was 13 questions with 'yes' or 'no' answers in this section prepared to determine the respondents' knowledge about AMs. Respondents will get score when they answered correctly and considered as knowledgeable when they obtained score 9 marks and above for this section.

#### **4.5. Practices on antimicrobial usage**

Fourth section (Section D) of the questionnaire was generated to evaluate the practices on AMU among the respondents. There was 6 questions with 'yes' or 'no' answers in this section and respondents will get score when they answered correctly and considered to practice the use of AMs responsibly when they obtained score 5 marks and above for this section. Results showed 54% of respondents (n=7/13) practiced the use of AMs responsibly as they able to recognize statements correctly.

#### **4.6. Knowledge and awareness about antimicrobial resistance (AMR)**

The last section (Section E) of the questionnaire was generated assess to the awareness of the issue of AMR and levels of understanding around the issue among respondents. There was 9 questions with 'true' or 'false' answers in this section. Respondents will get score when they answered correctly and considered to know and aware on the issue of AMR when they obtained score 4 marks and above for this section. As a result, 54% of respondents (n=7/13) did not understand the actual scenario regarding AMR and the impacts of arising AMs issue; whilst suggesting that there are relatively high levels of misunderstanding about certain aspects of the issue

#### **4.7. Statistical analysis**

Chi Square ( $X^2$ ) test was carried out to determine if there is any significant association between variables (risk factors) and awareness on AMR among the

respondents. Based on the results shown in Table 5, there was significant association between level of education and work position; and awareness on AMR among the farmers.

**Table 5: Statistical analysis of variables and awareness on AMR among 13 respondents**

No.	Types of variables		Aware (n,%)	Not Aware (n,%)	Chi- square ( $\chi^2$ )	p-value (Fischer's exact test)
1.	Level of education	Primary and secondary school	1 (8%)	6 (46%)	0.124 <sup>a</sup>	0.029
		Possess higher education	5 (39%)	1 (8%)		
2.	Position in the farm	Owner	5 (39%)	0 (0%)	9.479 <sup>a</sup>	0.005
		General worker	1 (8%)	7 (54%)		
3.	Herd size (heads)	≤100	4 (31%)	2 (15%)	4.282 <sup>a</sup>	0.155
		101-150	1 (8%)	0 (0%)		
		>150	1 (8%)	5 (39%)		
4.	Years of experience	< 9 years	4 (31%)	4 (31%)	0.124 <sup>a</sup>	1.000
		≥ 9 years	2 (15%)	3 (23%)		

## 5.0 DISCUSSION

This is a preliminary study and results of this study could provide a broad insight into the usage of antimicrobials and awareness on AMR among small ruminant farmers in *Ladang Angkat* farms, UPM.

Despite the fact that our samples were representative of the small ruminant farmers, the results of the current study revealed two key findings. Firstly, the farmers used multiple AMs in their livestock animals and near to half of them did not practiced the use of AMs responsibly. Secondly, majority of the farmers included in this study were not aware on the prudent use of AMs and its impact on AMR.

### 5.1. Antimicrobial usage among small ruminant farms

Most of the farms in this study (89%), have storage facilities and their own stock of AMs. The storage facilities mostly consist of storage boxes or locker in storage area which is protected from source of sunlight; whereas three farms have refrigerator mainly to keep vaccines and some antimicrobials. The ideal storage unit for AMs should be clean, dry, frost-free area and protected from changes in temperature, sunlight, dust, moisture, animals and insects. It is important to keep AMs in the ideal storage unit because in a study conducted by Philips *et al.*, (1990), they found that there was significant reduction in ciprofloxacin activity against *E. coli* when the solutions of ciprofloxacin were irradiated with longer wavelength of ultraviolet radiation.

In this study, we found that the most frequent types of antibiotics found among the farms were penicillins and tetracyclines. As for antiparasitic, the most frequently used drug is ivermectin (33%). To date, there is no other reports on AMU among ruminant farmers in Malaysia. In a study conducted to assess AMU in broiler chicken

farming across Tanzania regions, AMs that were frequently used were those in the groups of tetracyclines and sulphonamides (Nonga *et al.* 2009). In another study results indicated that the most frequent antibiotic classes used in cattle production across 25 European countries were penicillins, macrolides and aminoglycosides (Briyne *et al.* 2014).

