Biosecurity guidelines for piggery

Introduction

Pig rearing is one of the most important occupations of rural society especially among the tribal masses of India. It has largely remained under free range rearing with the weaker sections of the society both as a source of income and a choice of meat for consumption. Pig is one of the most efficient feed converting animals among all domesticated livestock species and can play an important role in improving the socio-economic status of the weaker sections of the society. Bulk of the pig population in India is indigenous type with low growth rate and productivity. The share of pork to the total meat production has been almost static for last 15 years at about 10%. Average meat yield of pigs in India is about 35kg/animal, which is about 55% less than the corresponding value of world average (78kg/animal). Over 70% of the pigs kept in India are indigenous. Pig rearing is still in the unorganized sector that requires science and technology driven support to make it a vibrant enterprise. The various stakeholders require promotion at various levels such as technology, entrepreneurship development, and financial support for Indian pig farming in attaining a place at global level. Further the shrinking land and water resources as well as threats from the changing environment besides emergence of new diseases are gradually expected to limit the capacity for pork production optimization. If the country does not take suitable step now to develop and execute scientific strategies to address the issues of bridging the gap between need and availability of pork, other countries, taking the advantage of globalisation, shall make inroads to a sector that is so inextricably linked with the economic condition of rural poor in the country. It is considered that the pig farming has immense potential to ensure nutritional and economic security for the weaker sections of the society. The pig population scenario over the decades in India indicates a decline in growth rate, which is a cause of concern. As per the latest livestock census, the pig population in India is 10.29 million. Majority of our pig population is owned by marginal and small farmers and landless labourers, who cannot effort much for scientific piggery which needs good housing, quality feed and better health management. Theses farmers are also not much aware about the diseases, which may have significant impact not only on the pig heath but also on human health. To sustain pig production in India and also to produce safe pork for human consumption the guidelines on biosecurity plan is prepared. Good herd biosecurity is essential to maintain herd health status and also for undertaking control or eradication programme of diseases. Biosecurity is a cornerstone of herd health maintenance. Management of disease outbreaks and

control of endemic diseases are challenges in many pig production systems, but particularly in small holder pig systems in developing countries like India, where high mortality and morbidity rates are a major problem.

Definition of biosecurity

Biosecurity is defined as: "The implementation of measures that reduce the risk of the introduction and spread of disease agents; it requires the adoption of a set of attitudes and behaviours by people to reduce risk in all activities involving domestic, captive/exotic and wild animals and their products" (FAO/OIE/World Bank, 2008). The OlE's *Terrestrial Animal Health Code* (OlE, 2008b) Code defines a biosecurity plan as: "a plan that identifies potential pathways for the introduction and spread of disease in a zone or compartment, and describes the measures which are being or will be applied to mitigate the disease risks, if applicable, in accordance with the recommendations in the Terrestrial Code" (OlE, 2008b).

Biosecurity at the National Level

At the National level, biosecurity mainly concerns on the development of strategies to prevent the spread of disease outbreaks, control or eradication of endemic diseases and transboundary disease transmission. The department of Animal Husbandry, Dairying and Fisheries, Govt. of India should identify the major economic diseases of pig and undertake action plan for control and eradication of the diseases on priority basis. The department should also develop strategies to establish quarantine/check posts at the porous borders of the country to prevent illegal migration of pigs from the neighboring countries.

Biosecurity at the farm/state level

The following points need to be considered while preparing biosecurity plan at the farm/state level.

Location of pig farm

The location of pig farm is a critical factor in the control of diseases. Ideally, a pig farm should be situated in an isolated area, far away from other animal farms. In high pig density areas, highly contagious diseases can spread with ease. The disease problems of farms where the density of pig population is high, illustrate the difficulty of preventing the spread of infectious diseases in places where pig farms are situated close to one another. In densely populated pig farm areas, it becomes very difficult to prevent the entry of some diseases into the farm.

