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Fakulteten för veterinärmedicin och husdjursvetenskap
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Zoonotic Pathogens at the Interface between Humans and Animals in Cambodia, a Rural Approach

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Zoonotic Pathogens at the Interface between Humans and Animals in Cambodia, a Rural Approach

Zoonoser i Kambodja, ett landsbygdsperspektiv

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INNEHÅLL

ABSTRACT

A zoonosis is a disease or infection that is naturally transmitted between vertebrate animals and humans. The majority of infectious diseases that affect humans are zoonoses. Environments where wild animals, domestic animals and humans live in close proximity with no or small boundaries in the ecological system favor the transmission of diseases between animals and humans**.** The above described situation is more common in low income countries, where humans and animals live in high density and zoonoses are generally more common. The study was conducted in Cambodia. Typically in Cambodia, poor families have chicken and may also raise pigs, cows, or buffalos. Most livestock is kept free ranging and not always penned at night.

The study was conducted as part of an ongoing cross-sectoral project between SLU, UU (Uppsala University) and in Cambodia CelAgrid (Center for livestock and agricultural development), NIPH (National Institute for Public Health), VPHO (Veterinary Public Health Office) and NaVRI (the National Veterinary Research Institute) with the title: Zoonoses in Humans and Domestic Animals: a cross-disciplinary approach in rural Cambodia. The present study focuses on the transmission of diseases between humans and animals which may happen through food, water, contaminated equipment and direct contact. The objectives of the present study was to: 1: Describe farmers' livestock management practice and knowledge of infectious diseases and zoonoses**,** 2: Identify risk factors for transmission of zoonotic pathogens at the interface between humans and animals at farm level and 3: Identify feasible and acceptable preventive measures for transmission of infectious pathogens by using participatory research methods.

Three villages in Kampong Cham province in the Mekong lowland swamp in the south of Cambodia were selected from the ongoing cross-disciplinary project; Pror Sam (village A), Roung (village B) and Tang Krang (village C). Gastrointestinal diseases were one of the major diseases seen and confirmed among humans in all three villages. An interview-based survey was carried out to collect information on general livestock management practices and farmers' knowledge of infectious diseases/zoonoses. The information was gathered through focus group discussions held with rural farmers. Participatory Action Research with transect walks was used as tools to gain a wider understanding of rural livestock practices.

The study shows that domestic animals are kept free ranging in the household close to where the humans cook and eat their food and that wild animals have access to this area. Further does the study show that farmers have limited knowledge about routes of transmission between animals and humans as well as about subclinical infected animals. Vaccination was regarded as an effective but expensive method by the farmers to stop diseases from spreading. The conclusion from the study is that further research on disease prevention in humans and animals and increased awareness of zoonoses by the rural Cambodian population is needed and could create a platform for communication and action such as building of closed animal pens and kitchens, an increase in biosecurity measures and cleaning of water.

SAMMANFATTNING

En zoonos är en sjukdom eller en infektion som naturligt sprids mellan ryggradsdjur och människor. Majoriteten av infektiösa sjukdomar som drabbar människor är zoonoser. Miljöer där vilda djur, tamdjur och människor lever nära varandra, utan eller med mycket små gränser i det ekologiska systemet främjar spridningen av sjukdomar mellan människor och djur. Den ovan nämnda situationen är vanligare i låginkomstländer, där många människor och djur lever på en liten yta och zoonoser förekommer oftare. Studien är utförd i Kambodja, där fattiga familjer ofta har höns och föder upp några grisar eller nötdjur. De flesta djuren går fritt, även på natten.

Studien utfördes som en del av ett pågående projekt mellan SLU, UU och i Kambodja CelAgrid, (Center for livestock and agricultural development), NIPH (National Institute for Public Health), VPHO (Veterinary Public Health Office) och NaVRI (the National Veterinary Research Institute) med titeln: Zoonoses in Humans and Domestic Animals: a cross-disciplinary approach in rural Cambodia. Den föreliggande studien fokuserar på spridningen av sjukdomar mellan människor och djur genom mat, vatten, kontaminerad utrustning samt direkt kontakt. Studies syfte var att: 1: Beskriva hur bönderna hanterar sin boskap samt deras kunskap om infektiösa sjukdomar och zoonoser, 2: Identifiera riskfaktorer för spridningen av zoonotiska patogener mellan människor och djur, 3: Identifiera rimliga och acceptabla preventiva åtgärder mot spridningen av infektiösa patogener med hjälp av deltagande forskningsmetoder.

Tre byar i Kampong Cham provisen i Mekong flodens lågland i södra Kambodja valdes ut från det pågående zoonosprojektet i Kambodja; Pror Sam (by A), Roung (by B) och Tang Krang (by C). Gastrointestinala sjukdomar var bland de vanligaste sjukdomarna som iakttagits och bekräftats bland människorna i samtliga tre byar. En intervjubaserad undersökning utfördes för att samla information kring hanteringen av boskap samt böndernas kunskap om infektiösa sjukdomar och zoonoser. Informationen samlades in genom fokusgruppdiskussioner som hölls med bönder. Deltagande aktionsforskning (Participatory action reseach) med observerande rundvandring (transect walk) användes för att få en ökad förståelse för djurhållningen.

Studien visar att boskap hålls frigående i hushållet, i området där människorna lagar och äter sin mat. Vilda djur kan ta sig in i köket och in till boskapen i hushållet. Vidare pekar studien på att bönderna har begränsade kunskaper kring smittspridning mellan människor och djur samt om subkliniskt infekterade djur. Vaccination anses av bönderna vara en effektiv, men kostsam metod att hindra sjukdomar från att spridas. Slutsatsen från studien är att vidare forskning behövs kring förebyggande åtgärder för sjukdomar hos djur och människor och kunskapen om zoonoser bör förbättras hos människor på landsbygden. En ökad kunskap skulle kunna skapa en grund för ökad kommunikation kring zoonoser och förebyggande åtgärder.

Acronyms

FGD	Focus group discussion
FMD	Foot and mouth disease
UU	Uppsala University
SLU	Swedish University of Agricultural Sciences, Sveriges lantbruksuniversitet
VPHO	Veterinary Public Health Office
NaVRI	The National Veterinary Research Institute
CelAgrid	Center for livestock and agriculture development
NIPH	National Institute for Public Health
Efsa	European food safety authority
WHO	World Health Organization of the United Nations
IMF	International Monetary Fond
PAR	Participatory Action Research
FGD	Focus Group Discussion
Vm	Village map
Tw	Transect walk
Fsk	Farm sketch
Tl	Time line
Sc	Seasonal calendar
Rm	Ranking matrix
Q	Questionnaire
FAO	Food and Agriculture Organization of the United Nations
NGO	Non Governmental Organization
DALY	Disability adjusted life years

INTRODUCTION

Zoonotic pathogens

A zoonotic pathogen is a pathogen which is naturally transmitted from vertebrate animals to humans. The majority of infectious diseases that affect humans are zoonoses and they constitute as much as 70 % of the emerging diseases (Jones *et al.*, 2008). Environments where wild animals, domestic animals and humans live in close proximity with no or small boundaries in the ecological system favor the emergence of new or already known diseases, as it also favors the transmission of diseases between animals and humans**.** The above described situation is more common in low income countries where humans and animals live in high density and zoonoses are generally more common. These diseases do not only constitute a threat to human and animal health, but also reduce the production capacity of livestock and contribute further to sustained poverty (Magnusson, U, 2009)**.**

The zoonotic diseases also constitute a possible global health problem due to their pandemic potential to spread over the world. Regarding pandemic and emerging zoonotic diseases, there is a strong consensus that these are most efficiently fought at the origin of the epidemic, i.e. mostly in low income countries (Jones *et al.*, 2008).

Zoonotic diseases make up 26 % of the infectious disease burden in low income countries in terms of lost DALYs (Grace *et al.*, 2012). DALY stands for disability adjusted life years and is the present value of future years lost due to premature death or being alive with poor health. Among high income countries, zoonoses are responsible for just 0.7 % of the infectious disease burden.

Food and water borne zoonotic pathogens

Pathogenic agents

There are over 200 zoonotic pathogens (WHO, 2013b). According to EFSA (European food safety authority) these pathogens can be divided into two groups, food borne and non-food borne zoonotic diseases. Food borne zoonotic pathogens are causing food borne zoonotic diseases when they contaminate food or drinking water for humans. Several of these micro-organisms can be found in the intestinal tract of healthy food-producing animals. Common bacteria and viruses causing food borne diseases are Campylobacter, Salmonella, pathogenic Escherichia coli, Yersinia, Calicivirus and Rotavirus. Common parasitic pathogens causing food borne zoonotic diseases are Trichinella, Toxoplasma, Giardi and Cryptosporidium (EFSA, 2013).

Campylobacter is the most frequently isolated bacterial pathogen from stool samples of children under the age of 2 with diarrhea in low income countries (Coker *et al.*, 2002). The genus *Campylobacter* comprises 18 species, of which 14 have been isolated from humans. The most important human pathogens are *Campylobacter jejuni* and *Campylobacter coli*, which colonize the intestinal tract of a variety of healthy animals, such as poultry, wild birds,

cattle, sheep and pigs. These animals do not show any signs of disease, but C. jejuni and C. coli cause a zoonotic diarrheal disease in humans (WHO, 2000).

Transmission

At the farm, animal feed and water can be contaminated with pathogens, which can cause infection in animals. Animal skin and fur can be contaminated by feces. Eggs and different vegetables can also be contaminated. During slaughter, meat and the environment can be contaminated by coming into contact with intestinal contents or animal skin. In the kitchen, food microbes can be transferred from food or water by improper use of kitchen utensils and water or by infected humans handling the food (EFSA, 2013).

Safe food and water

Five guidelines to safe food from WHO are (WHO, 2013a):

1. *Keep it clean (wash hands, kitchen equipment and surfaces in contact with food,*
2. *Separate raw and cocked,*
3. *Cook thoroughly (juices are clear),*
4. *Keep food at safe temperatures (5° – 60° danger zone),*
5. *Use safe water and raw materials.*

According to WHO guidelines for safe water two possible household water treatment technologies are A. membrane, porous ceramic, composite or granular media filters and B. thermal (heat) technologies. The thermal heat technologies include boiling and heating to pasteurization temperatures (WHO, 2011).

Non-food borne zoonotic diseases

Non-food borne zoonotic diseases are mainly transmitted to humans through vectors (mosquitoes, ticks, flies, fleas and lice) and direct contact or close proximity with infected animals. Two viruses spread by close contact to humans are avian influenza and Q fever (EFSA, 2013).

Influenza virus can be either of type A, B or C where Influenza A is one of the most important zoonotic viruses. The influenza A viruses are classified on a genetic/serological system of the two surface proteins, hemagglutinin (HA) and neuraminidase (NA). They can come in several combinations, especially in the natural reservoir dabbling ducks. Ducks and wild birds are subclinical infected and carry influenza virus without showing any signs of disease. Influenza virus is shed in the feces of wild birds and ducks can spread it to the domestic animals. In humans we have the seasonal influenza (type A, B or C) that occurs annually. From last year we had a new variant of Influenza A that spread globally, the so-called ”swine-flu” (H1N1). The appearance of a new variant is usually a consequence of a genetic re-assortment between influenza strains circulating among the human and/or animal population (Peiris *et al.*, 2009).

Humans can be infected by influenza by direct contact with infected poultry and their feces. The virus may also go through a re-assortment of genes with already existing human viruses. An important player in this may be pigs, which have been termed “mixing vessel”. Since pigs can be infected with both avian and human influenza virus the re-assortment is believed to take place in pigs, and then adapt to humans (Peiris *et al.*, 2009).

Cambodia

Figure 1: Cambodia (global earth)

Cambodia, see figure 1 has currently about 14.3 million inhabitants. In 2007, 30,1% of the total population was still living below the official rural and urban poverty lines. The year has two seasons, a rainy season which starts in June and ends in October and a dry season which starts in October and ends in May. The hottest time in the year is in April (World bank, 2013).

Livestock production in Cambodia and veterinary services

Typically, poor families have domestic birds and may also raise pigs, cows, or buffalos. Most livestock is kept free ranging and not always penned at night. This is a common situation in

several developing countries, and further facilitates the transmission of pathogens between wildlife, domestic animals and humans (Magnusson, U, 2009).

Small-scale confined pig production is frequently found in households across the world. According to FAO (Food and Agricultural Organization) the production systems for pigs used in low income and transition countries can be divided as follows (FAO *et al.*, 2010). This division could also be applied on other species like chicken, ducks and ruminants.

1. Semi-intensive backyard production;
2. Small-scale intensive production;
3. Multi-species integrated production.

In the *semi-intensive backyard production system*, which exists in both rural and urban areas, pigs are confined in very simple pens built from local materials. Usually no more than 1 to 100 animals are raised per year. Labor usually comes from the family (FAO *et al.*, 2010).

In the *small-scale intensive production system*, pigs are confined in separate pens for fatteners, boars, gestating sows and sows with their litters. The animals are kept primarily for commercial purposes and the farmers supply local markets with meat. These farmers live in peri-urban areas, close to markets. For this system a high level of input is required and pig production is often the sole or a major source of income (FAO *et al.*, 2010),

In the *multi-species integrated production system*, pigs are raised together with other agricultural activities (including those involving cattle, fish, algae, ducks, water hyacinth, vegetables, etc.). The pig manure can fertilize the farmer's field crops and gardens. Such mixed systems often exist in poor rural areas. Multi-species housing of pigs and other farm animals, including poultry, ducks and dairy cows, in the same sheds is often reported (FAO *et al.*, 2010).

In 2002 the total bovine population was approximately 3.55 million animals, the pig population was numbering 2.1 million and the chicken population was numbering 16.65 million animals. Livestock is recognized as a form of savings, chickens are sold for small expenses and cattle and buffalo are sold for major expenses like funeral and weddings. Estimation of livestock mortality by livestock professionals in Cambodia have been as high as 30-40% for pigs and 30% for chicken (Sophal Ear & Leonard, K.D., 2005).

