Disease Eradication Initiative in Pigs

by

Jennifer Kate Waters

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

The Yorkshire and Humberside Pig Health Scheme (YHH) was an initiative created to increase the health and welfare of pigs in the region. Disease remains the most detrimental factor to the health and welfare of pigs and as such the YHH focused on four chronic diseases, namely, Porcine Reproductive and Respiratory Syndrome, Enzootic Pneumonia, Swine Dysentery and Mange with a view to eradication. The YHH believed the best way to achieve their aims was to provide a framework thereby enabling all industry stakeholders to participate and collaborate with each other. From this, reasons as to both why and how the disease could be spread could be identified and subsequent solutions could be proffered to effectively combat disease and spread. The scheme was split into two stages; Stage One lasted approximately one year and planned the implementation protocols and provided the foundations for Stage Two. Stage Two will continue on from this indefinitely, applying appropriate measures until the four diseases have been eradicated from the region.

This work focuses on assessing the effectiveness and success of Stage One of the YHH and two pilot studies. Stage One of the YHH generated producer involvement, the creation of three clusters of farms and support from numerous industry stakeholders. It can be argued that Stage One as successful on the grounds that the YHH received further funding to progress on to Stage Two. However, there were areas in which Stage One could have been more efficient and a blueprint suggesting key components for a successful Stage One are provided in this work. Any future eradication schemes would benefit from utilising the recommendations provided in this blueprint. This work also provides recommendations for alterations that are hoped to benefit Stage Two.

Two pilot schemes ran parallel to the YHH and provided the scheme with essential information, these are assessed. First, the Veterinary Pilot Study; this assessed the veterinarians’ capability at determining disease presence within a herd, through comparison with diagnostic sampling. It was concluded that the veterinarians that participated were fully capable at diagnosing disease presence in a herd. The Veterinary Pilot Study also generated information regarding the location of many herds in the region. Second, an alternative sampling technique was trialled using
colostrum as an alternative to blood serum for antibody testing. It was concluded that further investigation into the creation of more accurate diagnostic tests was required before colostrum could become an alternative to blood serum sampling.
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### Abbreviations

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<td>APP</td>
<td><em>Actinobaccillus pleuropneumonia</em></td>
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<td>BPEX</td>
<td>British Pig Executive</td>
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<td>BPHS</td>
<td>British Pig Health Service</td>
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<tr>
<td>CSF</td>
<td>Classical Swine Fever</td>
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<tr>
<td>DEFRA</td>
<td>Department for Environment, Food and Rural Affairs</td>
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<tr>
<td>dpi</td>
<td>days post infection</td>
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<tr>
<td>ELISA</td>
<td>Enzyme Linked Immunosorbent Assay</td>
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<td>EP</td>
<td>Enzootic Pneumonia</td>
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<tr>
<td>FCE</td>
<td>Feed Conversion Efficiency</td>
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<tr>
<td>FRGDS</td>
<td>French Regional Sanitary Defence Confederation</td>
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<td>NPA</td>
<td>National Pig Association</td>
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<td>OD</td>
<td>Optical Density</td>
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<tr>
<td>PCR</td>
<td>Polymerase Chain Reaction</td>
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<td>PRRS</td>
<td>Porcine Reproductive and Respiratory Syndrome</td>
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<tr>
<td>PRRSv</td>
<td>Porcine Reproductive and Respiratory Syndrome Virus</td>
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<td>RDA</td>
<td>Regional Development Agency</td>
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<td>SD</td>
<td>Swine Dysentery</td>
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<td>SPHS</td>
<td>Swiss Pig Health Service</td>
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<td>VLA</td>
<td>Veterinary Laboratory Agency</td>
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<td>VPS</td>
<td>Veterinary Pilot Study</td>
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<td>YHH</td>
<td>Yorkshire and Humberside Pig Health Scheme</td>
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1 Introduction

1.1 Creating the YHH

The Yorkshire and Humberside Health for Pig Herds Initiative (YHH) is a unique pilot scheme designed to eradicate endemic disease in pigs in the Yorkshire and Humberside region. It is an ambitious and complex task; the scale of which has never been attempted before in the British pig industry. The YHH’s manifesto is to improve the health and welfare of pig herds within the region, thereby improving competitiveness, profitability and productivity. The scheme was started in early 2009 by pig veterinarians and agricultural project managers. The initiative will proceed in two stages; Stage One, planning and Stage Two, implementation.

