ปัจจัยเสี่ยงของโรคปากและเท้าเปื่อยในจังหวัดไชยะบุรี ประเทศสาธารณรัฐประชาธิปไตยประชาชนลาว (พ.ศ.2554 ถึง พ.ศ.2556)

นายวิริดเด็ด สุริยา

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RISK FACTORS OF FOOT AND MOUTH DISEASE IN XAYABOURY PROVINCE OF LAO PDR, 2011-2013

Mr. Viliddeth Souriya

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Veterinary Medicine
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Thesis Title	RISK FACTORS OF FOOT AND MOUTH DISEASE IN XAYABOURY PROVINCE OF LAO PDR, 2011-2013
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วิริดเด็ด สุริยา : ปัจจัยเสี่ยงของโรคปากและเท้าเปื่อยในจังหวัดไชยะบุรี ประเทศสาธารณรัฐประชาธิปไตยประชาชนลาว (พ.ศ.2554 ถึง พ.ศ.2556) (RISK FACTORS OF FOOT AND MOUTH DISEASE IN XAYABOURY PROVINCE OF LAO PDR, 2011-2013) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. ชัยเดช อินทร์ชัยศรี, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: รศ. ดร. กิตติศักดิ์ อัจฉริยะขจร, ผศ. ดร. ฐานิสร์ ดำรงค์วัฒนโภคิน, 67 หน้า.

การศึกษานี้มีจุดประสงค์เพื่อประเมินปัจจัยเสี่ยง (risk factor) ของโรคปากและเท้าเปื่อย (foot and mouth disease; FMD) ในจังหวัดไชยะบุรี ในพื้นที่ภาคเหนือของสาธารณรัฐประชาธิปไตยประชาชนลาว (สปป. ลาว) ในช่วงปี พ.ศ. 2554 ถึง พ.ศ. 2556 โดยข้อมูลการระบาดของโรคปากและเท้าเปื่อยได้รับความอนุเคราะห์จากกรมปศุสัตว์และประมง สปป.ลาว รูปแบบการศึกษาเป็นการวิจัยเชิงวิเคราะห์แบบย้อนหลัง จากผลไปหาเหตุ (case-control design) ในระดับครัวเรือน โดยการใช้แบบสอบถามกับเจ้าของปศุสัตว์ ในข้อมูลที่สำคัญที่เกี่ยวกับข้อมูลทั่วไปที่เกี่ยวข้องกับเจ้าของปศุสัตว์ มาตรการควบคุมป้องกันโรคปากและเท้าเปื่อย โปรแกรมการปฏิบัติเกี่ยวกับการให้วัคซีนในภาวะฉุกเฉิน ขนาดและชนิดของฟาร์ม ตำแหน่งที่ตั้งและความสูงจากระดับน้ำทะเลของแต่ละฟาร์มโดยการวัดด้วยเครื่องหาพิกัดสัญญาณดาวเทียม (GPS tracker; Garmin GPS map 60csx, สหรัฐอเมริกา) ข้อมูลการเครือข่ายของการเคลื่อนย้ายสัตว์ระหว่างหมู่บ้านที่ตรงกับหมู่บ้านที่ทำการศึกษาครั้งนี้ (29 หมู่บ้าน) ใช้ข้อมูลจากการศึกษาที่ผ่านมาในปี พ.ศ.2555 ของ Foot and Mouth Disease Control in Southeast Asia Through Application of the Progressive Control Pathway (FAO-ROK National Project) โดยกรมปศุสัตว์และประมง สปป.ลาว ข้อมูลทั้งหมดที่ทำการสัมภาษณ์ประกอบด้วย 434 ครัวเรือนจาก 59 หมู่บ้านใน 5 จังหวัด โดยมีจำนวนครัวเรือนที่เกิดการระบาด (case) ทั้งหมด 181 ครัวเรือน และ จำนวนครัวเรือนที่ไม่มีการระบาด (control) ในเขตหมู่บ้านที่มีการระบาด มีจำนวนทั้งหมด 146 ครัวเรือน และ 107 ครัวเรือน ในหมู่บ้านนอกเขตหมู่บ้านที่มีการระบาด ทำการวิเคราะห์ข้อมูลโดยใช้วิธีการวิเคราะห์การถดถอยโลจิสติก (logistic regression model) โดยกำหนดให้ข้อมูลจากแบบสอบถามรวมถึงข้อมูลเชิงพื้นที่เป็นตัวแปรต้น (independent variable) และกำหนดให้การเกิดโรคปากและเท้าเปื่อยระดับครัวเรือนเป็นตัวแปรตาม (dependent variable) สำหรับความสัมพันธ์ระหว่างดัชนีทางเครือข่ายและการเกิดโรคปากและเท้าเปื่อยได้ทำการวิเคราะห์ในระดับหมู่บ้านโดยใช้วิธีการทดสอบสมมติฐานที่ไม่ใช้พารามิเตอร์ (non-parametric test) ผลการศึกษาพบว่าผู้เลี้ยงปศุสัตว์ที่มีความรู้เกี่ยวกับโรคปากและเท้าเปื่อยมีโอกาสที่จะป้องกันการเกิดโรคปากและเท้าเปื่อยในสัตว์ของตนเองได้มากกว่า (P <0.01) แม้ว่าประชากรกลุ่มนี้อาจมีระดับการศึกษาที่ต่ำและมีการใช้วัคซีนน้อย ครัวเรือนปศุสัตว์ที่มีการขายสัตว์และอยู่ในชุมชนใกล้ถนนสายหลัก มีความเสี่ยงเกิดโรคปากและเท้าเปื่อยมากกว่า (P <0.01) นอกจากนี้การวิเคราะห์ข้อมูลการเคลื่อนย้ายสัตว์พบว่าหมู่บ้านที่มีการเคลื่อนย้ายมากมีความเสี่ยงมากในการเกิดโรคปากและเท้าเปื่อย (P <0.05) โดยสรุปจากผลการศึกษา เพื่อลดโอกาสในการเกิดโรคปากและเท้าเปื่อยในพื้นที่ที่มีจำนวนสัตว์ที่ได้รับวัคซีนต่ำ ตำแหน่งฟาร์มควรตั้งในตำแหน่งที่ห่างไกลจากชุมชน และความตระหนักของเจ้าของปศุสัตว์ในการป้องกันโรคปากและเท้าเปื่อยควรได้รับการยกระดับให้อยู่ในระดับที่สำคัญมากในการลดการเกิดโรคระบาด.

ภาควิชา อายุรศาสตร์	ลายมือชื่อนิสิต ....
สาขาวิชา อายุรศาสตร์สัตวแพทย์	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....
ปีการศึกษา 2558	ลายมือชื่อ อ.ที่ปรึกษาร่วม ....
	ลายมือชื่อ อ.ที่ปรึกษาร่วม ....

5675327631 : MAJOR VETERINARY MEDICINE
KEYWORDS: ANIMAL MOVEMENT, CONTROL AND PREVENTION STRATEGY, FOOT AND MOUTH DISEASE, SPATIAL LOCATION

VILIDDETH SOURIYA: RISK FACTORS OF FOOT AND MOUTH DISEASE IN XAYABOURY PROVINCE OF LAO PDR, 2011-2013. ADVISOR: ASST. PROF. CHAIDATE INCHAISRI, Ph.D., CO-ADVISOR: ASSOC. PROF. KITTISAK AJARIYAKHAJORN, Ph.D., ASST. PROF. THANIS DAMRONGWATANAPOKIN, Ph.D., 67 pp.

The objective of this study was to determine the risk factors of foot and mouth disease (FMD) in Xayaboury province the northern region of the Lao People's Democratic Republic (Lao PDR) during the years 2011 to 2013. FMD outbreak information was provided by the Department of Livestock and Fishery, Lao PDR. Using a case-control design at the household level, questionnaires were employed to livestock owners. Information on the important aspect of general information of livestock owners, FMD control and prevention strategies, FMD emergency vaccination programs, farm size, and farm types was captured. The farm location and the elevation above the sea level were determined by a GPS tracker (Garmin GPS map 60csx, USA). The network data of animal movement between villages that matched our survey villages (29 villages) were extracted from a previous study in 2012 of Foot and Mouth Disease Control in Southeast Asia Through Application of the Progressive Control Pathway (FAO-ROK National Project) under the Department of Livestock and Fisheries of Lao PDR. A total of 434 households in 59 villages of 5 districts were interviewed and their data collected comprising 181 case households, 146 control households inside the outbreak villages and 107 control households outside the outbreak villages. Data from questionnaires and spatial data were analyzed as independent variables in the logistic regression model using FMD occurrence at the household level as a dependent variable. Network parameters were analyzed the association with FMD occurrence at the village level by non-parametric test. The results show that livestock owners who had knowledge about FMD before the outbreaks were able to better prevent their animals from FMD (P <0.01) although they were less educated and administered less vaccination to their livestock. The livestock households in the community closer to a main road and selling their livestock before outbreak were at higher risk to developing FMD (P <0.01). Moreover, the information of network parameters at the village level indicated that the villages with high movements of livestock were at high risk of FMD (P <0.05). Based on the overall results, to reduce the chance of FMD outbreaks in the area with a low number of vaccinated livestock, the location of farm lands should be remote from a high density community and awareness of livestock owners on FMD prevention should be raised to a high priority to reduce the outbreak.

Department:	Veterinary Medicine	Student's Signature	....
Field of Study:	Veterinary Medicine	Advisor's Signature	....
Academic Year:	2015	Co-Advisor's Signature	....
		Co-Advisor's Signature	....

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CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBRAVIATIONS

DLF	=	Department of Livestock and Fisheries
EU	=	Europe Union
FAO-ROK National Project	=	Foot and Mouth Disease Control in Southeast Asia through Application of the Progressive Control Pathway
FMD	=	Foot and Mouth Disease
FMDV	=	Foot and Mouth Disease Virus
GPS	=	Global Positioning System
Lao PDR	=	Lao People's Democratic Republic
OIE	=	World Organization for Animal Health
Q	=	Quartile
SEACFMD	=	South-East Asia and China Foot and Mouth Disease
WRL	=	World Reference Laboratory

CHAPTER 1
INTRODUCTION

1.1. Definition and importance of FMD

Foot and mouth disease (FMD) is caused by Aphthovirus of the family Picornaviridae with seven strains (A, O, C, SAT 1, SAT 2, SAT 3 and Asia 1). FMD is a severe and highly contagious viral disease of livestock. All cloven-hoofed animals such as cattle, buffaloes, goats, sheep and pigs are susceptible to FMD (Kitching, 2005; Mahy, 2005). The clinical signs of infected animals depending on species, age of the animal, and strain of virus. Commonly, infected animals show high temperature up to 40°C for a few days (Kitching, 2002). For large ruminant, the vesicles appear on tongue, lips, gums and feet. With the vesicles on the foot sole, infected pigs show characteristic clinical signs of lameness or slow walking (Yoon et al., 2012). By comparison with cattle and pigs, the clinical signs in goats and sheep are not severe. Most of infected sheep and goats do not usually show symptoms. An infected small ruminant without clinical sings, often difficult to detect, might be the cause of FMD spread (Kitching and Hughes, 2002). In adult animals, high morbidity rates with a low mortality rates are detected, while higher mortality rates are in young animals (Cameron et al., 1999; Geering and Lubroth, 2002) (Ryan et al., 2008).

The economic loss caused by FMD is from weight loss, a decrease in milk production, costs for treatment, and time spent on taking care of animals. Moreover, the livestock industry might be damaged economically by a widespread outbreak of the disease. The animal production might put a limitation on export. For example, an FMD outbreak in the United Kingdom in 2001 caused a huge economic loss of approximately 11,600 million dollars and nearly 6.24 million animals were destroyed (Thompson et al., 2002). Moreover, United Kingdom lost revenues from tourism approximately 4,000 million dollars for that outbreak (Thompson et al., 2002).

1.2. FMD in Lao, PDR

In the Me-Kong region, FMD is an endemic and an important transboundary disease. Predominant strain of FMDV in Lao PDR detected during 2003 and 2006 was serotype O followed by serotype A, with no report of FMD type Asia 1 outbreak (Gleeson, 2002; Khounsy et al., 2009; Perry et al., 2002). Most farmers in Lao PDR are small holders. For cattle and buffalo, they are used mostly in free-range farming practices in the mountainous area during the rice growing season, while pigs are put in cages in the back yard behind their houses. In several reports, vaccination and animal movement control are a key control strategy to prevent and control FMD outbreaks (Elnekave et al., 2013; Ortiz-Pelaez et al., 2006). In Lao PDR, although FMD vaccination has been implemented and supported by World Organization for Animal Health (OIE), the vaccination budgets are still limited. Due to the fact that the vaccination program cannot cover all susceptible animals in all regions of Lao PDR. The outbreak of FMD has been reported regularly. The northern part of Laos is considered as a one of regions that have reported outbreaks of FMD. According to FMD outbreak reports from 2009 to 2013 of the Department of Livestock and Fisheries, Lao PDR, the high incidence of outbreaks during 2009 to 2011 was in Houaphanh province, which is in the north-eastern part sharing the border with Vietnam while the highest prevalence of FMD was in Xayaboury province, with a report of FMD outbreaks every year.

