Basic Field Epidemiology

Course Resource Book

Table of Contents

1   Overview of Field Epidemiology

1.1 The role of para-veterinarians

Para-veterinarians in Indonesia provide services to livestock owners to diagnosis, treat and prevent disease in animals. These services help improve the health and production of livestock.

Para-veterinarians are often employed by local government as district animal health officers to help with activities such as disease investigations, control and vaccination programs, collecting census data and provision of breeding services.

iSIKHNAS is Indonesia's animal health information system. The success of iSIKHNAS depends on para-vets contributing data into the iSIKHNAS system. Using simple SMS messages para-vets can enter animal health and disease information quickly and efficiently from the field. The system has been designed to improve the quality and efficiency of data collection and to make the data available quickly to those who may need it for making good evidence-based decisions. iSIKHNAS allows all animal health related staff including para-veterinarians to provide better services to livestock owners and bring better outcomes to their communities.

This training course is designed to support their work and increase the job satisfaction of para-vets.

1.2 What is field epidemiology

Epidemiology is the study of the patterns and causes of disease in groups of animals or populations.

Field epidemiology refers to applying epidemiology skills in the field - on farms and in day-to-day work to address real problems for livestock owners.

Field epidemiology skills are as important as veterinary clinical skills when dealing with disease in either individual animals or groups of animals.

Field epidemiology skills help para-vets to look beyond the individual sick animal and to think about patterns and causes of disease within the wider population. This broader approach will help the para-vet to treat individual sick animals more effectively and to provide better advice to farmers to control the spread of disease, prevent further deaths or sickness, and reduce the presence of chronic problems in the livestock.

Field epidemiology skills will also allow para-vets to assist farmers understand measures of livestock production (things like weight gain, milk production or fertility) and to understand how to use better animal and farm management to improve production.

1.3   Why epidemiological skills are useful to para-vets

Field epidemiology training will help para-veterinarians to:

- *understand causes of disease at the population level to explain why diseases are occurring, even when you are not sure of the exact cause*

- *provide better advice to farmers on disease treatment and prevention*

Para-veterinarians use a combination of *clinical* veterinary skills and *field epidemiology* skills all the time to diagnose, treat and prevent disease either in individual animals or groups of animals.

Field epidemiology skills will help you to gain a deeper understanding of how and why disease occurs and this will lead to being better able to advise farmers on how to treat and prevent disease in animals.

Field epidemiology skills will also help you to provide good data to iSIKHNAS and to use iSIKHNAS information to help monitor, prevent, and treat disease within your area.

Improving your skills in field epidemiology will help your local community and also increase the importance of your role within that community. The benefits will include;

- Better disease prevention and animal management will lead to healthier animals which are more productive. Farmers will get **better outcomes and improve their overall well-being and financial security**.

- Improved appreciation for and trust in para-veterinary services will lead to farmers asking their local para-vets to help more quickly and more often when they have an animal health problem. Para-veterinarians will have **more opportunity to treat animals and increase their income** if farmers tell them about the sick animals

- The village/community will be more productive and healthier (animals and people) through having **healthier animals, satisfied farmers and less zoonotic disease**.

- The use of better skills in disease investigation, disease control, and reporting at local, District and Province levels will improve:
  - identification of diseases
  - surveillance for local disease needs with some information available to the national level
  - information to government to help share resources to reduce disease (i.e. vaccination programs) and the effects of disease within a District or Province
  - community economic benefits through having healthier animals

For example field epidemiology skills will help in the following situations:

- **Better explain why a known disease has occurred at a particular time and place**

  Q: Why has anthrax occurred at this place and time in these animals?

- **Identify treatments and preventions**

  Q: Anthrax - How can I stop animals dying and more becoming sick?

- **Investigate and prevent disease whose cause(s) may be unknown or not well understood.**

> Q: I don't know what the disease is, but how can I stop animals dying and more becoming sick?

- **Explain how and why disease occurs through understanding the interaction between multiple causes of disease**

> Q: Why during the rainy season do my cows always get diarrhoea 3 weeks after my neighbour's cattle are sick?

1.4 Using epidemiology and clinical skills together

Clinical skills and laboratory tests are used to gather information from a single sick animal to diagnose the cause of the disease.

Epidemiology gathers information from a group of animals (sick and healthy) to describe patterns which help us determine the possible causes of disease.

At the individual animal level, veterinary clinical skills are used to:

- Examine a sick animal
- Identify the condition or disease causing the animal to be sick
- Apply a treatment to help that animal recover

> On Budi's farm, a single calf develops an abscess at the navel (where the umbilical cord attached to the calf during pregnancy). The calf gets sick and stops drinking. Pak Paimin, the para-veterinarian examines the calf, finds the abscess at the navel, cuts it open to drain the pus and treats the calf with antibiotics. The calf then makes a complete recovery.

Epidemiology applies a structured approach to investigate disease and causes of disease in groups of animals (populations). The most common approach is to collect information on animals affected with a disease and similar animals that are not affected (sick animals and healthy animals). Information on these two groups is then compared looking for differences that explain why some animals are getting sick and others are not.

> On Soleh's farm, there are many cows and a large number of calves are born in one season. This year most of the calves develop abscesses on the navel. Soleh wants his animals treated so they can recover and wants to know why so many of this animals developed the problem this year. He also wants to know what he can do to prevent it from happening again next year.
>
> Para-vet Ibu Putri, visited Pak Soleh's farm. She found that all the calves that had abscesses on the navel were born in a small yard that was very dirty. All the calves that were born out in paddocks on the grass were healthy.
>
> She concluded that calves born in the dirty yard were getting sick because the dirty environment was exposing them to bacterial infection soon after birth. She advisors Pak Soleh that cleaning the calving yard or calving cows in clean pasture will help to reduce the risk of abscess in the future.

The reason a disease occurs at a particular time, place, and in only some animals is because the *causes for that disease are present for some animals and are not present for others*. If we can understand the causes then we may be able to change management practices in order to prevent disease.

Good veterinarians and para-veterinarians need both individual clinical skills *and* field epidemiology skills to provide the best services to livestock owners.

Even where a particular disease is very well known and easily diagnosed, field epidemiology skills allow a para-vet to provide better advice to a farmer on why the disease may have occurred and how the farmer might prevent this disease either in other animals on the farm now or in future years.

Field epidemiology skills are especially useful when a new or unknown disease occurs or where the causes of disease are not known.

1.5 Epidemiological skills can help prevent zoonoses

> ***Zoonoses*** *are animal diseases that are able to infect humans.*

Epidemiology skills help you to understand how zoonotic diseases occur and how to prevent both animals and humans from exposure and infection. There are a number of zoonotic diseases of animals in Indonesia. Examples include:

- Rabies, brucellosis, Q-fever, leptospirosis, psittacosis, trichinosis, echinococcus, Japanese encephalitis, toxoplasmosis, salmonellosis, scabies, ringworm, Nipah virus and others.

Below is a little more detail about some common zoonoses.

- **Rabies** - Rabies is a viral disease of the central nervous system (brain and spinal cord). It is most often transmitted through a bite or scratch from a rabid animal. Humans infected with rabies almost always die.
- **Brucellosis** - Brucellosis is a bacterial disease that can cause disease in many different animals. Humans become infected by coming in contact with animals or animal products that are contaminated with *Brucella* bacteria.
- **Q fever** - Q fever is a bacterial disease caused by *Coxiella burnetii*. Q fever mainly affects cattle, sheep and goats. It is most commonly passed to humans by contact with biological material from infected animals such as blood, tissue, placenta or birth fluid.
- **Leptospirosis** - Leptospirosis is a bacterial disease that affects animals and humans. It can cause a wide range of symptoms in humans.
- **Psittacosis** – also known as parrot fever and ornithosis — is a bacterial disease caused by *Chlamydia psittaci,* many different bird species can be infected and spread the disease. In humans it can cause severe pneumonia and other serious health problems.
- **Trichinosis** - also called trichinellosis is a parasitic disease passed to humans by eating raw or undercooked meat of animals that are infected with the trichinella worm larvae.

Infection by trichinella occurs commonly in wild carnivorous (meat-eating) animals but can also occur in pigs.

2 Signs, syndromes, and making a diagnosis

2.1 The effect of disease on animal health and production

> ***Diseases*** *in animals will often result in reduced health and production and may result in death.*

Livestock are generally raised for production of meat, milk, hides, eggs, manure, and offspring (calves, chickens, etc.). Healthy livestock are more productive than livestock that are not healthy.

Some diseases cause animals to change their behaviour and look sick. Some of the sick animals may die and others may recover. It is easy to pick animals that are very sick with a disease.

Sometimes animals may be affected by a disease but still look healthy and it can be hard to pick whether or not these animals are sick at all. They may not show obvious signs of a problem. That is why it is important for farmers to watch (monitor) their animals frequently.

Sick animals may stop eating for a while and lose weight. Sometimes animals may look normal but suffer from reduced production (weight loss, infertility, pregnancy loss, reduced egg production). Many diseases cause a decrease in animal production.

There are many things other than infectious diseases that cause poor production in animals. Examples include animals that are offered poor quality feed, not enough feed, or feed and water that may be spoiled.

Epidemiology and clinical skills need to be used when investigating poor performance in livestock. A good investigator will be able to tell whether poor production or poor health is due to an infectious disease or due to some other cause such as poor feed.

Yesterday Budi reported to his local Pelsa that one of his cows was lame. The Pelsa sent a General Signs report (Tanda Umum) to iSIKHNAS.

Pak Paimin (the para-vet) received the notification from iSIKHNAS and talks to Budi. Budi tells Pak Paimin that there is one cow that is lame and she has been lame for several weeks now. She is skinny and her calf is weak. There are also 2 cows with diarrhoea.

Pak Paimin listens to Pak Budi describe the lame cow and comes up with a list of possible causes (differential diagnoses) for this situation. They include: injury, abscess, infectious diseases (brucellosis, black leg, etc.), or trauma (broken leg).

The 2 cows that have diarrhoea could be sick because of parasites, grain overload, bacterial infection, or liver disease from poisons. These diseases are differential diagnoses for diarrhoea in cows.

Pak Paimin decides to conduct a farm visit to get more information to narrow down the list.

2.2 Signs of disease

> ***Signs*** *are changes in an animal that are caused by disease and that people can detect.*

Many diseases make animals feel sick, develop a fever and they might stop eating or drinking for a period of time. Many signs of disease are easily observed by people. Farmers that know their animals well will be able to detect small changes in behaviour that indicate an animal may be getting sick. This will help them to get assistance from their para-vet early, before the case becomes very serious.

It can be easy to see the signs of some diseases but more difficult to see the signs of other diseases.

- Signs of disease that are easy to see include lameness, coughing, diarrhoea, severe weight loss and death

- Signs of disease that may be harder to see include infertility and reduced weight gain or milk production

Most signs provide an indication of which parts of the body and body systems are being changed by the disease

For example:

- Diarrhoea indicates diseases that affect gut motility or absorption (digestive system). There are many diseases that can cause diarrhoea.

- Coughing and difficulty breathing indicates disease of the lungs or airways (respiratory system)

- Saliva drooling from the mouth indicates inability to swallow either due to nervous system disease, physical obstruction of the throat, or increased production of saliva

- Lameness or altered gait may indicate disease or injury affecting the leg(s), spine or brain

Technical staff are trained to conduct clinical examinations of sick animals, to look for *signs* that indicate the animal may be sick. These include changes in:

- rectal temperature
- heart rate
- pulse rate
- respiratory rate
- respiratory sounds
- gut sounds
- mucous membrane colour

The time it takes for signs of disease to develop can vary depending on the infectious disease. Therefore, the time it takes you to identify if an animal is sick can also vary.

For example:

- Anthrax and haemorrhagic septicaemia are diseases that develop very rapidly and produce severe clinical signs or death.

- Papilloma virus (causing warts on the skin of cattle) is a disease that produces mild signs in many animals with little impact on health or productivity.

- Bovine Johnes disease (BJD) is a disease which develops very slowly, it causes chronic diarrhoea and wasting in older cattle. It takes a long time for BJD to these produce serious effects, the cattle are infected when they are very young but do not show signs till they are older. BJD produces the same signs as a cow with an intestinal worm infection.

Sometimes animals show signs such as weight loss that may be due to things other than an infectious disease, such as an injury (broken jaw), problems with teeth or even just poor feed.

iSIKHNAS has developed lists of common signs and codes to make reporting these signs easier and more consistent. Village reporters (pelsa), para-vets and veterinarians play a vital role in the identification, reporting, and treatment of these signs.

Figure 1   list of signs reportable to iSIKHNAS and their codes, as at 15/2/2014

Code	Sign
TL	**tanda lain**
OP	**syaraf dan perilaku**
PA	Kelainan perilaku
LI	liar
GG	gila galak
MB	mubeng
LP	lumpuh
KS	kelainan kesadaran
PG	pingsan
KR	kurang respon
MK	mudah terkejut
SS	**Kelainan sistem sensorik**
KMA	kelainan mata
BU	buta
RM	radang mata
KTL	kelainan telinga
TK	daun telinga keropeng
TY	daun telinga layu
SC	**saluran cerna**
KMU	kelainan mulut
AL	liur berlebihan
KSM	kesulitan mengunyah/menelan
LPG	lepuh gusi/lidah
LBK	lidah bengkak
RBK	rahang bengkak
ANX	Anorexia
KPR	kelainan perut
KBG	kembung
KRU	kelainan rumen
GL	gerakan usus lemah
GA	tidak ada gerakan usus
KFE	kelainan feses
MC	mencret
MD	mencret berdarah
FK	feses kering keras
FD	feses berdarah
FP	feses berparasit
KT	**perkulitan**
KM	kelainan kulit

Code	Sign
GT	gatal
LB	luka berdarah
BO	borok
BR	bulu rontok
RK	radang kulit
AE	abses
KAM	kelainan ambing
AG	ambing gangrene
LAM	lepuh pada ambing
AB	ambing bengkak
KPU	kelainan puting
RPU	radang puting
AS	kelainan air susu
PSB	Pusar bengkak
TO	**kelainan tulang dan otot**
JA	jalan tidak normal
PC	pincang
SPY	sempoyongan
BTN	berdiri tidak normal
SBD	susah berdiri
AK	ambruk
KA	kaki tidak normal
PTK	patah tulang kaki
KSE	kelainan sendi
TR	terkilir
SB	sendi bengkak
KKA	kelainan kaki
KKU	kelainan kuku
LK	luka pada kaki
SP	**kelainan sistem pernafasan**
KBN	kelainan bernafas
KB	kesulitan bernafas
BT	batuk
KHD	kelainan hidung
HB	hidung beringus
HL	hidung berlendir
HD	hidung berlendir dan darah
GU	**kelainan sistem perkemihan**
KU	kelainan urin
UM	urin berdarah
UK	urin keruh
SL	kesulitan kencing
KKK	kelainan kandung kemih
KKB	kandung kemih bengkak

SR	**gangguan sistem reproduksi**	JC	denyut jantung cepat
KVA	kelainan vagina	JP	denyut jantung pelan
RV	radang vagina	KSJ	kelaianan suara jantung
PV	prolaps vagina	SJL	suara jantung lemah
KRA	kelainan rahim	SJM	suara jantung murmur
PR	prolaps rahim	SJB	suara jantung bergesekan
RBE	rahim bengkak	SJP	**sejarah penyakit**
RP	retensi placenta	LKJ	lama kejadian
KFT	kelainan fetus	MT	mati mendadak
KG	keguguran	SM	sakit akut
KGM	keguguran muda	SK	sakit kronis
KGT	keguguran tua	POL	pola penyakit
LHM	lahir mati	PI	penyakit individual
FT	fetus tidak normal	PS	penyakit sporadis
DK	kesulitan lahir	WP	wabah penyakit
KP	Kematian Pedet	PK	peningkatan kematian
FKK	Fetus Kering Keras	KST	kelainan seluruh tubuh
KPE	kelainan penis	KKT	kelainan kondisi tubuh
CP	cedera penis	KK	kekurusan
LPE	luka penis	GEM	kegemukan
KTS	kelainan testis/scrotum	KSU	kelainan suhu
TB	testis bengkak	DM	demam
HS	hernia scrotum	HT	hipotermia
TT	testis tidak turun	KLC	kelainan cairan tubuh
KMJ	Kemajiran	KKC	kekurangan cairan tubuh
AES	anestrus	PIC	penimbunan cairan
KBR	Kawin Berulang	RB	rahang bawah bengkak
BRT	Berahi tenang	BP	busung papan pada dada
KEK	**kelainan sistem endokrin**	KMM	**kelainan membran mukosa**
KGB	kelenjar getah bening bengkak	MPU	Mukosa pucat
KTB	kelenjar tiroid bengkak	MKK	mukosa kekuningan
JD	**kelainan sistem peredaran darah**	MKB	mukosa kebiruan
KJT	kelainan jantung	PDM	pendarahan mukosa
KDJ	kelainan denyut jantung		

2.3 Syndromes

Syndrome refers to a particular sign or a group of signs that can be easily recognised and which may indicate a particular important disease.