Herd size

Many pathogenic microorganisms need a host to multiply. This is particularly true for organisms like viruses that cannot replicate without a susceptible animal. Therefore, every susceptible pig represents a potential virus factory. Each infected pig can generate and excrete millions of virus particles into the environment. If a new disease enters into a large herd, there are many susceptible pigs to infect. In a small herd, it may take a very short time before the entire herd is infected. Therefore, the outbreak in a small herd may not last very long. However, in a large herd, the outbreak will last longer because there is no shortage of susceptible pigs.

Introduction of new pigs

Bringing a new pig is the single most important method of introducing a new disease into a farm. Pathogens can enter a farm by several ways. When farmers buy pigs, many a times they do not know the health status of those purchased animals. As a result, bacteria, viruses, skin parasites or worms come along with those purchased pigs. For better disease control, it is always advisable that the pigs should be brought from one farm/ source, if possible. If this is not possible, then the boars may be purchased from one herd and the gilts from another. When pigs are brought from a farm, one must be prepared to "inherit" the same disease problems which the pigs had in their respective farm. It is quiet natural that different farms may have different health problems. If breeding stocks are brought from many different farms, one may eventually end up with a collection of nearly all the major disease problems in their farm. This is the main way by which most infectious diseases enter into a farm. This is why most outbreaks occur after the introduction of new pigs into the farm. Even common organisms such as *E. coli* or rotavirus, can cause problems if one introduces new strains for which their pigs have no immunity against. A breeder farm that regularly buys pigs from different farms from different countries can end up having intractable problems either because of introduction of new pathogens or new strains of common pathogens (for which the resident herd as no immunity). The purchase of pigs directly from market places should be strongly discouraged as it is also one of the important causes of spread of various diseases to healthy pigs from infected one.

Replacement stock

Buying pigs from different sources should be avoided to the extent possible. Closed herds (i.e. farms that breed their own replacements) generally have the fewest problems. The worst culprit in introducing new diseases into a farm is the pig itself. If pigs are brought from several farms there is a greater risk of introducing diseases into the farm. If one has to buy replacement breeders, it is important to buy from a farm with high health status with sound disease control program. The general principle is that the health status of the farm where the pigs are kept must be superior to the receiving farm.

Quarantine

Quarantine is a very useful method to detect the more dramatic diseases in time to prevent their spread. In acute diseases, pigs that are recently infected may not show any sign of the disease but if these pigs are kept under observation for few weeks, they may start showing signs of the disease. Newly purchased pigs should be kept separately from the rest of the herd for a period of time. It is highly desirable that quarantine shed should be situated away from the main herd/ herds.

The quarantine period should be at least 3 weeks. During the quarantine period, the new pigs should be observed frequently for any signs of disease and should be treated for internal and external parasites (preferably this should be done on the farm of origin), and their blood tested for antibodies to diseases such as brucellosis, PRRS, PCV2 and PPV infections etc.

It must be kept in mind that quarantine is not a perfect method for preventing the introduction of new diseases. There are many chronic diseases where recovered pigs remain as carriers without showing signs of illness. These pigs will continue to shed the organisms. Quarantine is useful for pigs incubating acute diseases. We must be aware of the inadequacies of farm quarantine. It is not effective for highly contagious diseases (e.g. transmissible gastroenteritis, foot and mouth disease).

Pig buyers

In most farms, the pig buyers used to enter the farm to catch and weigh the pigs. The same person may also enter another farm after visiting the first farm. Those pig buyers should not be allowed to enter inside the farm or if at all required they should follow the biosecurity measures like change of shoes and putting apron etc. in order to prevent the entry of diseases into the farm.

Visitors

It should always be determined whether it is necessary for the visitors to enter the farm or not. The entry of visitors to the farm should be restricted to the extent possible. In many farms, visitors are often permitted to enter the farm without any precautionary measures. At the minimum, they should wear gum-boots provided by the farm. Footbaths should always be available. Chlorine, iodine and alkaline compounds are most useful to destroy bacteria and viruses. Any person, procedure or agent that is capable of suddenly introducing a new agent into a pig herd must undergo a basic disinfection procedure. While not all the measures proposed can be undertaken by all farmers, some modifications can be made in the interest of safety. For instance, one can improvise foot baths by placing a bucket of water with disinfectants in front of their visitor and insists that he immerses his shoes or gumboots in it.