In Cambodia, rural markets for veterinary services do not attract qualified technicians from outside, service providers must be created at the village level using local people (Ballard, 2005). In 1996 Veterinaires Sans Frontieres introduced village animal health workers (VAHW), trained local people in animal health and production, which are then used in their villages and communes. Trained local people who are poor and/or otherwise lack social standing are likely to stop providing services after a period of time (Sophal Ear & Leonard, K.D., 2005).

A study investigating farmer knowledge and the possibility to improve it between 2008 and 2010 concluded that significant improvements can be made in just two years in farmer knowledge and attitudes to cattle production and animal health, including biosecurity. The research indicates that smallholder farmers are motivated by nutritional interventions that improve the value of their cattle and offer better marketing opportunities (Nampanya *et al.*, 2012)

Objectives and limitations

The study is conducted as part of an ongoing cross-sectoral project between SLU, UU (Uppsala University) and in Cambodia CelAgrid (Center for livestock and agricultural development), NIPH (National Institute for Public Health), VPHO (Veterinary Public Health office) and NaVRI (the National Veterinary Research Institute) with the title: Zoonoses in Humans and Domestic Animals: a cross-disciplinary approach in rural Cambodia. This project is carried out in three different agro-ecological zones in Cambodia: one highland, one Mekong lowland swamp, and one lake shore. The project investigates risk factors for transmission of pathogens at the interface between humans and domestic animals in the environment at large and at the farm level. Samples and written questionnaires are being used to collect data (SLU-UU-CelAgriD-NIPH–VPHO, 2011).

The aim of the present study is to provide a deeper understanding of the handling of the animals at the farm level and the risk factors for transmission of zoonotic diseases. The focus is on the transmission of diseases between humans and animals which is facilitated by close contact, a common situation in the developing world (Magnusson, U, 2009). In this study transmission through food, water, contaminated equipment and direct transmission has been studied as examples of close contact.

Objectives

1. *Describe farmers' livestock management practice and knowledge on infectious diseases and zoonoses*
2. *Identify risk factors for transmission of zoonotic pathogens at the interface between humans and animals at the farm level*
3. *Identify feasible and acceptable preventive measures for transmission of infectious pathogens by using participatory research methods*

MATERIALS AND METHOD

Participation in the study

The study has been conducted in three villages in the Mekong lowland swamp, participating in the project: Zoonoses in Humans and Domestic Animals: a cross-disciplinary approach in rural Cambodia. The selection has targeted villages with a high probability of transmission of

diseases between animals and humans by any of the routes of transmission included in the present study. Two inclusion criteria have been used for identification and selection: 1. Episodes of severe diseases in humans occur at least once a year or all year round/often and 2. Gastrointestinal diseases are among the major diseases seen and confirmed among humans in the village. Information about the villages regarding the inclusion criteria has been taken from previous research, see appendix E. Three villages have been selected in Bathay district in the Kampong Cham province, see figure 2. Pror sam (village A) and Roong (village B) in Tumrup commune and Taingkraing (village C) in Chelea commune.

Figure 2: Kampong Cham province (http://ephotopix.com/image/asia/cambodia_province_map.gif, accessed through http://tmb.exodus.ie/destinations/news.asp?id=187944)

Participatory Action Research

Participatory action research (PAR) is a method that engages people in examining their knowledge, skills, and values. It involves the investigation of actual practices and concrete practices of particular people in particular places. By understanding their practices as the product of particular circumstance, PAR becomes alert to clues how it may be possible to transform the circumstances. If their current practices are the product of one particular set of intentions, conditions, and circumstances, other (or transformed) practices may be produced and reproduced under other (or transformed) intentions, conditions, and circumstances (Denzin & Lincoln, 2007). Some of the tools used in the participatory research are mapping, transect walk, seasonal calendar and ranking matrix (Schneider, A, 2013) (Krishnaswamy, 2004).

Village map

A map of the village shows the layout of the village, where the animals drink and wash and where the humans collect their water. It also shows which water and which fertilizer is used on what fields and where in the village the animals are kept. This helps to estimate the risk of pathogen transmission between humans and animals through water and vegetables and the risk for transmission among animals.

This tool has been used in one village to show the typical layout of a village in rural Cambodia. In the first step village A and B have been selected for this tool because these two villages have most episodes of severe diseases among humans including gastrointestinal ones, see appendix E. According to previous results both village A and B are using treated well water for humans and untreated well and pond water for animals. Village A also uses treated pond water as a drinking source for humans. The treatment they use is to boil the water. Village A has been selected for this tool to be able to estimate the risk of transmission through pond water. The village map was made together in the focus group. Everyone participated in drawing the map. Material needed was a flipchart and pencils in different colors.

Transect walk

A transect walk gives the opportunity to observe the relationship between humans and animals. It also gives an opportunity to observe how animals are kept around cooking and sleeping places, where the animals eat, sleep and are slaughtered and how the manure is being handled. It provides an opportunity to observe where the humans collect their water for consumption. This will give the possibility to better estimate the risk of fecal oral transmission and transmission through food, water and close contact.

According to the same reasoning as for the village map this tool has only been used in one village. In the first step village A and B were selected but in the second step only village A was chosen, because the total number of households in this village was closer to the average number of total households in the ten villages in the Bathay district included in the study "Zoonoses in humans and domestic animals: a cross-disciplinary approach in rural Cambodia". This makes village A more representative of all the ten villages than village B.

Household map/farm sketch

A farm sketch shows the layout of the individual household and the distance between the humans and the animals. It shows where the animals eat, drink and where the manure is kept. It also shows how close the animals are to where the humans cook and sleep. This will give an opportunity to estimate direct transmission through close contact and fecal oral transmission through contaminated water and food.

This tool has been used in one household only to show the typical layout of a household in rural Cambodia. Village number A was selected according to the same reasoning as for the

village map. In village A, a household having pigs, ruminants and chickens/ducks has been chosen. The farm sketch was made together in the group and everyone participated in drawing.

Time line

The time line shows the trend and the quantity and can follow how a disease changes over time. The time line also adds a historical perspective. It gives the opportunity to follow a disease in both animals and humans over a period of 5 years.

For this tool C village has been selected, where the ongoing project had identified salmonella among animals, gastrointestinal diseases among humans and cough among animals and humans as major diseases.

Seasonal calendar

A seasonal calendar adds the perspective of season, showing how different diseases occur during the course of a year among animals and humans. It will also show how the livestock management practices change during a year and the food sources for humans. The seasonal calendar will help to estimate if any particular food source is responsible for an increase in diseases among humans or animals and if the diseases transmit between animals and humans.

For all four charts again village A has been selected because this is the village with most episodes of severe diseases among humans and the one village with most animal diseases reported including zoonotic diseases.

Ranking Matrix

The ranking matrix can help people to identify what they do and do not value about a class of objects. It can also help people to compare different objects. The ranking matrix can also help to estimate people`s knowledge by letting them compare different objects. This tool has been used in all three villages.

Questionnaire with open questions

An interview guide with open questions has been used to help estimate people`s knowledge, preferences and management practices in every village. Not all the questions have been tested in the pretest and where needed some questions have been changed during the fieldwork to better collect the information needed. This tool was used in all three villages.

Layout of the study

The information has been gathered through focus group discussions held with rural farmers with five to ten informants participating in each discussion. During the focus group discussions the farmers were offered snacks and water and after the discussion they were given a towel and a soap. The focus group discussions have been based on gender in order to include both men's and women's perspectives and have been formulated to take into account wealth and livestock species kept. The focus group discussions have taken place in the villages with a translator present

The rural famers participating in the focus group discussions have been selected by the village animal health worker who was present during the discussions, but instructed not to answer the questions. He was asked to include people who worked with the animals if possible.

From the beginning village animal health workers were recruited by the government under a program related to Avian Influenza supported by FAO. They do not have any formal degree but basic training of 3-4 weeks related to animal health care which is certified by the Government (Personal communication Dr. Seng Sokerya, 2012). "He/she is defined as a community-based or private village level worker trained to liaise between livestock owners and veterinarians, besides him/herself being able to provide veterinary, and preventive health services to the village livestock in the village itself" (Personal communication K Osbjer, 2012).

A pretest of the method has been conducted including a village map, a transect walk, a farm sketch and a ranking matrix. For the pretest one village has been selected according to its geographical convenience, not according to the inclusion criteria mentioned above because the aim of the pretest was to test if the information needed could be gathered with the tools used, not to investigate the pretest village in particular. Since the tools were working and risk factors for transmission of diseases were present, the information gathered in this village has been included in the study. A village map, a farm sketch and a ranking matrix from the pretest village has been included in the study.

RESULTS AND DISCUSSION

Men and women perspectives

Five focus group discussions were held in four different villages (including the pretest village) with six to nine members in each group, see table 1.

Table 1: Members in focus group discussions by village, gender and tool used

Village	FGD	Men	Women	Tool used						
				Vm	Tw	Fsk	Tl	Sc	Rm	Q
Pretest	One		6	yes	yes	yes		yes	yes	yes
A	One	2	5	yes	yes	yes			yes	yes

	Two	5	2					yes	yes	yes
B	One	1	6				yes		yes	yes
C	One		9				yes		yes	yes
Total	5	8	28	2	2	2	2	2	5	5

Focus group discussion (FGD), village map (Vm), transect walk (Tw), farm sketch (Fsk) Time line (Tl), seasonal calendar (Sc), ranking matrix (Rm) and questionnaire (Q)

Table one shows that more women than men participated in four out of five FGD and in two FGD only women participated. According to a statement of the animal health worker in the village it was hard to get men to join. When the men were working in the fields, it was not possible for them to leave work. The women were working around the house and it was easier for them to leave work for a couple of hours than for the men working in the fields.

Because it sometimes was hard to get men to join and because both men and women talked in the first mixed group the decision was made to allow mixed groups. The men tended to answer the questions about the handling of sick pigs and ruminants more and the women said more about the handling of sick chickens, but they did not disagree on any subject.

As it was hard to get men to join in, there was only one group where the majority was men. There were four groups where the majority was women. The fact that there were more groups where the majority where women than men, could imply that this study represents the women's perspective more than the men's perspective.

Farmers' livestock management practice

Village map

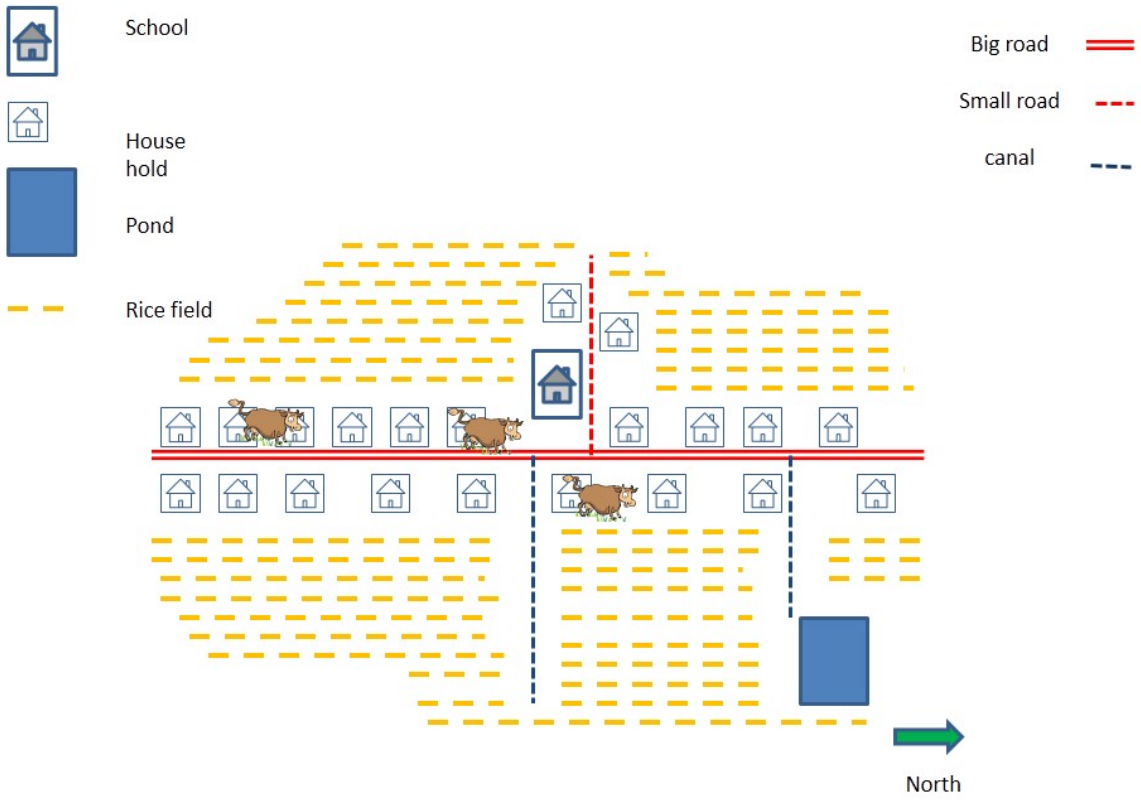


Figure 3. Village map from village A

The origin of figure 3 is the village map made together in the focus group discussion in village A. The pond and canal were used for rice and vegetable fields if needed during the rainy seasons when they grew rice and vegetables. During the transect walk in village A animal manure and animal feeding could be seen around the pond and no fences were observed in the village. Poultry was roaming free everywhere in all four villages participating in the study.

At the village level the manure and animal feeding around the pond in figure 3 could contribute to the spread of microorganisms by the fecal oral route between different animals. The feed around the pond and the water in the pond could be contaminated with feces. The feed is later eaten by the animals and the water is used as drinking water for the animals during the dry season, see table 3.