For example:

- A respiratory syndrome may be defined as including any animal that shows one or more of the following clinical signs: coughing, difficulty breathing, nasal discharge, elevated respiratory rate, and so on.

Syndromes are used to identify animals that *may* be suffering from a specific disease of importance.

For example:

Rabies is an important disease. It is not possible to diagnose rabies for certain in a live dog (or any animal). Definitive diagnosis of rabies can only occur when brain or other tissue is examined by a pathologist after the animal has died or has been killed.

However, many dogs infected with rabies will show changes in behaviour – becoming more aggressive, showing drooling of saliva from the mouth and more likely to attack and bite other animals and people. Some dogs show these signs even though they are not infected with rabies – just because they are aggressive dogs or drooling because they have something stuck in their mouth or throat.

We use the syndrome of changes in behaviour (aggression, biting, salivation, depression) as a way of identifying dogs that may have rabies. Dogs that show these signs can be isolated and watched to see if they continue to develop signs that are suggestive of rabies and they may be killed or sent for post mortem to test for rabies.

Some syndromes are strongly related to one disease so that when an animal shows these particular signs it is very likely that it has the disease. Examples include rabies (as described above) or sudden death with blood from the orifices (likely to be anthrax).

Syndromes are often used in disease control programs for important diseases to make sure that these diseases are identified when they occur. Livestock owners and animal health staff are encouraged to look for animals with defined syndromes. Animals that show those signs can then be examined more carefully or sampled for laboratory testing to try and diagnose the disease. Some animals will be found not to have the disease of interest. If the disease of interest is confirmed then other disease control activities may need to be done.

iSIKHNAS uses broad syndromes, this is because the diseases of interest are very important and we don't want to miss any cases. Village reporters (pelsa) and para-vets should report every suspected priority syndrome case. The important thing is that we all remain alert to the threat of these diseases. Most priority reports will probably end in a diagnosis which is not the priority disease. It is still very important that you report a priority syndrome (using a P SMS reporting message) and let the vet carry out a more thorough investigation.

iSIKHNAS uses the following priority syndromes for disease reporting:

- **MMU - Sudden increase in mortality in chickens and other poultry**

    - this syndrome is trying to identify cases of **Avian Influenza**

    - Other infectious diseases that could produce this syndrome include: Newcastle disease, infectious laryngotracheitis, and duck plague.

    - Other non-infectious causes include: acute poisoning.

- **KGS - Abortion in third trimester or swollen joints in cattle**

    - this syndrome is trying to identify cases of **Brucellosis**

    - Other infectious diseases that could produce this syndrome include: many bacterial and viral infections can cause abortion and swollen joints.

    - Other non-infectious causes of this syndrome include: genetic conditions, exposure to poisons, and administration of some drugs.

- **MTD - Sudden death with blood from the orifices in cattle**

    - this syndrome is trying to identify cases of **Anthrax**

    - Other infectious diseases that could produce this syndrome include: blackleg and leptospirosis.

    - Non-infectious causes include lightning strikes, lead poisoning, hypo-magnesia and bloat.

- **PLL - Limping, excessive salivation, and vesicles on the mouth / foot / teat in cattle**

    - this syndrome is trying to identify cases of **Foot and Mouth disease**

    - Other infectious diseases that could produce this syndrome include: vesicular stomatitis, bluetongue, bovine herpesvirus, malignant catarrhal fever, pestivirus, mycotic stomatitis, and rinderpest.

- **GGA - Changes in behaviour, increased aggression or depression, hyper-salivation, and biting in dogs**

    - this syndrome is trying to identify cases of **Rabies**

    - Other infectious diseases that could produce this syndrome include: canine distemper, Aujesky's disease, and any infectious disease involving the brain.

    - Non-infectious causes include - neoplasia, trauma, oral foreign bodies and poisoning.

- **DMB - High fever, conjunctivitis, and increased mortality in pigs**

    - this syndrome is trying to identify cases of **Classical Swine Fever**

    - Other infectious diseases that could produce this syndrome include: African swine fever virus, and many other bacterial and viral infections.

    - Non-infectious causes include exposure to some poisons such as anticoagulant.

2.4 Differential diagnoses

A **differential diagnosis** is a disease that could cause the clinical signs that have been observed. Often there is more than one disease that can cause the same signs. When sick animals are examined it is common to produce a list of multiple differential diagnoses as possible diseases that could be affecting the animals.

It is common practice to list diseases in order from *most likely* to *least likely*.

At Budi's farm there were 2 cows with diarrhoea. Immediately Pak Paimin can create a list of common diseases that could cause the clinical signs.

- Parasites (worms, coccidia, liver fluke)
- Grain overload
- Poisoning
- Salmonella infection in the gut (bacteria)

- Johne's disease infection (bacteria)
- Bovine virus diarrhoea infection (virus)
- Very rich, fresh pasture

The disease investigation is then used to try and determine which diseases are unlikely to be causing the signs and which ones might be more likely. This process leads to a short list and sometimes a single differential diagnosis.

2.5 Definitive diagnosis

A **definitive diagnosis** is reached when the vet is confident there is one disease that is most likely to be affecting the sick animal(s). The vet uses all the diagnostic information available (including history, clinical, environmental, laboratory and epidemiological information).

Often the para-vet will need to carry out a disease investigation before a definitive diagnosis can be reached. This may include colleting some samples from affected (and possibly unaffected) animals for laboratory testing.

3 Disease investigation

3.1 The approach to a disease investigation

Disease investigations usually start because a farmer is concerned that one or more animals are showing abnormal signs or are dead. The first part of a disease investigation involves four activities. These activities combine field epidemiology and veterinary clinical skills.

1. Taking a good history

To find out what happened in the period before disease was noticed a para-vet will need to talk carefully to the farmer about his animals and about how he manages his animals. Good history taking is an art; it requires diplomacy, use of non-technical language, and a good relationship with the farmer. History-taking involves collecting information about:

- The animal: Species, breed, sex, age, identification of the affected animal(s)

- The problem: clinical signs, development of signs over time, number of animals affected

- Any treatment(s) given by the farmer

- The housing and feeding: where the animals are kept and their access to feed and water

- Other animals on the farm

- Any recent events that may be related (animal movements on or off the farm, floods, chemical treatments of plants or release of chemicals into the environment)

Pak Paimin asks Budi about the history of his 2 cows that have diarrhoea. Budi tells us that they are both 2 year old Sapi Bali cows and he has been keeping them separate from the other cows as these two don't have calves. Budi wormed all his cows 3 weeks ago. He doesn't feed these 2 cows anything else

apart from short grass that is in the small paddock near the shed. There are no other cows on his neighbours' properties.

2. Clinical examination of the sick animal(s)

A basic examination of a sick animal consists of the following:

- General appearance

    - Body conditions score of animal

    - Swellings/lumps

    - Bright, depressed, dull

    - Examination of dung or urine already on ground

- Respiratory rate and lung sounds

- Heart rate

- Pulse rate and strength

- Temperature of animal

- Mucous membrane colour

- Capillary refile time (<2 sec)

- Gastro intestinal sounds

- Palpation – lymph nodes, skin, joints, abdomen,

There may be reason to conduct further examination of problem areas such as:

- rectal examination (pregnancy test in cows)

- inspect mouth

- further investigate any abnormal signs that are noticed

All observations should be recorded. Once the clinical examination is completed the para-veterinarian should consider the signs of disease shown and interpret them with the history to decide which diseases may be causing the problem (differential diagnosis list).

Where affected animals have died, a post mortem examination should be performed to look for changes that may suggest possible diseases to add to the differential diagnosis list.

Pak Paimin examines Budi's 2 cows that have diarrhoea. He looks at them and they both look a little weak, their eyes are sunken and they are depressed. From a distance they have very watery diarrhoea.

Pak Paimin puts his gloves on and then examines both animals closely. Overall the results of the clinical examination from the two animals were similar. Pak Paimin notes in his diary:

- slight increases heart rate

- pulse rate same as heat rate, strong

- respiratory rate and lung sounds normal

- gums pink but tacky and capillary refill time > 2 seconds - slow

- temperature increased above normal – 39.8, 40.1

- skin stays tent on pinching – dehydrated

- diarrhoea very watery, foul smelling and contains blood and what looks like intestinal ling

Pak Paimin explains to Budi that most of the clinical signs he can see are caused by dehydration which is secondary to the diarrhoea. The diarrhoea is causing the cows to lose a lot of water from their bodies. The animals are systemically ill (fever and depression).

When Pak Paimin finished looking at the animals he cleaned up, washed his hands, and started looking around the farm.

3. Examination of the environment

Examination of the environment where the animals are kept is an important part of the initial clinical examination. The value of environmental examination for veterinary clinicians is based on an understanding that there are multiple causes of a disease. Each cause influences whether or not disease occurs in a particular animal or population.

For animals maintained **outdoors** it may be useful think about:

- Their environment - what soils and pasture are available and what is the water source?

- Are there areas of muddy and boggy land (swamp), fast flowing water or steep hills?

- What wildlife exists in the area and are they capable of carrying any diseases that may affect livestock?

- Is there sufficient shelter from prevailing winds and rain or sun?

- Is there sufficient feed supply for the animals that are present?

- Is there any evidence to suggest that animals might be gaining access to poisons or toxins (garbage dumps, industrial areas, agricultural chemicals)?

- Is there any evidence of overcrowding that may lead to stress, contamination of the environment and increased risk of disease?

If animals are housed **indoors** then you should think about issues like:

- flooring
- ventilation

- air quality
- level of crowding

- bedding
- general hygiene

It is also important to look specifically at the feed and water supply to make sure animals are receiving enough feed and water and that there supplied feed and water are of acceptable quality.

The ability of veterinarians and para-veterinarians to assess and interpret information gathered during an environmental examination is based on understanding about multiple causes of diseases.

> Pak Paimin walks around Budi's farm while asking him questions. He finds that the cows with calves have good pasture and Budi also feed them some extra food. He finds that the 2 sick cows have been in paddock where the only water is from a drain. This drain carries all the waste water from the other paddocks including the pen where calves are held if they are sick. Budi mentions he was given a young calf that was sick for a long time; it is still alive and is more like a pet now.

4. Collecting samples for laboratory testing

The combination of history, clinical examination and environmental examination will often result in a diagnosis or list of differential diagnoses.

Sometimes it is helpful to collect samples for laboratory testing. Samples may be collected for laboratory testing, from the affected animals and sometimes from some healthy animals as well. Commonly collected samples include:

- blood or serum
- milk

- faeces
- urine

If one or more animals have died or are severely sick it may be useful to conduct a post mortem and collect additional samples including tissues to send to the laboratory for testing. Laboratories will provide information on how to collect and submit samples for the best results.

> Pak Paimin kept the 2 gloves from the rectal examinations he did on the cows. They both have enough faeces to send to the laboratory. After his examination of the environment he decides to collect some blood to send to the lab as well.

3.2 Developing a list of differential diagnoses

The findings from the investigation will identify the signs or syndromes displayed by affected animals and a list of differential diagnoses.

Correct diagnosis of disease in an individual animal often requires clinical skill and may require laboratory testing and/or pathology examination of post mortem material.

Most of the time you will start to create a list of differential diagnoses when talking to a farmer about his sick animals. As each of the four steps of the examination are conducted the differential diagnosis list should be reviewed and changed depending on new information or findings of any examination.

For example:

You find out that the affected animals are all young cows having their first or second calf, and that these cows are aborting dead calves. Knowing this may immediately narrow your list of possible diagnoses to one of several diseases capable of causing abortion in cattle.

Using the findings from the clinical examination to determine what body systems that may be affected is usually helpful.

For example:

If the affected animal is a lactating cow and she has a fever and a swollen, hot, painful udder with abnormal milk (foul smelling, watery fluid) present in two quarters and no other abnormal signs. Then the affected body system is the udder and the cow is likely to be suffering from mastitis.

As the examination process proceeds and new information is collected will be used to update our understanding of the body systems affected and the possible causes. Each new piece of information will contribute to your differential diagnoses list. In most cases new information will help add a new diseases or remove some diseases from the list.

Laboratory testing needs to be used and interpreted with care. Laboratory testing may take time, cost money and may or may not make a useful contribution to the diagnosis and management of disease in animals.

Pak Paimin has been thinking all the time what the list of possible causes could be. He started with a long list in his head and he even included the possibility this could be a new disease that no one had seen before.

As his investigation progressed he started to cross things off his list or move them lower down on the list in terms of likelihood. In this case Pak Paimin doesn't think poisoning can be a cause as he has not identified anything in the

history or on the farm that indicates possible access to poisonous plants or chemicals. From talking to Budi he doesn't think he would have overdosed these 2 cows on the worm treatment.

There was no evidence to suggest the cows could have eaten large amounts of grain and the grass they have been eating is not rich and green. This rules out two more differential diagnoses.

So, Pak Paimin's differential diagnoses contains;

- Bacterial enteritis – Salmonella, E-coli (most likely)

- Bovine Viral Diarrhoea Virus

- Parasites (least likely)

The two cows with diarrhoea have a fever and the diarrhoea is foul smelling and contains blood and what looks like bits of intestinal lining. These findings are strongly suggestive of salmonella infection, a bacterial infection that can cause diarrhoea and systemic infection.

Before Pak Paimin leaves Budi's farm he sends a Response, Laboratory and Treatment reports to iSIKHNAS from his phone.

Pak Paimin is not 100% certain of the diagnosis but he is pretty confident that the infectious agent is a bacterial infection causing enteritis and making the cows sick.

Pak Paimin treats the two cows with broad spectrum antibiotic and using field epidemiology skills, advises Budi about possible reasons for how the disease occurred and about future control. Pak Paimin knows the disease can be zoonotic and advises Budi to pay attention to general hygiene (hand washing) after handling cows. Often cows can develop this disease following some stressful event such as calving or following feeding of feed that has been

contaminated with faeces from other animals. Pak Paimin advises Budi to check that the animals have clean feed and water and that any animals he buys in future should be from someone who he trusts to supply him with healthy animals. All of these strategies involve a broader understanding of how salmonellosis behaves in a cattle population and will help Budi reduce his risk of salmonellosis occurring again in the future.