Fencing

When pigs farms are situated very close to each other with no physical barrier such as a fence between them then disease control measures become exceedingly difficult, as it becomes almost impossible to prevent the rapid spread of diseases that can be transmitted between farms by vectors, such as people and animals including dogs and rats. Therefore, it is not surprising that in such cases outbreaks of diseases occur almost routinely, and all the diseases that are present in the country are present in such localities. All pig farms should therefore be fenced off. A simple chain-linked fence should keep out people and animals such as dogs.

Workers

Workers must understand the importance of the measures that one follows in his farm. They should not bring any human food into the pig compound beyond the office. There should be a dressing room in the office where workers can change their clothing. Gum boots should be provided for all the workers of the farm.

Vaccination

Regular vaccination programmes for endemic diseases such as swine fever and FMD are essential in this country. There are even farms that have not vaccinated their pigs for more than a year. Since pigs are marketed at seven to eight months of age, and the production herd out number the sows by about 10 to one, failure to vaccinate pigs for half a year would result in almost 90 per cent of the pigs in the farm being susceptible to swine fever. Unfortunately, in farms where swine fever vaccination is irregular are usually those that are exposed to the greatest risk of swine fever outbreaks. These farms are situated in high-risk areas i.e. areas of high concentration of pig farms.

Farm design

The natural barrier to the spread of diseases is distance. Just as there should be as much distance as possible between pig farms and there should be a reasonable distance between the different age groups. Older pigs have greater resistance and immunity to diseases than younger pigs. Therefore, the different age groups must be kept separately. The only place in the farm where this rule is violated is the farrowing shed, where the sow mingles with her piglets. And it is also in this area where the mortality rate, due to infectious disease, is usually the highest.

Most of the pig farms in this country are poorly designed. Overcrowding and poor ventilation are two of the important factors that contribute to disease and poor performance. Heat stress is a common problem. Farmers must recognize that management practices that permit pigs to be stressed contribute to disease problems. In many cases, these problems can be alleviated, if such management defects can be corrected.

The layout of the sheds should be such that boar pens or mating area should be farthest from the entry gate, followed by dry sow area, farrowing shed, weaner sheds, grower-finisher sheds, with holding pens for market age pigs nearest the loading ramp or fence. The office should be near to the loading ramp.

Management practices

Management plays a very important role in most disease problems. Poor management and husbandry practices predispose pigs to disease problems. Malnutrition, overcrowding, pregnancy, parasitism, vaccination, heat, cold, weaning and dirty pens represent stress factors. Stress affects the immune system and reduces resistance of the pig to disease agents. For instance, cold stress is an important predisposing cause of neonatal piglet diarrhoea. In many pig farms, there are no heat lamps. As a result, piglets are subjected to cold stress, especially if they are born during a cold night or during the rainy season. This makes them more susceptible to colibacillosis. Even non infectious diseases are caused by management failures. The thin sow syndrome, for instance, is caused by inadequate nutrition. Lactating sows should be fed *ad libitum*. In many farms, the farrowing house is poorly designed. As a result, the building is often excessively hot. Farmers are forced to wash the sows every day. Washing them often means making the piglets and the pen wet as well. It is well known that a wet farrowing pen encourages the growth of bacteria such as *E. coli*. A clean dry farrowing pen is better for piglets than one that is constantly wet. Ideally, the farrowing pen should be kept dry for at least one week after farrowing. Faeces should be removed properly. However, in many farms, piglet diarrhoea becomes very difficult to control because of faulty management practices. Many infectious diseases would not become so severe if they were not compounded by poor management and other husbandry factors. Problems such as diarrhoea, enzootic pneumonia, uneven growth and unthrifty pigs following weaning, are more often the result of factors such as overcrowding, insufficient trough space or water supply, poor quality of feed, unfavorable temperature and poorventilation control rather than infectious agents. In many instances, the solution does not lie in the use of antibiotics or other medication. In the long term, proper housing and management practices are far more important in the control of diseases than the use of drugs alone.