Farm sketch

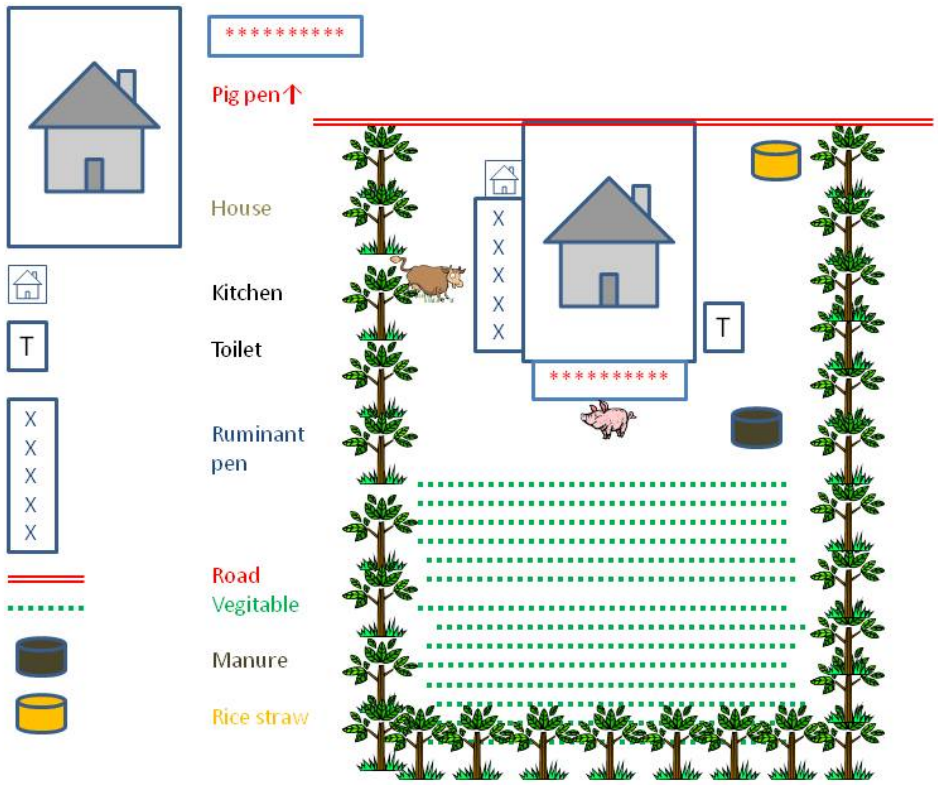


Figure 4: Farm sketch from village A.

All animal pens in figure 4 are open, see also figures 10 and 11. Chickens and wild birds could come into the pen. The pig pen was cleaned with water in the morning. The people slaughtered chickens in the kitchen. The kitchen was situated under the house close to the pigpen and had no walls and no door, see figure 5. It was possible for wild birds, chickens, ducks and pigs to get into the kitchen. Meat waste products were burned if the chicken was sick. If the chicken was healthy the waste was put on the manure pile.

Figure 5: Kitchen in village A.

The possibility for domestic and wild animals to come into the kitchen facilitated transmission of diseases between humans and animals. It was possible for wild birds and poultry entering the kitchen to contaminate the equipment in the kitchen and the food with their bodily excretions, which could result in transmission of food borne and non-food borne pathogens. There was also a risk of disease transmission to other animal species in the household as the pig and ruminant pens were in close proximity to the kitchen where slaughter was taking place.

Handling of manure and water

In the tables 2 to 5 results from the village map, transect walk and questionnaire have been summarized.

Table 2: Table of result for manure, collection and use as fertilizer

Practice	Pretest village	Village A	Village B	Village C
Manure collection and storage	Ruminant and pig pen: manure collected every morning.	Ruminant and pig pen: manure collected every morning and evening. Chicken: manure collected every morning.	Ruminant pen: manure collected once a day or once every few days, depending on how much animals they had	Ruminant and pig pen: manure collected every morning and evening. Chicken: manure collected once/day or every second day.
Season for growing rice and vegetables	-	Rainy season	Rainy season	All year
Manure used for fertilizer.	Vegetable and rice fields	Rice fields	-	Rice fields

Table 2 shows that manure is collected at least once/day in the ruminant and pig pen in three out of four villages and at least every second day for chickens. Manure was also used as a fertilizer.

Figure 6: Pile of manure village A.

The pile of manure in figure 6 in village A is uncovered with a fence and close to the house, the chicken pen and the pig pen. The feces were put on the pile of manure and during the rainy season they used the manure for fertilizing. The meat waste products from healthy poultry were also put on the pile of manure.

The pile of manure was uncovered, which made it possible for dogs to take meat waste products from it and play with them and eat them. This could facilitate the spread of microorganism from the meat waste products in the environment. It was also possible for the

dogs, poultry, wild birds and the wind to spread feces from the pile of manure and thereby contaminate the household and neighboring households.

The use of manure as a fertilizer on rice and vegetable fields could spread microorganisms excreted in the manure in these fields. Vegetables are often eaten raw and microorganisms excreted in the manure could be ingested by the humans when they eat vegetables (EFSA, 2013). In village A and B they only grew rice and vegetables during the rainy season. The village map and farm sketch from village A (figures 3 and 4) shows that during the rainy season, when they grow rice and vegetable there are only rice and vegetable fields in the village and no fields with only grass where the ruminants could stay during the day. This could be a reason for them to keep the ruminants in the household compound.

Table 3: Table of results for water sources for animals and humans

Practice	Pretest village	Village A	Village B	Village C
Drinking water for humans	Bottle	Dry season: pond Rainy season: rain water. All water is boiled.	Dry season: closed well. Rainy season: rain water. All water is boiled.	Closed well, filtered or boiled
Washing water for humans	Closed well	Pond and rainwater	Pond and closed well	Pond and closed well
Drinking water for animals	Closed well	Dry season: pond Rainy season: rain water	Dry season: closed well. Rainy season: rain	Pond water, not treated

Table 3 shows that the water used for humans is boiled or filtered if it does not come from a bottle. The water used for animal drinking is not treated. The water used for washing in village B and C is pond water and a well.

The pond water could be contaminated with microorganisms from the animals. When using the pond water for washing microorganisms from pond water could contaminate the hands of the humans. This could contribute to the spread of microorganisms between animals and humans. When using a closed well for drinking water, the humans either boiled or filtered the water. There is always a possibility that they do not boil or filter it every time they drink it. The animals drank untreated pond water. Microorganisms could thus spread between different animals through the untreated pond water (EFSA, 2013).

Animal keeping and handling of sick animals

Table 4: Table of results for animal housing and keeping system

Practice	Pretest village	Village A	Village B	Village C
Housing system for ruminant	In the pen during the night and bound in the field or along the road	In the pen during the night, bound in the house hold during the day	In the pen during the night, bound in the household during the day.	In the pen during the night, bound in the field during the day.

	during the day.			
Feed ruminant	Rice straw/grass	Rice straw/grass	Rice straw/grass	Rice straw/grass
Housing system for pig	In the pen all day and night or bound under the house.	In the pen all day and night or bound under the house.	In the pen all day and night or bound under the house.	In the pen all day and night or bound under the house.
Feed pig	-	Kitchen waste	Kitchen waste	Kitchen waste and concentrated feed from the market
Housing system for chicken/duck	In the pen during the night and free during the day, or free all day and night.	In the pen during the night and free during the day, or free all day and night.	In the pen during the night and free during the day, or free all day and night.	In the pen during the night and free during the day.
Feed chicken/duck	-	Rice	Rice	Rice and concentrated feed from the market

In table 4 two housing systems for pigs, ruminants and poultry could be identified, see figure 8 to 12 for demonstration of the housing systems. Table 4 shows that a multi species integrated production system (FAO *et al.*, 2010) is being used.

Figure 8: Ruminant in the field in the pretest village

Figure 9: Ruminants at a household resting in village A

Figure 10: Pigpen in village A.

Figure 11: Chicken pen in village A.

Figure 12: Street with free ranging chicken in village A

In villages A and B (figure 9) the ruminants where kept in the household during the day, which reduces the risk of disease transmission between ruminants in different households. In

the pretest village and village C the ruminants where kept in the fields during the day see figure 8, which contributes to the risk of disease transmission between ruminants from different households.

Chickens and ducks were kept free ranging during the day and chickens from different households could mix, see figure 12, which contribute to the spread of diseases between poultry from different households. Wilds birds were observed everywhere and could carry diseases across the village. The pigs were fed kitchen waste. This facilitates the spread of microorganism from the chicken waste products to the pigs (EFSA, 2013).

The chickens and ducks were free during the day and it was possible for poultry and wild birds to get into the domestic animal pens. This facilitated the transmission between different species and between wild and domestic animals (Peiris *et al.*, 2009). It was possible for the chicken and ducks to contaminate the feed of the pigs and ruminants with their feces. It was also possible for wild birds to contaminate the domestic animal pens with feces.

Table 5: Table of results for practices when a ruminant, pig or chicken/duck gets sick

Practice	Pretest village	Village A	Village B	Village C
Practice for sick ruminant	-	Treat and if they don't recover they are sold to trader	Treat and if they don't recover they are sold to trader	Treat and if they don't recover they are sold to trader
Practice for sick pig	-	Kept free around the house. They are treated and if they don't recover they are sold to a trader	They are treated and if they don't recover they are sold to a trader	Kept free around the house. They are treated and if they don't recover they are sold to a trader
Practice for sick chicken and duck	-	In a cage around the house, not treated, big ones are eaten and small ones burned. The waste from the big ones is burned	Not treated, big ones are eaten and small ones burned	In a cage around the house, treated, if they do not recover big ones are eaten and small ones burned

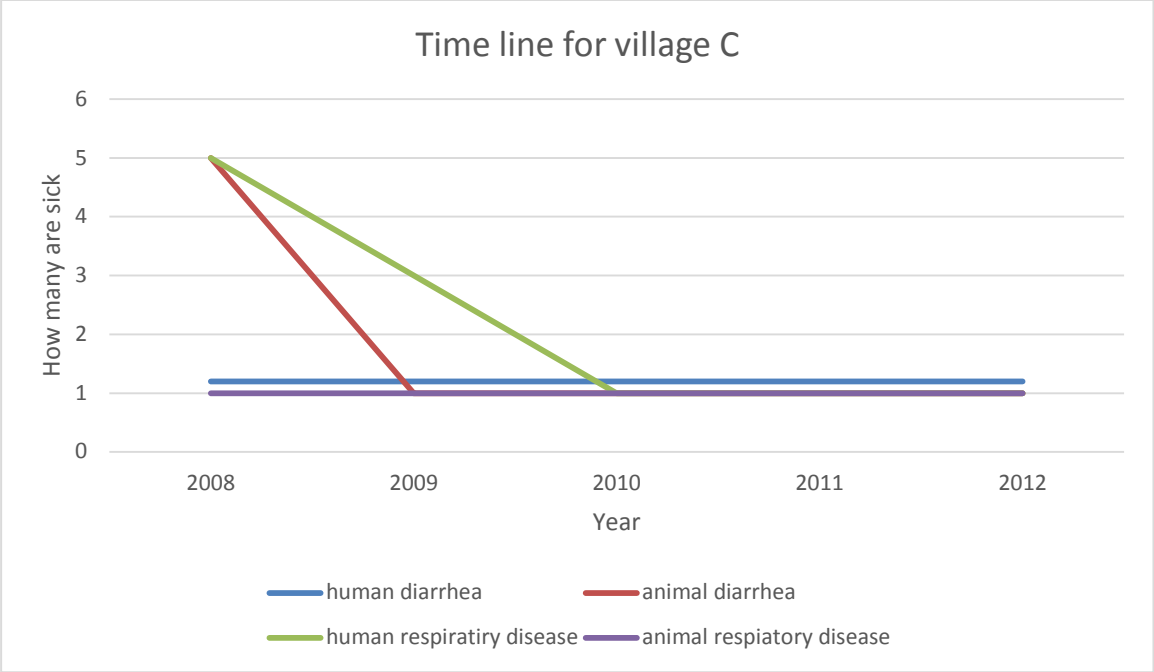
Table 5 shows that sick pigs and sick ruminants always were treated and sold to a trader if they did not get better. Sick pigs were kept free around the house. Big sick chicken were eaten.

The sick pigs were kept around the house to keep them away from the other pigs in the pig pen. These sick pigs could also contaminate the environment with pathogens, which could

transmit to the humans and other animals at the household. The practice to collect feces from the chickens once every day or once every second day reduces the amount of microorganism from feces present in the household, but it does not eliminate them.

The sick pigs and ruminants that were sold to a trader could infect pigs and ruminants in the household that purchased the sick pig or ruminant or within the live animal market where it was sold. The trader could also spread a disease by using the same vehicle to drive sick and healthy pigs between different households. Another option was that the sick pigs or ruminants were slaughtered and sold and microorganisms ingested by humans when eating the sick pigs and ruminants (EFSA, 2013).

Time line



1 = only a few in th village, 3 = half of the village, 5 = all the people or animals in the village

Figure 13: Time line in village C

Figure 13 shows that diarrhea among animals and human respiratory diseases declined between 2008 and 2010. When the focus group in village C was asked why, they answered because they had started using medicine.

Seasonal calendar

The seasonal calendar in village A, see appendix A, showed that humans and animals only had diseases during April to June. The diseases reported in humans were gastrointestinal diseases with fever during two days or more, diarrhea which always had blood in it and abdominal pain. The diseases reported in animals were FMD, Hemorrhagic Septicemia,

Salmonella and Fowl Cholera from which many chicken died. The animals had some Newcastle Disease, but only rarely.

Food sources for humans in the seasonal calendar in village A, see appendix A showed that the biggest meat source during the entire year was fish. The second biggest meat source was pork. The biggest vegetable source was water spinach and the second biggest was spinach. The only fruit source mentioned was mango and it was only eaten during four months, February to May.

According to the seasonal calendar the ruminants were working during the rainy season, June to October as draught power for farming. The animals drank pond water during the dry season and rain water during the rainy season.