In Stage One, the first step was to locate and map as many pig herds as possible within the region. In order to gather and log such information the cooperation of all stakeholders in the pig industry was required. The knowledge gained regarding the location of units will be a useful tool, particularly due to the ever increasing number of small, generally unregulated hobby farmers. Furthermore such comprehensive information would be invaluable should a disease epidemic occur. It would facilitate the swift tracking of disease movements and offer producers much needed time to increase preventative measures to stop the disease from entering their farms, particularly if there is a disease source nearby. Prevention would predominantly be achieved by increasing the farms biosecurity measures. This would include, but not be limited to, monitoring those entering the farms, preventing entry if in the preceding 48 hours they have visited other farms, or more extensive measures such as the re-siting of feed bins to farm perimeters thus prohibiting lorry access to the farm as the vehicles could be harbouring disease.

Once the units have been identified, the producers need to combine forces and work collectively to combat disease. This is achievable by creating a framework of ‘clusters’ within the region. Each cluster will comprise of a small group of five or six geographically close pig farms with the expectation that each cluster member will collaborate with its fellow cluster members to combat disease within their area. These clusters will subsequently amalgamate with other local clusters to form health districts. It is hypothesised that these health districts will gradually grow and
spread across the region, ultimately including all the farms in the region whilst still retaining the overarching aim of working collectively to combat disease. The key to combating these diseases is through knowledge transfer; with producers pooling and sharing their knowledge and experiences so that appropriate protocols can be created to assist the eradication of disease. Inevitably some producers will find sharing information, with those who are essentially competitors, difficult. However, if the British pig industry is to continue its success in this time of growth it is imperative that producers allay their suspicions and work with one another to combat disease. It is understood that sharing information on presence of disease is generally taboo, yet it is only with this knowledge that it can be accurately combated. It is necessary to know where disease is present and its extent in the Yorkshire and Humber region if appropriate protocols are to be created for eradication. Within a cluster the producers will still have the freedom of self-management; they will be given support and direction but will not be forced to make universal changes that may not be necessary to all units, nor will they be forced to take measures they are unwilling to take.

Stage Two; after farms have been located, and a cluster framework created, the measures for disease eradication will be implemented. Four chronic diseases were prioritised over others because of their significant negative economic impact, the potential feasibility of their control and the diagnostic tests currently available. The diseases are: enzootic pneumonia (EP), porcine reproductive and respiratory syndrome (PRRS), swine dysentery and mange. These are not the only diseases that pose considerable problems to the British pig industry yet they have been chosen over others because it is believed that their control, and hopefully their eradication, can be achieved in the region. However, this could just be a starting point, and once the framework for these four diseases has been implemented there will be nothing stopping the producers from using this to tackle the eradication of further diseases together.

1.2 Initial Producer Feedback

The idea of a health scheme was first brought to public attention through inviting all members of the pig industry to a ‘Good Will Meeting’ on July 1st 2009. The participants were informed of the meeting through formal invitations, phone calls and publications in Pigworld, NPA, on the Pigsite.com and through BPEX. This successful meeting was attended by around 50 producers from the Yorkshire and
Humberside region. According to DEFRA, in 2009 there were around 500 pig units in the region. Therefore, if it were to be assumed that every producer had only one unit, it would mean around 10% of the producers in the area attended the meeting. However, many producers have more than one unit; this could make the percentage of pigs represented at the meeting much higher. Unfortunately it cannot be determined more accurately as DEFRA provides information on the number of units in the area and not the number of producers (DEFRA, 2010). Local pig specialist veterinarians and allied tradesman from feed companies, genetic companies and marketing companies also attended the meeting. The gathering of industry stakeholders and interested parties meant the meeting was highly successful as it enabled all who are involved in the industry, the ‘whole chain’, to voice their opinions on how this pioneering scheme should be approached. The meeting emphasised that it would require all of the ‘chain’ to work together for the scheme to succeed.

The attendees were advised of the YHH’s main goals and feedback was sought on the likelihood the goals could be achieved and how the scheme should be implemented. They were split into discussion groups and views sought as to how they would approach such an ambitious scheme; any problems they envisaged and how they would overcome such problems. After each topic the groups re-formed to share their ideas.