Check posts and quarantine at the International boundaries

To prevent the entry of transboundary animal diseases there is urgent need to establish check posts and quarantine at the points through which migration of animals

takes place from the border countries.

BASIC BIOSECURITY MEASURES AT THE FARM LEVEL

The measures that can be used to improve biosecurity can be categorized in several ways. One way is to classify measures according to three goals: isolation, sanitation and traffic control. Another way is to classify measures into three steps:

1. Segregation
2. Cleaning
3. Disinfection

Segregation

It is the first and most important element of biosecurity. It involves keeping potentially infected animals and materials away from uninfected animals. Segregation is regarded as the most effective step in achieving the required levels of biosecurity; if a pathogen does not enter a holding, no infection can take place. No animals or materials should enter or leave a pig holding unless absolutely necessary: this includes not only pigs, but also other species (including humans) that may be infected with pathogens and that can also infect pigs.

Cleaning

The next most effective step in biosecurity is cleaning. Most pathogen contamination on physical objects is contained in faecal material, urine or secretions that adhere to the surface and therefore the cleaning will remove most of the contaminating pathogen. Any materials that must pass through the segregation barrier (in either direction) should be thoroughly cleaned.

Disinfection

The final step of biosecurity is disinfection. The Terrestrial Code defines disinfection as: "The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; this applies to premises, vehicles and different objects which may have been directly or indirectly contaminated" (OlE, 2008b). Disinfection is important when performed consistently and correctly, but should be regarded as a final "polishing" step in biosecurity, used after effective and comprehensive cleaning. Disinfectants are often not available in village conditions, so any programme that emphasizes their use will invariably be hampered. Even when available, disinfectants are often incorrectly used. The effectiveness of disinfection under ideal controlled conditions differs from its effectiveness in field conditions. Disinfectants will not necessarily penetrate dirt in sufficiently high concentrations, nor will they be present for sufficient time to be effective. In addition, many disinfectants are inactivated by organic materials, such as wood or faecal material. Thus, although important, disinfection can be regarded as the least effective step in biosecurity.

Health Alarm List for Pig unit

The veterinarian or the health personal should be informed as soon as possible if any of the following signs are seen by a working member of the pig herd. This is important to reduce any time delay between an outbreak and effective treatment.

Any age groups	The development of lameness in pens or groups of pigs
	Blisters on the snout or excessive salivation in pens or groups of pigs
Sows	Four or more sows off their feed with an elevated temperature
	Four or more sows breathing rapidly and with obvious respiratory

	distress
	Four or more sows aborting within seven days
Suckling herd	A noticeable rise in pre-weaning mortality over a week period
Growing-finishing herd	A noticeable rise in post weaning mortality
	Scour spreading through any age of pigs
	A marked rise in the number and severity of pigs coughing or with laboured breathing
	Three or more unexpected deaths in one day

STEPS TO DEVELOP A PRACTICAL BIOSECURITY PROGRAM FOR A PIG FARM

Step 1. Describe the farm

Information regarding the type, location, facilities, pigs, and diseases present on the farm will help in better designing the biosecurity program for a farm. Questions to ask for each category include:

A. Classify the farm. What type and size of farm he/she wants to operate?

- Nucleus herd
- Multiplier
- Boar Stud
- Farrow-to-wean
- Farrow-to-finish
- Fatteners
- A few pigs for the family consumption only

B. Location. Is the farm in a pig dense area?

- How close is the nearest swine unit to the farm?
- What is the distance of other livestock units to the farm?
- How many units are within 2 miles of the farm?

C. Facilities

- Farm has an outdoor, partial confinement, or total confinement operation?
- How many sites?
- Can one control access to the facilities?
- How old are the facilities?
- Are the facilities cleanable?