The 2 sick cows should be separated from other healthy animals on the farm. All healthy cows are to be kept higher up steam along the drain line than the 2 sick cows and the calf.

The example above has been carried through to illustrate how a disease investigation might start with a report of one or more sick cows, progress through an investigation and end with a likely diagnosis, treatment of affected animals and with the para-vet also providing advice to the farmer about preventing spread to other animals, how to prevent the same disease from occurring in the future and for zoonotic diseases how to avoid humans getting sick.

More information is provided in following sections about the application of epidemiology knowledge and skills for investigating and managing diseases in animals.

4 Causes of disease

> A **cause** is anything that can influence whether or not a disease occurs in one or more animals.

When diseases occur in animals there are nearly always some animals that develop disease and others that do not. There are a very small number of diseases that are so infectious that when they occur nearly every animal gets infected and develops disease. These are rare.

Causes of disease include many different things. Infectious diseases will have an infectious agent as one of the causes. For example, rabies virus is the infectious agent that causes rabies. For diseases that have only one infectious cause, if the infectious agent is *not present* we can be confident that the disease will not occur. BUT, exposure of an animal to an infectious agent does not mean that the disease *will* occur.

Often many different causes have to occur together before an animal will develop disease.

For example:

When one dog bites another dog there is a chance that the second dog might develop rabies. The likelihood of rabies occurring is much higher if the first dog:

- is infected with rabies

- is shedding rabies virus in its saliva

- the bite causes a break in the skin and the rabies virus can get into the tissues of the second dog

If the first dog is not shedding virus in its saliva then the bite may not cause rabies. If the bite does not break the skin then the virus may not get into the tissues of the second dog and it may not develop rabies. If the second dog is vaccinated against rabies then it may not develop rabies even if bitten by a rabid dog.

Knowledge of the causes of a disease and *how they act* to cause disease is important. This knowledge can be used in disease control to choose prevention measures to reduce the risk of disease occurring.

To investigate disease in populations, we need to understand how different possible causes of disease might act together to influence if disease will occur.

Figure 2   **Disease can occur when the causes in the environment, host and agent are present**
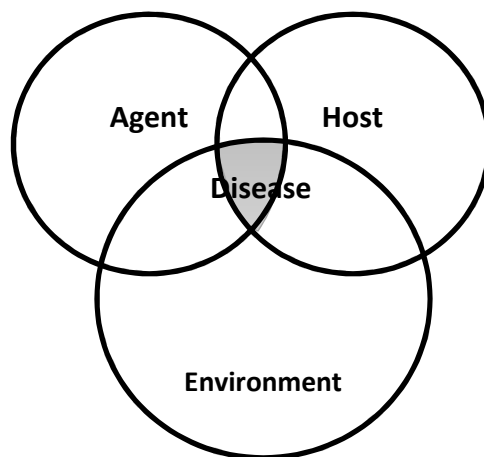
Host refers to the animal which can get the disease. The host (animal) has a variety of characteristics that may influence if disease will occur or not. Some diseases occur only in young animals while others only in older animals, for example. Pregnancy and abortion can only occur in females. The vaccination status of animal influences the risk of getting the disease.

Pinkeye is more common in younger cattle because they generally have not been exposed to *Moraxella bovis,* the bacteria that is involved in pinkeye. Lack of exposure in younger cattle mean they have a lower immunity to this bacteria and therefore a higher risk than older cattle of getting the disease.

Pinkeye will be more common in animals with physical characteristics where the eyes stick out (protrude) more than in others animals. This characteristic may be inherited and associated with a certain sire or breed.

Agent refers to the particular infectious agent that is a cause of the disease: virus, bacteria, fungus, parasite, or other microbe. Different strains of the same bacteria or virus may either produce no disease or more severe disease. There are many different infectious agents and different sub-types or strains, these may all have different abilities to cause disease. Sometimes non-infectious causes are classified as agents for example lead as the agent that can cause lead poisoning or a plant toxin that can cause a type of plant poisoning.

Some strains of avian influenza do not cause a high mortality rate, whereas other strains do.

Some strains of *Moraxella bovis* (the infectious agent causing pinkeye in cattle) produce a toxin that is more powerful and causes more severe eye disease than other strains.

Environment refers to external things that *affect* the host and agent and influence if disease will occur. Environmental characteristics include: land type, humidity, rainfall, insects that transmit the agent, crowding, sanitation, etc.

Ultraviolet light damages the eyes (cornea) of cattle which is a cause of pinkeye. Pinkeye is more common in summer when ultraviolet radiation is high.

Pinkeye is more common where a lot of cattle are kept very close together and less common where cattle have a lot of space.

Pinkeye is more common when there are lots of flies.

Pinkeye is more common when cattle are eating long grass which is hard. Hard grass can cause small injuries to the cornea which allows the bacteria to get in.
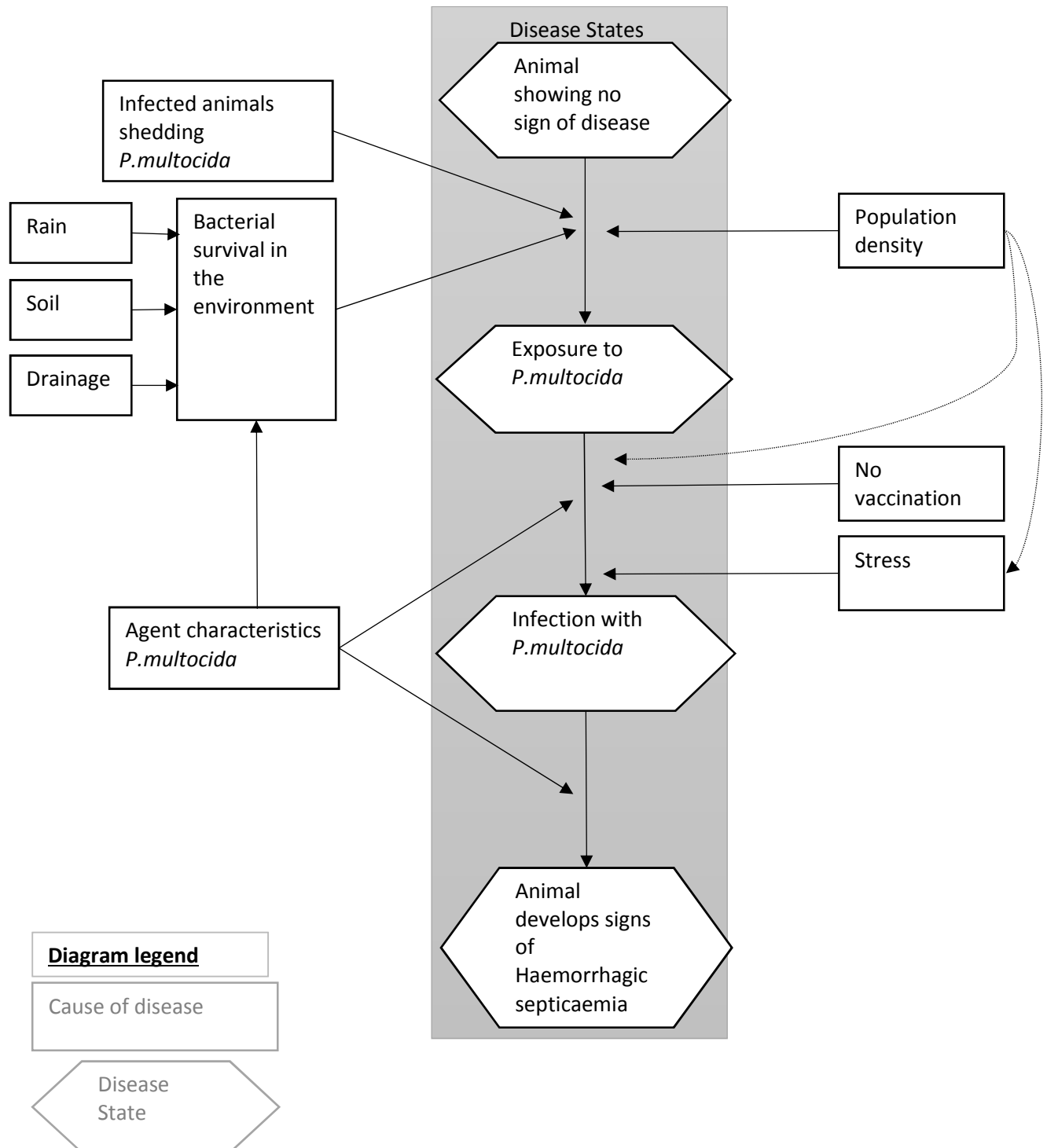
Simple exposure to the agent does not mean disease will occur. There are many causes and many combinations of these causes required for disease to occur.

The relationships among causes of disease can be represented in diagrams that show causes and how they act together to influence the occurrence of disease. These diagrams are often called causal diagrams or causal webs (because they can resemble a spider web of lines linking various causes to a disease). Causal diagrams can show in a diagram how causes related to the environment, the agent can act together to influence risk of disease occurring in animals. Some causes are defined as being necessary causes – meaning that disease will not occur if this cause is not present. Other causes may just act to increase or reduce the risk of disease occurring and these causes may not be necessary causes. Understanding causes often allows us to identify measures that can be used to reduce disease risk through activities such as changes to management practices or husbandry.

The bacteria *Pasturella multocida* is the infectious agent involved in Haemorrhagic septicaemia. The diagram below shows some of the causes of Haemorrhagic septicaemia and how these causes influence the occurrence of disease in an individual animal. You can see that this diagram is trying to show a complex interaction between many different individual causes that can influence whether or not disease occurs in any one animal.

Figure 3   Causal diagram showing some of the causes of Haemorrhagic septicaemia and how these causes influence the occurrence of disease in animals

Disease States

Animal showing no sign of disease

Infected animals shedding *P.multocida*

Rain

Soil

Drainage

Bacterial survival in the environment

Population density

Exposure to *P.multocida*

No vaccination

Stress

Agent characteristics *P.multocida*

Infection with *P.multocida*

Animal develops signs of Haemorrhagic septicaemia

Diagram legend

Cause of disease

Disease State

There are many combinations of causes that lead to disease, so it is possible for the same disease to occur on separate farms or at different times due to a different combination of causes.

Epidemiological investigations help identify the important causes of disease and epidemiologic knowledge about the causes of a disease and how they interact with each other can be used to develop measures that vets, para-vets and farmers can apply to prevent or control disease.

> We may find in a research study that cattle farms feeding dry grass and hay are at five times the risk of having pinkeye outbreaks in weaner cattle compared with those using silage or fresh grass.
>
> Using this information, a para-vet or vet might advise a farmer to change from dry feed to fresh grass or silage when lots or pink eye cases are occurring in the district. The farmer may even spray dry feed with water to reduce the risk of dust and small particles getting in to the eyes of cattle as they eat. These approaches may reduce the risk of having pinkeye in the weaner cattle.

A disease may be prevented by doing something that breaks an important relationship between different causes.

> For example:
>
> - using better hygiene measures and managing the property to avoid environmental contamination with the infectious agent(s)
>
> - vaccinating animals to increase host immunity and help prevent infection with the infectious agent

Understanding the different causes can help find cost effective ways to prevent or reduce the effects of the disease.

> If shade is provided for cattle, the damage caused by UV light to the eyes may be less and the amount of pinkeye disease reduced.

If we vaccinate all the cattle for haemorrhagic septicaemia and avoid crowding during the wet season we would reduce the number of disease events.

Below are some additional examples of causal diagrams.

Figure 4   Causal web for anthrax
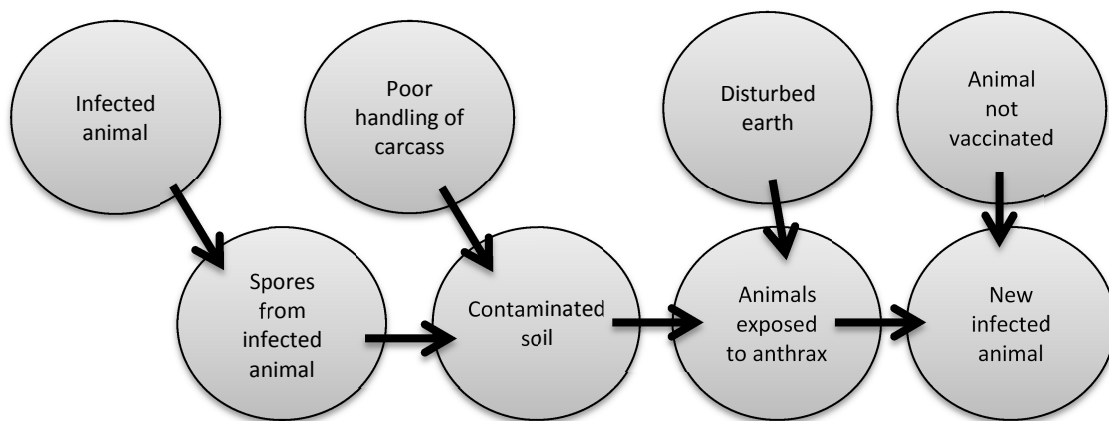
An animal infected with Anthrax sheds the disease on the ground. These spores can stay alive in the soil for a very long time if the spores are not properly killed through burning and decontamination. Unvaccinated animals coming into contact with the spores can become infected.

Figure 5   Key component causes of Anthrax
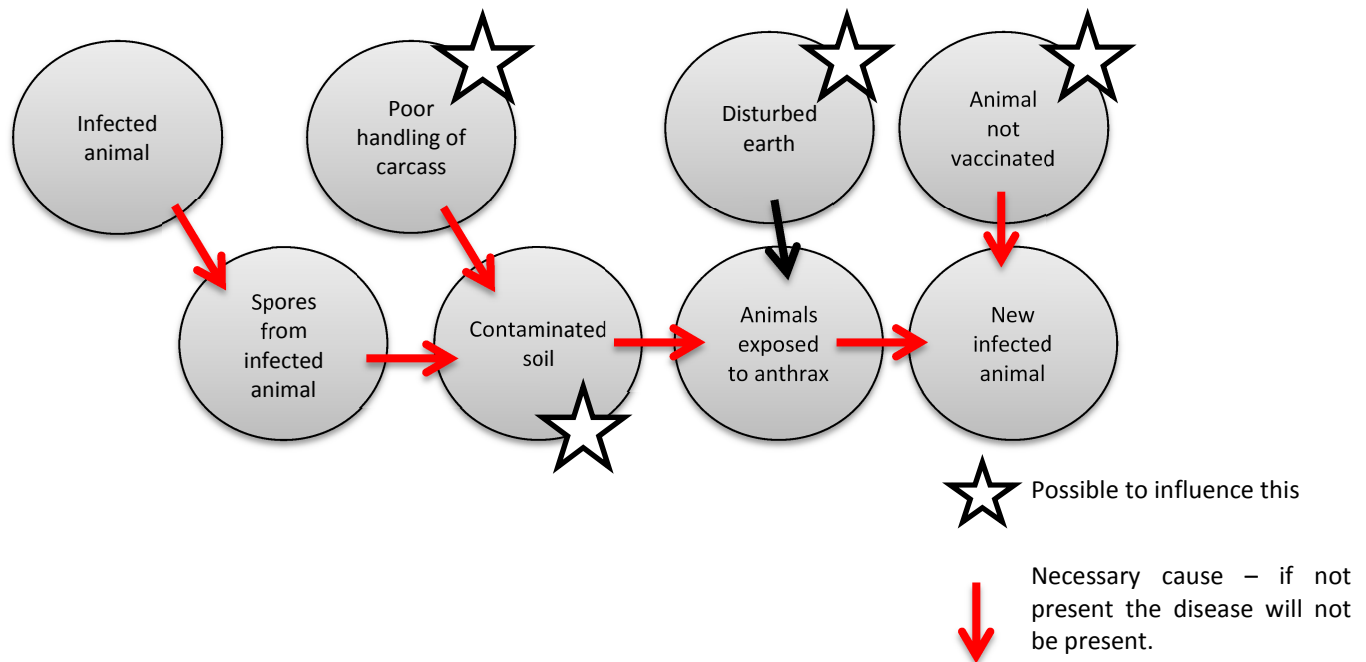
By understanding the interaction between causes in the environment, the way the agent behaves and the susceptibility of the host you can do things which will lower the risk of infection to other animals.   Burning any carcases to ash, properly disposing of soil contaminated with body fluids from the infected animals and vaccinating the entire herd will lower the risk of ongoing infection from spores in the environment.   There are many other management and husbandry activities which can also be considered.