Xayaboury is one of the seven provinces in the northern region, Lao PDR, having the total area of 16,389 square kilometers, of which is quite mountainous running roughly in a north-south direction and forming a natural border with the Thai highlands. The northern part of Lao PDR is declared to be the FMD control area by vaccination. The FMD outbreaks in Xayaboury occurred in a specific area, especially along borders of Thailand and along the Mekong River. Xayaboury was recognized as an FMD “hot-spots” area possessing a high risk of reinfection comprising a high number of ruminant population and extensive animal trading, especially among neighboring countries. Due to both legal and illegal cross-border trading, as well as people and animal movement without boundary from Thailand through Vietnam and

China, these can spread FMD across the entire region. Moreover, the animal holder communities in Xayaboury are located along the Mekong River from the north to the south of the province. The location of livestock holders might also be another important risk of FMD outbreaks and spread along rivers and roads. In some villages, FMD never occurred while in the same village, when FMD occurred, not all livestock holders were affected. Since vaccination cannot cover all of livestock population, the immunity level in some population might not be sufficient to prevent FMD outbreak. Different rates of FMD occurrence in livestock households in the same village might be related to the different immunity factors which can be a key for successful control strategies. Without immunity, an outbreak can be triggered and widely spread. Thus, containing an epidemic or outbreak in Xayaboury areas may reduce the prevalence of FMD in this province and prevent FMD spread from Xayaboury province to other regions of Lao PDR. However, the risk factors associated with an outbreak of FMD in Xayaboury province was rarely reported. The occurrence and geographical distribution of FMD is not reported and the association of livestock movement with FMD is not clearly known, which remains an area of exploration. Therefore, the aim of this study is to understand the risks of FMD outbreak and spread of FMD, focusing on animal trade connecting together livestock stakeholders, spatial location, control and prevention strategies, emergency vaccination and the outbreak managements to gain more understanding and information in order to control FMD effectively.

CHAPTER 2
LITERATURE REVIEW

2.1. Background of FMD

Foot and mouth disease (FMD) is a highly contagious viral disease of cloven-hoofed animals caused by Aphthovirus of the family Picornaviridae. FMD affects both domestic and wildlife animals (Geering and Lubroth, 2002). The FMD transmits via various routes including direct contact between animals, contaminated environment, grasslands, wetlands, and rivers (Bouma et al., 2003; Gibbens and Wilesmith, 2002). The FMD virus can spread rapidly depending on the conditions of each transmission mechanism. The amount of virus that can spread varies depending on the species of the animal. For instance, pigs can emit a large amount of virus, whereas a lesser amount can be observed in cattle and sheep (Donaldson and Alexandersen, 2002). FMDV can contaminate farmers, aerosols or milk (Geering and Lubroth, 2002). The disease can spread by indirect contact with subclinical animals and by airborne route. FMD-recovered animal can become a reservoir of disease and are able to trigger an unexpected outbreak with rapid dissemination of the disease through the border if movement is not sufficiently controlled (Gleeson, 2002; Premashthira et al., 2011). Because of contagious infection in all cloven-hoofed animals and multi-route transmission which can easily spread crossing the large area, FMD is classified as a transboundary disease (Premashthira et al., 2011; Sutmoller et al., 2003; Yoo, 2011). The seven serotypes of FMD virus which are A, O, C, Sat 1, Sat 2, Sat 3 and Asia 1 have been reported. Of all these strains, serotype O was distributed mostly in Southeast Asia (Kitching, 1999). The incubation period of the FMD is different among animal species depending on the transmission routing or strain of the virus. In cattle, the incubation period is normally 2-14 days while the incubation period in sheep and goat is at 3-8 days. In swine, the incubation period is greater than 2 days but it may be as short as 24 hours for host-adapted strains in pigs, especially under intense direct contact (Alexandersen et al., 2003; Kitching, 2002; Kitching and Hughes, 2002). Although there are many strains, the majority of clinical signs are related to blister-like sores on the tongue, lips and mouth. The vesicle- or blister-like lesion is also found on teats and between the hooves. The disease severely affects cattle and pigs both in adult and young animals. In adult animals, the fatality is rare whereas the mortality in young animals is often high due to myocarditis or starvation (Geering and Lubroth, 2002). The disease also causes severe production losses and the majority of recovered affected animals become weakened and debilitated. However, in some endemic countries of FMD, the vaccination strategy is suggested routinely for 2-3 times per year to control and prevent the FMD outbreak (Cai et al., 2014; Doel, 2003). The FMD immunity from vaccine or infection is highly specific and does not produce a cross-protective immunity against other strains of FMD virus.

2.2. Risk factors of FMD

In general, the risk factors of FMD outbreak possibly include several combinations of factor such as geographical factors, animal movement, environment, and preventive and control strategies. The geographical factor is one of the risk factors of FMD outbreak that often associate with low-land altitude, close distance from farms to risk areas. For instance, a study in Ethiopia demonstrated that if the height of lowlands is less than 1500 meters, an FMD outbreak is likely to occur when compared with high lands that rise more than 1500 meters (Megersa et al., 2009). Moreover, the risk factors associated with animal movement and spatial location are considered as important factors that can control FMD outbreaks. It is difficult to control animal movement from farm to farm or movement of infected animals to new herds, which consequently causes the disease to spread widely to other places. Another study in Argentina demonstrated that the highly frequent movement of animals between farms tended to increase the incidence of FMD. Moreover, farm-to-farm movement increased the disease risk at a higher rate than farm-to-slaughterhouse movement (Aznar et al., 2011). With regard to the spatial scales between farm locations, farm distance to disease-risk places and farm size are likely to correlate with the FMD outbreak. For example, livestock farm size and type are among the risk factors associated with FMD spreading. (Hayama et al., 2012) reported that different types of livestock farming also contributed differently to the risk of spreading FMD. For instance, pig farms had a greater risk to induce the local spread due to the high quantity of viral shedding from pigs whereas the middle and large size cattle farms had a potential to increase the risk of viral spread locally. Furthermore, the location of the farms and major roads where there is routine movement of animals could escalate the outbreak of FMD. The location of farms that have main roads with adjacent radius is also the factor of FMD outbreak (Hamoonga et al., 2014). The risk of local FMD spread also increases when farm size increases. Because a large-size cattle farm contains large numbers of highly susceptible animals, the virus spreads around the farm. The farm had a greater risk of contracting infection (Hayama et al., 2012). In contrast, pigs are relatively resistant to airborne infection. Pigs shed a large number of viruses to the environment if they show clinical signs. With a large amount of shedding, it is possible that the virus will escape from farm and infect neighboring pig farms (Hayama et al., 2012). In a large farm, the frequency of animal movement increases and hence the increased risk of FMD spread. In small ruminant farms, the clinical signs of FMD are often difficult to detect. FMD can easily spread by trading of small ruminants with subclinical disease (Ali et al., 2011). However, without movement, the role of goats and sheep in the spread of FMD is minor (Sutmoller et al., 2003).

There are many approaches to studying animal movement and analyzing pattern of animal movement. Information of animal movement is valuable to provide an insight network of movement and the value chain among livestock dealers, abattoirs and retail markets (Aznar et al., 2011; Martínez-López et al., 2009; Ortiz-Pelaez et al., 2006). The spreading pathway by contacts between farms, abattoirs or markets seems to be independent from geolocation and distances whereas the high risk areas for virus introduction and transmission would explain the pattern of disease spread (Gerbier et al., 2002; Nöremark et al., 2009; Premashthira et al., 2011). In network movements, the social network analysis model has been used by using in-degree, out-degree, betweenness, closeness and total-degree centrality to find the relationship of these nodes to other nodes on the network and can measure out the statistics. Betweenness is defined as the frequency of a specific livestock operation in the shortest path connecting between two livestock operation nodes relative to other nodes in the network (Dubé et al., 2009; Ortiz-Pelaez et al., 2006). In-degree is a number of livestock operation origins exporting animals to a specific livestock operation (Dubé et al., 2009). Out-degree is a number of individual livestock operation destination importing animals from a specific livestock operation (Dubé et al., 2009). Closeness is defined as a mean distance from one livestock operation to all other reachable livestock operations (Büttner et al., 2015). With those parameters, the important of animal movements to FMD spread can be explained and the key player in the network of FMD spread can be found leading to the priority of an appropriate strategy to control disease (Ortiz-Pelaez et al., 2006). For instance, the network analysis was applied to control FMD spread in the UK (Ortiz-Pelaez et al., 2006). In the network analysis, the measure of centrality was a good parameter to predict the risk of infection and to inform surveillance and infection control strategies (Christley et al., 2005). The retrospective study of FMD epidemic in the UK demonstrated that the spread of FMD was influenced by the frequency of animal movement and animal mixing in livestock markets (Ortiz-Pelaez et al., 2006). Besides epidemic size associated with transportation route, vaccination program and zoning of animal farming area, epidemic size also has been determined by the factor associated with the disease spreading including legal or illegal trading, movement of people, movement of animal, movement of animal products, i.e. milk and meat products (Nampanya et al., 2013; Ortiz-Pelaez et al., 2006).

The disease spread increases in the area with high road density, high cattle density but decreases with smaller farm size and greater distances between the case farm and the nearest road (Gilbert et al., 2005; Premashthira et al., 2011). Likely, a common environment factor could be found as a source of exposure (Gerbier et al., 2002; Premashthira et al., 2011). For example, rivers and railways had an additional protective effect on reducing FMD transmission (Premashthira et al., 2011). To control and reduce FMD spread effectively, the exploration of spatial disease patterns in cooperation with trade movement patterns should be investigated. In Lao PDR, although animal movement was also observed as a risk factor associated with FMD outbreak (Nampanya et al., 2013), the understanding of epidemiology associated with FMD outbreak is not sufficient to establish effective control measures.

2.3. Control and prevention

According to World Organization for Animal Health (OIE) report, the FMD is still rampant throughout the world and it has been set as high priority on the list of diseases to control and eradicate. In the European zone, the FMD is considered as a contagious disease for hundreds of years (Sutmoller et al., 2003). At the present, many countries in the Europe Union (EU) have become FMD-free countries, which are similar to the regions of America between the northern and central parts, New Zealand and Australia. However, other countries are still falling in endemic areas of FMD. Vaccination is the priority option to control and reduce the spread of FMD. For instance, the emergency vaccine was recommended to control the epidemic of FMD outbreak in the Netherland in 2001 (Bouma et al., 2003).

In Southeast Asia, FMD still occurs every year, especially in Myanmar, Cambodia, Thailand, Lao PDR and Vietnam (Gleeson, 2002). According to the OIE campaign to control and eradicate FMD in Southeast Asia, the member countries where FMD is endemic have cooperated to distribute information regarding control movement of livestock across borders.

In general, when the FMD outbreak occurs, the policy to control and eradicate disease depends on the disease status. In epidemic areas, stamping out or vaccination with movement control is considered as the tool to control disease. For example, the stamping out policy was applied to control of FMD outbreak in Britain, in which all infected animals were killed and destroyed including susceptible animals that were in contact with the diseased ones. Moreover, disinfection was employed around the affected premises (Sutmoller et al., 2003). For the FMD outbreak in the Netherlands in 2002, the ring vaccination was applied with the economical reason in the area with high density of livestock population. For the area where there was low density of livestock population, stamping out with ring vaccination was implemented followed by strictly banning the movement of animals and cleaning the equipment, vehicles in the farm and infected areas with disinfectant solution (Kobayashi et al., 2007; Phouangsouvanh, 2009; Tomassen et al., 2002). In Japan, the FMD outbreak occurred in 2000 but the country regained disease-free status in the same year through campaigns of culling, hooved-animal movement control in areas surrounding infected premises, and intensive clinical and serological surveillance (Sugiura et al., 2001).

In endemic areas, FMD is prevented by routine vaccination. After the outbreak, emergency vaccination and ring vaccination with movement restriction and disinfection of the outbreak areas are implemented. For example, the control measures of FMD in Brazil involved stamping out all infected animals and implementing quarantine measures, and within 2 years of a vaccination program afterwards, the country was free of FMD (Mayen, 2003). In Argentina, using new strain of vaccination reduced the outbreak and a number of infected livestock. Within 2 years after implementation, the outbreak was absent (Mattion et al., 2004). Furthermore, the control strategies of disease included quarantine and animal movement controls, strategic vaccination, surveillance and disease investigation, improved emergency response capability, reduction in FMD-risk factors and enhanced public awareness of biosecurity measures, all of which were applied in the Philippines to eradicate FMD (Windsor et al., 2011).

Since the movement of animals can spread the disease to other places, the quarantine of animal movement is another tool to reduce the movement of infected animals to other areas. The imported animals are clinically examined and vaccinated during the quarantine period. The vehicles used to transport them are disinfected.

However, to control and eradicate the FMD outbreak efficiently, the control and prevention strategy is also important. Whether a strategy option is suitable for a specific area depends on labors, economic factors, social acceptance, veterinary facility, laboratory diagnostic facility, and location. The FMD control disease measures need to take into account risk factors and epidemiology of disease. Proper risk management along with understanding of the relevant parties and plans can help to prevent FMD spread quickly and effectively.