It is reported that the most frequently used antibiotics preferred by veterinarians to treat the main food producing animals are still; many older antibiotics such as penicillins, tetracyclines and potentiated sulphonamides which were considered as not critically important antibiotics (CIAs) (Briyne *et al.* 2014). The trend of preferred AMU in farms across the countries might be influenced by several factors such as differences in availability of the medicines, in routes of administration authorized, different patterns of infectious diseases, different production systems or differences in veterinary prescribing behavior (Briyne *et al.* 2014). In the current study, this can be observed in the trend of AMU among the farms.

## **5.2. Farmers knowledge about antimicrobials and the practices of antimicrobial usage**

Results from the current study indicated that more than half of the respondents correctly identified true statements in Part C and D (refer to Section 4.4. and 4.5.). They appeared to be fairly knowledgeable about AMs; however less likely to be practicing the use of AMs responsibly. It has been shown that the use of AMs in farms can be influenced by certain factors, including lack of specific knowledge on pathogens causing the diseases, complexities of the number of available AMs that can be used for treatment and veterinarians' responsibilities to observe AMR on the client's farms (Reyher *et al.*, 2017). As a result, necessary skills and knowledge for

more prudent use of AMs among the farmers can be improved with veterinarian's intervention of good supportive skills and communication competencies among both of them (Speksnijder *et al.*, 2015).

**“62% respondents (n=8/13) agreed that antimicrobials treatment can be stopped when the animal's condition is improving, 38% of them (n=5/13) thought that giving less or more antimicrobials than prescribed to the animals is healthier”.**

Results for question above (Section 4.4.) showed that some of the farmers in the current study did not use AMs according to the length of treatment provided, thus suggesting that there is some degree of misconception and misguidance on the use of AMs among the farmers. Studies have shown that inappropriate use of antimicrobial agents that did not achieved desirable therapeutic outcomes and drug-related toxicity; as well as under-dosing the infected patient has association with the emergence of resistance (Wall *et al.* 2016; McDougall *et al.* 2016; Hwang *et al.*, 2016; WHO, 2001; Fleming, 1945). Thus results from the current study is alarming as this inappropriate use of AMs could have the potential to cause emergence of AMR.

**“31% of respondents (n=4/13) would directly sell or slaughter the animals that had been treated using antimicrobials to the market”.**

From the result above (Section 4.5.) was suggestive that more than half of the farmers understood the concept of antimicrobial withdrawal period in a way necessary to maintain the health and welfare of the animals. However, what is alarming is that there were some farmers that do not comply with the recommended withdrawal period by directly selling or slaughtering the animals shortly after the antimicrobial treatments were done. Similar scenarios were demonstrated in studies by Nonga *et al.*

(2009) in broiler chicken production, where 90% of the respondents admitted to have knowledge on antimicrobial withdrawal period but more than 95% of them admitted to slaughter the chickens even before the withdrawal period. This was further verified by the presence of antimicrobial residues in the chicken meat sampled from 70% of the farm. In the current study, detections of antimicrobial residues were not conducted.

**“77% of respondents (n=10/13) were not satisfied if veterinarian prescribing antimicrobials to the sick animals did not explain the treatment purposes”.**

Results from the current study (Section 4.5.) indicated that farmers were concerned in getting explanation regarding treatments on their livestock. It has been shown that veterinary-farmer communication should be improved in order to achieve responsible AMU among farmers (Reyher *et al*, 2017). Treatment or advices related to veterinary recommendations made by veterinarians should be supported by evidence base or research associated with that particular conditions (Reyher *et al*, 2017). Veterinarians should be able to talk and represent their views held by the veterinary profession to farmers who seek for their supports in responsible use of AMs (Reyher *et al*, 2017). When it comes to making decision on the use of antibiotics in farm animals by the veterinarian prescribing it, a brief clarity about what types of AMs are appropriate must be provided (Reyher *et al*, 2017). In a study conducted by Visscher *et al*, (2016) it was shown that veterinarian-farmer relationship has positive association in farmers' and veterinarians intention to reduce AMU. Thus, in order to reduce inappropriate AMU among farmers, positive collaboration between veterinarians and farmers is essential.

### 5.3. Farmers' awareness on antimicrobial resistance

Based on the results from the current study were suggestive that the farmers appeared inadequate to understand and were less worried about AMR. It also implied that not many farmers understood the issue of AMR and they were not aware or worried about the seriousness of this problem. A study conducted by Visschers *et al.* (2015) among pig farmers showed that farmers are more worried about financial and legal issues around pig farming than AMR. This can be explained by current global financial development that involved largely in the increasing production costs such as feeding cost.