To the question in village C how they diagnose FMD their answer was mouth and leg pain. To the question if they opened up and carried out any pathology on dead animals when diagnosing a disease they said no. The village animal health worker stated that someone from the animal health department had to come out to look at the organs inside a dead animal. That the diseases only are diagnosed by symptoms reduces the liability of the diagnosis and thereby the liability of the diseases stated in the seasonal calendar. As stated in the method the village animal health worker provides basic preventive and medical care to the livestock.

Both humans and animals only had diseases during the hot season and the meat and vegetable sources for the humans did not change during the year. Because of this, the meat and vegetable sources could not be ranked according to risks of disease transmission to humans and no meat or vegetable sources could be identified as a big source of disease for humans. The seasonal calendar instead indicates that the burden of diseases in humans and animals depend on the season. Since most of the pathogenic bacteria have an optimal growth temperature at 37° (Quinn *et al.*, 2011). This could be a reason for the high amount of diseases during the hot season in humans and animals. Humans had many gastrointestinal diseases and the focus group in village A stated that the animals had salmonella. This indicates that gastrointestinal diseases could be transmitted between animals and humans. In Cambodia the farmers refer to all gastrointestinal diseases among animals as salmonella. The animals started to get sick in April and started working as draught power and drink rainwater in June, this indicates that their work as draught power and the rainwater as drinking source is unlikely to contribute to the diseases among the animals.

Knowledge on infectious diseases and zoonoses.

Knowledge on disease transmission by water

Table 6: Summary of results from the ranking matrix with risk of infection by water from village A, B and C

Number of village that ranked the water source as:	Canal/river	Pond/lake	Rain	Bottle	Truck	Well closed	Well open

The biggest infection risk	1		2					
The second biggest infection risk	2		1					
The third biggest infection risk				2		1		
No infection risk							2	
Don't know					2	2		

The categorization of water sources in the top row in table 6 are taken from earlier research (Personal communication K Osbjer, 2012). In village A everyone in the focus group was given ten sticks to put on the ranking matrix, table 6 to rank the different alternatives in the top row. They were instructed to put more sticks on the water sources which they thought had a greater risk of infection. If they thought that there was no risk of infection, they should not put any stick on that water source.

In village B and C everybody in the focus group was asked to think about every water source in the top row in the ranking matrix, table 6 and to say which water source they thought was the biggest risk of infection, which one was se second biggest, third biggest risk of infection or if there was no risk of infection. They could also say that they don't know. The method was changed between village A and B to be able to also single out the water sources were they did not know from those where they thought that they knew.

Table 6 shows that in two of three villages the members of the focus group thought that the pond/lake was the biggest infection risk, in one village the members of the focus group thought that the canal/river was the biggest infection risk. This showed that members in the focus group from all three villagers were aware about the infection risk in a pond/lake and in a canal/river.

Knowledge on disease transmission between animals and humans

Which animals transmit diseases to humans and how

When the focus group members from village A were asked how a disease can transmit between animals and humans they said that it happens if you touch a sick pig and cook without washing hands. When focus group members from village C were asked the same question they said if you touch sick animals. For table 7 everyone was given a stick to lay down if their answer was yes to the question in the left column after the actions given in the top row. The number in the cell represents the sticks laid down. In table 8 they were only asked to answer yes or no to the question in the left row according to the actions in the top row, since they were reluctant to lay down the stick they were given.

Table 7: Spread of disease from animals to humans by feces in village B with 7 members in the FGD

	Touch sick chicken and cook without washing	Touch manure from sick chicken and cook without washing	Touch healthy chicken and cook without washing	Touch manure from healthy chicken and cook without washing

	hands	hands	hands	hands
Will you get sick if?	7	7	0	6

Table 8: Spread of disease from animals to humans by feces in village C

	Touch sick chicken	Touch manure from sick chicken	Touch healthy chicken	Touch manure from healthy chicken
Will you get sick if?	Yes	Yes	No	Yes

Table 7 indicates that all the members in the focus group in village B thought that you would get sick if you touched a sick chicken or manure from a sick chicken and cooked without washing hands. Six out of all 7 members in the focus group also thought that you would get sick if you touched manure from a healthy chicken and cooked and cooked without washing hands. Table 8 shows that the collective answer from the focus group in village C is yes to the question if you can get sick from touching manure from a healthy or sick chicken and from touching a sick chicken.

To the question which animals could transmit a disease to humans, people in the focus groups in all three villagers said a sick pig and a sick chicken. People in the focus group in village B also said sick dog and sick ruminant and then they said all sick animals. People in the focus group in village C said that a sick ruminant could not transmit a disease to humans.

When asked how to stop a disease from being transmitted from animals to humans people in the focus groups in both village A and B said that you have to wash your hands before cooking and after handling animals. People in the focus group in village A also said that you should kill and burn sick chickens and people in the focus group in village B also said that they vaccinated the animals and cleaned the pig pen wearing mask and glove.

To the open question how a disease could transmit between animals and humans no one mentioned equipment or feces. Table 7 and 8 shows at the same time that, the people in the focus groups in village B and C were aware of the fact that, a disease can be transmitted through feces from sick and healthy animals. It is possibly that table 7 and 8 was carried out in a leading way, but the quick answer to the question about feces from a sick animals indicated that it was genuine. The awareness of the fact that they could get sick from feces could lead them to avoid feces contamination when possible by cleaning more often and chasing the animals away from cooking and eating areas. This will not eliminate the contamination with feces, but reduce it and there by the risk of infection.

People in the focus groups from all three villages thought that chicken and pigs could transmit a disease to humans, but only people in the focus group in village B thought that ruminants and other animals could transmit a disease to humans. At the same time people in the focus group from village A and C said that they let sick pigs free around the house, see table 5. The

fact that they were aware of that they could get sick from pigs could lead them to chase the sick pigs away from the eating and cooking area, but the practice to have them free around the house indicated neglect towards the possibility that they could get sick from them.

Transmission through food

When asked about food people in the focus groups in all three villagers did not think that there was any risk of infection when eating sick animals after preparing them by boiling them. The vegetables are sometimes only washed, not boiled. People in the focus groups in village A and B also said that there was no risk of infection when eating the vegetables after washing them.

The practice to eat big sick chicken, see table 5, could be a result of the belief in that they cannot get sick if they boil their food. This belief and the conviction that they cannot get sick when eating vegetables that have only been washed and not cooked shows limited knowledge regarding survival of spores after cooking (Quinn *et al.*, 2011) and microorganisms on vegetables from manure used as a fertilizers and in the water used for washing the vegetables (EFSA, 2013).

Knowledge of disease transmission between animals

Table 9: Spread of diseases between animals

Question→ Answer ↓	Animals that transmit diseases to other animals	Animals that transmit diseases to other animals	How a diseases comes into the village
Sick animals	FG in village, B and C stated: sick animals transmit diseases to other animals		
Close contact		FG in village A, B and C stated: diseases is being transmitted when healthy eat and sleep together	
New animals			FG in two villages stated: A diseases comes to a village with new animals
Animals health worker			FG in two villages stated: A diseases comes to a village when animal health worker not changing cloth

FG: Focus Groups

In table 9 the question asked is given in the top row and the answer given is written in the left column. In the diagonal the focus groups and the exact answer is given. The statement from all three focus groups in village A, B and C, that a diseases is spread when healthy and sick animals eat and sleep together, showed that they were aware of that diseases are spread by close contact, direct transmission. The statement from two focus groups that a disease can come to a village with new animals is coherent with the statement earlier that sick animals are sold.

The statement that only sick animals could transmit a disease showed limited awareness of subclinical infected animals that can spread a disease. This indicated that the knowledge of wild birds and ducks that can be subclinical infected with for example avian flu and spread this disease to chicken, pigs and humans is scarce (Peiris *et al.*, 2009). In the present study, no practice to stop wild birds and ducks from getting in to the pig pen was identified. One reason for this lack of preventive measure to limit disease transmission between wild birds, ducks, chicken and pigs could be due to the knowledge gap.

To the question how a disease could transmit between animals, no one mentioned equipment. At the same time people in the focus groups in village B and C stated that they cleaned the pig pen with calcium carbonate and people in the focus group in village C also stated that they cleaned the chicken cage with it when it had been used for a sick chicken. This indicated that they knew that a disease could transmit by equipment between different animals of the same species.

Risk factor for transmission of disease

These risk factors for transmission of diseases between animals and humans and between animals and animals have been identified from the farmers' management practices above:

Between animals and humans

- People eat sick and dead animals
- Vegetables are fertilized with manure from animals and eaten raw
- Contamination from animals that are kept free ranging near cooking/sleeping areas
- Sick pigs are kept near cooking/sleeping areas
- Animal pens are near the cooking place
- Manure pile is kept in household premises
- Villagers only take precautions to prevent disease transmission (such as hand-washing) when the animals show signs of disease

Between animals and animals

- Animals of different species are mixing
- Wild and domestic animals are mixing

- Animals from different households meet in the fields during the day
- The villagers sell sick animals
- Trader/middleman is used for sale and purchase

Possible and feasible preventive measures

Between animals and humans

People in the focus groups in all three villages stated that they washed their hands with soap and water before cooking and after handling animals. They used water and liquid for washing their dishes. Either pond water, rain water or a closed well was used for washing their hands and dishes. The water was not treated.

Table 10: preventive measures to stop a disease from spreading between animals and humans

Preventive measures →	Hand washing	Cooking meat good	Burning all sick animals	Keeping all animals away from cooking/eating area
Cheapest/easiest	FG in village A, B and C ranked hand washing as the cheapest/easiest way			
Most effective	FG in two villages ranked hand washing as the most effective way	FG in one village ranked cooking meat good as the most effective way		

FG: Focus Groups

Table 10 shows that all focus groups in all three villages ranked hand washing as the cheapest and easiest way to stop a disease from spreading. One focus group ranked cooking the meat good and washing their hands as the two most effective ways, one focus group ranked washing their hands as the most effective way and one focus group ranked cleaning the pig pen with mask and glove as the most effective way. Focus groups in two out of three villages ranked burning sick animals instead of eating them very low on effectiveness. For the ranking matrix from the individual villages on how to stop a disease from spreading between animals and humans, see appendix A, B and C.

When the decision was made what should be in the top row in the ranking matrix about preventive measures to stop a disease from spreading between animals and humans (se appendix A, B and C) the answer from the focus group to the question how could you stop a disease from being transmitted between animals and humans was added to the alternatives that already were in the top row. This lead to the result that different focus groups compared

different alternatives, but all focus groups compared washing hands, cooking meat thoroughly, keeping all animals away from cooking areas and burning and not eating sick animals, see table 10. In some focus groups the ranking matrix also became very long, there is a possibility that these focus groups did not consider the alternatives at the end of the ranking matrix. This reduces the validity of the ranking matrix.

The statement that burning all sick animals, instead of eating them, is not effective for stopping a disease from spreading between animals and humans was coherent with the statement that you cannot get sick from sick or dead animals by eating them if they are cooked well. This showed as stated before, their limited knowledge about spores that survive 100 degrees when cooking (Quinn *et al.*, 2011). All three focus groups stated that hand washing was an effective and cheap/easy way to stop a disease from transmitting between animals and humans. The high density of animals around the house could however pose a risk that they neglected washing hands every time they handled animals and cooked. The practice to have the water for the hand washing at the toilet, away from the kitchen creates an inconvenience when the hands need to be washed before or during cooking, an inconvenience too big to overcome. The statement that they washed their hands after handling animals and before cooking does not have to represent the practice, as indicated by a study of Paul Fentiman in 2011 in the United Kingdom. During avian influenza outbreaks messages regarding hand washing after handling poultry were delivered to the people (The Academy for Educational Development, 2009), this could be the reason why the people in the focus groups mentioned hand washing so frequently.

Between animals and animals

All in all out practice biosecurity and isolation.

The focus groups in two villages stated that they sell all pigs together and then buy new pigs (all-in-all-out practice). The focus groups in two villages also stated that they used calcium carbonate when they cleaned the pig pen before new pigs arrived and one focus group stated that they also used it for cleaning the pig pen when a sick pig had been in it and for the chicken cage after it had been used for a sick chicken. The focus group in one village stated that before new chicken arrived the chicken pen was cleaned with a brush.

The focus group in village C stated that they kept new chicken separate for one week to ten days and new pigs and ruminant separate for three to four days. If the pigs and ruminants were not kept separate they would fight if they were of different size and the little one would get hurt. The focus group in village B stated that they kept new animals away from others for three days to one week to prevent their animals from getting sick. The focus group in village A stated that they vaccinated when a diseases came to the village and kept sick animals away from the other animals to prevent their animals from getting sick.

Vaccination

The focus group in village A said that they vaccinated ruminants against FMD and Hemorrhagic Septicemia. The focus group in village B stated that they vaccinated ruminants against Hemorrhagic Septicemia and pigs against Salmonella when they were young. The focus group in village C stated that they vaccinated ruminants twice yearly against FMD and Hemorrhagic Septicemia. Pigs were vaccinated against FMD once when they were young.

Cost and benefit of vaccination

The focus groups in all three villages stated that it was expensive to vaccinate. The focus group in village A said that the expensive vaccines from France were good, the animals did not get sick, but the cheap vaccines from Thailand and Vietnam were bad, the animals were still getting sick with them.

Table 11: Actions to stop animals from getting sick in village B, 7 people participated

	Vaccinating	Keep new/sick animals away for 2 weeks	Not sell sick animals
Cheapest/easiest way		17	18
Most effective	35		

Everyone was given 5 sticks to lay down on the alternative they thought was cheapest or easiest and then most effective to evaluate different preventive measures. When they did this they laughed and put their sticks down very fast without hesitating. When asked what was hard about vaccinating they answered that it was expensive. Table 11 shows that they all believed that vaccinating was the most effective way, but not the easiest and cheapest.