2.4. FMD in Lao PDR

FMD is an endemic disease in several countries. In Lao PDR, FMD outbreaks also occur regularly (Khounsy et al., 2008). The main serotypes that participate in the outbreaks are O and A. Sometimes, FMD outbreaks have been involved with Asia1 serotype but it is very rare (Khounsy et al., 2008). The World Reference Laboratory (WRL) also reported that the main serotypes of FMD outbreaks from 1978 to 1993 in Lao PDR were of serotype O for 8 years, A for 3 years and Asia 1 for 1 year (Khounsy et al., 2009). From 1998 to 2007, by using the FMDV antigen-typing, a number of 142 FMD outbreaks were diagnosed. Type O was the dominant serotype from 1998 to 2005 whereas type A was reported in 2003, 2006 and 2007, and Asia 1 was observed only in 1998. Approximately, 27.5% of FMD outbreaks occurred in Vientiane and it is the most frequent occurrence in Lao PDR. The FMD outbreak happens mostly in cattle (61.4 %), buffaloes (26.8 %) and pigs (11.7 %) (Khounsy et al., 2008).

FMD control measurement in Lao PDR is through vaccination and quarantine. Lao PDR routinely mass vaccinated cattle using trivalent FMD vaccine (O, A, and Asia 1) at least twice a year. FMD vaccine is provided by the OIE and the vaccine strains contained FMD virus that caused outbreak in Lao PDR (Gleeson, 2002). Commercial FMD vaccines also are available and they have been used in many pig farms (Gleeson, 2002). Imported livestock were also subjected to checking for the health certificate including vaccination against FMD at the animal quarantine station. Normally, vaccination program strategies for controlling disease required that 80 % of the population at risk should be vaccinated. However, due to the limited budget, less than 80 % of the susceptible animals were vaccinated in Lao PDR. Therefore, the risk of FMD outbreak in the region is still high. Furthermore, in Lao PDR if the FMD outbreak occurs, the district governor will declare where FMD infected animals were detected, the area of FMD outbreak and issue a ban on the livestock movement. After the outbreak, if there is no more new outbreak for one month, the district governor will declare that the area is an FMD-free area. Furthermore, the FMD outbreaks in Lao PRD are often related with mixing of infected animals together with susceptible population (Khounsy et al., 2008). Form the report above, they suspected that it might occur in many ways, especially through the transboundary movement of infected animals since animal movement is allowed for trading between neighboring countries and also for local trading in the country (Gleeson, 2002; Khounsy et al., 2008; Perry et al., 2002). Moreover, they also believed that FMD outbreaks are associated with livestock density areas (Khounsy et al., 2008). Emergency ring vaccination among outbreak farms is also practiced in FMD controlling with ring vaccination strategy, several times the outbreak can be contained in a small area (Elnekave et al., 2013). However, the use of vaccine to control outbreak is not effective if movement of livestock from infected areas cannot be controlled (Sutmoller et al., 2003). Moreover, immediately after an outbreak, times taken to detect disease and speed of implementing control measures are also essential to preventing spreading of the disease (Elnekave et al., 2013; Sutmoller et al., 2003). Thus, the knowledge of FMD outbreak patterns would be important to reduce spread and control FMD efficiently.

2.5. FMD in Xayaboury

Xayaboury has been considered as an endemic area of FMD for many years. Xayaboury's location is in the northern part of Lao PDR, out of seven provinces, and belongs to the five provinces in the north in Lao PDR which is in the control zone of the upper Mekong Zone of SEACFMD (The South-East Asia and China Foot and Mouth Disease) campaign. The geographic location in Xayaboury shares borders with many provinces, from Oudomxay and Bokeo in the north, and Luang Prabang and Vientiane provinces in the east. In addition, the west of Xayaboury shares the border with six provinces of Thailand. Xayaboury has the total area of 16,389 square kilometers, of which is quite mountainous areas. In terms of weather, the average temperature is 25 degrees, while the average rainfall is 1,440 mm/year.

Animal movements in Xayaboury have been in provincial areas and also between provinces. Moreover, animals move pass through other countries such as Thailand, Vietnam and China. Animal movement is rather difficult to control and this causes the spread of FMD. (Donaldson et al., 2001) reported that the most common mode of FMD transmission is a movement of infected animals to susceptible animals by direct transmission. Because a high number of animal movements confer risk to an outbreak of FMD, hence, Xayaboury province is located in a high risk area of FMD. Moreover, according to a Xayaboury Livestock and Fisheries Officer report, the dry season from October to April is likely to be a high risk period for FMD. The animal farming in Xayaboury is mostly practiced on the mountain during this period as it coincides with the rice growing season. During the rice growing season, farmers rear their animals together with animals of other farmers on the mountain. If there is one infected animal, the disease can be transmitted to other animals easily. Moreover, most of the farm owners in Xayaboury are in the community where small farms are close to each other. When a disease outbreak occurs in the community, it can easily spread to other farms within that community.

In conclusion, to provide a better knowledge of how to control FMD outbreaks and reduce the risk of FMD spread in Lao PDR, the objective of this study is to identify the risks of FMD in terms of owner characteristics, the number of livestock moved, spatial location, density of animal population, and prevention and outbreak control strategies.

CHAPTER 3
METHODOLOGY

3.1. Selection criteria and case and control definition

Due to a high density of large ruminant population, high prevalence of FMD and adjacent borders to Thailand, Xayaboury was therefore specifically chosen to represent the risk factor related to livestock movement between countries. Villages in 5 out of 11 districts of Xayaboury province (Xaysathan, Xayaboury, Phieng, Paklai and Kenthao) were declared by the Department of Livestock and Fisheries in Lao PDR (DLF) for FMD outbreaks from 2011-2013. All villages with FMD outbreaks were selected as the target villages, namely the outbreak villages. A study was conducted at the household level using a case-control study. The households in each village were asked to participate in the study. The participated households were interviewed to identify FMD from clinical sign pictures and answer a questionnaire. The participants who could identify FMD clinical signs correctly were case households. Others without FMD outbreak were control households. In an outbreak village, participated households with the occurrence of FMD were randomly selected as FMD case households (case) and other households without FMD occurrence were randomly selected as an FMD control household inside outbreak village (control 1). Moreover, villages that have never reported an incidence of FMD and are located far away from FMD outbreak villages for 1-10 km were selected. Livestock households in those villages were randomly selected as FMD control households outside outbreak villages (control 2). The sample size of case control study to define the risk factors at household level was calculated by online Epitools epidemiological calculators (Sergeant, 2015)[1]. Estimation of the number of samples showed expected proportion exposed in controls of 0.20, assumed odds ratio of 2.5, confidence level of 0.95 and power of 0.8, which resulted in 92 per group. In each village, the livestock households with at least 5 cases and 5 controls in the outbreak village and 5 controls in the outside outbreak village were interviewed. The total number of livestock household samples consisted of 434 livestock households in 59 villages of 5 districts (table 1).

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[1] Sergeant ESG. 2015. Epitools epidemiological calculators. Aua vet Animal Health Services and Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease. Available at: http://epitools.ausvet.com.au

3.2. Questionnaire design

The main content of the questionnaire for the interview was designed to capture the important aspect of general information of livestock owners, FMD control and prevention strategies, FMD emergency vaccination programs, farm size, and farm types. The questions focused on activities during, before and after the outbreak for 6 months. For the FMD control and prevention, the routine vaccination program and bio-security of households were included in the questionnaire. Farm types and livestock species were observed on a visit to categorize which household farm types are large or small in size with cattle, buffaloes and pigs. A questionnaire was tested with 10 animal holders before being adopted.

3.3. Data collection

All data were collected in Xayaboury province, and the data source of FMD outbreaks from 2011 to 2013 was derived from the Department of Livestock and Fisheries, Lao PDR (DLF). A number of livestock population, owner information, and location of FMD outbreaks were gathered from the DLF database. The author and veterinary assistants of selected districts and provinces administered the questionnaire in a face-to-face manner. In total the information that was collected in 434 households included 37 outbreak villages (case = 181 households, control 1 = 146 households) and 22 outside outbreak villages (control 2 = 107 households) (table 1).

For the household location, the coordinate (latitude and longitude) and the elevation above the sea level were determined by a GPS tracker (Garmin GPS map 60csx, USA). For the spatial analysis, the data associated with spatial location of livestock households including a distance from livestock holders to the nearest transport routes such as main roads, rivers, markets and slaughterhouses were determined in a mapping software (QGIS 2.4.0-Chugiak, Essen, Germany).

For the network data of animal movement between villages, data were extracted from a previous study in 2012 of Foot and Mouth Disease Control in Southeast Asia Through Application of the Progressive Control Pathway (FAO-ROK National Project) under the Department of Livestock and Fisheries of Lao, PDR. Briefly, livestock producers in 199 villages of 11 districts of Xayaboury were randomly selected for the interview on the origins and destinations of the animals they owned and animal movement frequency. The network of livestock movement was aggregated to the village level in our study. The villages that matched with our selected villages were in included our analysis. For all matched data, a total of villages for network movement analysis consisted of 29 with outbreak villages (N = 20) and control villages (N= 9).

Table 3.1 A number of interviewed livestock households in five districts in Xayaboury province.

District	Total number of villages in district	Total number of livestock households in district	Outbreak village			Outside outbreak village	
			Number of villages	Number of case households (case 1)	Number of control households inside (control 1)	Number of villages	Number of control households outside (control 2)
Paklai	12	544	9	46	35	3	15
Kenthao	8	484	4	21	17	4	19
Phieng	17	813	10	49	42	7	35
Xayaboury	13	512	8	36	24	5	23
Xaysathan	9	442	6	29	28	3	15

3.4. Statistical analysis

The statistical analysis was performed to compare the effect of variable on FMD occurrence at the household level between case livestock households with control livestock households in the outbreak villages or with control livestock households outside the outbreak villages. The effect of variable on FMD occurrence was analyzed by using the logistic regression model treating the FMD status of livestock households as the dependent variable in each analysis. The independent variables included the general information of livestock owners, FMD control and prevention strategies, FMD emergency vaccination programs, a number of livestock per household, farm types and spatial location. Continuous data were tested for normality and linearity. When distribution was not normal or linear, the variable was transformed to categorical data using quartile or median for classification. Initially, univariable logistic regression was performed to identify a subset of statistically significant variables using $P < 0.1$. The variables that affected FMD occurrence significantly in univariable analysis were tested for correlation with Pearson or Spearman rank correlations. The variables that showed high correlation with other significant variables ($r > 0.40$) were indicated as collinearity. Consequently, non-collinear variables were included in a multivariable analysis. In multivariable analysis, the backward stepwise selection was performed to derive a final model. In the final model, odds ratios (OR) and their 95% confidence intervals of statistically significant variables were calculated. Variables that changed the regression coefficient estimates of at least one other variable in the model by more than 20 % were checked for interaction and confounder. When categorized data were statistically significant, the mean of the probability of FMD occurrence was estimated and pair-wise means comparison between categorized data was carried out with Turkey adjustment at ($P < 0.05$).

The connections of animal movements between villages were analyzed to find the key link using centrality measures to calculate parameters relating to node relationships (in-degree centrality, out-degree centrality, closeness centrality, betweeness centrality and totaldegree centrality) in Ucinet 6 for windows (Analytic Technologies, USA) (Borgatti et al., 2002). The difference of network parameters between outbreak villages and control villages was analyzed by Mann-Whitney U test. The statistical significance was determined at $P < 0.05$. All statistical analyses in this study were performed in IBMSPSS 22.0 (IBM institute Inc., USA).

CHAPTER 4
RESULTS

All of FMD outbreak data during 2011 to 2013 in Xayaboury province were provided by the Department of Livestock and Fisheries, Lao PDR. The FMD outbreak villages in Xayaboury are shown on the map in (figure 1). A total of 434 households (181 case households, 146 control households inside the outbreak villages and 107 control households outside the outbreak villages) in 59 villages of 5 districts were in this study. The case and control households were distributed and shown on the map (figure 2).

The effects of variables on FMD occurrence at the household level were compared between case livestock households with control livestock households in the outbreak villages or with control livestock households outside the outbreak villages. The effect of general information of livestock owners, a number of livestock per household, farm types, FMD control and prevention strategies, FMD emergency vaccination programs are shown in table 2 and the effect of spatial location on FMD occurrence is shown in (table 3). The results clearly show that the household owners who suffered from FMD had a significantly lower knowledge about FMD before the outbreak (23.8 %) compared to the households with non-FMD experience both for the households in the outbreak villages (45.9 %; OR = 0.37; 95%CI 0.23-0.59) and households outside the outbreak villages (60.7 %; OR = 0.20; 95%CI 0.12-0.34) (table 2). For general information of owners, we found that no difference was found between households in the outbreak villages. However, the case household owners in the outbreak villages were significantly older, with an average age of 49.60±12.90 years, than the owners outside the outbreak villages whose average age was at 46.32±12.45 years (table 2). Moreover, case household owners in the outbreak villages were Buddhist (79 %) prevailing over other regions with 1.91 of odds ratio for FMD occurrence (95%CI 1.12-3.27) whereas the control household owners outside the outbreak villages were 66% Buddhist. Comparison between the livestock holders who suffered from FMD and the households with non-FMD experience showed that small livestock households (< 5 animals) had less probability for FMD occurrence than large livestock households (> 15 animals) (OR = 0.45 compared to households in the outbreak villages; 95%CI 0.24-0.87 and OR = 0.51 compared to households outside the outbreak villages; 95%CI 0.26-1.01) (table 2). For farm types, most households had beef cattle and buffalo. No household was found rearing pigs alone but they were always inhabited by a kind of beef cattle or buffalo. None of the farm types was found to indicate a significant effect on FMD occurrence.