Figure 6   Causal web for Photosensitisation
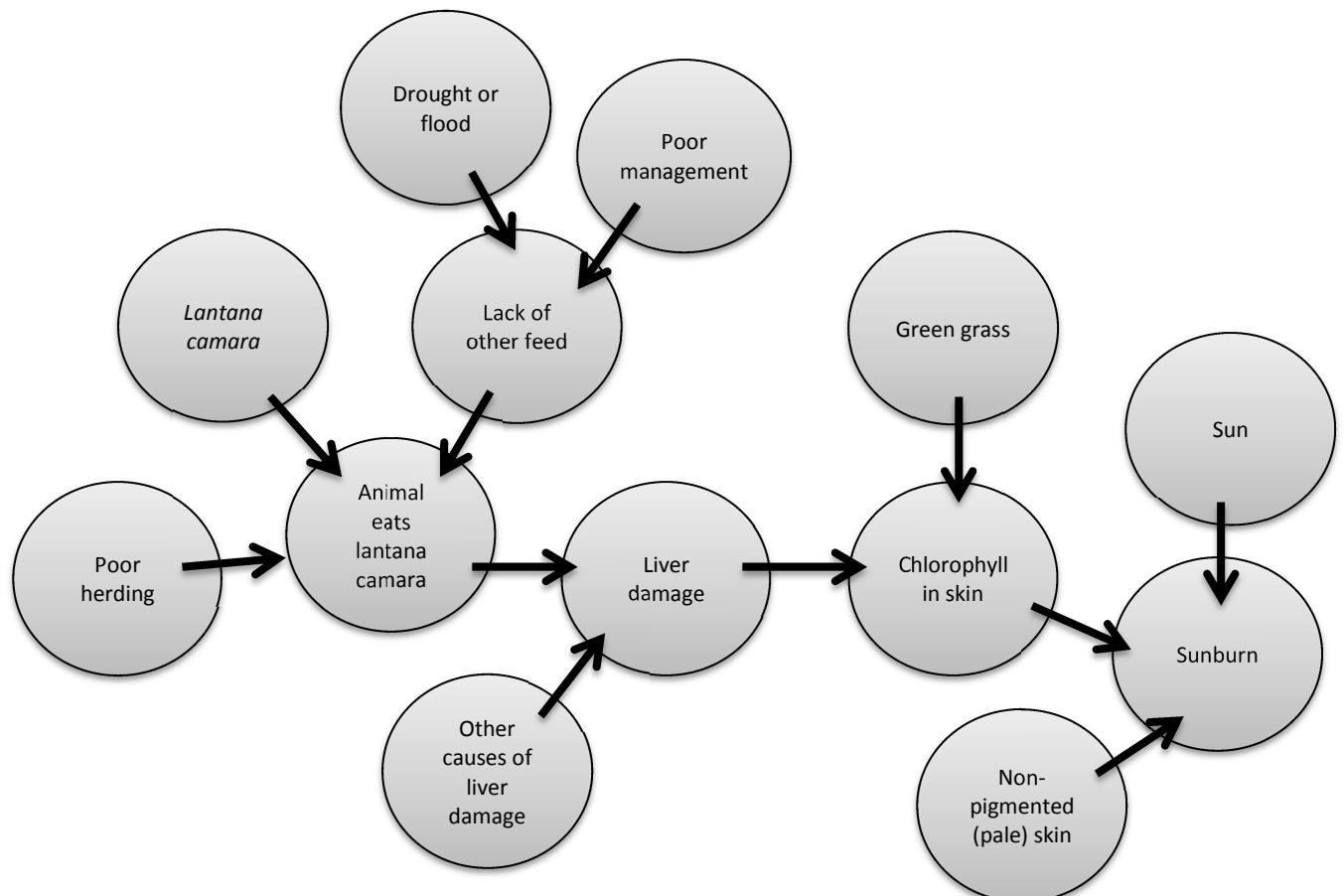
Lantana camara is an invasive species of flowering plant. The leaves on the plant are toxic to animals and cause liver damage. Animals usually avoid the plant but may eat it when there is no other food due to reasons such as drought or flooding, or poor management. Poor herding may allow access to the plant. In addition, animals will always seek access to green fodder (grass, reeds, leaves etc). This causes an accumulation of chlorophyll in the skin and when exposed to strong sunlight the pale skin of animals quickly becomes badly damaged by sunburn.

With a better understanding of the causes in the environment, host and the agent, we are able to significantly influence the outcome of the disease. Careful herding to avoid areas with lantana, and ensuring sufficient feed of adequate quality can lower the likelihood of animals eating lantana. Providing cattle who have had access to lantana (particularly pale skinned animals) with good access to shade can provide immediate protection against photosensitisation. Providing them with dry fodder (hay etc) instead of green (chlorophyll

filled) feed will also greatly diminish the sunburn. It is also important to remember that lantana camara poisoning is not the only cause of liver damage however the combination of chlorophyll and sun for a pale animal with liver damage without shade will result in similar signs.

Figure 7   Key causal components for Photosensitisation
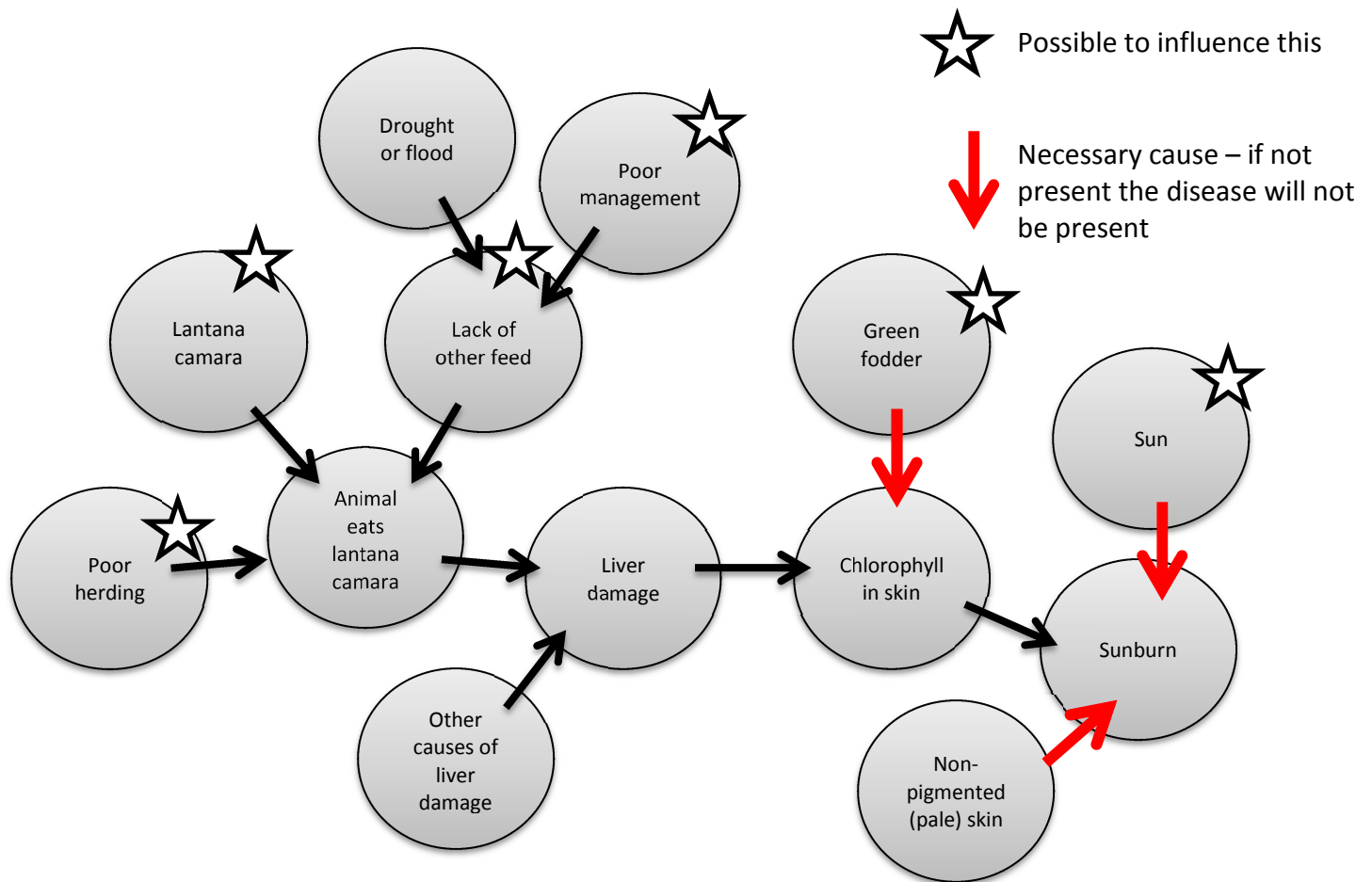
5 How disease progresses

5.1 Progression of disease in an individual animal

First we need to learn and understand some definitions before we learn about the progression of disease in individual animals.

- **Infectious agent:** living organisms that are capable of causing disease in susceptible animals. Infectious agents include: bacteria, viruses, parasites, protozoa, and fungi.

- **Infectious disease:** A disease due to a specific infectious agent that occurs due to transmission of the agent from an infected host to a new host, either directly or indirectly through intermediate hosts, vectors, or the environmental.

- **Contagious disease:** A contagious disease is an infectious disease that can spread directly from animal to animal. All contagious diseases are infectious but not all infectious diseases are contagious.

    – Examples of contagious diseases include foot-and-mouth disease (FMD) and highly pathogenic avian influenza (HPAI). These diseases can pass from one animal to another directly.

    – Examples of infectious diseases that are not contagious include tetanus, anthrax, and liver fluke infection. These diseases cannot be passed directly from one animal directly to another. With these diseases, infected animals contaminate the environment, and other animals get the disease from this environmental contamination.
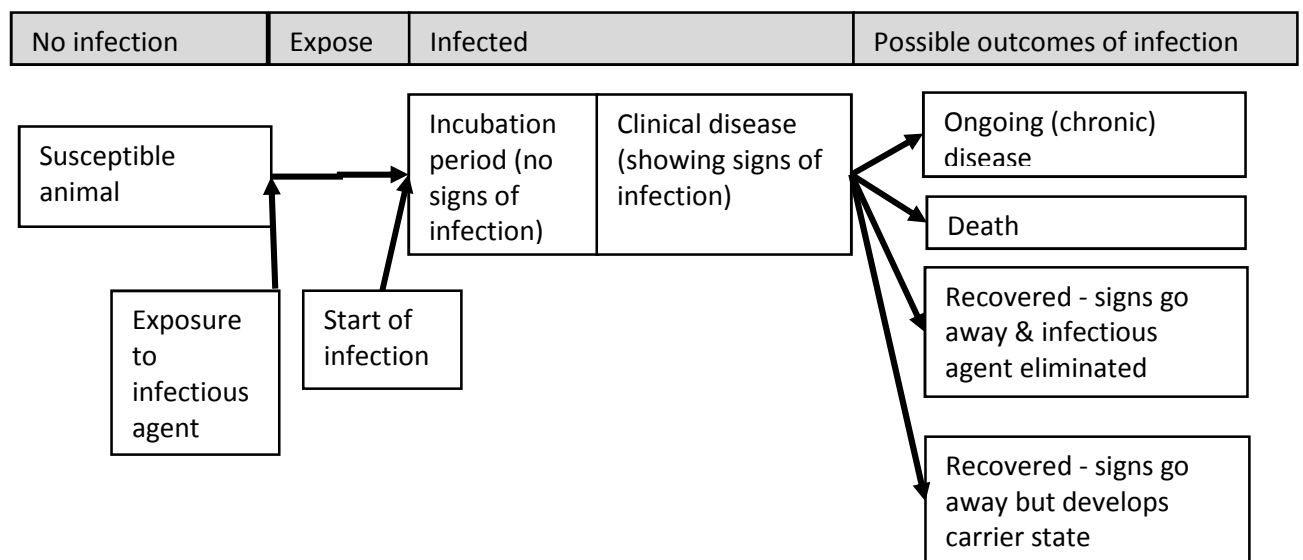
    Please note: the terms *infectious disease* and *contagious disease* are sometimes incorrectly used interchangeably and this can create confusion sometimes.

- **Susceptibility**: An animal must be susceptible to the infection in order to develop the disease. Animals that are not susceptible may be exposed to causes of disease including an infectious agent and they will not develop disease.

– Only the horse family (Equidae) are susceptible to equine infectious anaemia

– Younger cattle are more susceptible to pinkeye because they have a lower immunity to *Moraxella bovis* compared to older cattle who have been exposed previously.

- **Exposure:** The interaction between an animal and an infectious agent. Animals that are not exposed to an infectious agent will not develop the disease. Not every animal that is exposed will get infected.

    – When an influenza virus affects a crowded flock of chickens, every chicken will be exposed but not every chicken will become sick.

- **Incubation period:** the period of time from infection until the animal develops clinical signs of disease.

Within the host (animal) there are a number of steps that determine if the animal develops disease after being exposed to an infectious agent for that disease.

Figure 8   **Progression of an infectious disease in individual animals showing disease states and outcomes in shaded boxes at the top. The diagram is ordered in time from left to right.**

No infection	Expose	Infected	Possible outcomes of infection

Susceptible animal

Exposure to infectious agent

Start of infection

Incubation period (no signs of infection)

Clinical disease (showing signs of infection)

Ongoing (chronic) disease

Death

Recovered - signs go away & infectious agent eliminated

Recovered - signs go away but develops carrier state

Firstly an animal must be susceptible to a disease to become infected. A susceptible animal must be exposed to an infectious agent in order for infection to occur. Exposure means that the infectious agent has entered the body of the animal in some way. Not every exposure will result in infection. Sometimes after exposure the infectious agent will die or be killed by the animal's immune system before it can cause infection. If the infectious agent begins to grow and replicate within the body then at this point the animal moves from exposure to infection. In the very early stages of infection the animal will usually show no signs of disease. This is called the ***incubation period***.

During this period the infectious agent is multiplying; as the amount of agent increases within the animal the greater the effect on the animal (host). The incubation period starts with infection of the animal and ends with the onset of clinical signs of disease. In some cases infected animals may not show any signs of disease.

Each infectious disease has a characteristic incubation period. The length of this period is dependent on:

- the way the infectious agent entered the host

- the amount of infectious agent that entered the host

- how quickly the infectious agent multiplies within the host

- the ability of the agent to cause disease

- the immune response of the host

This interplay causes the incubation period to vary among different animals even when infected by the same agent.