D. Pigs. The ability of a pathogen to infect a pig depends a lot on the characteristics of the pig.

- How old are the pigs? Generally, younger animals are more susceptible to infection.
- Are the pigs immunocompromised? Some diseases can prevent the immune system of the pigs from working properly. Early weaned pigs do not develop natural immunity to some diseases so they are more susceptible and generally get very sick if exposed to some common diseases.
- How effective the vaccination program? Many vaccines are very good in protecting pigs from signs of disease, while others are less effective.
- Are the pigs genetically resistant to certain diseases?
- Is the environment, nutritional program, management program, optimal for pig health. Stressors can make a pig more susceptible to disease.

E. Diseases

- What diseases are currently infecting the pigs?
- What diseases are currently causing the most problems on the farm?
- What are the concerned diseases that are not present in the farm?

F. Movement of pigs, people or other vectors (trucks/equipment) within the farm

- How the pigs move or enter to the farm?
- What is the source of pigs?
- What is the source of semen, feeds, etc?
- How do employees move about within the system?
- What is the current program for rodent control and exclusion of other animals (dogs, cats, etc) from swine contact?

Step 2: Set goals

- Does the owner of the farm want to keep specific diseases off of his farm?
- Does he want to keep diseases that are already on his farm from spreading to different groups of animals or to neighboring farms?
- Does he want to do both?

Step 3: Select the target pathogens

To implement an effective biosecurity program one must pick the diseases that he wants to target. This process works just like selecting a vaccination protocol. By selecting specific pathogens increases the chance of success and makes it easier for monitoring the success of the program.

Step 4: Get to know about the enemy

Pathogens vary in their ability to cause disease. Some questions to ask about the target pathogen include:

- How severe is the disease? How many pigs get infected? What is the death loss in infected pigs?
- What is the impact on productivity?
- How is the pathogen transmitted? By direct contact with infected pigs? By aerosol? By rodent carriers?

- How contagious is the pathogen? Do pigs shed the pathogen in large numbers?
- How long does the pathogen live outside of the pig? Can the pathogen survive for extended times in the environment?
- How often are the pigs exposed to the pathogen?
- What are the sources of the pathogen? Pigs? Semen?Rodents? Air? Water?

Step 5: Implement a biosecurity program

Investigate possible biosecurity procedures to minimize the chance of infection with the target pathogens. Select those protocols that appear to be best for the farm.

Step 6: Monitor the effectiveness of the biosecurity program

This step involves periodic testing to determine how well the biosecurity protocol is working. Periodic monitoring of the biosecurity program is recommended. The veterinarian can collect blood samples for serology to see if the animals have been exposed to a pathogen, perform necropsies and collect samples to isolate pathogens, or do slaughter checks to monitor the success of the protocols.

Finally, it should be remembered that biosecurity protocols will not work 100% of the time, just like vaccines do not prevent disease 100% of the time. The goal of the program should be to minimize the chance that the pigs will get infected by the target pathogen.

DISEASES OF PIGS, THEIR ROUTES OF TRANSMISSION AND IMPLICATIONS FOR BIOSECURITY

Important diseases of pigs

Pigs are typically affected by three major groups of pathogens viz. parasites, bacteria and viruses. Pigs can act as a host for a variety of other life forms, which range from the relatively large *Taenia solium* worms which can reach up to 7m long to the extremely small Circovirus which is only 17nm in diameter. Under normal circumstances most of the life forms do not harm the pig. However there are certain organisms which are potential pathogens and usually cause diseases. The major bacterial, viral and parasitic diseases of pigs are shown below.