For FMD prevention and control within 6 months before FMD outbreaks, a number of households were vaccinated for 13.8 % of case households with FMD experience, 16.4 % of control households with non-FMD experience in the outbreak villages, and 17.8 % of the control households with non-FMD experience outside the outbreak villages. However, a non-significant effect of FMD vaccinating was found between households with FMD experience and households with non-FMD experience. Before FMD outbreak, the activity of selling animals in the households with FMD experience was significantly higher than the households with non-FMD experience (OR = 6.60 compared to households in the outbreak villages; 95%CI 1.93-22.50 and OR = 2.82 compared to households outside the outbreak villages; 95%CI 1.04-7.69). During the FMD outbreaks, no livestock household did vaccinate animals. For the households suffering from FMD, 36.5 % of households disinfected farms and 50.3 % of households informed governor veterinarians while the households with non-FMD experience did not do so (table 2). After the outbreaks, no activities or variables were found to have a significant difference between the households inflicted by FMD and the households with non- FMD experience (table 2).

Due to non-normality of the data, the distance from households to the nearest rivers, the nearest main roads, the nearest markets, the nearest slaughterhouses and the elevation above sea level of households were classified to two groups by its' median value. The elevation above the sea and the distance between households and risky places are presented on map in figures 3, 4. The results of univariable logistic regression model are shown in table 3. The elevation above the sea level and the distance from households to the nearest main roads significantly affected FMD occurrence (table 3).

The final model derived after stepwise backward selection of the risk factors is shown in Table 2 and 3. There were no significant interaction terms. For both households inside and outside outbreak villages, the results clearly showed a significant association between FMD occurrence with selling animal before outbreak ($P < 0.01$) and knowledge about FMD before the outbreak ($P < 0.01$). For only the control household outside the outbreak village, the results clearly showed a significant association between FMD occurrences with the households close to main roads ($P < 0.01$). The estimated probability of FMD occurrence for livestock owner who knew FMD before outbreak was 60 % and 57 % while the probability for the households who did not know FMD before outbreak was 82 % and 89 % for inside and outside outbreak village, respectively (figure 5). The estimated probability of FMD occurrence in the households who sold animal before outbreak was 88 % and 88 % while the probability for the households who did not sale was 48 % and 61 % for inside and outside outbreak village, respectively (figure 6). For the household outside outbreak village, the estimated probability of FMD occurrence in the households closed to main road less than 767 meters was 90 % while the probability for the households far away from the main roads more than 767 meters was 56 % (figure 7).

According to the social network data of animal movements form the Department of Livestock and Fisheries, Lao PDR, the data was analyzed at the village level for all surveyed villages in Xayaboury (199 villages) and for only the villages that matched with our surveys in this study (29 villages). The location and network between all villages in Xayaboury are shown on the map in figure 8. Aggregated data of villages were analyzed for the network parameters such as indegree, outdegree, totaldegree, betweenness and closeness. The mean ranks of those parameters are shown in table 5. The different mean ranks of indegree, outdegree and total degree between the outbreak villages and the villages without outbreak were significant at $P < 0.05$ (table 5).

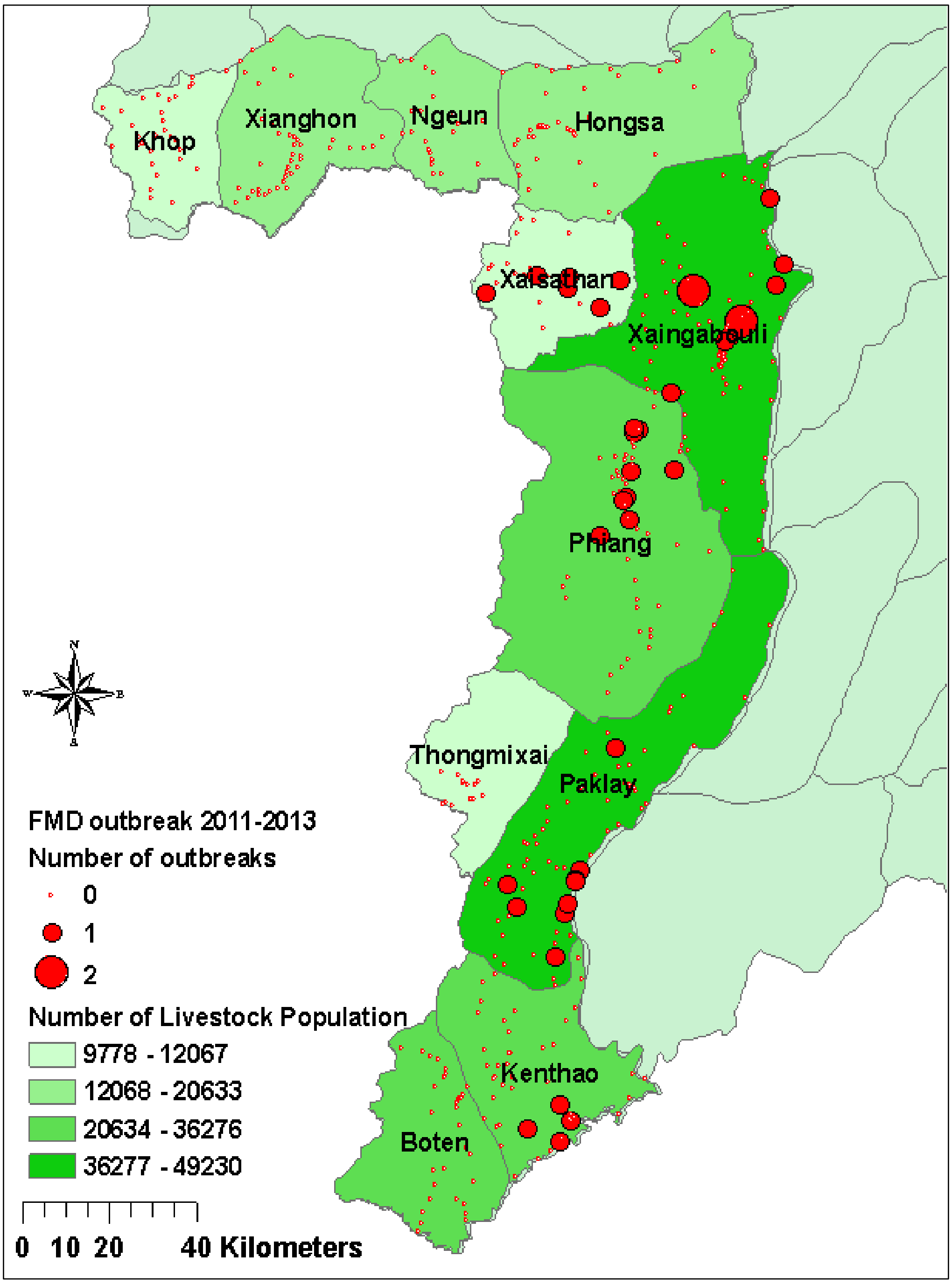

Figure 4.1 Map of the location of the FMD outbreak villages in Xayaboury Province.

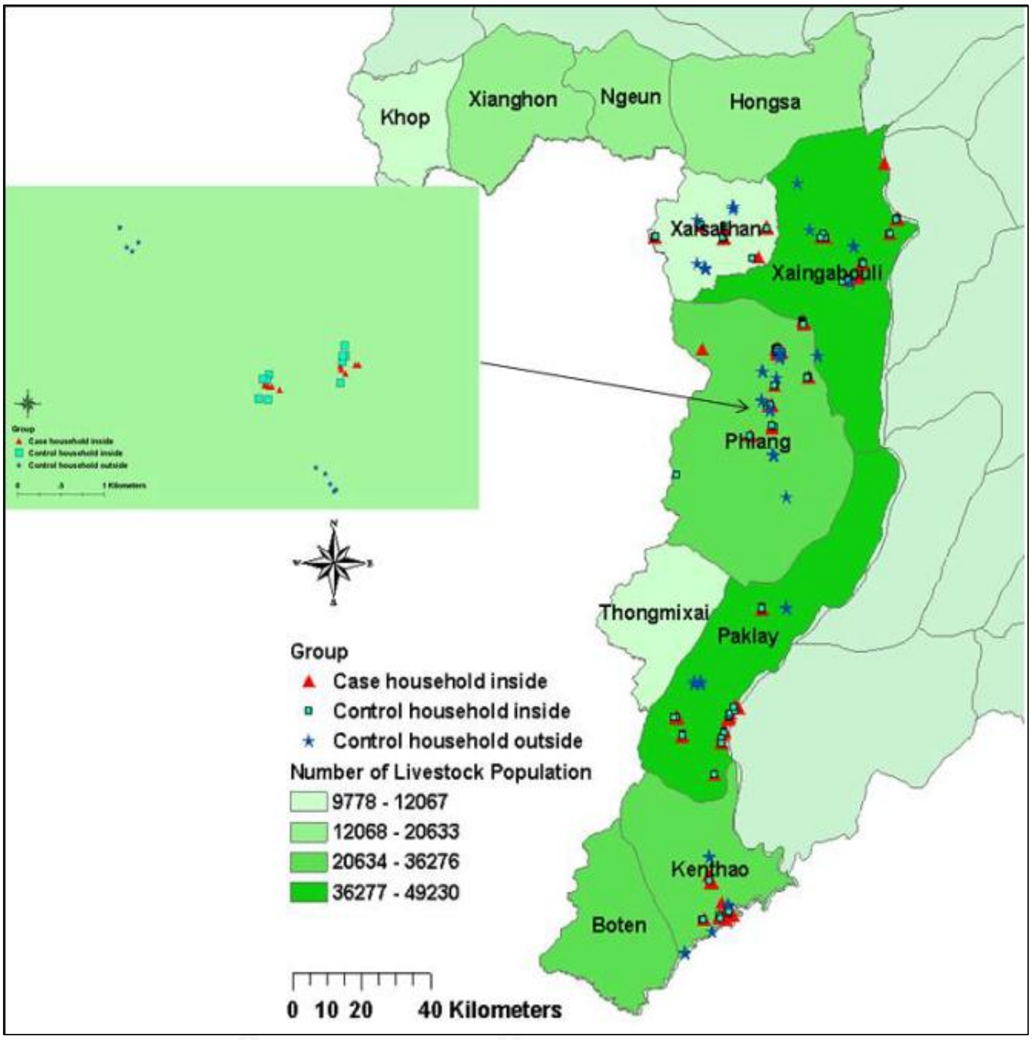

Figure 4.2 Map of the location of case households (▲), control households inside the outbreak villages (■) and control households outside the outbreak village (★) in Xayaboury province.

Table 4.1 Univariable logistic analysis of the association between FMD occurrence and the general information of livestock owner, FMD control and prevention strategies in this study.