> Soleh has a lot of chickens. All his chickens have got sick before with influenza. He noticed that from the day he put he put a sick bird in with the others it took between 3 – 5days before all his other chickens became sick.
>
> Soleh has measured the incubation time of this influenza virus to be between 3 and 5 days.

Infected animals may develop chronic disease (continue to be infected and show signs of disease), die from the disease or may recover. Recovered animals may recover completely and eliminated all infectious agent from their system. Sometimes recovered animals stop showing any clinical signs of disease but continue to carry the infectious agent (carrier).

In some diseases, infected animals may never develop clinical signs of disease. In other diseases almost all infected animals may develop signs of disease.

> Soleh has some cows as well. One year some of his cows had bad diarrhoea. Pak Paimin, the para-vet, investigated the problem. As part of a university study he took faecal samples from all the cows. He found all Soleh's cows were infected with high worm numbers yet only a few had diarrhoea. All the cows recovered and became healthy again once they were wormed.
>
> Two years ago, Soleh had several cows die suddenly as a result of anthrax infection. Anthrax is an example of a disease where almost all infected animals will die.

Carrier animals may show no signs of disease but may continue to carry the infectious agent and may shed the agent into the environment either continually or only at times when the animal is stressed or has some other disease. Carrier animals pose a risk to other susceptible animals in the population.

> For example:
>
> Bovine viral diarrhoea virus can produce a carrier state where the animal remains persistently infected, never grows very well and continually sheds the virus. Animals persistently infected with BVD can spread virus to infect other animals.
>
> Some animals that clinically recover from pinkeye will remain carriers of *Moraxella bovis.* The bacteria can live in the eyes, nose, and vagina of these carrier animals. Flies carry the disease from these animals to other non-carrier

animals, sometimes this causes disease if the other host, agent, and environmental characteristics are right.

Animals that recover from infection often develop immunity to the infectious agent so that if exposed again they do not become infected. Immunity may last a lifetime for some diseases while for other diseases it may be shorter. In these situations as the animals immunity declines the may become susceptible to infection again.

For example:

Bovine babesiosis is a parasite spread by tick bites that is capable of causing clinical disease in cattle. Animals that recover from infection have a life long immunity.

Bovine ephemeral fever (BEF) is a viral disease of cattle spread by mosquito bites. It causes fever and lameness and weight loss in infected animals. Recovered animals have a lifelong immunity to infection with the same strain.

Cattle that develop bacterial infection of the udder (mastitis) may recover with or without treatment but do not have long immunity and may get re-infected with the same bacteria at some time in the future.

Some vaccines are capable of producing long lasting immunity to a disease while other vaccines produce short acting immunity and animals must be re-vaccinated at regular intervals to protect against particular diseases.

Soleh noticed that once all his chickens got better from the influenza they didn't get sick again. Even the new healthy chickens didn't get sick when he put some sick chickens in with them. He didn't get any influenza in his chickens for about a year.

He asked Ibu Putri, the para-veterinarian, why this might have happened. She explained that his chickens had immunity for the most common influenza virus. It must have taken a year for a different or new influenza virus to come along or the current population of chickens consists of very few of the original chickens due to them being sold or dying.

5.2   Progression of disease in a population

Imagine a population of animals that has never been exposed to a particular disease agent before. This population is likely to be highly susceptible to an infectious disease. Introduction of infection to the population is likely to result in rapid spread of disease (an outbreak or epidemic).

Some diseases spread quickly through a population whereas other disease spread slowly.

For example:

Newcastle disease spreads rapidly between birds housed together whereas bovine diarrhoea virus (BVDv) spreads slowly within a population of cattle.

For diseases that are already present in a population (endemic diseases), the population will usually be made up of a mixture of animals that are:

- Susceptible
- Infected
- Diseased
- Recovered
- Immune

The amount of disease in the population will depend on the mixture of these classes of animals within the population at any point in time.

The proportion of animals that are susceptible to infection will have most influence over the amount of disease that develops in a population following introduction of a disease agent. If the population is mostly immune then introduction of disease will have relatively little effect. If there are many susceptible animals then introduction of the disease into the population may result in a large outbreak (epidemic).

There are many things that can change the spread of a disease within a population including:

- The area where the disease occurred

Why did Jembrana disease appear in Bali? What was special about Bali for this disease to occur there?

Jembrana disease is an unusual viral disease of Bali cattle caused by Jembrana disease virus (JDV). The first outbreak occurred in 1964. We don't know exactly how the initial infection occurred but there were several events that occurred shortly before the first outbreak that may have acted as causes:

- A ship containing cattle was reported in the area. Could this ship have introduced one or more infected animals onto Bali?_

- There had been a vaccination program in parts of Indonesia the previous year to vaccine cattle against FMD. Could the vaccine have been contaminated with JDV?

- Mount Agung volcano erupted in 1964 killing many people and contaminating pasture with volcanic ash. Could this event have contributed in some way to the appearance of JDV infection?

- The time period when things happened

Was the whole population exposed to the infection at the same time or did 1 animal get sick and pass it on to 2 others, which passed it on to 8 others, etc.?

- Sometimes occurrence of infectious disease in animals can be traced back to the introduction on one sick animal several days previously. In this situation the initial sick animal may infect 1-2 other animals who in turn infect several more animals. The number of disease cases may be very small to begin with and then rapidly grow as more infected animals spread the disease.

- Sometimes multiple animals can be exposed at once to an infectious agent and disease occurs all at once in many animals. An example is anthrax where several animals may die suddenly and then no more cases may occur for a period.

- Population density

How close do animals need to be for disease to spread from animal to animal either directly or indirectly?

- Some diseases like highly pathogenic avian influenza virus (HPAI) and foot-and-mouth disease (FMD) are capable of spreading very rapidly from one animal to another through direct contact (touching) or by airborne spread of virus on nasal droplets from one group of animals to another nearby group. The most rapid spread of these diseases occurs in animals that are hosued in large numbers in sheds.

- Bacterial agents that can cause diarrhoea and other infections (salmonella, coliform bacteria) may be able to live for hours or days in water, wet soil or feed. Other animals can be exposed when they ingest contaminated water

or feed. This sort of disease spread tends to be more likely when animals are housed close together in relatively larger numbers.

- The proportion of susceptible animals within the population

If older animals were the only ones to get sick - as is the case with Johne's disease - then we would expect a farmer who had many old animals to be more affected by the disease than a farmer with mostly young animals.

Herd immunity describes a form of immunity that occurs when a significant portion of a population of animals is immune and this provides a measure of protection for the susceptible animals in the population

When a large proportion of the population is immune, the immune animals protect susceptible animals within the population. As the proportion of immune animals (natural or vaccinated) rises, there is less opportunity for an infectious animal (animal that is infected and shedding the agent) to encounter a susceptible animal. Therefore, new cases of disease become less likely and may stop occurring.

Soleh vaccinates his chickens against newcastle disease virus (NDV). A month later he introduces some unvaccinated chickens into his flock.

Another farmer in the area has not vaccinated his chickens and when many of his birds get sick and die the veterinary investigation identifies NDV. Soleh's birds did not get sick even though one of the sick birds from his neighbour's farm had mixed with Soleh's chickens.

Having a high proportion of vaccinated birds in his flock almost certainly produced a herd immunity effect that protected both the vaccinated and unvaccinated birds in Soleh's flock from infection with NDV.

Figure 9   **Progression of an infectious disease in a population showing a single infected animal (black circle), susceptible animals (outline with no shading) and immune animals (gray shading). The infected animal is shedding agent and exposing either susceptible animals (no shading) or immune animals (shading).**
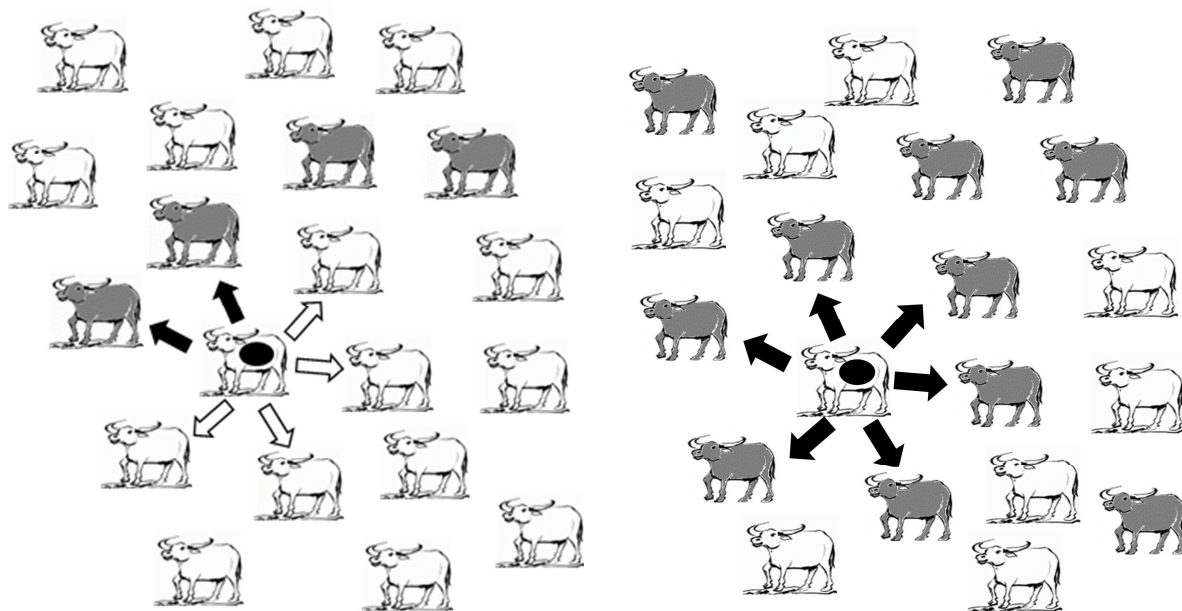
If there are fewer immune animals in the population then introduction of one or more infected animals is more likely to result in spread of infection. If there are more immune animals in a population then an infected animal may contact only immune animals and not result in any disease spread.

The threshold of immune animals needed in a population to reduce disease will differ for different diseases.

The concept of herd immunity can be used to estimate the level of vaccine coverage needed to reduce disease. Due to the effect of herd immunity, disease control programs do not have to vaccinate the entire population of animals to reduce disease or prevent epidemic.

For example:

The figure below shows a simulation of a contagious disease being introduced into a susceptible population. The lines represent the number of animals

- that are susceptiblethat are infected and showing clinical signs

- that are recovered

- Pattern of distribution of susceptible, clinically infected and recovered animals in a population following introduction of a contagious disease

Figure 10   Figure showing number of animals in each of three groups (susceptible, infected or clinical, and recovered) following introduction of a contagious disease into a population of 500 animals
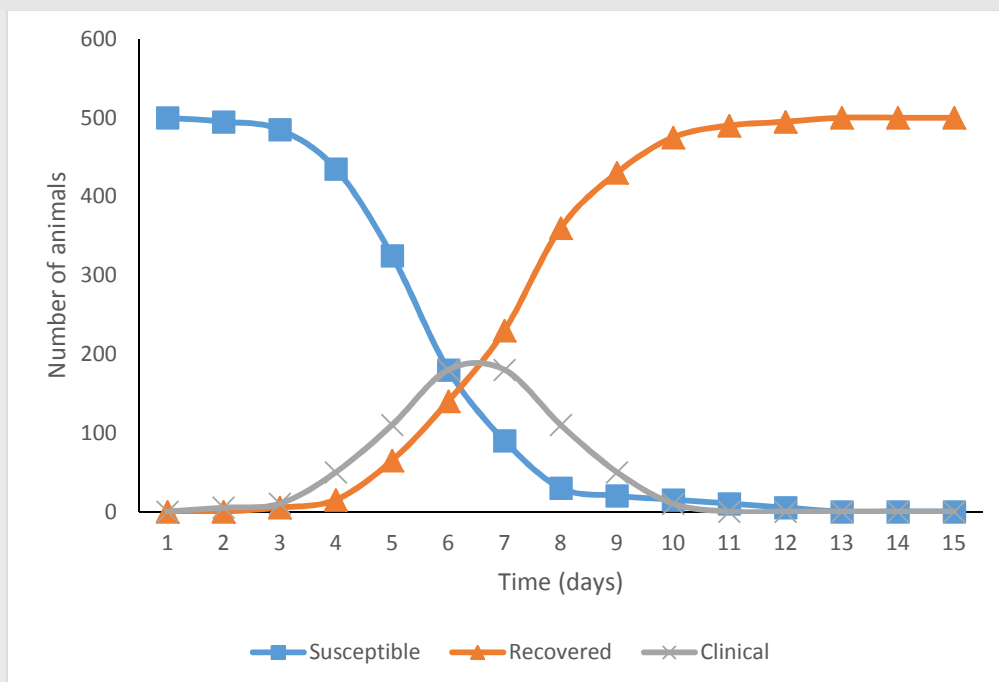
In this example there are 500 animals in the population at the beginning; all 500 animals are susceptible, there are no clinical infections, and no recovered animals. This means the disease is not present within the population in the beginning.

When the contagious disease is introduced, initially there will be a small number of infected animals. Over time these animals will infect others and the disease will spread within the population. This is shown by the rise in clinical animals (infected animals with clinical signs) and the fall in susceptible animals.

After some time the clinical animals will recover from the disease. The final pattern will depend on how contagious the disease is and how severe it is. If the disease became endemic there would be a constant mixture of susceptible, clinical and recovered animals. The number within these categories will move up and down over time depending on all the causes that influence if disease will occur.

6 Transmission and spread of diseases

In order for infectious diseases to continue to occur, infection has to be transmitted from an infected animal to a susceptible animal. If this does not occur, the disease will disappear.


Transmission describes how an infectious agent can move from one animal to another

Maintenance refers to how an infectious agent can survive or continue to occur in a population over time

Spread describes how an infectious agent moves from one population to another

---

In order for transmission to occur, an infectious agent has to leave the infected animal and enter a susceptible animal.

Figure 11   **Transmission of an infectious agent from an infected host to a susceptible host**

Infected animal	Transmission →	Susceptible animal
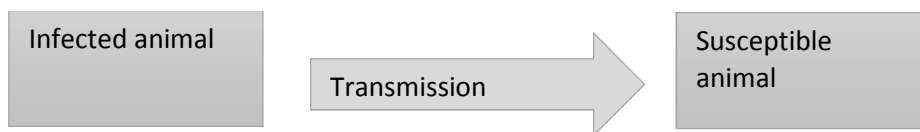
Infectious agents can leave the host in different ways. Examples include:

- *Body surface* – agent in hair, pus or scabs (ringworm)

- *Nose secretions* – (influenza virus)

- *Mouth* – saliva (rabies and foot and mouth viruses, tuberculosis)

- *Mammary gland* – milk (streptococcus bacteria)

- *Anus* – faeces (salmonella bacteria)

- *Urogenital tract* – urine and sperm (leptospirosis, campylobacter)

- *Eyes* – tears (pinkeye)

- *Blood* – (Q fever by tick vectors)

Infectious agents can enter the new host by different ways. Possible ways to enter a host include:

- *Orally* **–** by being eaten (many parasites/worms survive on grass or feed)

- *Respiratory* – through breathing the agent into the nose, throat and airways, (avian influenza virus, bacteria causing pneumonia).