Table 12: Actions to stop animals from getting sick in village C, 10 people participated

	Vaccinating	Keep new/sick animals away for 2 weeks	Not sell sick animals
Cheapest/easiest way	18	11	16
Most effective	35		

The same method as in table 11 was used. Table 12 shows that the focus group in village C thought that the easiest or cheapest way and also most effective way was vaccination. The expensive vaccines were considered effective, but the cheap ones were not.

Vaccines must be kept chilled, which is difficult in remote rural tropical regions that lack a continuous refrigeration chain from manufacturer to farm (Warner, R, 2006). In the past, the government in Cambodia has tried to provide subsidized vaccines, but seems increasingly less able to manage this in the absence of external support. The costs associated with delivering vaccines included fuel or other means of transportation, ice for vaccine storage, food and meal preparation for the technicians and others who assisted with the organization of the vaccination effort (Ballard, 2005). Poor locally trained technicians cannot afford to give credit

or discount on vaccines and financial support to subsidize vaccines could be needed. The high mortality rates among livestock (Sophal Ear & Leonard, K.D., 2005) could however motivate the farmers to increase the use of vaccines.

Introduction of diseases in villages can be prevented by quarantining introduced animals and avoiding contact between infected and uninfected stock and other sources of infection, including thorough cleaning and possibly disinfection of equipment (Fukai *et al.*, 1997).

The statement from the focus groups in village B and C that a new disease could come to the village by a new animal is coherent with the statement that they sell sick animals. The ranking in table 10 and 11 of not selling sick animals as ineffective indicates that they do not consider selling sick animals as a big source of transmission of diseases. The focus groups in all three villages stated that they separated sick animals from other animals of the same species. The statement from the focus group in village C that they separate new pigs and ruminants for three to four days to prevent fighting, not to prevent spreading of diseases, indicates that they neglect the possibility that the new animal is sick and can spread a diseases if it is not put in quarantine (Fukai *et al.*, 1997).

CONCLUSION

Results from this study indicate that villagers in rural Cambodia were aware of transmission by close contact between sick and healthy animals of the same species and had in place practices to avoid it. In no village equipment, food or water was mentioned as an answer to how a disease can transmit between animals. Practices to stop diseases from spreading by equipment could be identified, which indicated that they were aware of this risk of transmission between animals.

The results also indicate that the farmers interviewed had limited knowledge on transmission of pathogens between different domestic species and of subclinical infected animals. The scarce knowledge could contribute to the practice to have open animal pens where animals of different species can meet and the practice to keep domestic animals near an open cooking and eating space.

The open animal pens and the free ranging domestic animals contribute to the mixing of and direct transmission between different domestic species and wild and domestic animals. As mentioned in the beginning ducks and wild birds can carry influenza virus without showing any signs of disease and spread it to the domestic animals. The possibility for humans, chicken, ducks and wild birds to spread influenza virus to the pigs increases the probability that the pig will act as a mixing vessel and a new influenza virus will emerge.

Education on the above mentioned subjects could create a platform of communication where the building of closed animal pens and kitchen and an increase in biosecurity measures could be addressed. Further research on the subject is needed and new interventions could be used.

Interventions in villages with a high amount of gastrointestinal diseases during the warm season could motivate the farmers if a decrease in diseases could be observed. Questionnaires to further investigate knowledge and on existing and preferred channels to collect knowledge on the above mentioned subjects could be used to identify an appropriate channel of communication.

On the subject possible and feasible preventive measures the results indicated that washing hands was regarded as cheap/easy and effective and there by a possible and feasible preventive measure. Notable is however that the villagers used a water source with risk of contamination without boiling the water for washing their hands. The statement that they washed their hands after handling animals and before cooking does not have to represent the actual practice and further research on the subject is needed. This research should preferable be by observation to get to the real practice. Vaccination was regarded as effective, but expensive and further research involving the possibility to support vaccination economical and education on how often and when they should vaccinate is needed for vaccination to be a possible and feasible preventive measure.

Validity and reliability

To be able to conduct the present study a translator was used. The translation was conducted in two steps, first the questions in English were translated into Khmer and then the answers in Khmer were translated back to English. This could have reduced the validity of the study and to compensate, different measures were used to gather information on the same aspect. For example was the matrix on ways a disease can transmit between humans and animals used in focus groups in the villages B and C to measure their knowledge on fecal oral transmission, which the focus group in village A had not mentioned on the open question about transmission. The change of method between different villages also reduces the reliability of the present study, but was considered necessary to be able to get the information needed.

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I would also like to thank my translator Sina Vor, who drove me for two hours, so that we could reach the villages I had selected for the study. He also made the research possible by translating my questions to the people in the focus groups and then translating their answer to me.

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Finally I would like to thank Loam and Narin from the pretest village for receiving me in their home and letting me stay there for 2 nights to be able to observe how animals are kept and test my research tools in my first focus group discussion in their village.

APPENDIXES

Appendix 0: Agenda and field report for the field pretest of the method for:" Zoonotic Pathogens at the Interface between Humans and Animals, a Rural Approach".

Province: Kandal
District: Kandal Steung
Commune: Siem Reap
Village: Siem Reap
Date: 15/9, 16/9 and 17/9 – 2012
Season: Rainy season

The aim of this field trip is to test if some of the tools that I have design work in the field, not to investigate this village in particular. The village has been chosen because of its geographical convenience, not because there are many diseases among humans and animals in this village. If the tools are working I will use the information gathered in this village in my essay, since it is a village in rural Cambodia and thereby part of the area in Cambodia which I am studying.

Agenda day one, PM
I will arrive at the village.
Get introduced to the host and get an overall view of the village.
Agenda day two AM
6.30. Preparation for FGD with Men group
08:00 – 11:00 (FGD):

Introduction

I am Sunniva, a veterinary student from Sweden. I am here as a part of the Sida funded project "Zoonoses in humans and domestic animals: a cross-disciplinary approach in rural Cambodia". You already have participated in this project by answering questions and leaving samples. The project is as you might know an cooperation between Sweden and Cambodia. A zoonosis is a disease or infection that is naturally transmitted from vertebrate animals to humans. Environments where wild animals, domestic animals and humans live in close proximity with no or small boundaries in the ecological system favor the transmission of diseases between animals and humans**.** The objective of the Sida funded project is to:

- reduce poverty and improve livelihood in rural Cambodia by improving human and animal health through increased awareness of zoonoses and improved preventive measures.
- Globally and in Sweden
- To improve emergency preparedness for zoonotic diseases by increased understanding of the spread of these diseases between domestic animals and humans.
- Human capacity building in Cambodia and Sweden regarding communicable Zoonoses.

During the research so far we have not found any campylobacter/bacteria among the people in the Bathay district. One third of the animals were positive for campylobacter and only a few were positive for the avian flu. Today we will discuss transmission of diseases between animals and humans further. The purpose of this gathering is for me to understand what is important to you in your everyday handling of the animals, I want you to know that there is no right or wrong answer.
The title of my project is "Zoonotic Pathogens at the Interface between Humans and Animals, a Rural Approach" and I am here to learn more about your:

4. *Livestock management practice and knowledge on infectious diseases and zoonoses*
5. *Identify risk factors for transmission of zoonotic pathogens*
6. *Identify feasible and acceptable preventive measures for transmission of infectious pathogens.*

The tools I will use are:

- ***Village map***
- ***Farm sketch***

Village map

A village map is made together in the group. Material needed for the village map is flip chart and pencils of different color. Everyone will participate in drawing the map.

What will be included on the village map:

- *Where the people collect their water and what they use it for*
- *What water is used for the vegetables and rice fields*
- *Where the animals drink and wash:*
- *Where the animals are fed/graze (if it is seasonally, specify the season) on what type of feed?*
- *What fertilizer is used on what fields*

Farm sketch

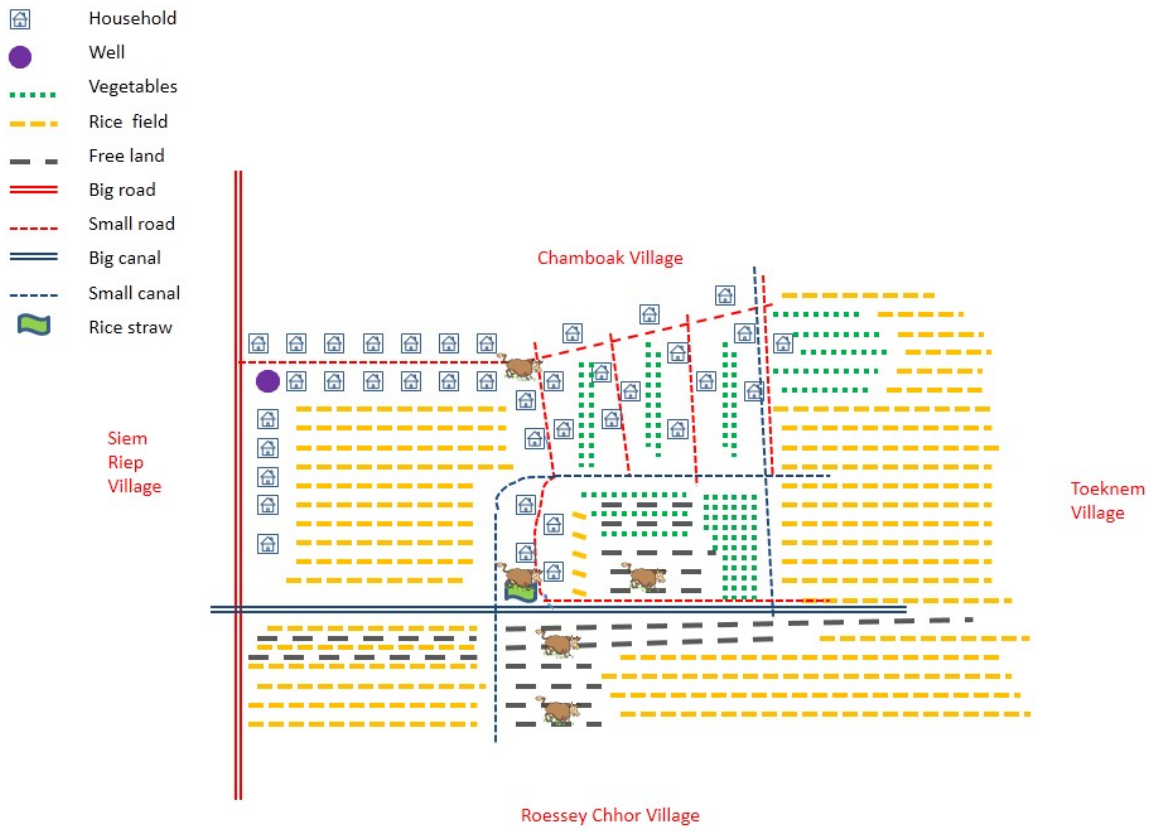
A farm sketch will be made according to the same method as the village map and with the same material.

What will be on the farm sketch:

- *Where and what specie animals are kept?*
- *How they are kept (free ranging, with in a fence or bound)*
- *Where people slaughter the animals*
- *Where do they cook and eat*
- *Where do they sleep*
- *What do they do with meat waste products*
- *Where the animals eat*
- *What the animals eat*
- *Feces/pile of manure. How the manure is used?*

Result day two AM

Because the people living in the village had to prepare a ceremony for the evening that day they could not sit down with me to make a map of the village and a sketch of a farm. Instead I walked with the translator around the village, accompanied by three different people living in the village. These people could answer my questions and after that I sat down with the translator to make a map. The same procedure was used for the farm sketch.



Village map

Figure 0.1: Village map from pretest village.

The ruminants washed every week in the canal. The water from the canal in the village map is also used for the vegetables and the rice fields. Every household has its own well, from which the animals drink and in which the humans washed. The humans drank water from the bottle. The vegetables and the rice were being fertilized with ruminant manure. The Ruminant where bound by the road or in the field, eating rice straw or grass during the day and were in the pen during the night. The pigs and chicken were kept around the house. Free birds were everywhere.

Farm sketch

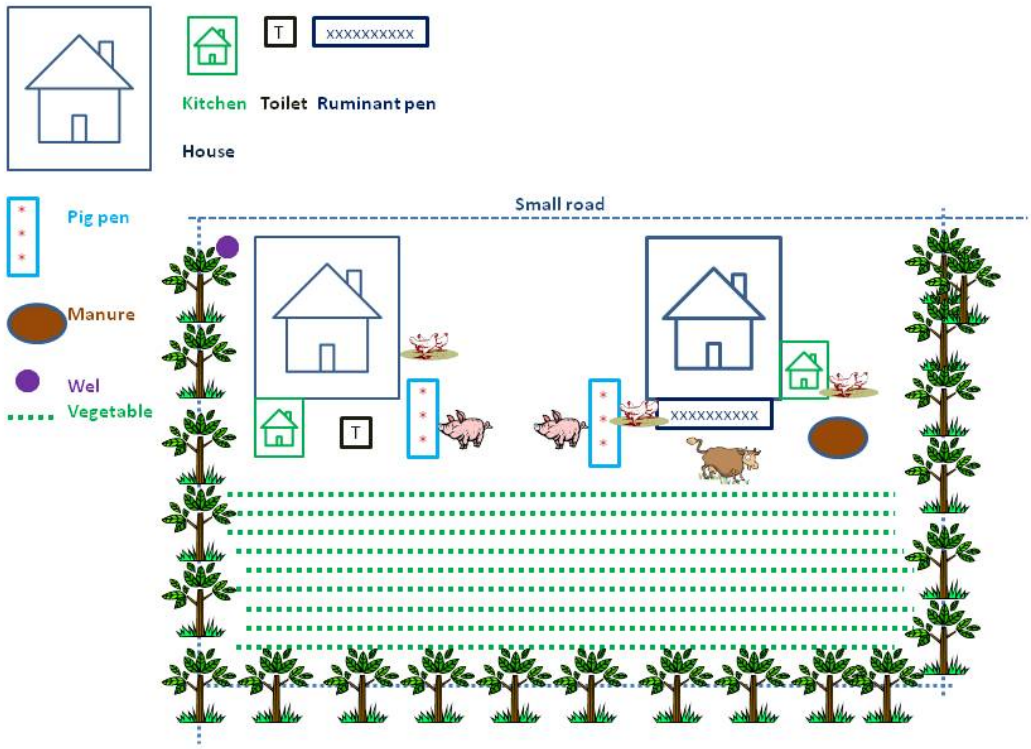


Figure 0.2: Farm sketch from the pretest village.