Important Diseases caused by bacteria

- Actinobacillosis
- Atrophic rhinitis
- Bordetelosis
- Brucellosis
- Campyobacteriosis
- Clostridium infection
- Colibacillosis
- Edema disease
- *Streptococcus suis* infection
- Pateurellosis
- Erysipelas
- Exudative dermatitis
- Leptospirosis
- Listeriosis
- Salmonellosis

- Mycoplasma infection
- Yersiniosis
- Glasser disease
- Tuberculosis

Important viral diseases of pigs

- Classical swine fever
- Foot-and-mouth disease
- Rotavirus infection
- Porcine circovirus infection
- PRRS
- Porcine parvovirus infection
- Swine pox
- Pseudorabies
- Swine influenza
- Hepatitis E virus infection
- Japanese B encephalitis
- Nipah virus disease
- Enterovirus encephalomyelitis
- TGE

Important parasitic diseases of pigs

- Porcine cysticercosis
- Ascariasis
- Cryptosporidiosis
- Coccidiosis
- Mange
- Metastrongylosis
- Toxoplasmosis
- Trichinellosis
- Trichuriasis

Infectious diseases of transboundary nature

The porous international borders more particularly in the North Eastern Region of the Country and migration of live pigs from the neighbouring countries like Myanmar, Nepal and Buthan etc make the Country vulnerable for the transboundary diseases. For example the recent outbreak of PRRS in Mizoram was due to migration on pigs from Myanmar to Mizoram and due to biosecurity lapses. There are many transboundary diseases which are prevalent in the South and East Asian Countries. These diseases can enter to our country unless biosecurity including check posts/quarantine sheds are established or strict measures are taken to prevent the entry of pigs from the neighbouring countries.

Other severe infectious diseases

These diseases are highly contagious and are consequently widespread around the world; they can occur in epidemics, striking in waves, and some also result in an endemic form, with persistence of viral activity in herds over long periods. Porcine reproductive and respiratory syndrome **(PRRS)** - and to a lesser extent swine influenza - often show the endemic pattern. On farms with no appropriate control measures, such diseases can have a serious economic impact.

Zoonotiic diseases of pig origin

Zoonotic diseases are those in which people are infected with pathogens carried by pigs. They can be transmitted directly through pig-to-person contact, or indirectly through consumption of contaminated food/pork. *Streptococcus suis,* is considered an occupational health hazard for those working in the pork industry. Recently, a link was suggested between Methicilin-resistant *Staphylococcus aureus* (MRSA) in pigs and MRSA infection in humans. The domestic pig is known to be susceptible to several other zoonotic diseases: rabies, leptospirosis, brucellosis, erysipelosis, tuberculosis, Japanese B encephalitis (JE),hepatitis E virus infection etc. Pig meat from infected pigs, when consumed raw or inadequately prepared, can transmit a number of pathogens, such as *Trichinella* spp., *Cysticercus* spp., *Salmonella* spp. and *Listeria* spp.; for the last two, inadequate hygiene during meat processing or at home can also be a source of contamination.

ROUTES OF DISEASE TRANSMISSION AND IMPLICATIONS FOR BIOSECURITY

- Direct pig-to-pig contact
- Semen
- Airborne transmission
- Visitors
- Vehicles and other fomites
- Pig feed, including swill feeding, and drinking-water
- Pig manure and bedding
- Birds, bats, rodents, feral and wild pigs and stray/domestic animals and arthropods

Direct pig-to-pig contact

Many pathogens are transmitted through direct contact between an infected shedding pig and a susceptible pig. This is the most potent route of transmission for most pig diseases. For pathogen transfer to occur, there must be a sufficient infectious dose of the pathogen from the infected to susceptible animals. For example, swine influenza virus reproduces in the upper respiratory tract and is shed through the nose, so nose-to-nose contact will spread the virus. Close, prolonged or repeated contact between infected and susceptible animals, such as in pens or trucks during transport, increases the likelihood of transmission. Pathogen shedding is not constant and is usually highest during the acute phase of a disease.

Some animals that seem to be in good health may also be shedding pathogens at sufficient levels to spread infection; these "silent carriers" can be seen particularly in endemic diseases. Such animals present a clear risk when moved and commingled with susceptible animals.