- *Mucous membranes* – through contact with the eye, mouth, or nose. (Pinkeye)

- S*kin* - through intact skin (ringworm) or through damaged skin (human anthrax) or through biting insects (bluetongue) or through animal bites (rabies)

- *Coitus* - transmitted when animals breed (vibriosis in cattle)

- *Iatrogenic* – through some management or veterinary procedure (surgery, vaccination, dehorning, castration, injections) Bluetongue in livestock and HIV/AIDS or Hepatitis in humans

Transmission – For disease to get from one animal to another the infectious agent must be transmitted between the animals. This can occur:

- **Directly** where an infectious agent is passed from one animal to another by:

  - animal-to-animal contact

  - an animal contacting infected discharge from another animal (nasal secretions, urine, faeces etc.)

  - infection of the embryo in the pregnant uterus (mammals) or of the egg (birds, reptiles, amphibians, fish and arthropods), or through the milk from dam to offspring

- **Indirectly** where the infectious agent is passed from one animal to another via other living and non-living things.

- Living things (intermediate host) that can transmit some infectious diseases include insects such as mosquitoes in spreading Malaria between humans or ticks in spreading Babesia between cattle and many other animals or insects.

- Non-living things that can transmit some infectious agents include feed, equipment, clothing, needles and syringes.

Spread - Common methods for an infectious agent to spread between populations of animals include:

- Movement of infected animals into a new population

- Movement of contaminated materials

- Spread via contaminated equipment such as veterinary, farming, etc.

- Movement of vectors such as ticks, birds, wild animals between populations

- Airborne spread of bacteria, viruses (foot and mouth disease), or fungi from one population to another

Maintenance - Infectious agents need to survive over time or the infection will disappear. Infectious agents have developed different ways to survive either in animals or the environment. These include:

- developing a resistant form that can survive for a long time in the environment (anthrax spores, helminth eggs, toxoplasma cysts)

- continual transmission to susceptible hosts through:

  - rapid infections that cause little immune response

  - or by altering their genetic makeup to avoid any immunity that developed against previous forms

- forming persistent infections in host animals (Johnes disease, tapeworm, maedi-visna virus, BVD)

- developing the capacity to infect multiple different species to increase likelihood of continual transmission (Nipah virus infects bats, pigs, humans, rabies infects all mammals)

- avoidance of any external or environmental forms as a way of avoiding dying in the external environment (trichinella species)

The following two figures provide examples of transmission and maintenance for some diseases using life cycle diagrams.

**Figure 12   The trichostrongylus spp. life cycle in sheep and cattle.**
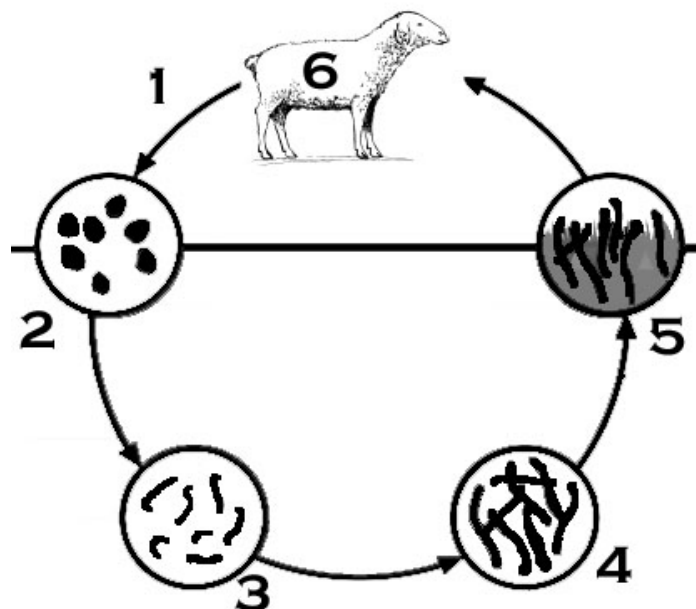
The Trichostrongylus spp. life cycle includes the following steps.

1. Eggs passed in faeces

2. 1st stage larvae hatch from eggs in faeces

3. 1st and 2nd stage larvae feed on bacteria in faecal pallets

4. 3rd stage larvae is protected from drying out by its outer shell

5. 3rd stage larvae move out of faeces and onto grass. The free living stage in the environment of the life cycle can take from 2 -12 weeks to complete

6. Sheep eat grass and 3rd stage larvae. These moult in the small intestine to 4th stage larvae which then become adult worms. Adult worm produce eggs which are passed in the faeces. The host stage of the life cycle can take 18-21 days to complete

Figure 13   Anthrax life cycle
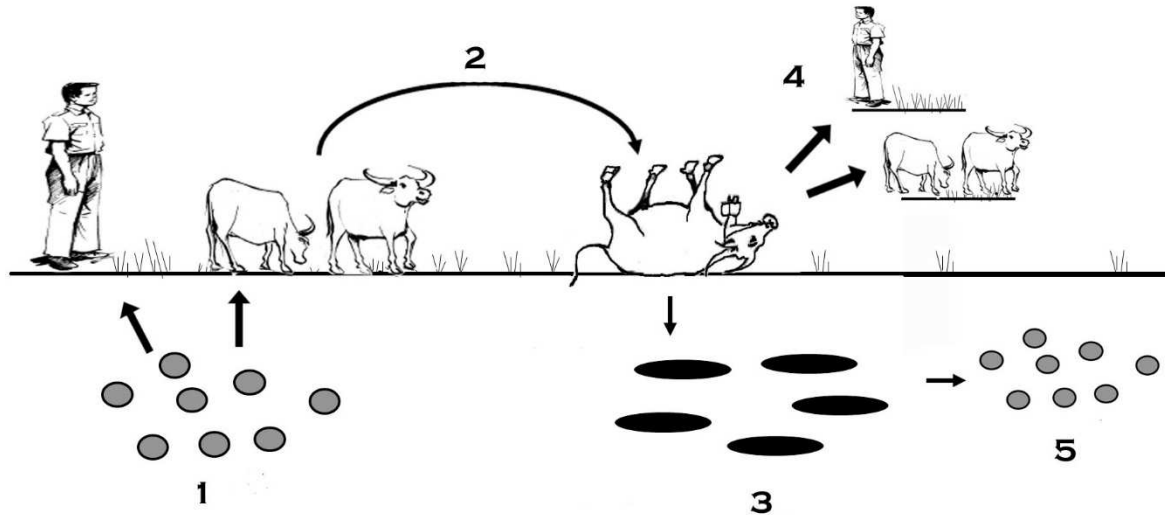
The anthrax life cycle includes the following steps:

1. Anthrax spores are ingested, inhaled, or contacted by the host (human or animal)

2. Disease and death occur in the host

3. Vegetative cells are released into the environment following death of the host

4. Anthrax infection can occur from contact with animals that have died from anthrax

5. Vegetative cells in the environment turn into spores and remain infective to hosts for many years

7 Using a field epidemiology approach to larger disease investigations

Field epidemiology skills are important in all disease investigations even when only one animal or one farm is affected.

The epidemiologic approach to disease investigation becomes more and more important where:

- there are larger numbers of animals are affected

- the disease is spreading rapidly

- the causes of the disease are uncertain (affected animals displaying signs that are different to commonly seen diseases or more severe)

Examples of these situations include outbreaks of exotic diseases or new diseases or where a common disease has changed so that it spreads more rapidly or has a higher mortality rate. In these situations, an epidemiological investigation is likely to provide the best approach to understand possible causes and identify control measures for the disease.

The advantage of an epidemiological approach is even when you do not know what the disease is or what the specific infectious agent(s) might be you can often draw conclusions about:

- the likely causes of the disease

- identify possible control measures

Larger disease events often involve one of the following situations:

1. *Where the causes of the disease are known*

   There may be interest in trying to understand how or why the disease occurred in this a particular event so control measures can be put in place. The agent causing the

outbreak will be known or identified early in the investigation. In these situations the investigation is directed at identifying causes that contributed to this particular occurrence of the disease.

2. *Where the causes of the disease are not known*

    For new disease or exotic disease the investigation is directed at identifying causes and possible control measures. The diagnosis is important but may not occur until after initial control measures are implemented.

> For example:
>
> The initial investigation of *Mad Cow Disease* or *Bovine Spongiform Encephalopathy (BSE)* in the United Kingdom suggested that the disease was likely to have been spread through contamination of cattle feed products with meat and bone meal. Preventative measures involving a ban of feeding ruminant-derived protein were identified from initial epidemiologic investigations and put in place well before the agent was identified. Years later additional research identified the causal agent (a prion) and confirmed that the initial recommendations were effective in preventing further spread of the disease.

An epidemiologic disease investigation follows a systematic approach, and includes the following activities.

1. Develop a case definition and assign animals to 'cases' or 'non-cases'
2. Collect data on cases and non-cases
3. Apply simple analyses to the data collected to describe the patterns of disease and identify possible causes
4. Describe initial findings and make recommendations

Each of these four steps will be described in more detail in the following sections.

NOTE: It is likely that epidemiological investigations will involve a district veterinarian working with para-veterinarians to plan and conduct the investigation. Para-veterinarians need to understand the general approach and the types of data and information that need to be collected.

7.1 Describing cases and non-cases

A ***case definition*** *is a set of standard criteria for deciding whether an individual animal has a particular disease or other aspect of interest.*

*A **case** is an animal with characteristics and clinical signs that meet a case definition for the disease being investigated*

This step involves first completing the initial investigation (Section 3) to describe signs or symptoms of animals that are affected by the disease of interest. This involves examination of sick animals as well as animals that are not sick, i.e. unaffected animals. By comparing affected and unaffected animals we can develop a case definition.

It is often useful to have 3 separate levels of a case definition:

1. *confirmed case* where all the criteria for the case are met

2. *suspect case* where some but not all the criteria are met

3. *non-case* where the animal can confidently be declared as not meeting either the suspect or confirmed criteria

For field investigation of an unusual disease it may be best to start with a broad and non-specific case definition. This may mean that some non-cases will be classified as cases. However, it should mean that few true cases are missed and wrongly classified as non-cases.

Once a case definition is developed, all sick animals are compared to the case definition and assigned to one of the levels (confirmed case, suspect case, or non-case). Case definitions are used so information collected on cases and non-cases can be compared to look for associations that identify potential causes.

For example:

Case definitions that might be used when investigating mastitis in dairy cows

Study Unit	Case definition
Animal	A cow with visible clots in the milk
Animal	A cow with a milk cell count greater than 200,000 cells/ml

In some cases of mastitis there are few or no visible clots in affected milk. Thus, the first case definition will result in some false negative results. In any test system, there is always a trade-off between false positive and false negative results.

Case definitions are important in epidemiological investigation as a population of animals may have many different diseases occurring at once. Only some of the sick animals may be affected with the disease that is being investigated.

Imagine if you are investigating a disease outbreak where there were several cases of sudden death due to a new disease. But there might also be 1-2 cases of death due to other common diseases - one animal died of acute mastitis and another died from a twisted stomach.

It will be important to examine all the dead animals and develop a case definition for the new disease. This should allow the 2 animals that died from well-known diseases (mastitis and twisted stomach) to be identified and removed from the group of animals with the new disease.

A case definition will allow you to identify and separate information about different diseases that may be occurring in the population. It also helps keep the disease investigation focused on the disease of interest.

Pak Paimin starts to think that this case may need a more epidemiological approach. He starts to put all the information together that he has found out so far.

He thinks about the cow that was lame, the 2 cows with diarrhoea and the calf that Budi was given who was sick. Pak Paimin needs to go over the dates of when all the animals got sick from his diary and put a time line together. The only cows to get sick were down stream of the pen where the sick calf would have been kept.

Pak Paimin decides on a case definition for this stage of the investigation:

Any cow (or calf) that has watery diarrhoea and temperature above 39°C

8 Collecting data and counting cases

To collect data on cases and non-case you will need to ask the farmer questions about their animals.

> For example:
>
> - When did the first case of this disease become apparent?
>
> - Is it possible to get the date when each affected animal first showed clinical signs?
>
> - Where were animals when they got sick and where were they in the days to weeks before they got sick?
>
> - Is it possible to collect information on all the animals on the affected farm (or that mix together in a village population) over the days or weeks before cases started to occur?
>
> - Have there been any animal movements into this group or out of this group?
>
> - Were any treatments given to animals (what was administered and when)?
>
> - Were there any other changes (change of feed, chemicals dumped in the paddock or river, new fence erected, etc)?

Data can also be collected from making direct observations of signs of disease from animals or from laboratory results.

> Pak Paimin thinks about the additional important information he needs. He will ring Budi and ask him what was happening during the 2 weeks before these animals became sick and where the calf came from.

Budi finally tells Pak Paimin that he was away from the farm for 10 days and came back 4 days before the animals got sick. His brother in law was looking after the farm and he was in a bad mood the whole time. Budi is embarrassed because he is sure that his brother in law caused the cow to get an injury and go lame, he is also sure that he caused his animals a lot of stress.

The calf was given to him from a friend, Soleh, who is from another village. The calf had been sick for a long time and that was why he gave it to Budi.

Now Pak Paimin must ring Soleh and find out some information from him. But first he logs onto iSIKHNAS to see if there are any reports of sickness or diarrhoea from that village or area.

9 Making sense of the information you collect

This step then involves arranging and analysing the data that has been collected to try and describe the disease and identify possible causes.

If it is not possible to identify a diagnosis, then it is best to try and determine:

- the body system(s) that may be affected

- if the disease is likely to be infectious or non-infections

- if it may be spreading from one animal to another (contagious)

The following types of activities may be completed to help answer the above questions:

1. Describe the patterns of disease in terms of time, place, and animal

2. Arrange and analyse data looking for associations between disease and possible causes

3. Developing ideas on possible diseases, causes, and control measures

9.1 Describing patterns of disease

*To describe patterns of disease we need to count **cases** (animals with disease) and **non-cases** (animals without the disease) on the affected farms.*

Epidemiology studies patterns of disease occurrence. To find the patterns we need to count cases and non-cases. These counts can be used to describe disease occurrence in terms of ***time, place, and animal***. Doing this will help us understand the disease, its impact, and explain how and why the disease occurred. This will help develop control strategies.

Time

Describing disease occurrence in *time* is usually done using epidemic curves. An epidemic curve is a plot of the number of new cases of disease over time.

> For example:
>
> The epidemic curve below shows time in days on the x-axis (horizontal) and a count of new cases on the y-axis (vertical).
>
>
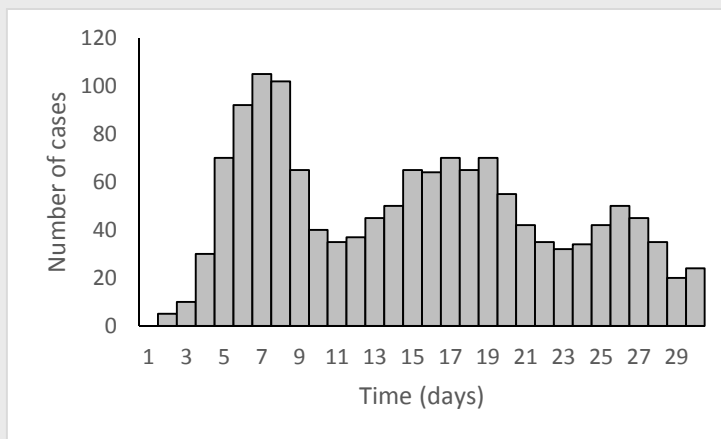
This is a very common way of describing the pattern of disease occurrence. Epidemic curves do not require information on non-cases.