The results of the current study showed a consistent direct association between levels of education and work positions of farmers with awareness on AMR. Farmers that have higher educational background represents higher work positions in the farms. In a study conducted by Eng *et al.* (2003) on consumer attitudes and the use of antibiotics, it found that demographic groups particularly persons with lower educational status had both higher levels of misconceptions and lower levels of knowledge about potential adverse impact of antibiotics. In the current study, it is suggestive that levels of education may be crucial in determining the knowledge, understanding and awareness on AMU and AMR. However, as there are no previous studies on the risk factors affecting the awareness on AMR among ruminant farmers in Malaysia, further studies is warranted. Effort to reach groups with lower educational background must be achieved to change their perception on this issues.

## **CONCLUSIONS**

Most of respondents in this study used multiple antimicrobials in their livestock and this is alarming as majority of them were not aware the prudent use of antimicrobials and its impact on antimicrobial resistance. Therefore, guidance and education on responsible use of antimicrobials as well as the facts regarding antimicrobial resistance is important to prevent the incidence of antimicrobial resistance.

## **RECOMMENDECTIONS**

It is highly recommended to provide open-ended questions in future studies and prepare multi-languages set of questionnaire other than Malay and English language. This is due to language barriers during the interview session with the farm workers. Similar studies should be continued in collaboration with other ruminant production such as cattle and buffalo farmers. Lastly, trial questionnaire should be conducted before the study.

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APPENDICES



Figure 5(a): Locker box – away from source of sunlight



Figure 5(b): Locker box – away from source of sunlight



Figure 5(c): Drugs kept inside separate boxes, placed inside a storage room



Figure 5(d): Drugs kept inside separate boxes, placed inside a storage room



Figure 5(e): Cupboard – to keep drugs



Figure 5(f): Drugs kept inside a cupboard

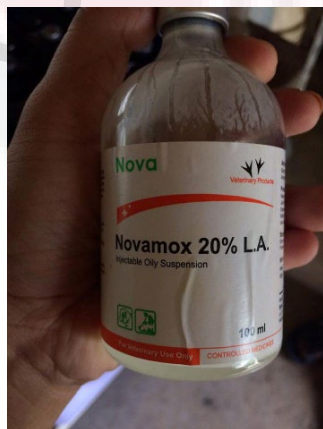


Figure 5(g): Amoxicillin as the most commonly found antibiotics in the farms



Figure 5(g): Oxytetracycline as the most commonly found antibiotics in the farms

**Figure 5: Storage facilities and AMs available in the farms**

**Table 6: Types of antimicrobials and storage facilities found in farms investigated**

Types of antimicrobials	Storage facilities	Antibiotics	Antiparasitic	Antiviral/vaccines	Antiseptic
Farm A	Locker box – away from source of sunlight	Tetracyclines: a) Oxytetracyclines b) Terramycin	1. Fenbendazole 2. Ivermectin		1. Acriflavine
Farm B	Drugs kept inside separate boxes, placed inside a storage room	Penicillins: a) Amoxicillin b) Benacillin Tetracyclines: a) Oxytetracyclines Sulfonamides: a) Sulfadimidine Quinolones: a) Enrofloxacin	1. Amitraz 2. Doramectin		
Farm C	Locker box – away from source of sunlight	Tetracyclines: a) Terramycin Sulfonamides: a) Sulfadimidine	1. Fenbendazole 2. Ivermectin		
Farm D	Locker box – away from source of sunlight	Penicillins: a) Amoxicillin Tetracyclines: b) Oxytetracyclines	1. Albendazole 2. Ivermectin		1. Acriflavine

Farm E	Drug boxes – away from source of sunlight	Penicillins: a) Benacillin Tetracyclines: a) Oxytetracyclines	1. Amitraz 2. Ivermectin 3. Diminazine aceturate		1. Negasunt powder 2. Woundsarex spray
Farm F	Locker box – away from source of sunlight	1. Penicillins: a) Amoxicillin b) Terramycin	1. Ivermectin 2. Albendazole		
Farm G	Inside cupboard and shelf at room temperature and refrigerator to keep vaccines	Tetracyclines: a) Terramycin Aminoglycosides: a) Streptomycin b) Gentamycin Penicillin-streptomycin (pen-strep)	1. Levamisole 2. Doramectin 3. Ivermectin 4. Asuntol 5. Thiabendazole	1. Heptavac-P	1. Negasunt powder 2. Woundsarex spray 3. Gusanex
Farm H	Refrigerator and storage room	1. Penicillin – kanamycin 2. Penicillin – streptomycin 3. Ampicillin			