From this meeting, two lists were created. One identified attendees expectations and the second identified areas on which either further clarification or information was needed:

What the attendees expect from the scheme:

- A timescale and framework for the scheme
- Cooperation from all the industry, especially producers
- 100% involvement and commitment from all the industry
- Increased British Pig Health Service (BPHS) involvement
- Creation of a Swine Dysentery Charter
- Clusters would be formed
- Cluster Managers appointed
- Uniformity over acceptable goals and when they are achieved
- Open declarations between producers regarding unit health status
What the attendees wanted clarifying about the scheme:

- The level of commitment required from all the industry
- Specific information on how health and welfare affects competitiveness
- What will happen next, what the stages were
- The involvement of the allied industries and what they will provide
- How health status will be improved
- What the financial costs and benefits will be
- Details of realistic objectives and a plan
- What the increased biosecurity will involve

It was stressed to the attendees that the eradication scheme was neither government nor singular management led. The producers would be self-directed but given guidance and relevant support from the YHH management team to achieve both the YHH aims and individual aims. The meeting was reported in ‘Pigworld’ to increase industry awareness of the scheme and inform those who could not attend about the YHH. Although the meeting was reasonably well attended, attendance could have been greater had the meeting not been scheduled during harvesting as some producers were unable to make the meeting because of harvest commitments.

1.3 Stage One: Planning

Following the July 1st 2009 meeting a Steering Committee was created, comprising of four producers, two veterinarians, and representatives from feed companies, marketing groups, genetics businesses, abattoirs and co-managers of the project from the British Pig Executive (BPEX) and the National Pig Association (NPA), plus the two creators of the YHH; Sam Hoste and David Thelwall, I was also in attendance at the meetings. Due to the large number of the Steering Committee members, each bringing with them their own expertise of their branch of the industry it was sometimes difficult to find and maintain focus. Meetings often covered the same issues, sometimes without resolving them. However, this did not deter the committee, but merely made them more eager to solve problems thus demonstrating their determination and belief in the goals of the YHH and what it could provide for the British pig industry in the future.

Stage One commenced in autumn 2009 and began locating and mapping all the units in the Yorkshire and Humber region. This task will continue indefinitely. A 'live'
map was created and can be viewed on the YHH website (www.yhh.org.uk). Producers and vets can log in to the website, and using the traffic light colour scheme, can determine the presence or absence of one of the four diseases the YHH focuses on within the YHH region. Red areas denote the disease is present; amber that the disease is present but under management, green that there is an absence of disease and grey that there is an undisclosed disease status. The creation of this map is a significant achievement and an important tool for the YHH and other sectors of the industry. Chapter Four of this thesis assesses its implementation and success.

1.3.1 The Veterinary Pilot Scheme
A small scale veterinary pilot scheme (VPS) was implemented in Stage One; it ran parallel to the YHH planning to provide the scheme with vital information on the units in the region. The VPS aimed to assess the competence of the veterinarians in the region at correctly diagnosing disease status on units by comparing their results with those from diagnostic tests.

To determine the veterinarians’ level of competence, they completed questionnaires pertaining to each of their clients units. These questionnaires focused on the presence or absence of the four diseases, any treatment or medication that was underway and the effect the diseases were having on productivity. Wherever possible, the questionnaires were completed when veterinarians carried out their quarterly visits at units so as to minimise disruption for both themselves and the producers. Blood and faecal samples were taken from some of these units and were examined at the Veterinary Laboratory Agency (VLA). These results were subsequently compared with the results from the questionnaires. Furthermore the questionnaire also gave information on the logistics of the units, for example size and type.

1.3.2 Alternative Sampling Methods
Colostrum samples were obtained from the Leeds University pig farm as a further, small scale study to determine whether colostrum antibodies could provide an alternative method of determining whether disease was present on a unit. If successful, it was hoped that this method of sampling could be incorporated into the scheme as it is less invasive than blood sampling, less time consuming, easier
to obtain and can be performed by the producers themselves rather than requiring a qualified technician.

1.4 Stage Two: Implementation

Implementation of specific on farm measures to reduce the prevalence of disease in individual clusters in the YHH has not yet commenced. This is due to a current absence of funding. Applications have been submitted to Yorkshire Forward, The Regional Development Agency (RDA) for the Yorkshire and Humber area, and the European Development Agency.

Due to a change in government and the subsequent disbandment of the RDAs concerns were raised as to whether the funding previously agreed upon would remain. It is understood that the funding for Stage Two is safe, although this has not yet been allocated. An initial request of £1 million from the YHH to the funding bodies has been requested. With this funding the YHH aims to demonstrate success of disease eradication in three initial clusters before requesting for further funding. This funding will go towards potential depopulations and repopulations of stock, medication, vaccination and other eradication strategies. Funding can also go towards improvements in farm biosecurity, for example moving feed-pipes to unit perimeters to prevent lorries entering a site, or providing lorry wash facilities. The funding will also aid in the management of the scheme. Currently the YHH is waiting on the creation of a managerial company that will run alongside BPEX to direct the scheme. After the management company has been created and implemented, the official bid for Stage Two will be submitted.