An epidemic curve can be produced from counts of cases and the time of onset of clinical signs. This is generally the day or date when clinical signs were first detected. Epidemic curves can provide a lot of information about the disease under investigation.

> For example:
>
> Epidemic curves can provide information about the type of disease and or type of exposure.
>
> • Highly contagious diseases have an exponential pattern with a steep rise followed by a progressive decline as susceptible animals are exhausted in the population.
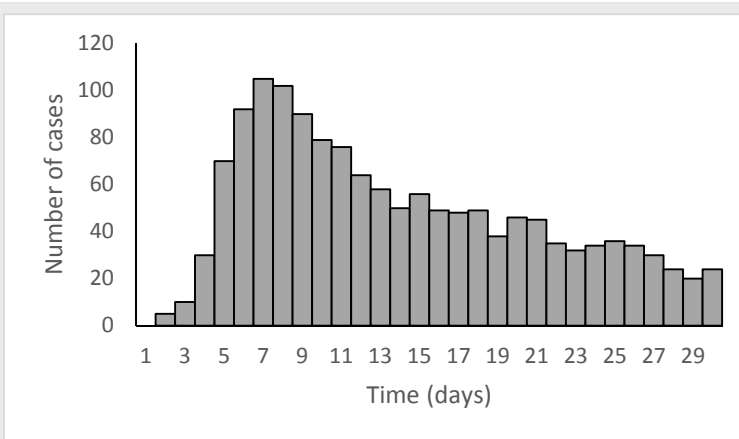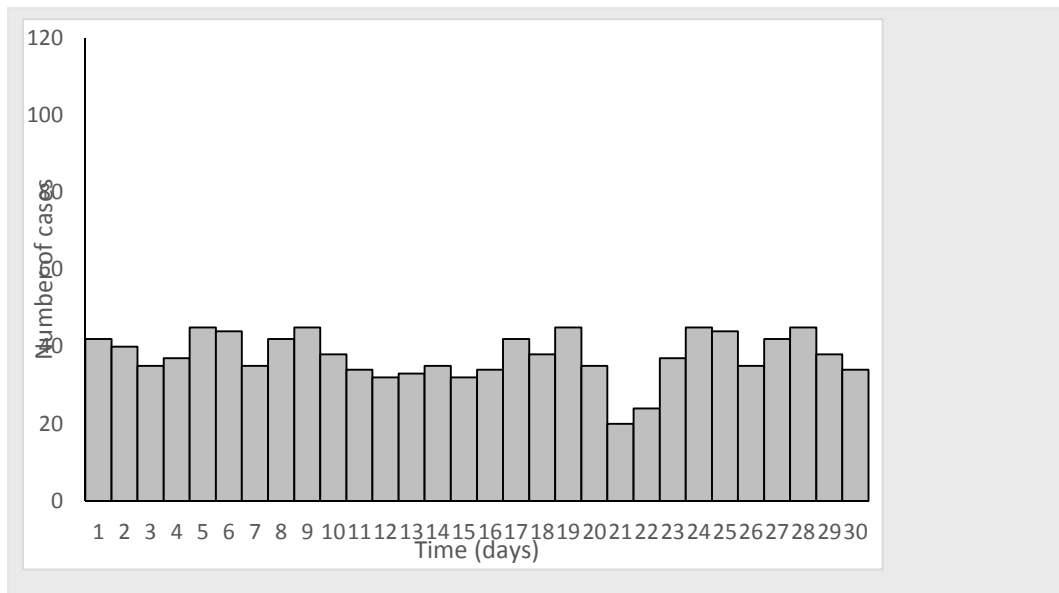
- A disease outbreak associated with point exposure of animals (single exposure at a point in time e.g. toxic spill or food poisoning at a picnic) will show a sharp rise in cases and then a sharp fall.
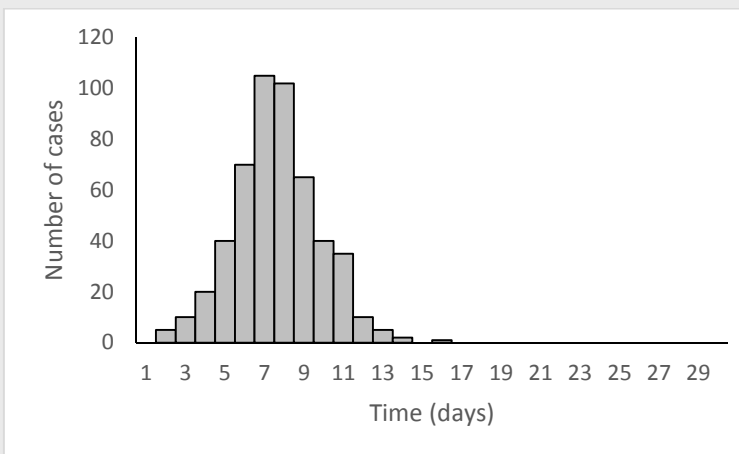
- Endemic diseases that are not very contagious will show a fairly level pattern with some small peaks and troughs but no large rises.

Place

Describing disease occurrence by *place* is usually done by mapping. Some highly skilled epidemiologists may often turn to computer based mapping software. However simple, hand-drawn maps remain very useful tools to summarise disease occurrence.

**Figure 14   Example of a simple map generated by iSIKHNAS to help you monitor where disease is occurring**

Animal

Describing disease occurrence by *animal* is usually done by arranging counts of cases by some host characteristic. Common characteristics used to describe disease occurrence by animal are:

- age group
- breed
- species

- sex
- body condition
- vaccination status

This may also include descriptions of outcomes such as; the number of animals that were infected, the number that have died, and the number that have recovered.

> Pak Paimin finds there have been lots of reported diarrhoea cases in the village where the calf came from and also in the next Kabupaten where the drain runs to from Budi farm. Pak Paimin alerts the DINAS vet and together they create the below epidemic curve and plan a more detailed epidemiological investigation.
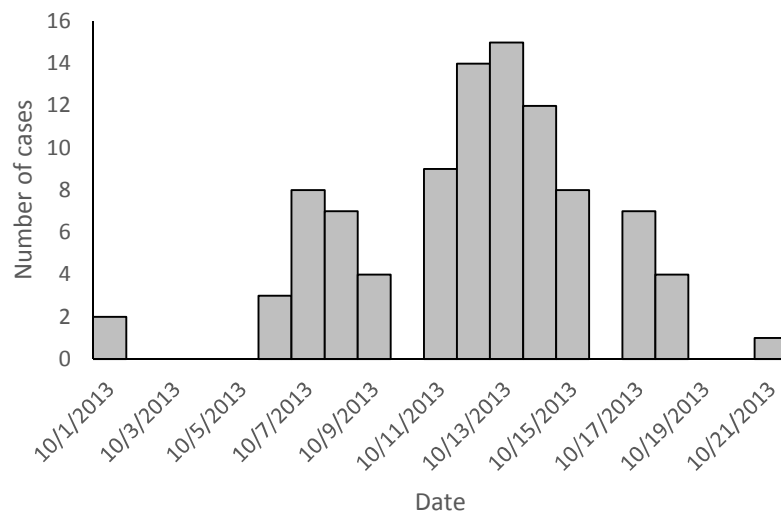
9.2 Arranging and analysing data to look for associations

Proportions are often used to express disease occurrence. Proportions can be easier to understand and sometimes more useful than whole numbers. To calculate a proportion you will need to count two different groups of animals:

- *Number of cases of disease*, either as:

    – The number of new cases over a period of time, or

    – The number of cases at a point in time (this method possibly includes old cases as well as new cases)

    The number of cases of disease forms the *numerator* (the number on top) in the calculation of proportion.

- *Population-at-risk*

    – The number of animals that may be considered eligible to get infected with the disease. The population-at-risk should include all those animals in the area of interest (farm, village, district, province etc.) that could get the disease. This may not include every animal.

In an outbreak of Milk Fever (Calcium deficiency) in cattle, the population-at-risk is all pregnant female cattle on the farm. Male cattle, and non-pregnant females are not part of the population-at-risk.

The population-at-risk for retained placenta would be all cows and heifers which calve in the herd; for porcine parvovirus, the population-at-risk would be serologically negative gilts and sows.

The population-at-risk forms the *denominator* (the number on the bottom) in the calculation of a proportion.

$$Proportion = \frac{numerator}{denominator} = \frac{number\ of\ cases}{population - at - risk}$$

Describing disease occurrence using proportions may help identify differences in proportions that may indicate a cause of disease. Looking at data in this way can help describe patterns of disease in more detail and identify possible causes of disease.

Often it is useful to describe the proportion or percentage of animals that are affected based on other characteristics associated with the host, agent, or environment.

For example:

Some characteristics that are useful to arrange the data by:

Unit of study	Some relevant characteristics to compare
Animal, cage, mob, paddock	species, sex, age, breed, weight, size, soil type, stocking density, stage of production, available feed, water source
Farm	location, size, source of stock, source of feed and water, production method, other business
Village	location, number of farms, farm types, geography, climate
District	location, size, government services, geography, climate

Data on cases and non-cases may show that most cases occurred in one paddock or in one age-group of animals.

The proportion of animals developing disease can be arranged using other characteristics to look for patterns that may offer clues about causes of disease. If the proportion of animals developing disease is much higher in young animals than in adult animals then this may suggest that the disease is more likely to infect younger animals. This information may allow the para-vet to identify some possible diseases to add to the differential diagnosis list.

Attack rates (AR) can be used to compare proportions between different levels of some other characteristic. Attack rates require a numerator (number of cases arranged by each characteristic) and a denominator (total number of animals on the affected farm arranged by each characteristic).

Pak Paimin and the Drh. Agung DINAS vet find the case and population data out of iSIKHNAS for the two affected Kabupaten.

They make the following calculations:

$$\text{For Kabupaten 1, AR1} = \frac{\text{Cases of diarrhoea in cattle}}{\text{Total cattle in Kabupaten 1}}$$

$$\text{For Kabupaten 2, AR2} = \frac{\text{Cases of diarrhoea in cattle}}{\text{Total cattle in Kabupaten 2}}$$

Pak Paimin and Drh. Agung think during the time period the disease problem has been occurring, there are 100 cattle and 10 cases of diarrhoea in Kabupaten 1, and 300 cattle and 84 cases of diarrhoea in Kabupaten 2.

The initial data analysis from the epidemiological investigation that started with disease on Budi's farm:

	Count of cattle		Attack Rate
Kabupaten	Cases	Total	AR
1	10	100	10%
2	84	300	28%

In the above table, attack rates are expressed as percentages.

There are 100 cows in Kabupaten 1 and 10 of these are classified as cases, leading to an attack rate of 10/100= 0.1 or 10%. There are 300 cows in Kabupaten 1 and 84 of these are classified as cases, leading to an attack rate of 84/300= 0.28 or 28%.

Looking at attack rates for the different Kabupaten suggests that cattle in Kabupaten 2 are more likely to get diarrhoea than cattle in Kabupaten 1.

Dividing one AR by another AR produces a measure of the relative risk (RR). Cattle in Kabupaten 2 have a 2.8-fold higher risk of diarrhoea than cattle in Kabupaten 1 (RR=28%/10%).

In this example the cattle in Kabupaten 2 are more likely to have diarrhoea. From our investigation we know that the cases on Budi's farm were some of the very first cases of diarrhoea reported over this time. From the mapping of cases we know that most of the cases are very close to the drain that runs from Budi's farm.

> This finding could lend support to the idea that cattle down stream of this drain are more likely to develop diarrhoea and that the drain is somehow involved in the spread of disease.

More detailed analyses of epidemiologic data are possible and may be important to identify possible causes. More detailed analyses are beyond the scope of this Basic Field Epidemiology Resource Book. Additional information is provided in the Advanced Field Epidemiology Resource Book.

9.3   Developing disease control strategies

When investigating a disease it is important to develop control strategies quickly to minimise the number of animals that are affected. This is very important for diseases that have a high mortality rate or spread rapidly.

It is often important to implement some control measures as the initial investigation is finishing and before the para-vet (or veterinarian) leaves the farm. Even in situations where you may have multiple differential diagnoses or when you may not be certain of what the causes might be, it is usually possible to put into practice some useful control measures before leaving the farm. Sometimes additional investigations may be done or laboratory tests performed to try and identify possible causes and work towards a definitive diagnosis and in that case the control measures may change as you gather additional information.

Examples of possible control measures that might be put in place during the initial investigation include:

- removing susceptible animals to a new area may control the disease if the investigation suggests the cause of disease is a point source exposure such as a poisonous plant – **Movement of hosts**

- improving farm management, husbandry, or feeding if the investigation suggests that contamination, poor feed, or poor husbandry is a cause of disease – **Animal management**

If the investigation suggests an infectious agent that may be contagious then initial strategies should include:

- treatment of affected animals – **Animal treatments**

- stopping animals and people moving onto and off the affected farm – **Control of animal movements**

- separating the affected animals from unaffected animals – **Isolation**

- using and promoting good hygiene, disinfection, and other management strategies – **Biosecurity**

In many cases it is necessary to put some initial control strategies in place, then conduct further investigations to identify possible causes. As more information is available then treatments and prevention can be modified.

It is expected that District Veterinarians will be involved in the planning and interpretation of detailed epidemiologic investigations.

Some diseases will have pre-planned national control programs that are implemented when the disease is either suspected or confirmed. This sort of control is usually limited to specific diseases of importance where there is a policy of control or eradication (priority diseases and exotic disease of importance). Often a large amount is known about these diseases. This sort of control program often involves national legislative support and animal health policies that define what actions should be taken to investigate and control the diseases. Additional strategies that can be used in these types of control programs include:

- separating infected and suspect animals from susceptible animals as well as preventing animals or humans from moving onto of off affected farms will help reduce the spread and transmission of disease - **Quarantine**

- killing diseased animals and possibly suspect animals, disposal of the carcasses and other infectious material to reduce the number of sources of the infectious agent - **Slaughter**

- using vaccination to increase the immunity against the disease to reduce the number of susceptible animals – **Vaccination**

- reducing the number of intermediate hosts (such as insects and wild animals) that transmit the disease will help reduce the spread – **Control of intermediate host**

More detailed information on these matters is provided in the Advanced Field Epidemiology Resource Manual.

10 Application of epidemiological approach to routine cases

10.1 Field Epidemiology in day to day work

Thinking about the possible causes of disease, the host, the agent, and the environment when looking at every sick animal will help para-veterinarians provide better services to farmers for treatment and prevention of disease in animals. Para-vets should be involving field epidemiology skills in all aspects of their every-day activities. The following examples are intended to illustrate how field epidemiology skills can be useful in all sorts of activities ranging from managing an individual sick animal to a larger scale disease outbreak.

Example 1

Case introduction

> You visit a farm where a calf is sick and has stopped drinking.

Information collected during investigation

> - The mother of the calf has had poor milk
> - The calves were all born in clean grassy paddocks

Para-veterinarian's actions

> You examine the calf, find an abscess on the navel, and you treat the calf.
>
> You advise the farmer that causes for these abscesses include: dirty calving environment, damp/wet conditions, exposure to bacteria, and lack of milk (colostrum) in the first 6 hours.
>
> You advise the farmer how to prevent further cases maintaining a clean environment for calving and to help calves drink from their mothers in the first 6 hours of life.

Epidemiology context

Epidemiology skills help you to think about how this case might have occurred – **multiple causes of disease** *(host, agent, and environment).*

Knowing the common causes for this disease (the epidemiology of the disease) allows you to provide the best advice on how to treat the individual sick calf and even more importantly how the farmer can improve management to **prevent** further cases of this diseases from occurring in the future.