Variables	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
General information of livestock households							
Gender of owner							
Female	34	29	0.93(0.54-1.62)	0.81	27	0.69(0.39-1.22)	0.20
Male	147	117	Ref	-	80	Ref	-
Age of owner	49.60±12.90	49.40±13.83	100(0.99-1.02)	0.88	46.32±12.45	1.02(1.00-1.04)	**0.04**
Occupation of owner							
Farmer	154	122	1.12(0.62-2.04)	0.71	91	1.00(0.51-1.96)	0.99
Others	27	24	Ref	-	16	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Religion of owner							
Buddhist	143	104	1.52(0.92-2.52)	0.11	71	1.91(1.12-3.27)	0.02
Others	38	42	Ref	-	36	Ref	-
Education							
Lower than primary school	20	22	0.36(0.06-2.09)	0.26	15	1.07(0.24-4.66)	0.9
Primary school	106	87	0.49(0.09-2.57)	0.40	63	1.35(0.35-5.20)	0.67
Secondary school	50	35	0.57(0.11-3.12)	0.52	25	1.60(0.40-6.49)	0.60
Higher than secondary school	5	2	Ref	-	4	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Farm type							
Cattle	94	90	0.57(0.30-1.06)	0.08	64	0.76(0.39-1.45)	0.40
Buffalo	40	26	0.84(0.40-1.76)	0.64	13	1.58(0.68-3.69)	0.29
Cattle/Buffalo	12	11	0.59(0.22-1.59)	0.30	12	0.51(0.19-1.37)	0.18
Cattle/Buffalo/Pig	35	19	Ref	-	18	Ref	-
Farm size							
Q1 (<5)	37	41	0.45(0.24-0.87)	**0.02**	32	0.51(0.26-1.01)	0.06
Q2 (5-9)	53	41	0.65(0.34-1.21)	0.17	26	0.90(0.45-1.78)	0.76
Q3 (9-15)	41	39	0.53(0.27-1.00)	**0.05**	27	0.67(0.33-1.34)	0.26
Q4 (>15)	50	25	Ref	-	22	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Knowledge on FMD							
Did you know FMD before or after outbreak?							
Before	43	67	0.37(0.23-0.59)	<0.001	65	0.2(0.12-0.34)	<0.001
After	138	79	Ref	-	42	Ref	-
Prevention and control within 6 months before FMD outbreak?							
Was your livestock vaccinate?							
No	156	122	1.23(0.67-2.56)	0.51	88	1.35(0.70-2.58)	0.37
Yes	25	24	Ref	-	19	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Who did vaccinate your livestock?							
Governor veterinarian	94	90	0.57(0.30-1.06)	0.08	64	0.76(0.39-1.45)	0.40
Private assistant Veterinarian	40	26	0.84(0.40-1.76)	0.64	13	1.58(0.68-3.69)	0.29
Livestock owner	12	11	0.59(0.22-1.59)	0.30	12	0.51(0.19-1.37)	0.18
When was the latest of vaccinating?							
Less than two weeks	16	15	0.84(0.40-1.76)	0.64	15	0.61(0.29-1.29)	0.20
Two weeks to six months	11	10	0.86(0.36-2.10)	0.75	4	1.57(0.49-5.08)	0.45
More than six months	154	121	Ref	-	88	Ref	-
Did you sale your livestock?							
Yes	22	3	6.60(1.93-22.50)	**0.003**	5	2.82(1.04-7.69)	**0.04**
No	159	143	Ref	-	102	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Did you buy livestock?							
Yes	1	1	1.24(0.8-20.02)	0.88	0	-	-
No	180	145	Ref	-	107	-	-
Prevention and control during FMD outbreak							
Was your livestock vaccinated?							
No	181	146	-	-	107	-	-
Yes	0	0	-	-	0	-	-
Did you use disinfectant?							
No	115	146	-	-	107	-	-
Yes	66	0	-	-	0	-	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Did you inform the governor veterinarian?							
No	90	146	-	-	107	-	-
Yes	91	0	-	-	0	-	-
Did you move the animal?							
No	180	146	-	-	107	-	-
Yes	1	0	-	-	0	-	-
Did your animal shared grass field with other households?							
No	93	85	0.76(0.49-1.18)	0.22	61	0.80(0.49-1.29)	0.36
Yes	88	61	Ref	-	46	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
Prevention and control within 6 months after FMD outbreak?							
Was your livestock vaccinated?							
No	126	113	0.67(0.41-1.10)	0.12	79	0.81(0.48-1.39)	0.45
Yes	55	33	Ref	-	28	Ref	-
Who did vaccinate your livestock?							
Governor veterinarian	36	22	1.46(0.81-2.62)	0.21	15	1.49(0.77-2.90)	0.24
Private assistant veterinarian	18	11	1.46(0.66-3.21)	0.35	13	0.86(0.40-1.85)	0.70
Livestock owner	127	113	Ref	-	79	Ref	-

Table 4.1 (Continue)

Variable	Case inside outbreak villages (N=181)	Control inside outbreak villages (N=146)			Control outside outbreak villages (N=107)		
	n or mean±sd	n or mean±sd	OR (95%CI)	*P*-value	n or mean±sd	OR (95%CI)	*P*-value
When was the latest of vaccinating after outbreak?							
Less than two weeks	22	11	1.79(0.83-3.86)	0.14	9	1.56(0.68-3.56)	0.29
Two weeks to six months	35	24	1.31(0.73-2.33)	0.37	19	1.17(0.63-2.19)	0.62
More than six months	124	111	Ref	-	79	Ref	-
Did you sale your livestock after outbreak?							
Yes	63	44	1.24(0.78-1.98)	0.37	27	1.58(0.93-2.70)	0.09
No	118	102	Ref	-	80	Ref	-
Did you buy livestock after outbreak?							
Yes	0	0	-	-	0	-	-
No	181	146	-	-	107	-	-

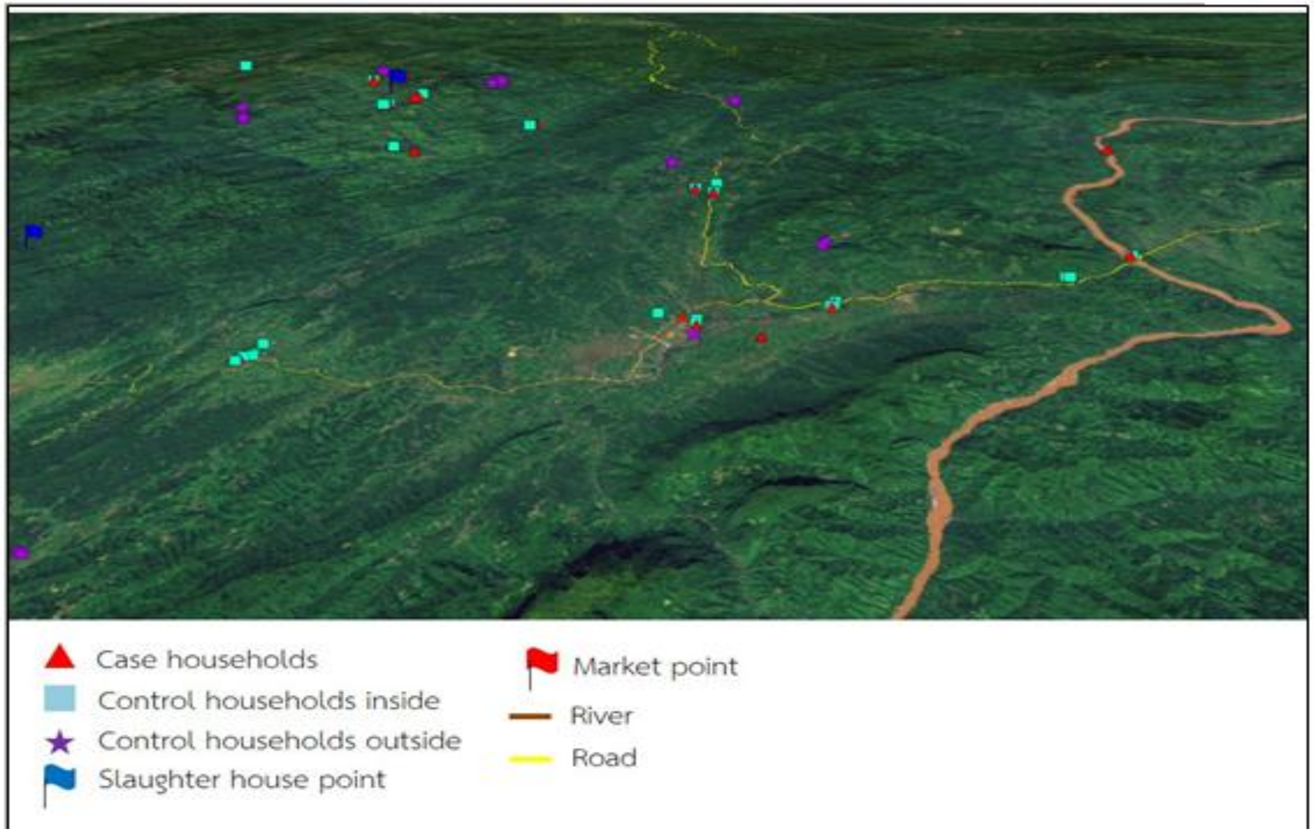

Figure 4.3 Map shows the risky place locations of FMD including markets, slaughterhouses, rivers, and main roads related to case and control households.

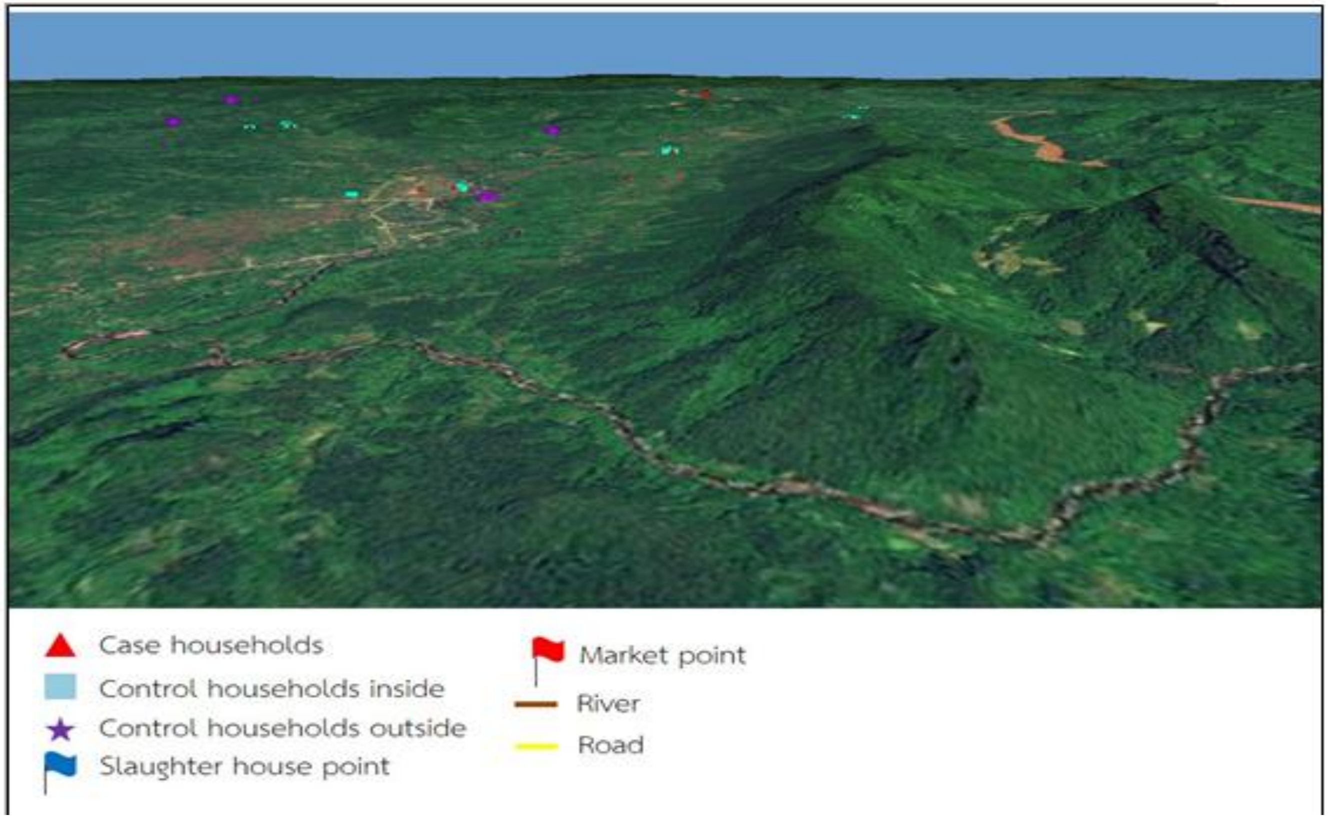

Figure 4.4 Map shows the elevation above the sea level with case and control households.

Table 4.2 Results of spatial location effect on FMD occurrence of livestock households in the outbreak villages compared to control households in both inside and outside the outbreak villages.

Variables	Case inside Outbreak village (N = 181)	Control inside outbreak village (N = 146)			Control outside outbreak village (N = 107)		
	n	n	OR (95%CI)	*P*-value	n	OR (95%CI)	*P*-value
Elevation above the sea level (meters)							
Median (≤356)	104	79	0.74(0.48-1.15)	0.18	42	2.09(1.28-3.40)	<0.01
Median (>356)	77	67	Ref	-	65	Ref	-
Distance to the nearest market (meters)							
Median (≤14,773)	83	79	1.27(0.82-1.97)	0.28	55	0.88(0.54-1.42)	0.58
Median (>14,773)	98	67	Ref	-	52	Ref	-
Distance to the nearest slaughterhouse (meters)							
Median (≤15,391)	83	79	1.34(0.87-2.07)	0.19	55	0.86(0.53-1.38)	0.52
Median (>15,391)	98	67	Ref	-	52	Ref	-

Table 4.2 (Continue)

Variables	Case inside Outbreak village (N = 181)	Control inside outbreak village (N = 146)			Control outside outbreak village (N = 107)		
	n	n	OR (95%CI)	*P*-value	n	OR (95%CI)	*P*-value
Distance to the nearest main road (meters)							
Median (≤767)	108	86	1.00(0.64-1.57)	0.99	23	5.53(3.19-9.57)	<0.01
Median (>767)	77	67	Ref	-	65	Ref	-
Distance to the nearest river (meters)							
Median (≤4,371)	98	71	0.82(0.53-1.26)	0.36	48	1.39(0.86-2.24)	0.18
Median (>4,371)	83	75	Ref	-	59	Ref	-

Table 4.3 Results of the multivariable logistic regression model of the association between FMD occurrences with risk factors at the household level in Xayaboury province.