Once received, the funding will facilitate the first three clusters: Boroughbridge, Melbourne and Mappleton. This will provide the opportunity for the clusters to implement planned biosecurity measures and thus begin the process to eradicate disease by relevant means for the individual clusters. The members of these clusters have always had the capacity to improve their biosecurity measures, yet this funding will enable them to go further than before in a more financially secure environment. It is anticipated that as other producers see the benefits these participants receive, that they too will become involved. An ever increasing number of producers involved will be a great achievement for the YHH as the more producers actively involved the greater the likelihood of the YHH’s success. Without
producers who are committed to the scheme and willing to work and cooperate with each other it is unlikely that this eradication scheme can be successful.

1.5 Further Possibilities from the YHH

As a result of this scheme the YHH would hope to see eradication programmes of its kind implemented across England. This improvement in pig health and welfare would increase productivity and profitability for those in the British pig industry. To date an additional regional eradication programme has been set up through BPEX in East Anglia with the potential for another in the Midlands. Furthermore, the government has requested that these eradication schemes be implemented nationwide. This demonstrates the importance this eradication scheme, it is widely understood that disease is detrimental to the productivity of pig units. With the information this scheme will be able to provide the industry should be able to quantify the prevalence of disease in the region, propose methods to control and eradicate disease and determine the cost of disease on a unit.

As this is the first initiative of such ambition and magnitude in the British pig industry it could be easy to underestimate and lose sight of how important small successes are, if measured against the scheme as a whole. For example, knowledge of the location of pig farms is crucial information in the event of a severe disease breakdown; like that seen in the 1990’s with foot and mouth disease and the YHH will be able to provide this information and hopefully this will facilitate a less invasive disease breakdown.

The success of Stage One will be assessed in this thesis and recommendations for Stage Two will be proposed along with a ‘blueprint’, creating protocols that could be used as guidelines for future eradication schemes.
1.6 Aims and Objectives

The YHH hopes for the creation of a framework, comprising of all industry stakeholders working collaboratively to decrease the incidence of four diseases in the Yorkshire and Humberside region.

The aim of this research is to assess Stage One of the YHH. It also aims to analyse the success of two pilot studies running parallel to the YHH; the Veterinary Pilot Scheme and the creation of alternative sampling techniques.

The objectives of this thesis are:

- To produce literature reviews of the four disease to be tackled, including their transmission and eradication, to produce literature reviews on previous successful eradication schemes, and how their successful implementation may be replicated in the YHH

- To aid in implementing the veterinary pilot scheme, including sample collection from units and abattoirs

- To review the accuracy of veterinary diagnostic assessment of disease status in herds, by comparative analysis with results from diagnostic testing of units

- To assess the success of the veterinary questionnaires in regards to its effectiveness at acquiring information and suggest further means of improving these for future reference

- To determine if alternative methods of diagnostic sampling techniques are effective and if their use in the YHH is plausible

- To provide information on the mapping service and its role in the YHH, examine its effectiveness and present any potential improvements

- To discuss Stage One of the YHH as a whole and provide recommendations for the creation of future eradication schemes, creating a ‘blueprint’ for future eradication schemes to utilise
• To provide recommendations to aid in the future of the scheme and the success of Stage Two
2 Eradication Programmes

There have been a number of successful regional and national disease eradication schemes throughout the world; evaluating such schemes and drawing from their experiences allows the YHH to create a tailored approach to eradicating the four diseases from the region. In this chapter a number of successful programmes will be assessed; their accomplishments will be evaluated to determine whether their structure could be used as templates for the YHH planning and implementation. Perhaps the most relevant schemes to the YHH are the Pays de la Loire scheme in the North of France, which focused on combating PRRS, and the Enzootic Pneumonia Scheme in Switzerland. These will both be evaluated in detail and any components from their structure will be recommended for possible implementation in the YHH eradication scheme. The successful eradication of Aujeszky’s disease and Classic Swine Fever are also of great importance to the YHH when planning their scheme. These have previously been eradicated in the British pig industry, demonstrating how eradication schemes can work specifically within the British pig industry. A case study of a small scale regional disease eradication in three Yorkshire pig farms will also be described in this chapter, which demonstrates the effectiveness of producer collaboration and improvements in biosecurity. Hopefully, through a combination of knowledge from worldwide eradication schemes and British eradication schemes, the YHH can devise an effective eradication scheme to tackle the four chosen diseases.