Example 2

Case introduction

> You visit a farm where there is a number of calves with abscesses on the navel and a number of calves without abscesses.

Information collected during investigation

- Some new cattle arrived 9 weeks ago
- The cows moved paddocks 9 weeks ago
- All the sick calves are between 6 and 8 weeks of age
- All the healthy calves are older than 10 weeks of age
- All the sick calves were born in a small yard that was very dirty
- All the healthy calves were born in clean grass paddocks

Para-veterinarian's actions

> You examine the calves and treat them.
>
> You advise the farmer that causes for these abscesses include: dirty calving environment, damp/wet conditions, exposure to bacteria, and lack of milk (colostrum) in the first 6 hours.
>
> You advise the farmer how to prevent further cases mainly by trying to have a clean environment for calving. The small yard is a cause that can easily be changed to prevent further cases. It is possible the new cows may have brought a new bacteria with them because the older calves do not have the

disease. However, because the cows also changed paddocks it is hard to determine if this is true.

Epidemiology context

Epidemiology skills help us to think about the **patterns of disease** in the two groups of calves (sick and healthy) and how these differences can be related to the likely **causes of disease**.

We can use this information to provide the best treatment for affected calves and advise the farmer about what he can do to reduce the amount of disease in the future, providing long term benefit to the farmer that will improve animal health and productivity and reduce costs and losses into the future.

Example 3

Case introduction

You visit a farm where there are 2 cows with diarrhoea.

Information collected during investigation

- The 2 cows are both 2 year old Bali cows
- They have been kept separate from the other cows because they recently calved
- All the cows on the farm were wormed 3 weeks ago.
- All they have to eat is short grass in the small paddock near the shed.
- There are no cows on the neighbouring properties.
- Both cows look weak, their eyes are sunken and they are depressed.
- They have very foul smelling watery diarrhoea that contains fresh blood
- They are dehydrated
- Their temperatures are increased above normal: 39.8° and 40.1°

Para-veterinarian's actions

You examine the cows, take samples for laboratory investigation, and treat them.

You advise the farmer that the infectious agents that may cause diarrhoea (*differential diagnoses*) include: Bacterial infection of the intestines (Salmonella, E-coli), Bovine Viral Diarrhoea Virus, Parasites. Due to the fever and severe illness and foul smelling diarrhoea a bacterial infection is most likely.

You advise the farmer this may be a zoonotic disease. Everyone must be careful and be sure to wash their hands before they eat or prepare food, especially after coming in contact with the cows.

You advise the farmer how to prevent further cases:

- Keep the 2 cows and the calf separate from the other cattle (isolate)
- Healthy cows are to be kept higher up stream along the drain line from the 2 sick cows and the calf

Epidemiology context

Epidemiology skills help para-veterinarian to understand likely **causes of disease** and use this information to provide the best advice for treatment of the two sick cows and also for prevention of transmission of the disease to other animals on the farm.

Epidemiology skills also allows you to recognise when a **zoonotic disease** may be present and to provide the best advice to people to help prevent humans getting the disease.

Example 4

Case introduction

You visit a feedlot and cattle trader where there are cows and calves with pinkeye.

Information collected during investigation

- There are many cattle with pinkeye in one or both eyes
- The feedlot feeds very stalky grass in a large feed trough off the ground
- It is very dry, there has been no rain for some time

- There are big piles of dung close to the feedlot and there are many flies
- There is little shade in the feedlot
- There are always cattle coming and going but there is always pinkeye. At the moment the feedlot is very full

Para-veterinarian's actions

You examine the animals and treat them.

You advise the farmer that causes of pinkeye include:

- Young cattle
- Flies
- Dust
- Physical characteristics of the animal, eye conformation (bulging eyes), lack of coloured (pigmented) skin around the eyes
- High sunlight (UV) exposure
- Crowding (high population density)
- Feeding long stalky grass

You advise the farmer that the infectious agent of pinkeye is *Moraxella bovis.*

Some strains cause more severe eye disease than other strains.

You provide treatment for the affected animals.

You advise the farmer how to prevent further cases:

- Separate animals with pinkeye from the healthy animals (isolate), monitor the cattle and remove any newly affected animals as soon as they are noticed.
- Move the piles of dung further away from the feedlot and try and reduce the number of flies.
- If possible source another type of feed that is not long and stalky, consider modifying the feeding troughs so the feed is not standing upwards, and consider spraying dry feed to reduce dust.
- Try and do cattle work in the mornings when there is less dust and sunlight. Consider watering the yards before working the cattle
- Recognise that having more cattle in the feedlot will increase the occurrence of disease, particularly when other causes are present (dry, hot, dusty conditions). When multiple causes are present, preventive strategies should be implemented even if there are no cases in order to try and prevent new cases from occurring.
- If vaccination is available and economically viable consider vaccination to reduce disease.

- Do not bring new cattle that have pinkeye as you will introduce the infection to the animals in the feedlot. Try to avoid moving infected animals from the feedlot to other groups of cattle for the same reason.

Epidemiology context

Epidemiology skills also help us think about the **causes of disease** and the **methods of spread and transmission** the infectious agent uses to infect animals.

Knowing about the epidemiology of this disease will help you to provide the best treatment for affected animals but even more importantly, field epidemiology skills allow you to provide advice for preventing the disease from occurring.

Prevention is important when there are cases already occurring in order to minimise the number of animals that get affected and require treatment. These are control measures that are implemented in the face of an outbreak.

Finally, the trader can also act on your advice to put preventive strategies into place when there is no pink eye occurring but when known causes of the disease are present. This allows the trader to reduce the risk of disease occurring, which will improve animal growth and profitability and reduce his costs into the future.

Example 5

Case introduction

You visit a chicken farm where there are some chickens that have drooping heads, closed eyes, sneezing, and greenish diarrhoea and there has been chicken deaths.

Information collected during investigation

- this is mainly a problem in the young chickens
- the chickens are not eating and have little energy
- there were a few new birds that were sick when they arrived at the farm 8 days ago
- there were a few sick chickens 3 or 4 days ago and now there are many
- there are many chickens in a small area and it is a bit dirty
- there are wild birds nesting in the roof

Para-veterinarian's actions

You conduct some post-mortems on dead chickens and take samples from these and from sick chickens for laboratory testing.

You advise the farmer that causes of this disease could include:

- Introduction of the disease into the farm by newly bought chickens
- Wild birds
- No vaccination
- Young age of chickens
- Crowding (high population density)
- Visitors with dirty clothes (contaminated with the infectious agent)
- Contaminated food or water

You advise the farmer that the infectious agent (*differential diagnoses*) could be Newcastle disease, avian influenza (Highly pathogenic HPAI), duck plague, acute poisoning, fowl cholera, and mycoplasmosis. The incubation period could between 3 and 5 days. For your area the most likely infectious agent is Newcastle disease.

You advise the owner that the chickens have clinical signs fit a priority syndrome (MMU or sudden increase in mortality in chickens and other poultry). This has to be reported to iSIKHNAS as MMU. Further actions including government response activities and control strategies, may be required if a priority disease is confirmed once laboratory results are obtained.

You advise the farmer this may be a zoonotic disease. Everyone must be really careful to avoid very close contact with sick or dying birds, not to drink or wash with water from the chicken shed and be sure to wash carefully after handling birds and before eating or preparing food.

You advise the farmer how to prevent cases in general:

- Don't keep chicken too many chickens in a small area and keep the area clean

- Keep chickens in good health – worm, vaccinate, provide good feed and water
- Dispose of dead birds properly (bury or burn them)
- Separate sick birds from healthy birds
- Keep wild birds from coming into contact with your chickens
- Develop strategies to reduce the likelihood of introducing the disease into your birds from new birds or from visitors – only bring healthy chickens onto your farm, separate new chickens for 10 days if possible to see if any signs of disease develop, and ensure that any visitors are clean and have not come straight from other poultry farms to your farm.

Epidemiology context

Epidemiology skills help para-veterinarian to understand likely **causes of disease** and use this information to provide the best advice for treatment and prevention of disease in other animals on the farm.

Field epidemiology and your knowledge of priority diseases and priority syndromes and your training in iSIKHNAS allow you to report this case as a priority syndrome and ensure that appropriate disease investigations are conducted to diagnose the cause. If a priority disease (such as HPAI) is confirmed this will then lead to the correct response actions as outlined in national policy.

Where the investigation identifies some other disease agent (such as Newcastle disease) as the cause and rules out a priority disease, then routine disease control measures will apply based on treatment and prevention measures for that disease. This is an example of successful disease surveillance and indicates that the iSIKHNAS system and the para-vet service is doing exactly what they should be doing – investigating disease occurrence to identify the causes and act accordingly.

Epidemiology skills allow you to provide useful advice on future management of the farm to prevent new infections being introduced.

Epidemiology skills also help you to think about possible zoonoses and provide appropriate advice to the farmer and his family so they can minimise the chance of getting sick themselves.

10.2 Field Epidemiology in priority disease control programs

Field epidemiology skills are very important for para-vets involved in priority disease control programs. The understanding of causes and the effect of disease at a population level is very helpful when thinking about why different strategies are used to control specific diseases, and also in explaining processes to farmers.

Example 6

Case introduction

> You visit a farm where there are dead cow with un-clotted blood oozing from their orifices.

Information

- There have been cases of anthrax on the same farm years ago
- There are 4 dead cows and another 15 live cows on the farm

Para-veterinarian's actions

> You examine the dead animals and take samples.
>
> You advise the farmer that this is a priority syndrome (MTD - Sudden death with blood from the orifices in cattle), and that you need to report this to iSIKHNAS. There will most likely be a formal government investigation and response. This is also a dangerous zoonotic disease.
>
> You advise the farmer of initial control strategies that they can start to put into place today to prevent further cases:

- remove any live animals from the immediate area where the dead cattle are or from potential sources of anthrax - **Animal management**
- consider treating live animals that have been in contact with the dead animals with penicillin to treat or prevent anthrax – **Animal treatments**
- stop any new animals entering the farm or sick animals leaving - **Control of animal movements**
- proper disposal of the carcasses of dead animals is very important, and all people should pay attention to hygiene when handling the dead animals and the dead animals are not suitable for eating - **Biosecurity**

You advise the farmer that it is really important to control this disease because it can last so long in the environment and can also kill humans. Additional control strategies may be put into place once anthrax is confirmed including:

- Separating animals and humans from potential sources of infection and preventing animals and sometime humans from going onto or off the farm - **Quarantine**
- Conducting a vaccination program for live animals on the farm and possible surrounding farms or district - **Vaccination**

Epidemiology context

Epidemiology skills help us to understand **causes of disease** and think about **control strategies** to prevent further cases.

Effective use of iSIKHNAS will help in rapid reporting of a priority syndrome and in triggering an investigation with appropriate laboratory testing to confirm the diagnosis of anthrax. This ensures that effective control measures can be put into place as soon as possible and minimise the risk of additional animal deaths or infection in humans.

With anthrax this is important as it can cause disease and death in humans. Some control strategies can be implemented immediately to help prevent further cases. Other control strategies need formal government direction such as quarantine or more in depth planning and funding such as vaccination programs.

Example 7

Case introduction

A cow is reported to be drooling saliva on a nearby farm.

Information available

- The cow has been examined and some lesions observed on the mouth and tongue that resemble ulcers and fluid filled blisters or vesicles.
- The case has been identified as a priority syndrome (PLL − limping, excessive salivation and vesicles on the mouth / foot / teat in cattle).

- Samples were sent to the laboratory
- The case has been reported to iSIKHNAS and there has been a formal government response involving DINAS veterinarians.
- The following control strategies have been implemented:
  - Quarantine - locally
  - Biosecurity
- The IndovetPlan for foot-and-mouth disease outlines further control strategies if the laboratory result is positive. These may include
  - Quarantine for larger areas
  - Slaughter programs
  - Vaccination programs
- The laboratory result and other information rule out foot-and-mouth disease for this particular case

Para-veterinarian's actions

You ensure the community, especially local farmers, are aware of the serious nature of FMD to Indonesia and that they understand why control measures are being used before a confirmed case exists.

You need to communicate and celebrate with the community and the affected farmer that FMD has been ruled out because of the testing that was done. This will include having to explain why it was important to have initial control measures in place before the test results were released, just as a precaution in case the cow did have FMD. As soon as the negative test result is released the control measures were removed.

Epidemiology context

Epidemiology skills help to understand **signs**, **syndromes, differential diagnoses,** how a **definitive diagnosis** is reached, and the **approach to disease investigation.** This combined with an understanding of **causes**, **transmission,** and **spread** of diseases and knowledge of the need to recognise, investigate and control priority diseases will allow you to explain why it is important to start control strategies before a diagnosis is confirmed.

Effective use of iSIKHNAS ensures that the initial priority syndrome is reported rapidly and that appropriate measures including laboratory testing and initial control

measures are carried out quickly to prevent any possible spread of disease just in case it had been a priority disease such as FMD.

This is an example of successful disease surveillance and indicates that the iSIKHNAS system and the para-vet service is doing exactly what they should be doing – investigating disease occurrence to identify the causes and act accordingly.

Example 8

Case introduction

> There has been a rabies control program running on this area for the last 2 years

Information available

- In the last 2 years there have been 86 confirmed rabies cases in dogs and 3 cases in humans
- The current vaccination program has been running for 18 months
- The current estimate of dogs in the area is 2000
- The current estimate of vaccinated dogs is 1200 (60%)
- The program's goal is to vaccinate 80% of dogs

Para-veterinarian's actions

> You ensure the community is educated about the risk of rabies, the control program, and the importance to avoid being bitten by dogs.
>
> You work with the dog catching and vaccination team. You need to ensure that as many dogs are vaccinated as possible, they are given booster vaccination if required, the vaccine is always stored at the right temperature, results of each days vaccinations are entered into iSIKHNAS.

Epidemiology context

Epidemiology skills help us to understand **disease progression in individuals and populations** and how vaccination can be used to reducing the susceptible population. The vaccination program aims to reduce the number of susceptible

animals by increasing immunity and reducing the **transmission** and **spread** of disease. Epidemiology also helps us to understand how the concept of **herd immunity** is helpful in disease control since it means that provided a high proportion of the dog population is vaccinated (more than 70-80%), the herd immunity effect will mean that the vaccination program should result in a progressive reduction in the number of new cases of rabies in dogs.

Knowledge of zoonotic diseases helps us to communicate effective strategies for humans to prevent exposure (avoid being bitten) and to go to a doctor for post-exposure treatment (PET) if they have been bitten by a dog that may have rabies.

Example 9

Case introduction

> There has been HPAI confirmed in a chicken farm in your area

Information available

- The investigations identified many chickens were sick or dead
- Laboratory samples were taken and the laboratory confirmed HPAI virus
- The laboratory test result and the clinical signs mean that HPAI has been confirmed as the definitive diagnosis in this case
- There has been a formal government response including the following control strategies:
  - Slaughter
  - Quarantine
  - Biosecurity
  - Vaccination programs for surrounding areas

Para-veterinarian's actions

> You ensure the community is educated about the risk of HPAI, the control program, and the importance getting rid of this disease. You explain to the community why all the chickens need to be slaughtered and how the disease can cause deaths in people. You explain why biosecurity is very important to prevent humans spreading the disease to new farms

You work within the different parts of the control program.

Epidemiology context

Epidemiology skills help us to understand **causes of disease** and think about **control strategies** to prevent further cases. HPAI is important as it can cause disease and death in humans. A number of control strategies need to be used together to best prevent spread of the disease.