The farm sketch shows that the chickens are kept free around the house and the cocking place. The pigs are kept bound under the house in the shade or they are in the pen. The ruminants are bound in the field or next to the road during the day and in the pen that is near the house and the kitchen/cocking place during the night. The ruminant pen is cleaned every morning. The ruminants are taken in from the field at 17:00 and let out around 6:00. They cock on the ground over a small fire. The pile of manure is about 16 meter from the house.

Day two PM

Transect walk

In the walk through the village following one direction the objects in the left column will be recorded according to how they appear in the different areas in the top row. Before the walk the village map will be used to see what will be seen if the village is walked through in different directions. From this information the direction will be chosen.

The transect walk was conducted with the translator Sina. During the walk information was gathered from different people along the road. Everyone was working with the ceremony and it was not possible to get anyone to join during the entire walk. The walk went in the direction from Chamboak village to Roessey chhor village. When coming on the small road from the

main road, the first road to the right was taken, see the village map. This gave an opportunity to see many households along the way and also to see the rice field on the right side and the pile of rice straw at the end.

Table 0.1: Transect walk in pretest village

	Rice and vegetable field, free land, road	farm area	Resident settlement
Animal	Ruminants		Ruminants, Chicken, Pigs and dogs
Wild animals	Free birds	Free birds	Free birds
Animal pen			Ruminant, Pig
Keeping system	Ruminants: bound		Pigs: under house, Chicken: free
Animal feeding	Rice straw, grass		
Water: source and use	Canal: in which the animals wash	canal	Well from which the animals drink and in which the humans wash. the Humans drink bottle water
Manure: pile/fertilizer	Manure, fertilizer for rice an vegetable fields	Manure fertilizer for vegetable fields	Manure pile
Fences around	non	non	Manure pile
Slaughter	-		-
Q.1:	-	-	-
Q. 2:	-	-	-

Q.1 Is there any possibility of disease transmission between animal, wild animal and human in this area?
Q. 2. How do you think it is possible to reduce this transmission?

The transect walk showed that the canal were the animas wash is in the in the same area as the rice and vegetable fields. The well from which the animals drank was inside the resident settlement. The transect walk also shows that pigs, chickens and a pile of manure is kept inside the resident settlement and that manure is used as a fertilizer.

Day three AM. Six women participated
6.30 prepare for FGD
08.00 – 10.30 FGD

The tools I will use are:

- ***Seasonal calendar***
- ***Ranking matrix***

Seasonal calendar for animal diseases

In the seasonal calendar table 02, one means January, two February, three March, four April, five May, sex June, seven July, eight August, nine September, ten October, eleven November and twelve December. If they had had the disease or the object in the left column during the month in the top row an X was made in the chart. Material needed was a flip chart and a pencil.

Table 0.2. Seasonal calendar: Animal diseases in the pretest village

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
FMD	x	x	x	x	x	x	x	x	x	x	x	x
Hemorragic septicemia						x	x	x	x			
Blackleg: never												
Salmonella	x	x	x	x	x	x	x	x	x	x	x	x
Avian flu												
ND												
Fowl cholera					x	x	x	x	x	x	x	
Other (specify): leg, lay down, cannot get up, piglet (small pig). Days after 24 hours.	x	x	x	x	x	x	x	x	x	x	x	x

The seasonal calendar showed that they had FMD, salmonella and one other disease where the pigs cannot get up and die within 24 hour during the entire year. They only had hemorrhagic septicemia during the rainy season and fowl cholera from Mai to November. They also stated that if they did not vaccinate against ND, they had it during the entire year in the chickens.

- *What kind of animals or animal's products do you eat during last one year?*

Pork, fish, ruminant, chicken, egg, seafood and frog

The objects in the top row in ranking matrix, table 03 are taken from earlier research and answers from the question above will be added. Everyone was given five sticks and then everyone was asked to put the most sticks on the food source that they eat the most, the food source that was cheapest and the food source that was most important for survival. Everyone was asked how they treated the objects in the top row before eating and how they avoided infection. They were also asked to name the food sources that had the biggest risk of infection.

Table 0.3: Ranking matrix on transmission trough food in the pretest village

	P	Fish	R	C/D	egg	Sick	Dead	Wild	Sea-food	F
Quantity (scoring)	9	8	1	2	6	0	0	0	1	3
Most important for survival	4	14	7	10	5					
Cheapest food	4	20	3	2	6					
How do you treat it before	boil	boil	boil	boil	boil				boil	

eating									
Biggest infection risk						x	x		
How to avoid infection	boil	boil	boil	boil	boil	boil	boil	Boil	Boil

P: pork, R: ruminants, C: chicken, D: duck, F: frog

The table shows that they eat the largest quantity of pork, fish and egg during the year. Fish is the cheapest food and most important for survival. They boil everything they eat and they know that they can avoid infection by boiling. They have not eaten sick, dead or wild animals last year and they stated that they did not have any zoonotic diseases.

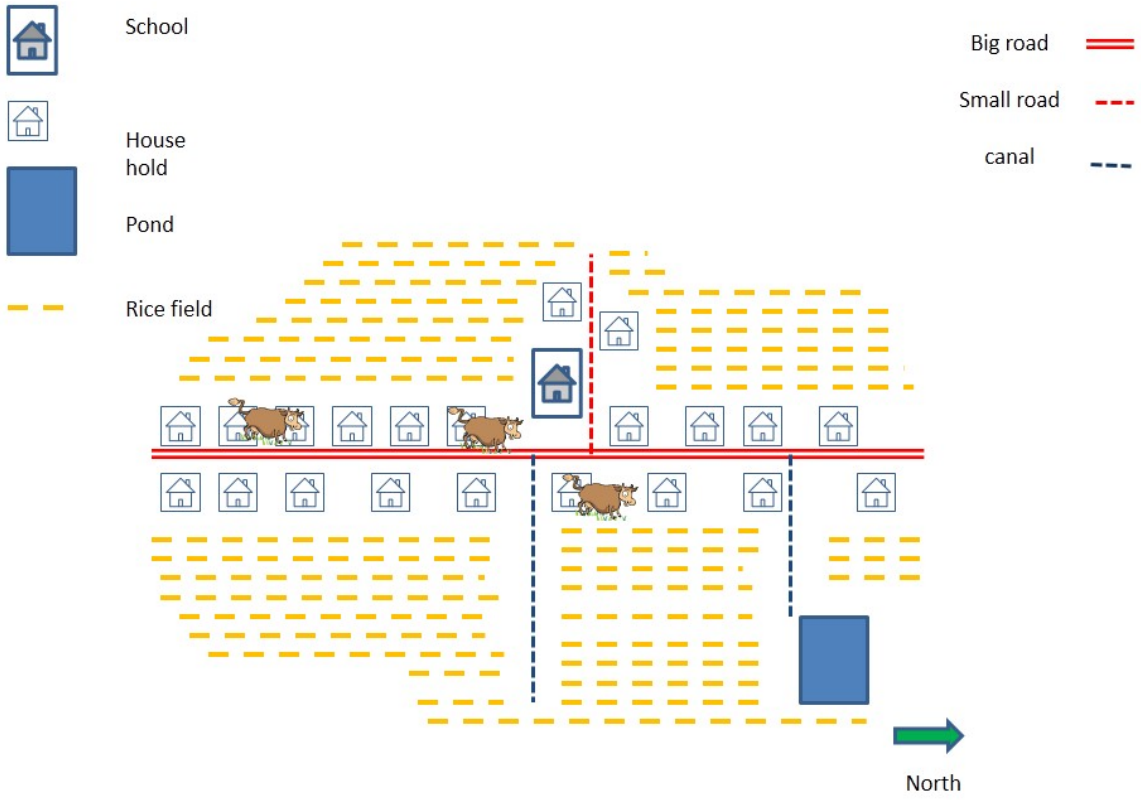
Appendix A: Agenda and field report from the field work of: ” Zoonotic Pathogens at the Interface between Humans and Animals, a Rural Approach” in village A.

Province: Kampong Cham
District: Bathay
Commune: Tumnup
Village: Pror Sam
Date: 30/9 and 1/10 - 2012
Season: rainy season

Day 1 AM: 7 people, 5 women and 2 men
Tools I will use

- ***Village map***
- ***Farm sketch***
- ***Questionnaire***
- ***Ranking matrix***

For introduction, method for the village map and farm sketch see appendix 0, agenda and field report for the pretest village.



Village map

Figure A.1: Village map from village A.

Village A was using a pond for drinking water, se figure A.1. The pond was used for drinking for humans and animals during the dry season. The drinking water for human was being boiled. A closed well was used for washing hands and dishes, they did not boil this water. During the rainy season rain water was used for drinking for humans and animals, for the humans they boiled the rain water. They did not wash the animals. Village A was only farming during the rainy season, the pond and canal was used for rice field and vegetables if needed during this seasons and manure was used as fertilizer on the rice fields.

- *Can you see any way a disease can transmit from humans to animals in this area?*

Don't know, never seen a disease transmit from animal to human

- *How would you stop a disease from being transmitted between animals and humans in this area?*

Don't know

Table A.1: Ranking matrix on risk of infection by water in village A

	Canal/river	Pond/lake	Rain	Bottle	Truck	Well closed	Well open
Biggest infection risk	24	13	3	6	10	0	3

The water sources in the top row are taken from earlier research. Everyone was given 10 sticks to put on the matrix to rank the different alternatives in the top row. They were instructed to put more sticks on the water sources which they thought had a greater risk of infection. If they thought that there was no risk of infection, they should not put any stick on that water source.

The ranking matrix showed that they thought that the canal or river was the biggest risk of infection. The second biggest infection risk was the pond or lake. There was no risk of infection in a closed well and only little risk of infection in an open well and in the rain water.

Farm sketch:

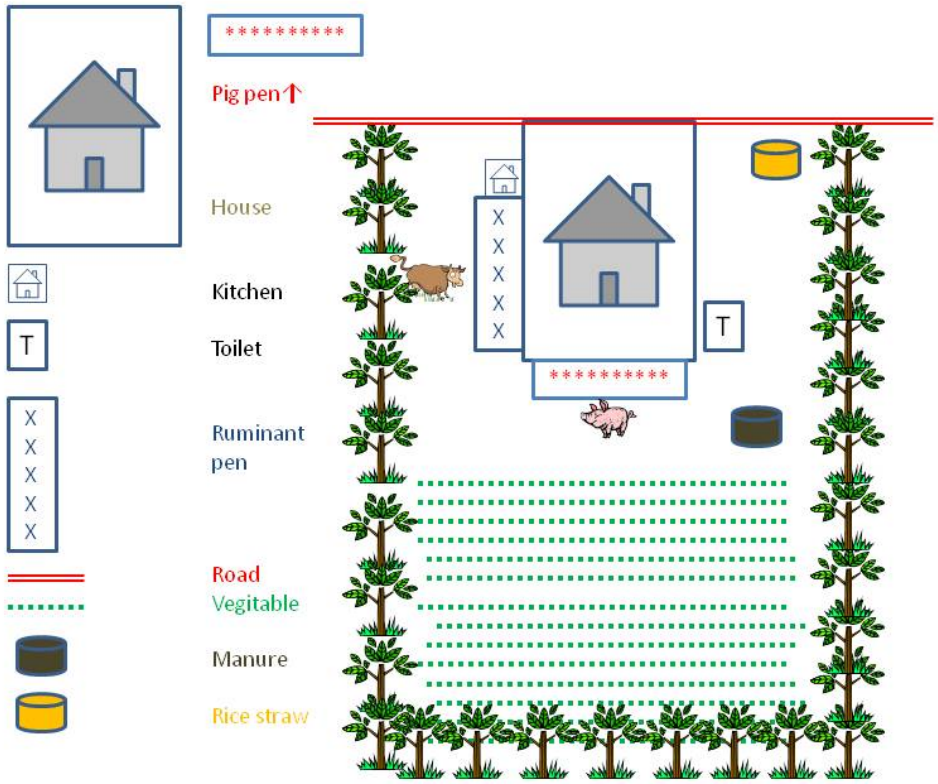


Figure A.2: Farm sketch from village A.

The pigs were in the pen in the farm sketch all day or bound under the house in the shadow. The chickens were free all day. Some households had a chicken pen near the house where the

chickens and ducks were during the night. Ruminant were in the ruminant pen in figure three at night. During the day in the dry season they were in the field and during the day in the rainy season, they are bound in the household. The chickens ate rice free ranging around the household, the pigs ate kitchen waste in their pen or bound under the house. The ruminants ate at a pile of rice straw or grass in the household. The people slaughtered the animals at the kitchen. Meat waste products were burned if the animals were sick, if they were healthy, they put them on the manure pile.

- *How do you think a disease can be transmitted from animals to humans?*

If you touch a sick pig and cock without washing hands

- *Which animals can transmit a disease to humans?*

Sick pig and sick chicken

- *Can you see any ways a disease can transmit between animals and humans in this area?*

Don't know

- *How could you stop a disease from being transmitted between animals and humans?*

Wash hands with soap, kill and burn sick chicken

At the same time they told me that they kill and eat sick big chicken, but burn meat waste products from it, and kill and burn little chicken.

Table A.2: Ranking matrix on how to stop a disease from spreading from animals to humans

	Hand washing with soap	Keeping the animals away from cocking areas	Cocking meat good	Burn sick, not eat	Keeping sick animals away from cocking area
Cheapest/easiest way	18	10	15	5	13
Most effective	26	0	26	0	18

Everyone was given 10 sticks to put on the matrix to rank the different alternatives in the top row. They were instructed to put more sticks on the alternative they thought was cheaper, easier or more effective.