2.1 Pays de la Loire

The Pays de la Loire scheme is based upon the eradication of PRRS. It began in the early 1990’s when the disease was relatively new and farmers were only just becoming aware of the negative impact the disease has upon herds (Chapter Three details the PRRS disease further). Interestingly, vaccines were not yet available and the eradication scheme was based almost solely upon improving biosecurity measures. The success of the scheme impressed the coordinators of the YHH so much that before they began creating the YHH they visited the region and assessed whether a scheme of its magnitude could be effective in the British pig industry.

The most striking difference between the Pays de la Loire scheme and the YHH was its initiation by the producers in the region. The Pays de la Loire region is
situated adjacent to Brittany, which in the early 1990’s had a high infection rate of PRRS (Le Potier et al., 1997). The farmers in the Pays de la Loire region were unwilling to allow this risk of transmission to threaten their farms and thus designed their own preventative eradication scheme in March 1993. Eight months later, this PRRS agreement between groups of producers was extended to all members of the pig industry in the region and leadership of the scheme was passed onto the French Regional Sanitary Defence Confederation (FRGDS) (Le Potier et al. 1997). The FRGDS is a confederation of farmers that aim to improve the health status of regions; it had previously tackled and successfully eradicated Aujeszky’s disease in France. With the support of the FRGDS control measures were created. The Pays de la Loire scheme was a voluntary initiative that incorporated strongly motivated producers alongside financial support of 3 million Francs from bank loans. It was a highly successful scheme as the incidence of PRRS became impressively low with 98% of herds being PRRS free 2 years after the scheme began. This was achieved only through improving biosecurity measures as vaccinations were unavailable at this time (Le Potier et al. 1997; Benoit and Blanquefort, 1998).

The methods used to eradicate PRRS in the Pays de la Loire region were relatively straightforward. The methods involved annual blood sampling of one sow per farrowing group and five finishing pigs in each breeding herd (Benoit and Blanquefort, 1998) to detect antibodies against PRRS. Whilst simultaneously increasing biosecurity by controlling animal movements, testing artificial insemination centres for the presence of PRRS antibodies in semen and controlling fomite biosecurity. Whenever a seropositive herd was detected, measures to trace the infection were implemented. These included screening semen, locating and screening herds where animals had been purchased from and screening herds located within a 2 km radius of infected herds (Le Potier et al. 1997). Not all infected herds could be tackled simultaneously; priority was given to herds determined upon the density of pig population and location of the herd, for example if it were in close proximity to a nucleus herd and thus would pose a greater threat to other units (Le Potier et al. 1997). Once herds were prioritised, the PRRS virus was eradicated through both partial and total depopulations and repopulations of stock. Total depopulations occurred on farms that were at a high risk of transmitting disease; after depopulation of all pigs the premises were rigorously disinfected and left to dry for 3 weeks before restocking. Partial depopulation occurred when there was still viral circulation, but was only present in growing pigs and all the sows and
gilts were negative, therefore only the growing pigs were removed from the unit for slaughter (Benoit and Blanquefort, 1998).

This scheme validated how important biosecurity measures are and how an improvement in biosecurity measures on a unit can significantly reduce the chances of disease transmission and virus circulation (Chapter 3 details the effect high quality biosecurity can have on reducing disease transmission). PRRS can be difficult to determine when circulating within a herd because the clinical symptoms may not be noticeable and vary greatly throughout a herd; therefore to reduce the infection rate to less than 2% is a remarkable achievement.

2.2 Enzootic Pneumonia in Switzerland

Arguably the most successful regional and national eradication scheme was implemented to eradicate enzootic pneumonia (EP) in Switzerland in the 1990’s. The scheme spread nationwide across Switzerland over 11 years and its initial implementation is similar to the YHH’s. It began with small pilot schemes and gradually expanded until all Switzerland was included in the scheme and the incidence of EP was less than 1%. The scheme was proposed in 1993 by the Conference of Cantonal Veterinarians and focused not only on EP, but also Actinobacillus pleuropneumoniae (APP). It took three years to design a strategy for control and the programme was finally initiated in 1996 (Stark et al. 2007).