Variable	Inside outbreak village					Outside outbreak village				
	β	SE	Odd-Ratio	95% CI (OR)	*P*-value	β	SE	Odd-Ratio	95% CI (OR)	*P*-value
Did you know FMD before or after outbreak?										
Before	-1.09	0.24	0.34	0.21 - 0.55	<0.01	-1.85	0.31	0.16	0.09-0.29	<0.01
After	Ref	-	-	-	-	Ref	-	-	-	-
Did you sale your livestock before FMD outbreak?										
Yes	2.07	0.64	7.94	2.28.- 27.67	<0.01	1.56	0.53	4.76	1.68-13.50	<0.01
No	Ref	-	-	-	-	Ref	-	-	-	-
Distance to the nearest main road (meters)										
≤median (≤ 767)	-	-	-	-	-	1.19	0.32	6.77	3.59-12.75	<0.01
>median (>767)	-	-	-	-	-	Ref	-	-	-	-

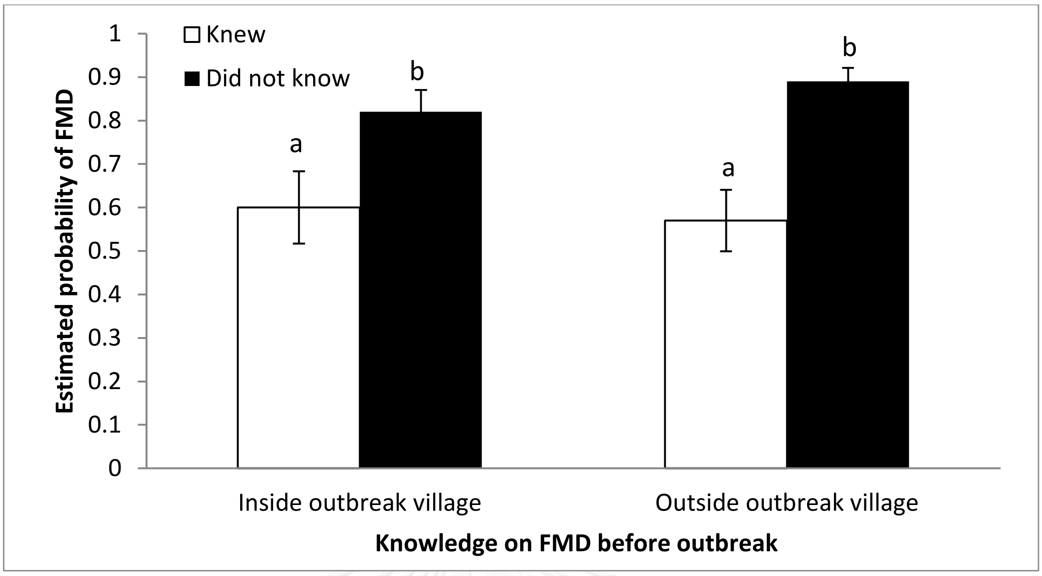

Figure 4.5 The estimated probability of FMD occurrence of households with different knowledge on FMD before outbreak. (a) and (b) represents a significant result with the probability of FMD occurrence at P <0.05.

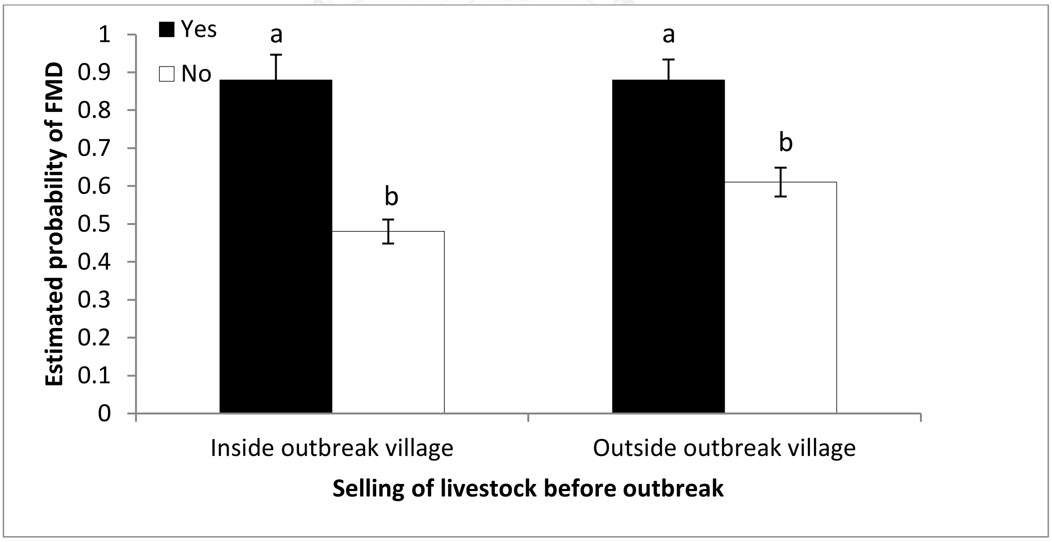

Figure 4.6 The estimated probability of FMD occurrence of households with selling of livestock before outbreak. (a) and (b) represents a significant result with the probability of FMD occurrence at P <0.05.

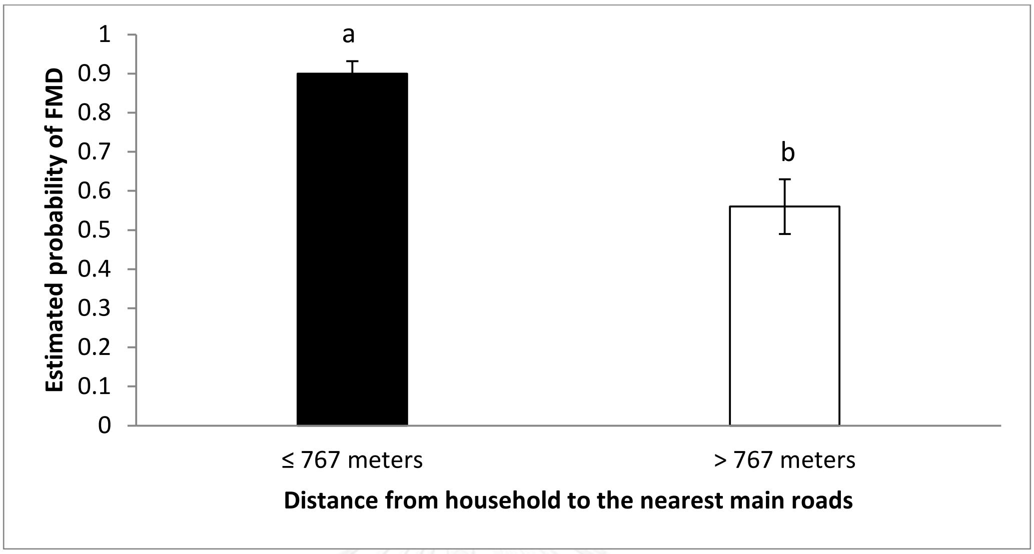

Figure 4.7 The estimated probability of FMD occurrence of households with different distances from households to the nearest main road. (a) and (b) represents a significant result with the probability of FMD occurrence at $P < 0.05$.

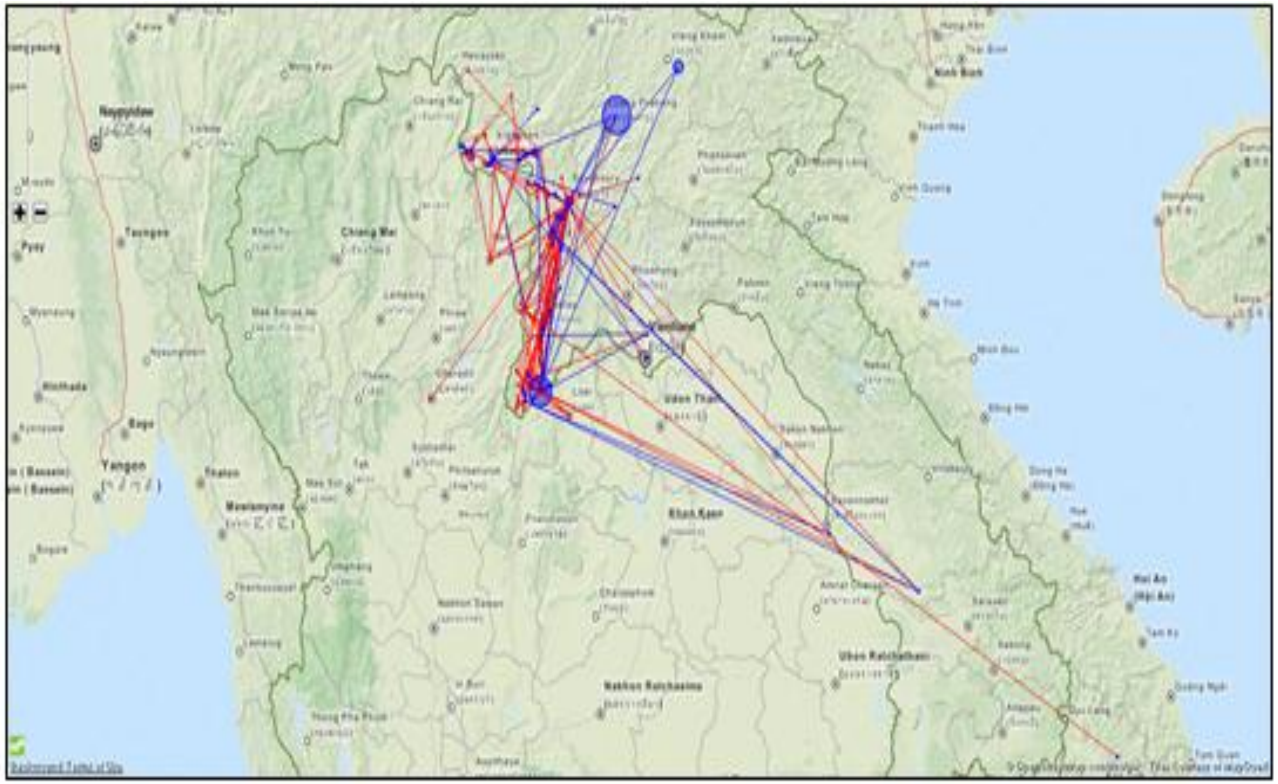

Figure 4.8 Visualization of the network of livestock movements between villages in Xayaboury and node size represents the degree of centrality. Blue nodes represent of in-degree while red nodes are for out-degree.

Table 4.4 The association between network parameters and FMD outbreak at the village level in Xayaboury analyzed by non-parametric test (Mann-Whitney U test).

Social network parameter	Villages In Xayaboury (N=199)			Selected villages (N=29)		
	Mean rank of outbreak villages (N = 23)	Mean rank of villages without outbreak (N = 176)	P-value	Mean rank of outbreak village (N = 20)	Mean rank of control village (N = 9)	*P*-value
Indegree centrality	122.48	97.06	0.03	17.23	10.06	0.03
Outdegree centrality	128.67	96.25	0.01	17.05	10.44	0.05
Totaldegree centrality	122.87	97.01	0.04	17.35	9.78	0.02
Betweenness centrality	117.93	97.66	0.06	15.60	13.67	0.54
Closeness centrality	100.00	100.00	1.00	15.00	15.00	1.00

CHAPTER 5
DISCUSSIONS

In general, the risk factors related to FMD outbreaks are the factors associated with pathogen, host and environment. In this study, the analysis focused on owners, farm types, farm size, location, the risky managements related with FMD such as prevention and control measures and animal movements. Our results in the final model indicated that knowledge on FMD, trading or selling before outbreak were very important risk factors for FMD outbreak in Xayaboury for both household inside and outside outbreak village. Moreover, for the household outside outbreak village, the households location that was remote from the main road also was very important factor to reduce FMD outbreak. In our study, the educational level of livestock owners was mostly less than that of the secondary school (97.5 % of all owners). The results indicated clearly that the livestock owners who had knowledge about FMD before the outbreaks can protect their animals from FMD. This finding is very important to utilizing the ability of livestock owner to prevent FMD occurrence based on their awareness of FMD. Farmers' attitude relates to the level of biosecurity, which was explained in a previous review (Young et al., 2013). The biosecurity interventions involve consideration for the interaction of the pathogen, the host and the environment, and how to limit the successful transmission and infection (Young et al., 2013). However, the good biosecurity of small holders in Lao PDR is rare (Nampanya et al., 2013; Young et al., 2013). Similarly to livestock holders in Cambodia, FMD is not perceived as a major animal health problem. Thus, the management of the disease and the prevention of animal disease by their owners are more difficult (Bellet et al., 2012). Sharing grazing lands and water sources of livestock in the villages poses a high risk of disease transmission from one livestock holder to another livestock holder (Dukpa et al., 2011; Nampanya et al., 2013). Moreover, a limited number of holders in our survey (13.8 %-17.8 %) did vaccinate animal before the outbreak during 2011 - 2013. This finding strongly indicates that farmers still lack the awareness and ability to vaccinate their animals. A low number of livestock with high immunity against FMD were concordant with a previous study that reported the low level of antibody titer of large ruminants in Lao PDR sampling in 2010 (Nampanya et al., 2013). However, the study in Lao PDR shows that FMD vaccination can reduce the attack rate of FMD from 70 % in villages with unvaccinated animals compared to 1 % in villages with fully vaccinated animals (Rast et al., 2010). In our study within 6 months before the outbreak, non-significant FMD occurrence was found between vaccinated households and unvaccinated households, which might relate to low levels of immunity in all livestock. Other factors such as animal density and animal movements might play a role in FMD outbreaks.