The ranking matrix showed that they believed that the cheapest, easiest and most effective way to stop a disease from transmitting between animals and humans was to wash their hands with soup and water and cock the meat good. To cock the meat good meant, that there was no blood left in the meat.

- *How often do you collect animal feces in your farm (by species if any)?*

Pig and ruminant pen 2/day, morning and evening, clean pig with water in morning chicken one 1/day, morning, put it on the pile of manure during dry season. Use manure for fertilizing during rainy season.

- *How are sick animals kept (around cocking and sleeping areas)?*

Sick chicken are kept in a cage around the house, away from other chicken, sick pig are kept free around the house, away from the other pig in the pig pen.

- *When(s) do you wash your hands during the day? Why?*

Before cocking, after handling animals

- *What do you wash your hands with?*

Soap and water from pond in dry season, rain water in rainy season

- *What do you use when you wash your dishes?*

Water and liquid,

- *Treated?*

No

- *What will they do when new animals are purchased/given to the house hold?*

Pig: sell all, by new

- *Do you, and if how do you clean the pigpen between the old and the new animals?*

Wash pig pen with carbohydrate or soap

Day 1 PM: One women from the village and the animal health worker participated.
Tools I will use:

- ***Transect walk***

Transect walk with one women from village one

The transect walk started on the road going by the school and ended at the pond, see the village map. This way many households could be seen along the way. The pond could also be seen, where the humans collected their water.

Table A.3: Transect walk in village one

	Rice field, free land, road	farm area	Resident settlement
Animal			Ruminant, pig, chicken, dog
Wild animals	Bird	bird	Bird
Animal pen			Ruminant, pig and chicken pen.
Keeping system			Ruminants are bound some were near the house. Pigs are in the pen or bound under the house. Chickens are free.
Animal feeding			Pile of rice straw and grass for the ruminants.
Water: source and use	Pond with animal manure and animal feeding around. During the dry season it is used for drinking water for animals and humans. Canal used for vegetable and rice fields during the rainy season.		
Manure: pile/fertilizer	Fertilizer for rice fields		Pile
Fences around	-	-	-
Slaughter			The slaughter takes place at the kitchen
Q.1 don't know			

Q.1 Is there any possibility of disease transmission between animal, wild animal and human in this area?
Comment commune vet: many wild are birds everywhere in the evening.

One women from the village and the animal health worker participated in the transect walk in village one. The transect walk showed that there were dogs, ruminants, pigs, chicken and wild birds in the resident area where the people cooked, ate and slept. The transect walk also showed that manure was used for fertilizing during the rainy season on the rice fields and a pile of manure was kept in the resident area, se table A.3.

Around the pond where the people collected their water during the dry season animal manure and rice straw for ruminant feeding could be seen. No fences could be seen in the village. The pigs were kept in the pen or bound in the house in the shadow. The chickens were kept free ranging, see table A.3.

Day 2: AM 5 men and 2 women participated.
Tools I will use:

- ***Seasonal calendar***
- ***Ranking matrix***
- ***Questionnaire***

- *How do you diagnose FMD and hemorrhagic septicemia?*

FMD hurt leg and hurt mouth

Hemorrhagic septicemia: hurt in stomac and drags.

Seasonal calendar

For method for the seasonal calendar see appendix 0.

Seasonal calendar, table A.4, part 1: Human diseases in village one

Human diseases	1	2	3	4	5	6	7	8	9	10	11	12
Fever during two days or more				X	X	X						
Diarrhea (by WHO: three or more loose or liquid stools per day, or as having more stools than is normal for that person).				X	X	X						
Bloody stool (blood in diarrhea stool):				X	X	X						
Vomiting during two days or more												
Abdominal pain during two days or more				X	X	X						
Tuberculosis												
Cough during two days or more												
Other specify												

Table A.4 part 1 showed that they only had diseases in humans during the hot season. The diseases they had were gastrointestinal diseases with fever, diarrhea which always had blood in it and abdominal pain.

Seasonal calendar, table A.4.part 2: Food and water source for humans

Food and water source for humans	1	2	3	4	5	6	7	8	9	10	11	12
Biggest meat source: fish	X	X	X	X	X	X	X	X	X	X	X	X
Second biggest meat source: pork	X	X	X	X	X	X	X	X	X	X	X	X
Biggest vegetable source: water spinach	X	X	X	X	X	X	X	X	X	X	X	X
Second biggest vegetable source: spinach	X	X	X	X	X	X	X	X	X	X	X	X
Biggest fruit source: mango		X	X	X	X							
Second biggest fruit source: none												

Table A.4 part.2 showed that the biggest meat source during the entire year was fish. Sometimes they also ate pork. The biggest vegetable source was water spinach and the second biggest was spinach. They ate mango from February to May.

Seasonal calendar, table A.4. part 3: Diseases in animals

Disease in animals	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Foot and mouth disease (FMD)				X	X	X						
Hemorrhagic septicemia.				X	X	X						
Blackleg												
Salmonella				X	X	X						
Avian flu						X						
ND				(x)	(x)	(x)						
Fowl cholera				X	X	X						

Table A.4 part 3 showed that during the hot season, April, May and June they had FMD, hemorrhagic septicemia, salmonella and fowl cholera from which many chicken died. They did not have diseases during the rest of the year and they had some ND, but only rarely. They never had black leg.

Seasonal calendar table A.4 part .4: Animal keeping

	1	2	3	4	5	6	7	8	9	10	11	12
Ruminant working/ Draught power						X	X	X	X	X		
Ruminant Feeding	A	A	A	A	A	B	B	B	B	B	A	A
Ruminant Keeping system	C	C	C	C	C	D	D	D	D	D	C	C
Animal drinking's source	P	P	P	P	P	RW	RW	RW	RW	RW	P	P

Ruminant feeding system and ruminant keeping will was recorded according to:

A = ruminant feeding grass in the field during the day

B = ruminant feeding grass straw or rice in the household during the day

C = ruminant is bound in the field during the day and stays in the pen during the night

D = ruminant is bound in the household during the day and stays in the pen during the night

P = Pond, RW = Rain water

Table A.4. Part 4 showed that the ruminants were working during the rainy season as draught power for farming, they were kept in the field during the day during the dry season and in the household during the day during the rainy season. The animals drank pond water during the dry season and rain water during the rainy season.

Disease transmission trough food

- *What kind of animals or animal products do you eat during the rainy season? Dry season?*

Pork, fish, rarely ruminant, chicken, egg.

The food sources in the top row in table A.5 are taken from earlier research and the question above. The group in the FGD will be asked to name the food source most important for survival, the cheapest one and the one which has produced the biggest health cost by transmitting the most diseases. The answers will be marked with an X in the chart.

Table A.5: Ranking matrix on disease transmission trough food

	P	F	R	C/D	Egg	Sick	Dead	Wild	Vegetables	rice
Most important for survival		X								
Cheapest food		X								
How do you treat before eating	B	B	B	B	B	B	B	Don't eat	Some B, some dont	B
Is there an infection risk after boiling/preparing	no	no	no	no	no	no	no	no	no	no
Biggest health cost for transmitting disease to human during the last year	x									

P: pork, F: fish, R: ruminants, C: chicken, D: duck, F: frog, B:boil

The table shows that fish is the cheapest food and most important for survival. After preparing the food by boiling it or if vegetables sometimes only washing it they did not thing that there was any risk of infection. Table A.5 also shows that the food that according to their opinion had transmitted the most diseases was pork.

- *When you do eat sick/dead animals, how do you choose which ones to eat?*

Eat big chicken and burn little,

Disease prevention in animals and knowledge.

- *What do you do with sick animals?*

Keep away from other animal, sometime let the pig free in the house hold and put the sick chicken in a cage somewhere in the house hold. Burn or eat sick chicken, treat sick pig and ruminant and if not better, sell. Sometime let dead animal in the field

- *Which animals can transmit a disease?*

Sick animals.

- *How do you think a disease can spread between animals?*

Sick and healthy eat together, sleep together

- *How would you prevent your animals from getting sick?*

Vaccinating when a disease comes to the village

Keep sick animals away from other animals

- *Which animal species do you normally vaccinate? What vaccination? How often?*

FMD and hemorrhagic septicemia, ruminant

- *What are the positive effects of vaccinating your animals?*

Cheap vaccinate, animals still get sick, from Thailand and Vietnam, expensive vaccinate animals don't get sick, from france, some vaccinate and some don't, that's a problem,

- *Do you mix vaccinated and not vaccinated?*

Yes.

Appendix B: Agenda and field report from the field work of: " Zoonotic Pathogens at the Interface between Humans and Animals, a Rural Approach" in village B.

Province: Kampong Cham
District: Bathay
Commune: Tumnup
Village: Roong
Date: 1/10-2012
Season: Rainy Season

Day 1 AM: 6 women and one man participated,
The tools I will use:

- ***Ranking matrix***
- ***Questionnaire***

The questionnaire has been revised from the FGD in village one. Those open questions that needed a bigger answer, but their answer was don't now have been taken away. When the question was asked twice, they answered don't know, don't studied. The conclusion was drawn, that these questions were not working. Questions which were directly connected to the tools used in village one, but which will not use in this village have also been taken away. Charts on subjects were their answer was not satisfying to an open question on the theme have been added. The reasoning for the new charts will be explain again when they apear in the genda.

Disease transmission trough water

- *What do the humans and animals drink and how do they treat it?*

Humans: water from the rain during the rainy season and closed well during the dry season, treated by boiling. Animals also drink water from the rain and closed well, they don't treat it.

Table B.1: Ranking matrix on the risk of infection by water in village two

	Canal/river	Pond/lake	Rain	Bottle	Truck	Well closed	Well open
Biggest infection risk	2	1	3	Don't know	Don't know	No infection. risk	Don't know

Everybody was asked to think about every water source in the top row and to say which water source they thought was the biggest risk of infection, which one was se second biggest or if there was no risk of infection. They could also say that they don't know. Here the purpose of "Don't know" was to be able to separate the water sources were they did not know from those where they thought that they knew.

Table B.1 showed that members of the FGD thought that the pond or lake was the biggest infection risk, the canal or river was the second biggest, the rain was the third and that they didn't know about bottle, open well or bottle. They believed that there was no infection risk in a closed well.

- *How are ruminants, pigs, chicken and ducks kept?*

Ruminants in the pen during the night and eating rice straw or grass at the household during the day. Pigs are in the pen all day and night or bound under the house. Chicken and duck are kept in the pen during the night and free ranging during the day

- *What do the chicken and pigs eat?*

Pig eat waste products from the kitchen, chicken eat rice

Spread of disease between animals and humans

Table B.2 Ranking matrix on the spread of disease from animals to humans in village two

	Touch sick chicken and cock without washing hands	Touch manure from sick chicken and cock without washing hands	Touch healthy chicken and cock without washing hands	Touch manure from healthy chicken and cock without washing hands
Will you get sick if?	7	7	0	6

Everyone was given a stick to lay down if their answer was yes to the question to the left column after the actions given in the top row. The question in the top row was taken from an earlier FGD where the answer to the question: how can a disease transmit between animals and human was: "when you touch a sick pig and cock without washing hands", see appendix a. Their knowledge about transmission trough feces (bacteria shed in feces) was the object of

interest. They had not mentioned it when asking how a disease can transmit between animals and humans.

The table B.2 showed that everyone thought that they would get sick if they touch a sick chicken or manure from a sick chicken and then cocked without washing hands and no one thought that they would get sick if they touch a healthy chicken and then cocked without washing hands. When asked about the manure from the healthy chicken there was a discussion were they said: "don't know, don't know if the chicken is healthy" and then 6 out of 7 put down their stick.

- *Which animals except chicken can transmit a disease to humans?*

Sick pig, sick dog, sick ruminant, all sick animals.

- *How could you stop a disease from being transmitted between animals and humans?*

Vaccinating animals, clean pig pen with mask and glove, washing hands with soap

- *When do you wash your hands during the day?*

Before cocking, after handling animals

- *What do you wash your hands with?*

Water and soap

- *What do you use when you wash your dishes?*

Water and liquid

Table B.3: Ranking matrix on how to stop diseases from spreading between animals and humans

	Keeping all animals 10m away from kitchen	Keeping all sick animals 10m away from kitchen	Hand washing with soap and water before cocking	Cocking meat good	Burn all sick animals	Cleaning pigpen with mask and glove	Vaccinating animals
Cheapest/easiest way			18			17	
most effective			17			18	

Everyone was given 10 sticks to put on the matrix to rank the different alternatives in the top row. They were instructed to put more sticks on the alternative they thought was cheaper, easier or more effective. Sick animals and 10 meters from the kitchen was added to be more specific and burn all sick animals was added to catch how much it would cost to burn them instead of eating them. Answers from the question above: "How could you stop a disease from being transmitted between animals and humans" which not were in the chart already were added in the top row.

Table B.3 showed that they believed that washing the hands and cleaning the pig pen with mask and glove was the most effective and also easiest way to stop a disease from spreading between animals and humans.

Disease transmission trough food

- *What kind of animals or animal products do you eat during the rainy season? Dry season? When there is plenty of food? Shortage of food?*

Mostly fish, then pork and chicken, egg and ruminant rarely.

- *What do you do with sick or dead animals?*

If big eat

- *How do you avoid infection?*

Boil

- *Do you see any risk of getting sick from any of this food after boiling*

No

Transmission of diseases between animals.

- *What do you do with sick animals?*

If small chicken burn, if big eat. If pig or ruminant sometimes treat, if not better sell to middleman or slaughter.

- *How do you think an animal disease comes into the village?*

By new animal and village animal health worker not changing suit when going from one sick animal to another

- *What do you do when new animals are purchased or given to the household?*

Sell all pig and by new. Before pig arrives pig pen is cleaned with carbohydrate or and soap, new animals are also kept separate away from other animals.

