The interrelation of genetics to health

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An optimised pig performance is a balancing act of genetics, nutrition and health. This was aptly described by Dr Mike Varley in 2007 as the pig performance triangle.

Pig producers and veterinarians would likely resort to modifying nutrition and management techniques plus antimicrobial intervention in case of disease outbreaks.

However, with the increasing awareness on drug residues and antibiotic resistance, there has been an increasing call for geneticists to step up their research and breed for resistance to specific infections without sacrificing growth and reproductive performance.

Such infections may not only be devastating in terms of morbidity and mortality but economically as it could lead to growth retardation or poor reproduction.

Health status of pigs

Based on health status, pigs produced by hysterectomy are classified as axenic or germ free animals. They are used to stock newly built farms. For existing farms, a disease control programme may be established to make herds free from a short list of specified pathogens.

The farm thus establishes a specific pathogen free (SPF) herd. If a pig is produced and reared initially as germ free but deliberately infected with known micro-organisms, the said animal is known as a gnotobiotic pig.

They are used basically for research purposes. In the early 1980s many farms worldwide were established as minimal disease (MD), high health status (HHS) herds. They adopted a strategy popularised by Dr Tom Alexander when they raised segregated early weaned (SEW) and medicated early weaned (MEW) herds.

Incoming pigs are probably the greatest potential source of infection to a herd. The methods by which they are introduced or other methods by which you improve the genetic potential of a herd are vitally important. Adequate and balanced nutrition plus strategic medication is not always insurance to good health.

There are various genetic interventions that could help in keeping pigs healthy:

- Introduction of live pigs.
- Practice SEW or MEW.
- Establish herd by hysterectomy and rational fostering.
- Adopt artificial insemination.
- Do embryo transfer.
- Look at cloning.

Artificial insemination

Artificial insemination is now practised by many farms in more advanced countries of Europe, North and South America although the use of natural insemination is still popular in the largely family owned backyard farms in Asia.

Artificial insemination is geared towards genetic improvement, improved biosecurity, enhanced carcase quality and definitely cost savings as a producer gets the benefit of using the best but minimal number of boars to a bigger sow herd.

The biggest challenge to AI today is the development of a rapid, large scale, cost effective method to determine the sex of sperm cells with the aim of reducing the cost of production, while accelerating genetic progress.

Hysterectomy

Hysterectomy was introduced in the 1970s to commence new herds of disease-free animals. These specific pathogen free (SPF) herds are also reared for animal experimentation.

Embryo transfer

Embryo transfer (ET) provides a humane alternative to the stress of transporting live animals. It is used to propagate superior genes. It is very safe with regard to preventing the introduction of infectious diseases into previously unaffected herd.

The zona pellucida, a transparent, non-cellular, secreted layer surrounding the ovum provides the primary resistance to many viral and bacterial pathogens. These organisms are too large to penetrate the intact zona pellucida.

The small size embryo in its early stage of development and limited mobility will have reduced potential exposure to disease pathogens. Some pathogens do not survive well in embryo support media.

Genetic engineering

Gene therapy involves introducing a new gene or modifying an existing gene (itself or its activity) in cells to treat diseases.

However, the creation of genetically identical animals by means of nuclear transfer or more popularly known as cloning appears to be the direction being taken by most geneticists to prevent or control diseases.

Most cloning today uses a process called somatic cell nuclear transfer (SCNT). Just as with in vitro fertilisation, scientists take an immature egg from a female animal, often from ovaries obtained at the slaughterhouse. Instead of combining the egg with a sperm, they remove the nucleus which contains the egg's genes.

This leaves behind the other components necessary for an embryo to develop.

The justifications for the use of cloning as a genetic intervention are as follows:

- Disease resistance

Sick animals are expensive for farmers. Veterinary bills add up and unhealthy animals do not produce as much meat or milk. With cloning, a disease resistant herd can be developed. These animals are extremely valuable because they do not lose any production time to illness, and will not cost the farmer extra money for veterinary treatment.