According to our results in univariable analysis, age and religion of control households outside the outbreak villages were significantly different from the case households. However, the effect was not found in the final model and this difference was not found when compared to the control households in the outbreak villages. For overall, 73 percent of livestock owners are Buddhist and these households were at higher risk of contracting FMD compared to other religions. For other religions, the information from our dataset identified only the owners in one village that are Christian while livestock owners in other religious groups pay respect to ghosts. The livestock owners outside the outbreak villages were younger than the livestock owners in the outbreak villages, which might be involved with the establishment of a new community of new families that separated from their parent families. It is possible for new families to extend their lives in the new land closer to a forest or a mountain and, accordingly, people living close to the forest or mountain are likely to believe in and respect ghosts. Their lifestyle might be different, which might be associated with farm management and FMD occurrence. This information agrees with the effect of spatial location on FMD outbreaks. Our results indicated in univariable analysis that livestock holders in a lower elevation area from sea level and closer to the main road were at high risk of FMD. This was indicated clearly when no different effect was found in comparison between case and control household inside outbreak village but the difference was found between case household inside outbreak village and control household outside outbreak village. This agrees with a study in Tanzania that indicated that increases in the distance to main roads decreased the risk of FMD (Allepuz et al., 2015). In a lower land, it seems to be a high density area of community and transportation. The density of livestock in the high density community was possibly higher compared with the livestock outside the community and direct contacts between animals in high density areas were identified with a high probability of infectious transmission. (Rojanasthien et al., 2006) mentioned that the high density of livestock farms has a high chance of the disease occurring. Moreover, in a high livestock density area, there tends to have a high number of movements (Emami et al., 2015). Concordant with our results, we found that the villages with a high degree centrality were at high risk of having FMD and a higher number of livestock in a household also increased the risk of FMD (table 2). In addition, livestock holders who sold animals before the outbreak also clearly added to the risk of FMD (table 2). This result agrees with other studies that proved the risk of trading on FMD (Emami et al., 2015). In the same manner, (Ayebazibwe et al., 2010) demonstrated that animal movement with any motive for feeding, finding water, or trading was the important risk factor for being the source of the disease outbreak. The movement of animals on the dry season to find new sources of food increased the risk of the disease 50.8 times (Ayebazibwe et al., 2010). In Bhutan and Lao PDR, raising animals by grazing increases the chance of FMD occurrence 39.2 and 4.4 times respectively (Dukpa et al., 2011; Phouangsouvanh, 2009). In addition, the FMD occurrence in Tanzania was suggested to result from the strong relationship between animal movement and human activity via communication networks to FMD occurrence (Allepuz et al., 2015). In Thailand, (Rojanasthien et al., 2006) reported that farms in Thailand which are located near to slaughterhouses has an increased risk of the disease 1.2 times and also in Japan, (Lindholm et al., 2007) reported that cattle farms in Japan near to slaughterhouses and animal markets were prone to FMD occurrence 25.85 and 39.58 times respectively. Nevertheless, non-significant association of closeness and betweeness between the outbreak and control villages was found on FMD occurrence. A sampling design in our study for connecting between nodes is needed to improve and complete the network among involved nodes. Additionally, the effect of the distance from households to markets or to slaughterhouses in our study was not significant on FMD. The difference might be related to the difference in household distribution in the districts and other natural barriers, which should warrant further exploration.

In conclusion, this study clearly indicated the association of owners' knowledge and the community areas with high density of movement on FMD occurrence. The households far away from the center of community had a decreased probability of FMD occurrence. The owners' awareness is also important to reducing FMD occurrence. However, there are still a limited number of livestock that were vaccinated and low levels of biosecurity to prevent FMD within villages. The study to increase immunity and improve the biosecurity at the village level to prevent and control FMD represents a challenging task for future investigation.

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APPENDIX

APPENDIX A

Questionnaire translate into English language

Date of interview………..

Questionnaire for livestock owner on the occurrence of FMD outbreaks

during (2011-2013)

Name of interviewer..Phone number..

Name of interviewee.............................. ☐ Owner, ☐ Not owner, Phone number.............

Address:Village...................................District................................Province.................................

Sex: ☐ Male, Age.........................., Occupation: ☐ Main........................, Religion............

☐ Female ☐ Secondary.........................

Coordinate: Latitude ☐ Longitude ☐ Elevation ☐

Education: ☐Uneducated, ☐Primary school, ☐Secondary school,

☐Higher than secondary school

Section1: Current general information.

1. How many animals do you have currently?.........................heads

Animal species	Parent stock(male)	Parent tock(female)	(0-6 months)	(>6-12 months)	(>12months)
Cattle					
Buffalo					
	Parent stock(male)	Parent stock(female)	(0-3months)	(>3-12months)	(>12months)
Goat					
Sheep					
	Parent stock(male)	Parent stock(female)	Suckling Pig	Weaning Pig	
Pig					

2. Do you know what kind of disease in this picture?

☐ Yes, ☐ No

3. If yes, how about?

Cattle picture: ☐Picture1,☐Picture 2,☐Picture3 ☐ Picture4,☐ Picture5,☐ Picture6

For pig: ☐Picture1,☐ picture2 ☐picture3,☐ picture4

4. You know this disease before or after outbreak? ☐ Before, ☐ After

5. During (2011-2013), have your animal been infected FMD ? ☐ Yes, ☐ No

6. If yes, how many time? ☐1time, ☐2times, ☐ more than 2times

7. Month, year of the occurrence of disease outbreak (for owner):.................................

8. Month, year of the occurrence of disease outbreak (for Department):........................

<u>Section2</u>: Information before FMD Outbreak.

1. Six months before FMD Outbreak, do you vaccinate your animals?

☐ Yes, ☐ No

2. Who vaccinate your animals?

☐ Veterinary Officer, ☐ Village Veterinary Worker, ☐ Yourself

3. Twelve months before disease outbreak, did you vaccinate your animals?

☐ Yes ☐ No

4. When was the latest month of vaccination and before how many months the outbreak occurred?

☐Less than 2 weeks, ☐ two weeks- six months, ☐ more than six months

5. Before the outbreak occurred not over 6 months, do you buy or sell the animals?

5.1. Did you buy or bring the animals for raising?

☐ Yes, ☐ No

Animal species	Cattle	Buffalo	Pig	Goat
Batch				
Number of animal				
Cost				
Live animal				
Body weight				

5.2. With whom do you buy?

☐Trader, ☐Farmer, ☐ Slaughter

5.2. Did you sell or give the animals to some one?

☐Yes, ☐ No

Animal species	Cattle	Buffalo	Pig	Goat
Batch				
Number of animal				
Cost				
Live animal				
Body weight				

5.2. With whom do you sell?

☐Trader, ☐Farmer, ☐ Slaughter

Other, explain...	Other, explain ....
Name..	Name..
Village..	Village..
District...	District...
Province...	Province...

Section3. Information during the occurrence of FMD outbreak.

1. How many infected or dead animals in your farm?

Animal type	Parent stock (male)	Parent stock (female)	(0-6 moth)	(>6-12 month)	(>12 month)
Cattle					
Sick					
Dead					
Buffalo					
Sick					
Dead					
	Parent stock (male)	Parent stock (female)	(0-3 month)	(>3-12 month)	(>12 month)
Goat					
sick					
Dead					
	Parent stock (male)	Parent stock (female)	Suckling pig	weaning pig	
Pig					
Sick					
Dead					

2. Management and control the disease, when FMD Outbreak occurred.

2.1. In case if your animal get sick, how did you deal with?

☐ Treatment, ☐ Do nothing

2.2. Did you vaccinate your animals?

☐ Yes, ☐ No

2.3. Did you use disinfectant?

☐ Yes, ☐ No

2.4. Did you inform the Veterinary Officer?

☐ Yes, ☐ No

3. Did you move your animal during FMD outbreak ? ☐ Yes, ☐ No

3.1. If yes, what is your purpose?

☐Buy or Sell, ☐Move to another place for raising, ☐for breeding, ☐other purpose, explain

3.2. If you moved the animal, how did you practice? ☐ Vehicle, ☐ on foot

3.3. If vehicle, what kind of vehicle?

☐ Pickup car, ☐ Tractor, ☐ Motorbike

3.4. How many kilometers for the movement of your animals?

☐ Less than 5 km, ☐ Less than 5-10 km, ☐ More than 10 km

4. During FMD outbreak, did your animals shared grazing pasture with other herds?

☐ Yes, ☐ No

4.1. If yes, please explain the source of infection.

How many animal owners in that grazing pasture? (......................).

Name of animal owner 1:..........................., Village......................., District....................Province.................

Animal species : □Cattle, □ Buffalo, □Goat.

Name of animal owner 2:..........................., Village......................, District....................Province.................

Animal species : □ Cattle, □ Buffalo, □ Goat.

Name of animal owner 3:..........................., Village......................, District....................Province.................

Animal species : □ Cattle, □ Buffalo, □ Goat.

4.2. Total number of animals that shared the same grazing pasture (approximatly)......................

5. During FMD outbreak, did you bring your animals to the slaughter house?

□ Yes, □ No

5.1. If yes, where is the slaughter house?

Name of slaughter house...............................

Coordinate of slaughter house: Longitude...................., Latitude...................

Address: Village.........................District.........................Province..............................

<u>Section4.</u> Information after FMD outbreak.

1. Six months after FMD outbreak , do you vaccinate your animals?

□ Yes, □ No

1.2. Who vaccinate your animals?

□Veterinary Officer, □Village Veterinary Workers,□ by yourself

1.3. Twelve months after FMD outbreak, do you vaccinate your animals?

☐ Yes ☐ No

1.4. How many months after FMD outbreak that you practice the latest vaccination?

☐Less than 2 weeks, ☐ two weeks - six months, ☐ more than six months

2. After FMD outbreak not more than 6 months, did you buy or sell your animals?

2.1. Did you buy or bring the animal for raising ?

☐ Yes, ☐ No

Animal species	Cattle	Buffloa	Pig	Goat
Batch				
Number of animal				
Cost				
Live animal				
Body weight				

5.2. With whom do you buy ?

☐Trader, ☐Farmer, ☐Slaughter

Other, explain ....

Name...

Province...

District...

Village..

2.1.Did you sell or give the animal to some body ?

☐ Yes, ☐ No

Animal species	Cattle	Buffloa	Pig	Goat
Batch				
Number of animal				
Cost				
Live animal				
Body weight				

5.2. To whom do you sell ?

☐Trader,☐Farmer, ☐Slaughter

Other, explain ....

Name...

Province..

District.......................................

Village...

APPENDIX B

Questionnaire translate into Lao language

ວັນທີສຳພາດ

ແບບສອບຖາມສຳລັບເຈົ້າຂອງສັດທີ່ເຄີຍເປັນພະຍາດປາກເປື່ອຍລົງເລັບໃນຊ່ວງປີ (2011-2013)

ຊື່ຜູ້ສຳພາດ...ເບີໂທລະສັບ..

ຊື່ຜູ້ໃຫ້ສຳພາດ....................□ ເຈົ້າຂອງສັດ □ ບໍ່ແມ່ນເຈົ້າຂອງສັດ ເບີໂທລະສັບ...........

ທີ່ຢູ່:ບ້ານ...............................ເມືອງ....................................ແຂວງ...........................

ເພດ: □ ຊາຍ ອາຍຸ........... ອາຊີບ: □ ຫຼັກ......................... ສາດສະໜາ...........

□ ຍິງ □ ລອງ......................

Coordinate: Latitude [ ] Longitude [ ] Elevation [ ]

ລະດັບການສຶກສາ: □ ບໍ່ໄດ້ຮຽນ □ ຊັ້ນປະຖົມ □ ມັດທະຍົມ □ ສູງກວ່າມັດທະຍົມຂຶ້ນໄປ

<u>ສ່ວນທີ່1</u>: ຂໍ້ມູນທົ່ວໄປໃນປະຈຸບັນ.

1.ປະຈຸບັນທ່ານມີສັດທັງໝົດຈັກໂຕ?......................ໂຕ

ປະເພດສັດ	ພໍ່ພັນ	ແມ່ພັນ	ລູກ(0-6ເດືອນ)	(>6-12ເດືອນ)	(>12ເດືອນ)
ງົວ					
ຄວາຍ					
	ພໍ່ພັນ	ແມ່ພັນ	ລູກ(0-3ເດືອນ)	(>3-12ເດືອນ)	(>12ເດືອນ)
ແບ້					
ແກະ					
	ພໍ່ພັນ	ແມ່ພັນ	ໝູດູດນົມ	ໝູຢ່ານົມ/ຂຸນ	
ໝູ					

2.ທ່ານຮູ້ຈັກພະຍາດໃນຮູບນີ້ບໍ່?

□ ຮູ້ □ ບໍ່ຮູ້

3.ຖ້າຮູ້, ຮູ້ຫຼາຍປານໃດ?

ຮູບງົວ	□ຮູບ1	□ຮູບ2	□ຮູບ3	**ຮູບໝູ**	□ຮູບ1	□ຮູບ2
	□ຮູບ4	□ຮູບ5	□ຮູບ6		□ຮູບ3	□ຮູບ4

4.ທ່ານຮູ້ຈັກພະຍາດນີ້ກ່ອນ ຫຼື ຫຼັງທີ່ເກີດພະຍາດ □ ກ່ອນ □ ຫຼັງ

5.ໃນຊ່ວງປີ (2011-2013)ສັດຂອງທ່ານເຄີຍເກີດພະຍາດປາກເປື່ອຍລີບເລັບບໍ?