- *For how long are new animals kept separate?*

For 3 days up to a week.

- *How is the chicken pen cleaned before the chicken arrive*

Before new chicken arrives the chicken pen is cleaned with a brush.

- *How is the ruminant pen cleaned?*

No cleaned, old ruminant still in it.

The translator Sina explained to me that they usually keep the mother chicken and pig and sell her kids until she gets old or sick, then they sell or kill her and by a new chicken or pig mother.

Table B.4: Ranking matrix on animals that can spread a disease

	Pig healthy	Pig sick	Ruminant healthy	Pig sick	Chicken healthy	Chicken sick
Can the animal transmit a disease	No	Yes	no	yes	no	yes

Everyone was asked to say yes or no to if the animal in the top could row could transmit a disease to another animal. Their knowledge about subclinical infected animals that shed bacteria or virus was the object of interest. When asking earlier which animals that can spread a disease they answered sick animals.

Table B.4 showed that they did not think that an animal that was healthy could transmit a disease to another animal.

- *How do you think a disease can spread between animals?*

Eat together, sleep together in the same pen, by air when one animal breath out the disease and one breath in.

- *How would you prevent your animals from getting sick?*

Vaccinating animals, keeping new animals away from others for 3 days to one week

Table B.5: Ranking matrix on actions to stop animals from getting sick

	vaccinating	Keep new/sick animals away for 2 weeks	Not sell sick animals
Cheapest/easiest way		17	18
Most effective	35		

Everyone was given 5 sticks to lay down on the alternative they thought was cheapest or easiest and then most effective to evaluate different preventive measures.

When doing this they laughed and put their stick down very fast without hesitating. When asked what was hard about vaccinating they said that it was expensive. Table B.5 showed that they all believed that vaccinating was the most effective way, but they thought that keeping new/sick animals away from other animals for 2 weeks and not selling sick animals was easier and cheaper.

- *Which animal species do you normally vaccinate? What vaccination? How often?*

They vaccinate by the program animal aid.

- *Turning to animal health person: what is that program, how often, what animal and what disease:*

18 days old piglet for salmonella, young ruminant for hemorrhagic septicemia. Once against hemorrhagic septicemia and salmonella.

- *What are the positive effects of vaccinating your animals?*

Don't get sick but expensive.

Appendix C: Agenda and field report from the field work of: ” Zoonotic Pathogens at the Interface between Humans and Animals, a Rural Approach” in village C.

Province: Kampong Cham
District: Bathay
Commune: Chelea
Village: Taingkraing
Date: 23/10 - 2012
Season: rainy season

Day one AM: 10 women participated
The tools I will use:

- ***Ranking matrix***
- ***Questionnaire***

Transmission between animals and humans

- *What water do the animals drink specify by season, treated and how?*

Pond water, not treated

- *What water do the humans drink, specify by season, treated and how?*

Closed well, some boil, some filter

Table C.1: Ranking matrix on the risk of infection by water in village six

	Canal/river	Pond/lake	Rain	Bottle	Truck	Well closed	Well open
Biggest infection risk	2	1	3	Don’t know	Don’t know	5, only little, less than open	4

Everybody was again asked to think about every water source in the top row and to say which water source they thought was the biggest risk of infection, which one was se second biggest, third and fourth, or if there was no risk of infection. They could also say that they don’t know.

- *Where and how are animals kept by species?*

Ruminant are kept bound in the field during the day and in the pen at night all year.

Sometimes they have a flood and then they move the ruminants up to higher ground.

The pigs are in the pen all day and night or bound under the house.

The chicken and ducks are in the pen during the night and free during the day.

- *During witch season are you farming?*

All year, have an irrigation system

- *What do the animals eat and where by species?*

Ruminant: grass in the field during the day and rice straw in the household during the night.

Pig: by products from the house (meat, vegetable and rice) and concentrated feed from the market.

Chicken and duck rice and concentrated feed from the market

- *How often do you collect animal feces in your farm (by species if any)?*

Ruminant and pig: 2/day morning and evening, chicken 1/day or every second day.

- *What do you do with the feces after collecting?*

Put them on the pile of manure near the house.

- *And what do you do with the pile of manure?*

Use all for fertilizer

- *Fertilizing on what fields?*

Only rice fields

- *How are sick animals kept by species?*

Chicken and duck are kept from other chicken and duck by a cage, pig are kept away from other pig in the pen, free around the house. Ruminant are not kept away from other ruminant, but treated.

- *How do you think a disease can be transmitted from animals to humans?*

Touch sick animals.

- *Which animals can transmit a disease to humans?*

Sick chicken, duck and pig, not ruminant

- *How could you stop a disease from being transmitted between animals and humans?*

Don't know, not studied.

- *When do you wash your hands during the day?*

Before cocking

- *What do you wash your hands with?*

Water and soap or liquid

Table C.2: Ranking matrix on the spread of disease from animals to humans in village six

	Touch sick chicken	Touch manure from sick chicken	Touch healthy chicken	Touch manure from healthy chicken
Will you get sick if?	yes	Yes	no	Yes

First they were given a stick to lay down if their answer was yes, but they were very reluctant to lay down their stick. Instead they were instruct to only say yes or no.

- *What do you do with sick animals*

Chicken: keep away from other chicken and treat with medicine, if not better burn, some eat big chicken.

Ruminant and pig treat, if not better sell to trader.

- *What do you do when you find dead animals?*

Chicken: some burn, some eat big

Pig: some eat, some sell to trader.

Ruminant: sell to trader.

- *Do you think there in a risk of infection after boiling sick or dead animals when eating them?*

No.

- *How do you know that you have boiled the meat good?*

Boil for ten minutes

Table C.3. Ranking matrix on how to stop a disease from spreading from animals to humans

	Hand washing	Keeping all animals 10 meter away from cocking areas	Cooking meat good	Burn or treat all sick animals
Cheapest/easiest way	14	9	13	9
Most effective	18	10	4	13

Everyone was again given 10 sticks to put on the matrix to rank the different alternatives in the top row. They were again instructed to put more sticks on the alternative they thought was cheaper, easier or more effective. Some alternatives in the top row in the FGD in village two were taken away because during the FGD in village two they did not consider all the alternative in the top row, but put down their sticks very fast.

- *When you diagnose what disease an animals is suffering from, do you look at the inside of the animals or do you only look at the outside?*

Only look at the outside.

- *Do you look at organs from the sick animals after their death to make a diagnose or confirm and what do you do with the organs?*

Chicken, when dot in the skin or grayish color, still eat, when yellow color of the skin, don't eat. Only look at the outside.

Later conversation with animals health worker: sometimes, for example when new castle disease the animal health department comes out to look at the liver, the animals health department looks at organs.

- *What do you do with meat waste products?*

Some burn, some throw away around the house.

- *Are the dogs allowed to eat/play with the meat waste products?*

Yes.

Transmission between animals

- *How do you think an animal disease comes into the village?*

New animal and village vet.

- *How do you think a disease can spread between animals?*

Sick and healthy keep together, eat together, by animal manure.

- *How would you prevent your animals from getting sick?*

Clean animal pen, pig pen with calcium carbonate (TH4) when sick pig in it, chicken and ruminant with brush. Clean chicken cage after using it for sick chicken with calcium carbonate.

- *Which animals can transmit a disease to other animals?*

Sick animals

- *To which animals can a chicken transmit a disease?*

Other chicken.

Table C.4: Ranking matrix on animals that can spread a disease

	Pig no sign of disease	Pig sick
Can the animal transmit a disease to other animal	no	yes

Again everyone was asked to say yes or no to if the animal in the top could row could transmit a disease to another animal.

- *What will they do when new animals are purchased/given to the house hold?*

Keep new chicken separate for 1 week to ten days, keep new pig and ruminant separate for 3 - 4 days if not same size, if different size fight, small get trouble, together when know each other.

Table C.5: Ranking matrix on actions to stop animals from getting sick

	vaccinating	Keep new/sick animals away for 2 weeks	Not sell sick animals
Cheapest/easiest way	18	11	16
Most effective	35		

Everyone was again given 5 sticks to lay down on the alternative they thought was cheapest or easiest and then most effective to evaluate different preventive measures.

- *Which animal species do you normally vaccinate? What vaccination? How often?*

Ruminant: 2/year against FMD and hemorrhagic septicemia, it is sponsored by the animals health, so they don't have to pay for it.

Pig against FMD once when small, they have to pay themselves

Chicken: chicken cholera and Newcastle when small, they have to pay themselves.

- *What are the positive effects of vaccinating your animals?*

Expensive and take time, after vaccination not disease, prevent disease.

Time line:

- Have you had diarrhea during the last five years in animals. How much (only a few, half the village, all the village?

2008 most of the animals in the village, 2009, 2010, 2011 and 2012 only a few

- *Have you had diarrhea during the last five years in humans. How much (only a few, half the village, all the village)?*

Only a few all five years

- *Have you had cough and nasal discharge in animals during the last five years, how much (only a few, half the village, all)?*

Only a few all five years

- *Have you had cough, fever and body ache in humans during the last five years, how much (only a few, half the village, all)?*

2008: most of the village, 2009 half of the village, 2010, 2011 and 2012 only a few

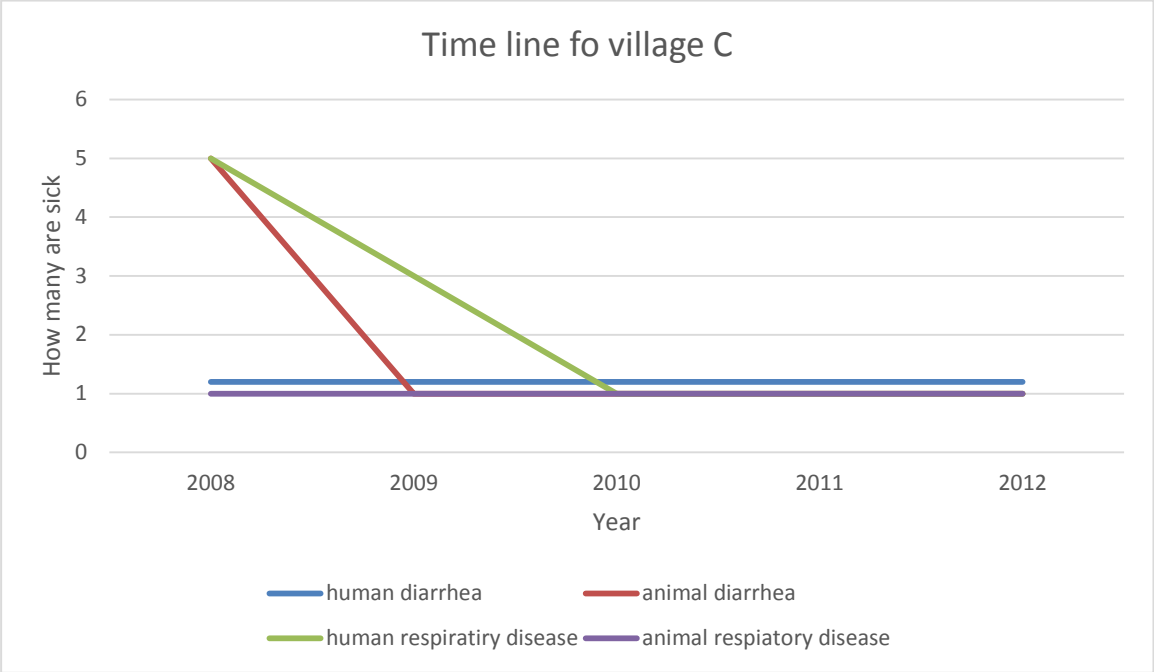


Figure C.1: time line village c

- *What made the amount of cough among humans and diarrhea among animals decries between 2008 and 2010?*

Start use medicine

Appendix D: Report of personal communication

Dr: seng Sokerya:
From the beginning village animal health workers were recruited by the government under a program related to Avian Influenza supported by FAO. They do not have any formal degree but basic training of 3-4 weeks related to animal health care which is certified by the Government.

Kristina Osbjer:
"He/she is defined as a community-based or private village level worker trained to liaise between livestock owners and veterinarians, besides him/herself being able to provide veterinary, and preventive health services to the village livestock in the village itself"

Village animal health worker Vorng Vin:
How are duck kept in village A and B? The ducks are scavenging for food during the day and kept under the house/ under the chicken pen/ under or nearby the kitchen during the night (most of the chicken and duck are kept together during the night).

How are sick ducks kept and treated? Put in cage under/around the house and by medicine to treat or treat with the traditional medicine. Duck rarely treat by the village vet.

What do the ducks eat? In small scale keeping, they scavenge for their own food and are supplemented by rice grain or left-over from the kitchen.

Can the dogs eat and play with the organs? Yes, particularly chicken, duck and fish's organs which is not well disposed.

Village B: how often is the manure collected for different animals and on which fields is it used as manure? For cattle/ buffalos once a day or once every few days depend on how many animals they have.

Village B and C: Washing water for humans? Pond, well and tap water for some household.

Appendix E: Results from previous research used in this study

Personal communication Kristina Osbjer

Table 4.1: Results from the study" Zoonoses in humans and domestic animals: a cross-disciplinary approach in rural Cambodia"used in the present study.

Village	Episodes of severe diseases in humans	Major diseases seen and confirmed in the village: Gastro intestinal	Major diseases seen and confirmed in the village: cough/cold	Episodes of severe diseases in livestock	Major diseases seen and confirmed: salmonella
One	D	X		1	X
Two	D	X		1	X
Three	C	X		4	X
Four	B	X		1	X
Five	E	X	X	1	X
Six	A	X	X	1	X
Seven	B	X		1	X
Eight	B	X	X	1	
Nine	E		X	1	X
Ten	D			1	

These results have yet not been published.

A: at least once a year

B: once every 2-3 yers

C: every 5 years

D: all year round/often

E: more than 5 years/rarely

1: at least once a year

2: once every 2-3 years

3: every 5 years

4: more than 5 years

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