Semen

Viral shedding through semen has been well-documented in both experimentally and naturally infected boars. Most systemic viruses can be excreted into the semen, which can be a source of transmission of parvovirus, CSF virus and PRRS virus. Some specific bacterial pathogens causing brucellosis and leptospirosis also shed in semen, but most bacterial ontaminants of semen are from faecal/environmental material. Important pathogens which can be transmitted through infected boar semen are *Actinobacillus suis and* Adenovirus virus, *Brucella suis*,Circovirus ,Classical swine fever virus,Congenital tremor virus, Enterovirus,Foot-and-mouth disease virus,Japanese encephalitis virus, Leptospira, Porcine parvovirus, Porcine reproductive respiratory syndrome virus, Reovirus, Swine vesicular disease virus, Transmissible gastroenteritis virus. Besides, raw semen contains large number of different bacteria.

Appropriate hygiene during semen collection and distribution is therefore of primary importance, together with routine screening of boars for infections known to be spread by semen.

New reproduction technologies and risk of disease transmission

New reproductive technologies like artificial insemination (AI) though considered safer than bringing boars to the farms, yet AI using boar semen may lead to disease transmission. Boar semen is subjected to contamination. Viral shedding through semen has been well documented in both experimentally and naturally infected boars. Therefore, implementation of quality assurance in the semen production centre is a priority. Further, AI by using certified semen reduces the chances of disease transmission. Little information is available regarding porcine embryo transfer in connection to disease transmission. Before hatching the "zona pellucida" offers an inherent resistance to pathogens. However, the delicate question of endogenous viral infection of the embryos is still open.

Airborne transmission

Airborne transmission of pathogens is difficult to assess properly because of too many uncontrollable variables. However, experimentations in totally controlled facilities have clearly shown airborne transmission of several pathogens over short distances. *Actinobacillus pleuropneumoniae* and PRRS virus are transmitted by air over a distance of 1 to 3 m. Aerosol transmission of organisms for more than 4.5 km has recently been described for PRRS virus and *Mycoplasma hyopneumoniae*. Under specific climatic conditions, some strains of FMD virus can be carried by wind for up to 20 km (although it is unlikely that pigs would be infected through this route), and pseudorabies virus for up to 9 km. Swine influenza virus is certainly transmissible through aerosol droplets over short distances.

People

The role of people as transmitters of pathogens to pigs has been studied carefully over the last decade. People can transport pathogens on footwear, clothing, hands, etc. People can carry viruses on their nasal mucosae (nasal carriers) without being infected, and can also be infected by and shed pathogens when they are sick or may remain as carriers with no clinical signs.

Pig workers must be aware of their own potential role in the spread of diseases, as they have physical contact with pigs - including those that are clinically affected - in their daily work. Service providers and intermediaries, such as pig transporters, technicians and veterinarians, may be required to visit several farms on the same day, thereby increasing the risk of disease spread. The same is also true when farm workers or their households keep pigs at their houses.

It should also be remembered that people determine the movements of animals and products among herds, markets and regions. The specific interaction between herds and processors depends largely on the consumer demand and supply of pig products. Large price differentials mean significant - often seasonal - movements of animals, and can therefore spread the disease through increased interaction. Economic forces can cause animals to move large distances, increasing the possibility of geographical spread of disease.

Vehicles and other fomites

Equipments used by pig farmers must be considered as potentially contaminated fomites. Moreover, vehicles can transmit swine pathogens when manure containing disease agents adheres to vehicle tyres or bodywork. There is evidence that *Actinobacillus pleuropneumoniae* and *Streptococcus suis* can be spread by contaminated vehicles. Lorries, trailers, vans and even motorbikes used for transporting pigs or carcasses to rendering plants represent a high risk for disease transmission.

Pig feed, including swill feeding and drinking-water

Feed and water can become contaminated and play a role in maintaining endemic or toxic diseases. As some pathogens can survive in contaminated meat waste, specific attention must be paid to the use of food wastes in feeding pigs (which can include processed pork products, such as dry cured meats, that have not been heated). Fresh pork is a documented risk factor for transmission of a number of pathogens, such as FMD and , CSF viruses. Recently, investigators have also implicated fresh pork as a potential route of virus spread. Many countries prohibit the feeding of unrendered meat products to pigs.