- Suitability to climate

Different types of livestock grow well in different climates. Some of this is natural and some results from selective breeding. In Asia, where more than 50% of the world's pig population is grown, performance is still wanting compared to those in temperate countries. Cloning could allow breeders to select those pigs that naturally do well in a

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new climate, and use them to breed more pigs to be used for food production. The good news is that pork production is fast moving towards the different regions in tropical Asia.

- **Quality body type**

Swine farmers could breed strong, heavy muscled and quick maturing pigs that yield high quality meat in the shortest possible time.

- **Fertility**

Pigs need this genetic trait to replace animals that are culled and sent to slaughter. Cloning will allow farmers and breeders to clone only highly fertile animals that could produce piglets that would also tend to be fertile.

- **Market preference**

Farmers may also want to breed pigs to meet the changing tastes of consumers. Preferences vary by culture and cloning may help tailor traits like leanness, tenderness, colour, size of cuts as well as the type of pork products that will suit various international markets and ethnic groups.

Is it safe to eat cloned pork?

While the main purpose of clones is for breeding, and not eating, time will come when meat producing animals can no longer reproduce, and will be put into the food supply. The US FDA, after more than four years of risk assessment studies found that it could not tell a healthy clone from a healthy conventionally bred animal.

All of the blood values, overall health records, and behaviours were in the same range for clones and conventional animals of the same breed raised on the same farms.

Recently, the human medical community has announced the use of pig's liver, skin and small intestines in providing the matrix to regenerate tissues.

Impact of genetics

Porcine stress syndrome is a condition associated with a recessive gene, also known as the halothane gene because of the adverse effect of the halothane anesthetic on pigs carrying it.

Heavy muscled pigs usually carry the gene. Pigs with PSS suffer acute stress and may die suddenly due to malignant hyperthermia. They also show pale, soft and exudative muscle. Back muscle necrosis may be observed and its meat is dry, dark and firm.

During the US National Barrow Show in 1991, it was observed that the Duroc, Hampshire, Landrace, Yorkshire and Spotted breeds had gene frequency of PSS less than 10%.

Poland China had 43% with PSS gene, Pietrain had the highest incidence of PSS gene with 50%, while the Chester White had the lowest incidence at 0.0%.

Genetics figured significantly in the management of PSS. The gene had to be removed from the population.

To improve carcase quality, a homozygous (possessing a pair of halothane genes) or heterozygous (possessing one normal and one halothane gene) male had to be used on stress gene free females. Thereafter, the producer has to maintain a PSS gene free herd.

PRRS control by genetics

Artificial insemination and embryo transfer have been used to control PRRS. This was highlighted in a report by Drs John Pollard and Marie Claire Plante of the Ontario Veterinary College who ran trials demonstrating that the PRRS cycle could be broken using ET in a 280 purebred Duroc farm owned by Arnold Ypma. The PRRS positive farm that used caesareans since 1985 as a disease eliminating technology was transformed to a PRRS negative herd using ET.

Genetic changes in PCVAD

In 2006, Dr Robert Desrosiers said that different breeds, genetic lines or genetic combinations (a specific boar line with a specific sow line) may have a vastly different resistance to PCVAD. He suggested that the Landrace breed or some Landrace lines could have an increased susceptibility to PCVAD, while Pietrain and Hampshire breeds are resistant.

In 2007, Dr Joaquim Segales said that certain genetic lines of pigs, specifically in relation to boar lines, were more or less susceptible to PMWS. He stressed that significant changes in the use of sire lines have been implemented in the last three years in many European countries.

Some veterinarians are fully convinced that this has been the major point in overcoming the epizootic form of the disease in their practice.

Avian flu genes

Researchers have identified a new strain of swine influenza, H2N3, which belongs to the group of H2 influenza viruses that last infected humans during the 1957 pandemic.

This new strain has a molecular twist in that it is composed of avian and swine influenza genes. The exchange and mutation of the avian H2 and N3 gene segments with that of the common swine influenza viruses gave the H2N3 viruses the ability to infect swine.

These findings have provided further evidence that swine have the potential to serve as a mixing vessel for influenza viruses carried by birds, pigs and humans.

If this is so, the next question is aptly asked by Dr Marc Siegel of the New York University School of Medicine – "Is yesterday's swine flu today's bird flu?" ■