□ ເຄີຍ □ ບໍ່ເຄີຍ

6.ຖ້າເຄີຍ, ເຄີຍເກີດພະຍາດຈັກເທື່ອ? □ 1ເທື່ອ □ 2ເທື່ອ □ ຫຼາຍກວ່າ 2ເທື່ອ

7.ເດືອນ,ປີທີ່ເກີດໂລກລະບາດ(ຂອງເຈົ້າຂອງສັດ):...........................

8.ເດືອນ,ປີທີ່ເກີດໂລກລະບາດ(ຂອງກົມ).......................................

<u>ສ່ວນທີ່2</u>. ຂໍ້ມູນກ່ອນເກີດພະຍາດປາກເປື່ອຍລີບເລັບ.

1.ໃນຊວ່ງເວລາ 6 ເດືອນກ່ອນເກີດພະຍາດປາກເປື່ອຍລີບເລັບທ່ານໄດ້ສັກຢາວັກຊີນບໍ່?

□ ສັກ □ ບໍ່ໄດ້ສັກ

2.ຜູ້ສັກຢາວັກຊີນໃຫ້ທ່ານແມ່ນໃຜ?

□ ເຈົ້າໜ້າທີ່ □ ອາສາບ້ານ □ ສັກເອງ

3.ພາຍໃນໄລຍະເວລາ12 ເດືອນກ່ອນເກີດໂລກທ່ານໄດ້ສັກຢາວັກຊີນໃຫ້ສັດບໍ່?□ສັກ,□ບໍ່ໄດ້ສັກ

4.ເດືອນທີ່ສັກຢາວັກຊີນໃຫ້ສັດເທື່ອສຸດທ້າຍກ່ອນເກີດໂລກປະມານຈັກເດືອນ?

□ ນອ້ຍກວ່າ 2 ອາທິດ □ 2 ອາທິດ-6ເດືອນ □ ຫຼາຍກວ່າ 6 ເດືອນ

5.ໃນຊວ່ງກ່ອນເກີດພະຍາດບໍ່ເກີນ 6ເດືອນທ່ານໄດ້ມີການຊື້-ຂາຍບໍ່?

5.1. ທ່ານໄດ້ຊື້ ຫຼື ເອົາສັດເຂົ້າມາລ້ຽງບໍ່?

□ຊື້ □ ບໍ່ໄດ້ຊື້

ຊະນິດສັດ	ງົວ	ຄວາຍ	ໝູ	ແບ້
ຄັ້ງ				
ຈຳນວນສັດ				
ລາຄາ				
ເປັນໂຕ				
ກິໂລ				

5.2. ທ່ານໄດ້ຂາຍ ຫຼື ໃຫ້ສັດລ້ຽງໃຜບໍ່?

□ ຂາຍ □ ບໍ່ໄດ້ຂາຍ

ຊະນິດສັດ	ງົວ	ຄວາຍ	ໝູ	ແບ້
ຄັ້ງ				
ຈຳນວນສັດ				
ລາຄາ				
ເປັນໂຕ				
ກິໂລ				

5.3.ຊື້ກັບໃຜ?

□ ຄ້າ □ ຊາວນາ □ ໂຮງຂ້າ

ອື່ນໆ,ຈົ່ງອະທິບາຍ....................................

ຊື່..

ທີ່ຢູ່:ແຂວງ...

ເມືອງ...

ບ້ານ..

5.4.ຂາຍໃຫ້ໃຜ?

□ ພໍ່ຄ້າ □ ຊາວນາ □ ໂຮງຂ້າ

ອື່ນໆ,ຈົ່ງອະທິບາຍ............................

ຊື່...

ທີ່ຢູ່:ແຂວງ.....................................

ເມືອງ...

ບ້ານ..

<u>**ສ່ວນທີ່3**</u>.ຂໍ້ມູນໃນຊ່ວງເກີດໂລກລະບາດຂອງພະຍາດປາກເປື່ອຍລົງເລັບ

1.ຈຳນວນສັດທັງຫມົດໃນຄອກມີປະມານຫຼາຍປານໃດ.........................ໂຕ

ປະເພດສັດ	ພໍ່ພັນ	ແມ່ພັນ	ລູກ(0-6ເດືອນ)	(>6-12ເດືອນ)	(>12ເດືອນ)
ງົວ					
ເຈັບ					
ຕາຍ					
ຄວາຍ					
ເຈັບ					
ຕາຍ					
	ພໍ່ພັນ	ແມ່ພັນ	ລູກ(0-3ເດືອນ)	(>3-12ເດືອນ)	(>12ເດືອນ)
ແບ້					
ເຈັບ					
ຕາຍ					
ແກະ					
	ພໍ່ພັນ	ແມ່ພັນ	ຫມູດູດນົມ	ຫມູຢ່ານົມ/ຂຸນ	
ຫມູ					
ເຈັບ					
ຕາຍ					

2.ການຈັດການກັບໂຕສັດແລະການຄວບຄຸມໃນຊ່ວງເກີດພະຍາດປາກເປື່ອຍລົງເລັບ

2.1.ໃນກໍລະນີມີສັດເຈັບທ່ານໄດ້ປະຕິບັດແນວໃດກັບສັດຂອງທ່ານ

□ ປິ່ນປົວ □ ບໍ່ໄດ້ເຮັດຫຍັງເລີຍ

2.2.ທ່ານໄດ້ສັກຢາວັກຊີນໃຫ້ສັດຂອງທ່ານໃນຊ່ວງສັດເປັນພະຍາດບໍ?

□ ສັກ □ ບໍ່ໄດ້ສັກ

2.3.ທ່ານໄດ້ໃຊ້ຢາຂ້າເຊື້ອໃນຊ່ວງເກີດພະຍາດກັບສັດຂອງທ່ານຫຼືບໍ?

□ ໃຊ້ □ ບໍ່ໄດ້ໃຊ້

2.4.ເມື່ອເກີດພະຍາດທ່ານໄດ້ແຈ້ງເຈົ້າຫນ້າທີ່ບໍ?

□ ແຈ້ງ □ ບໍ່ໄດ້ແຈ້ງ

3. ທ່ານໄດ້ມີການເຄື່ອນຍ້າຍສັດໃນຊ່ວງເກີດພະຍາດບໍ່? □ ເຄື່ອນຍ້າຍ □ ບໍ່ເຄື່ອນຍ້າຍ

3.1.ຖ້າມີການເຄື່ອຍຍ້າຍ, ຈຸດປະສົງຂອງທ່ານເພື່ອ:

□ ຊື້-ຂາຍ □ ລ້ຽງທີ່ອື່ນ □ ຍ້າຍໄປປະສົມພັນ □ ອື່ນໆ...................................

3.2.ຖ້າມີການເຄື່ອນຍ້າຍສັດທ່ານເຄື່ອນຍ້າຍແນວໃດ? □ ໃຊ້ພາຫະນະ □ ຈູງ

3.3.ຖ້າໃຊ້ຍານພາຫະນະແມ່ນຊະນິດໃດ?

□ ລົດກະບະ □ ລົດຕ໊ອກຕ໊ອກ □ ລົດຈັກ

3.4.ໄລຍະທາງທີ່ເຄື່ອນຍ້າຍຈັກກິໂລ?

□ ນ້ອຍກ່ວາ 5km □ ນ້ອຍກ່ວາ 5-10km □ ຫຼາຍກ່ວາ 10km

4.ໃນຊ່ວງເກີດໂລກສັດຂອງທ່ານໄດ້ສໍາພັດກັບສັດຝູງອື່ນເວລາທີ່ໄປກິນນໍ້າກິນຫຍ້າບໍ່?

□ ສໍາພັດ □ ບໍ່ສໍາພັດ

4.1.ຖ້າສໍາພັດ, ອະທິບາຍແຫຼ່ງທີ່ມາ

ຈໍານວນເຈົ້າຂອງສັດມີເທົ່າໃດ................ເຈົ້າຂອງສັດ

ຊື່ເຈົ້າຂອງສັດ1.............................ບ້ານ................ເມືອງ..................ແຂວງ.................

ຊະນິດສັດ: □ ງົວ □ ຄວາຍ □ ແບ້

ຊື່ເຈົ້າຂອງສັດ2.............................ບ້ານ.................ເມືອງ..................ແຂວງ.................

ຊະນິດສັດ: □ ງົວ □ ຄວາຍ □ ແບ້

ຊື່ເຈົ້າຂອງສັດ3.............................ບ້ານ.................ເມືອງ..................ແຂວງ................

ຊະນິດສັດ: □ ງົວ □ ຄວາຍ □ ແບ້

4.2.ຈໍານວນສັດທັງໝົດທີ່ມາຢູ່ລວມກັນ (ປະມານ)........................ໂຕ

5.ໃນຊວ່ງເກີດໂລກທ່ານໄດ້ນໍາສັດຂອງທ່ານໄປຂ້າຢູ່ໂຮງຂ້າສັດບໍ? □ ໄປຂ້າ □ ບໍ່ໄດ້ໄປຂ້າ

5.1.ຖ້າໄປ, ທ່ານເອົາສັດໄປຂ້າຢູ່ໂຮງຂ້າສັດໃດ?

ຊື່ໂຮງຂ້າສັດ...................................

ຈຸດພິກັດ: Longitude………………………Latitude………………………………….

ທີ່ຢູ່: ແຂວງ…...............................ເມືອງ........................ບ້ານ..............................

<u>ສ່ວນທີ່4.</u> ຂໍ້ມູນໃນຊ່ວງຫຼັງເກີດພະຍາດປາກເປື່ອຍລົງເລັບ

1.ໃນໄລຍະເວລາ 6 ເດືອນຫຼັງຈາກທີ່ເກີດໂລກລະບາດທ່ານໄດ້ສັກຢາວັກຊີນບໍ່?

□ ສັກ □ ບໍ່ໄດ້ສັກ

1.2.ຜູ້ສັກຢາໃຫ້ສັດຂອງທ່ານແມ່ນໃຜ?

□ ເຈົ້າໜ້າທີ່ □ ອາສາບ້ານ □ ສັກເອງ

1.3.ພາຍໃນໄລຍະເວລາ12 ເດືອນຫຼັງເກີດໂລກທ່ານໄດ້ສັກຢາວັກຊີນໃຫ້ສັດບໍ່?□ສັກ,□ບໍ່ໄດ້ສັກ

1.4.ເດືອນທີ່ສັກຢາວັກຊີນເທື່ອສຸດທ້າຍຫຼັງເກີດໂລກປະມານຈັກເດືອນ

□ ນ້ອຍກວ່າ 2 ອາທິດ □ 2 ອາທິດ-6ເດືອນ □ ຫຼາຍກວ່າ 6 ເດືອນ

2.ການຊື້-ຂາຍສັດໃນຊ່ວງຫຼັງເກີດໂລກບໍ່ເກີນ 6ເດືອນ

2.1.ທ່ານໄດ້ຊື້ ຫຼື ເອົາສັດເຂົ້າມາລ້ຽງບໍ່?

□ ຊື້ □ ບໍ່ໄດ້ຊື້

ຊະນິດສັດ	ງົວ	ຄວາຍ	ໝູ	ແບ້
ຄັ້ງ				
ຈຳນວນສັດ				
ລາຄາ				
ເປັນໂຕ				
ກິໂລ				

2.3.ຊື້ກັບໃຜ?

□ ພໍ່ຄ້າ □ ຊາວນາ □ ໂຮງຂ້າ

ອື່ນໆ,ຈົ່ງອະທິບາຍ....................................

ຊື່...

ທີ່ຢູ່:ແຂວງ..

ເມືອງ..

ບ້ານ...

2.2 .ທ່ານໄດ້ຂາຍ ຫຼື ໃຫ້ສັດລ້ຽງໃຜບໍ່?

□ ຂາຍ □ ບໍ່ໄດ້ຂາຍ

ຊະນິດສັດ	ງົວ	ຄວາຍ	ໝູ	ແບ້
ຄັ້ງ				
ຈຳນວນສັດ				
ລາຄາ				
ເປັນໂຕ				
ກິໂລ				

2.4.ຂາຍໃຫ້ໃຜ?

□ ພໍ່ຄ້າ □ ຊາວນາ □ ໂຮງຂ້າ

ອື່ນໆ,ຈົ່ງອະທິບາຍ............................

ຊື່..

ທີ່ຢູ່:ແຂວງ...................................

ເມືອງ..

ບ້ານ..

VITA

Mr. Viliddeth Souriya was born in December 27, 1987 in Vientiane, Lao PDR. I graduated doctor of veterinary medicine (DVM) from college of agriculture and forestry-Hue University in Vietnam in 2011. After graduation, I have worked at epidemiology unit under division of veterinary service at Department of Livestock and Fisheries, Lao PDR for one year. Then, I was received the scholarship program for Asian countries by Chulalongkorn University, Bangkok, Thailand in academic year of 2013. I have studied in Master of Science Program of Veterinary Medicine, Chulalongkorn University during 2013-2015.