The Swiss structure for regional eradication was made easier through the support of the government; this made both EP and APP ‘diseases to be controlled’ (Stark et al. 2007). This meant the Swiss Pig Health Service (SPHS) could sample and test suspected infected units for EP and APP without requiring cooperation from the producer, as all suspected units were notifiable to the Veterinary Services. They also prevented any vaccinations against EP and APP during this time to prevent the disease being masked from any units. Masking of disease could happen as vaccinations would render ELISA testing on a herd for antibodies ineffective. This is because ELISA tests would not be able to distinguish between antibodies created in an immune response against the vaccine or against the pathogen, making it impossible to determine whether EP or APP was present or absent in the herd.

The scheme started its control with a mass screening of units, based initially upon clinical signs and confirmation through diagnostic testing to determine what a confirmed case of EP or APP was and what a suspected case was. This also gave
the scheme knowledge on the incidence of disease present at the start and allowed the management to create eradication protocols based upon this knowledge. It then focused on two pilot regions, Berne and Aargau, in 1996. There was a strict code of practice here to control EP and APP disease. Described below are the protocols implemented to control EP:

1. All farms that were not members of the SPHS and could not provide evidence that they were EP negative were assumed to be EP positive

2. Partial depopulation was used on all breeding and breeding finishing farms suspected to be positive

3. Total depopulation was used on all finishing farms that were not members of the SPHS and could not provide evidence that the farm was EP negative

4. During down time, empty housing was cleaned and disinfected and any sows or gilts were treated against EP with medication such as tylosin

5. The down time was coordinated throughout the region and occurred simultaneously on each unit in the last two weeks of August

6. Trade of animals was highly regulated with specific ear tags demonstrating the origin and health status of the pigs

7. Transport companies were given specific codes of practice when dealing with herds of different health status

8. Where there was any risk of airborne transmission, infected finishing pigs were moved to isolated areas to reduce the chance of transmission until they reached slaughter weight and could be killed. Specific farms were created throughout the country for the isolation purposes and were managed by the scheme (Stark et al. 2007).

These procedures gradually spread over the next 8 years until all regions of Switzerland were included in the programme. This scheme was so carefully devised and well organised it generally had little resistance from farmers (Stark et al., 2007). When units were diagnosed as positive for EP the control programmes ran smoothly without much complaint from producers. However, there was occasional resistance from producers of APP infected farms, but if the resistance
could not be resolved the programme had the authority from the government to put movement restrictions on the farm. It is believed that the resistance by producers from APP infected farms was because of the different serotypes of APP in circulation in Switzerland. Serological tests at the time could not determine between the serotypes and could not distinguish the virulence of the virus that was present on the unit. Serotype 2 was known to have a clinical effect on a unit, however, this could not be differentiated from serotypes 3, 7 or 12; the pathogenicity of these serotypes was unknown (Stark et al. 2007). A similar problem is seen in the YHH regarding diagnostic testing for swine dysentery and the difficulties in determining between the virulent \textit{Brachyspira hyodysenteriae} and other three avirulent strains of \textit{Brachyspira}.

Much can be learnt from the success of this eradication programme; it reduced the incidence of clinical cases to less than 1% along with a decrease in reinfection rate. Without the backing and support from the government, SPHS and veterinarians it is unlikely the scheme would have been as successful. The YHH does not yet have all of this support as many of the industry think it is too big a task to achieve and would not be an efficient use of resources. This is a major blow to the YHH scheme and could hinder its success. A further feature that aided the success in Switzerland was the high cooperation from the producers and the industry; this greatly aided transition from small regional pilot scheme up to the nationwide scheme, something that the YHH strives to achieve and will constantly have to address.

When comparing the set up of the YHH with Switzerland’s EP eradication program it is clear that a different approach was used by the Swiss; they utilised an already established Pig Health Service (SPHS) to encourage producers to join. There is a similar scheme that runs in the British pig industry, the BPHS, and it could be suggested that utilising this in the future to increase producer involvement could be more successful than the current approach. Producers already have faith in schemes such as the BPHS and support from schemes like this for an eradication scheme could increase producer cooperation.
2.3 Aujeszky’s Disease and Classic Swine Fever Eradication Programmes

2.3.1 Aujeszky’s Disease

Perhaps the most well-known eradication programmes that have been repeatedly successful across the world were created to tackle Aujeszky’s disease. The battle against this disease was one of the first eradication programmes of its kind and created a framework for other eradication protocols to follow.