Pig manure and bedding

Manure from infected pigs contains large quantities of viruses, bacteria and/or parasites. Careful disposal of pig manure must be considered when designing and implementing biosecurity programmes, as manure may contain pathogenic organisms, leading to faecal-oral-transmission of diseases. Contamination from pig manure poses a risk to the health of both animals and humans, if the manure is not adequately treated or controlled. The spread of pig slurry on agricultural land may introduce pathogens into the human food chain and ecosystem, if due care is not taken during storage and spreading. Pig manure may contain *Ascaris, Taenia, Cryptosporidium, Yersinia* and *Salmonella* species, *Campylobacter,* faecal coliforms, faecal Streptococci and other pathogens, such as hepatitis E virus.

The bedding material provided to pigs can also spread pathogens; for example, sawdust and wood shavings can carry *Mycobacterium avium* bacteria.

The potential for disease transmission by people, vehicles and/or equipment, feed, bedding material or manure will be affected by temperature: cold temperatures enhance the survival of pathogens, whereas exposure to sunlight and drying tends to reduce survival.

Birds, bats, rodents, feral and wild pigs and stray/domestic animals

Birds and bats are a particular risk for disease spread in open piggeries. Birds (e.g., sparrows, starlings and crows) come into close contact with pigs when looking for feed, and may contaminate other herds with droppings and by mechanical transfer.

Birds can transmit *Bordetella* spp., erysipelas and avian tuberculosis. There is also evidence that birds can transmit the viruses that cause PRRS, influenza and TGE. Rodents, particularly rats and mice, commonly live in close contact with pigs and are involved in endemic disease transmission in pig operations. Rodents may roam the countryside looking for new food sources when pig houses are emptied, and return when they are repopulated and can re-contaminate the incoming pigs. Rodents can travel up to 3 or 4 km from infected areas where pigs are kept and thereby carry the infections. They can carry the agents that cause atrophic rhinitis, *E. coli* diarrhoea, leptospirosis, rotaviral diarrhoea, salmonellosis, swine dysentery, PRRS, *Streptococcus suis* infection and encephalomyocarditis.

Wild animals can harbour brucellosis, leptospirosis, trichinella, pseudorabies and many other pathogens. Wild and feral pigs are a major disease threat as they are common in many areas and harbour pathogens that affect domestic pigs. Among other diseases, feral

and wild pigs may transmit CSF, FMD and pseudorabies etc.

Stray dogs can spread TGE, swine dysentery and brucellosis pathogens, while cats are a potential transmitter of toxoplasmosis to pigs

Arthropods

Certain viruses, including those responsible for JE and PPRS, can be hosted by arthropods, such as ticks or mosquitoes, on which they can replicate, thereby complicating control and eradication programmes. Ticks are unable to travel to pigs, but pigs can be in contact with ticks when they graze or sleep in tick-infested areas. Flies are attracted to organic matter, such as manure and carcasses, and can mechanically spread pathogens such as TGE and *Streptococcus suis* as they fly between farms.

Ten Step Guide in Implementing an Effective Biosecurity Plan in pig farm

Implementing any of these suggestions will reduce the risk of disease entry. Each additional step implemented will further reduce biosecurity risks.
1. Replacement stock should be quarantined and it should be ensured that their health status is compatible with the existing herd.
2. Entry to the farm should be restricted only to essential personnel and their entry should be recorded.
3. Boots and coveralls should be provided for staffs and visitors for each pig shed.
4. Staffs should use dedicated boots and coveralls upon entering each different sheds. Clean footbaths may be appropriate at the entry point.
5. Vaccination programme should be followed regularly.
6. Entry of equipment and other materials to the farm should be minimized and appropriate precautionary measures such as disinfection, removal from shipping boxes etc. should be strictly followed.
7. Entry of wild animals (rats, birds, insects) or pets (dogs, cats) to the farm should be prevented.
8. Semen should be used from a known source, which routinely tests against major infectious agents that can be transmitted through semen.
9. It should be ensured that feed and water sources are free from infectious agents.
10. Biosecurity plan and herd health program, including vaccination protocols should be reviewed on a regular basis.