The USA tackled Aujeszky’s disease for 26 years, from 1975 to 2001, and used various methods to try and control the disease. It began with quarantining infected herds in 1975 and when this was unsuccessful a vaccine was created. It was acknowledged at the time that the vaccine would only provide short term relief of clinical symptoms and would not eradicate the disease, but it was deemed necessary because of the substantial losses the industry was having because of the disease. In 1987 the National Pork Producers Council approved an eradication plan; it provided five stages to create Aujeszky’s free States:

1. Preparation. State committees were formed; these measured prevalence of disease and created eradication protocols.
2. Disease Control. Surveillance to detect infected herds and quarantine them.
3. Mandatory Herd Clean Up. Owners of infected herds were to implement individual plans for eradication. If a small number of infected herds remained in a state, animal health officials could perform depopulations and the producers would receive an indemnity payment.
5. Aujeszky’s no longer present in the state.

By 1991 all but four states were involved in the eradication scheme and 10 years later only 12 infected herds remained in the US with 29 states being ‘stage 5’ and fully Aujeszky’s free (United States Department of Agriculture, 2008)

Eradication schemes based upon the USA’s protocols were implemented across the world. The first case of Aujeszky’s disease in Great Britain was in 1979, the last
in 1989. Great Britain was declared free of Aujeszky’s in 1991 following serological surveys. The eradication programme in Britain was funded by a levy on all pig producers in the form of the Pig Disease Eradication Fund. The key with controlling Aujeszky’s disease in the United States was that disease presence was notifiable by law; this was also the case in the British pig industry and this measure still remains in place currently. As there is no specific treatment for acute Aujeszky’s a slaughter policy is in place. Herd slaughter is compensated for by the government in Britain and applies to stock lost, disinfecting of premises, any further down time and movement restrictions (DEFRA, 2010). There was also a seizure order in place whereby any object that could potentially spread the disease could also be seized and destroyed. This was clearly a hard hitting eradication scheme, but was necessary because the disease could not be easily treated. Piglets generally do not survive it and breeding pigs remain carriers, therefore, in order to stop the cycle of transmission culling was required. This approach would not be needed in the diseases confronted in the YHH, but the Aujeszky’s eradication programme does demonstrate how important it is to be fully organised and prepared for disease outbreaks as a preventative measure.

2.3.2 Classical Swine Fever
Classical Swine Fever (CSF) had a resurgence in the 1990’s in the European domestic pig population; eradication strategies were put in force and the disease is still classed in the British pig industry as notifiable. The eradication is based solely on culling or quarantining potentially infected herds to preserve international trade (Le Potier et al. 2006). In the US the United Nations devised a plan to eradicate CSF. It focused on a similar structure to the eradication of Aujeszky’s but with only three stages instead of 5:

1. Control Stage: disease is endemic, outbreaks still occur. Implementation of vaccinations and disinfection procedures created at individual infected farm level.

2. Eradication Stage: region has ceased to have regular outbreaks. When an outbreak does occur all pigs infected or exposed will be slaughtered.

3. Free Stage: determined when a region has had no disease for a minimum of two years.
Vaccination was only permitted during stage one of the eradication. The programmes that are still in place enforce a ‘no vaccination’ policy after stage one to prevent diseases from being undetected and potentially spread. The schemes used demonstrated the need for rapid diagnosis and efficient measures to prevent the spread of disease. However, in relation to the YHH this is a drastic scheme designed for a disease that is highly contagious and categorised as a List A disease in the Office International des Epizooties (OIE) (Le Potier et al. 2006). Diseases placed on this List A if they are:

“Transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, that are of serious socio-economic or public health consequence and that are of major importance in the international trade of animals and animal products.” (World Organisation for Animal Health, 2011).

The diseases the YHH focuses on do not fall under the List A category with OIE, thus, the eradication protocols seen with CSF are too severe for the diseases the YHH are attempting to tackle. Nevertheless its implementation for control could still be of use to the YHH. What is important to take from the USA eradication of CSF was the planning that went into creating eradication protocols. Firstly, a census was required from each region on all pig units, their location and size. This information will have proved crucial in creating realistic and appropriate protocols to eradicate the disease. The scheme also provided training days for veterinarians on the most up to date diagnostic techniques and means for eradication. Another highly useful tool, not only for the veterinarians themselves but the producers too, was knowing that the diseases where being fought in the most appropriate manner.

2.4 The BB Group

Three producers in Yorkshire (named as Producers A, B and C as wish to remain anonymous) initiated methods to collectively eradicate disease in their units. In the last seven years the producers having achieved much in regards to disease eradication and still collaborate together today. They demonstrate to the YHH how producer led initiatives can be successful if people are willing to cooperate and collaborate.
In 2003, Producer A had a partial depopulation on the unit to make it PRRS and EP negative. Fifteen months later the unit had an outbreak of EP, Producer A concluded from this that the disease had been transmitted to the unit from an outside unit. Producer A then initiated a meeting with 10 surrounding neighbours, 2 of which agreed to join him in tackling the spread of disease in the area.

Producer A owned one breeding unit, one farrow through finish unit and one grower unit. This meant that Producer A could relocate sows from one unit and split them between the other two whilst cleaning down accommodation and medicating the original sows with pulmotil and chlortetracycline to combat any respiratory diseases. The dirty sows were grown to slaughter weight offsite so all farrowing accommodation was clean for the 250 new gilts that were supplied. All new pigs were blood sampled to ensure they were disease free on entry to the unit.

In 2007, Producers B and C coordinated depopulation together. Producer B had high parity sows and cleared out all sows. In May 2008, 290 gilts entered the unit. In the downtime between, the farrowing accommodation was cleaned up, and once the gilts were in place dam line semen was used in order to make the unit self-contained. This meant that Producer B did not procure any gilts from offsite, thus reducing the chance of direct introduction of disease onto the farms.

Producer C had PMWS (postweaning multisystemic wasting syndrome) on site and had begun using PCV2 vaccinations. In order to tackle this further Unit C removed all 40 and 50 kg pigs on site, treated its current 210 sows with PCV2 vaccinations and acquired 50 gilts; from then on Producer C’s unit was also self-contained, producing its own gilts.

Collectively, Units A, B and C coordinated when feed bins were emptied in order to add medication to the feed. This was a substantial problem as medication could only be added when the feed bins were empty; the producers worked with the feed companies and bulk bought the feed collectively to accommodate this.

This may seem like a lot of work, and an initial large investment. However, the benefits of doing this included an increase in pigs per sow, an increase in average daily gain, a decrease in mortality and the routine use of EP and PRRS medication has ceased which has saved the producers a lot of money in medication expenses.
The farms have remained disease free since this work and continue to work together to ensure breakdowns do not occur in the future. This is an excellent example of what the YHH could achieve if its producers were to work together. It demonstrates cooperation throughout the industry and what this can achieve. Admittedly, to smaller producers, the idea of depopulations and repopulations could be daunting, but with the benefits that can be reaped and at the right time it can be a very useful tool. These producers have decided to perform depopulations and repopulations again in the future in order to keep the diseases at bay. It is also an excellent way of ensuring accommodation is well kept and up to standard, especially as legislation regarding farrowing accommodation is expected to be altered, with a ban on all sow stalls, including the farrowing crate, by 2013 in adherence with EU regulations. (BPEX, 2010b).

2.5 Knowledge Transfer from these Schemes

When evaluating previous eradication schemes it is clear that the key to their success was found in the cooperation of the industry stakeholders themselves, particularly the producers. Without the producers wanting to change and see a decrease in disease prevalence through collaboration, programmes of this kind are under immense strain from the beginning and their likelihood of success is greatly reduced. Most impressive is the Pays de la Loire scheme in which the producers themselves initiated and constructed their own eradication scheme against PRRS. In regard to the Switzerland programme the large amount of preparation that went into creating the scheme, planning for all potential outcomes, was why the scheme was so efficient and effective in the eradication of EP.

The larger schemes all follow a similar pattern; the first step is determining the location and number of all pig herds in the desired region. In the Aujeszky’s eradication scheme in France a census was issued in each region in which the location of any pigs had to be declared to the regional management team (Benoit and Blanquefort et al, 1997). This undoubtedly made it easier to tackle PRRS in the Pays de la Loire region over the next few years when the knowledge of pig locations was already known and diagnostic testing of units could quickly begin. This provides invaluable evidence on the value of the YHH’s mapping service; even if the eradication scheme were to go no further; the knowledge of the locations of all pig herds in the region is a great achievement and could be a very useful tool if in the future notifiable diseases were to enter the region. The YHH’s mapping
service could quickly provide the locations of many pig farms in the region and this information could aid in preventing the spread of disease.

However, when assessing these previous eradication schemes and their use for the YHH a realistic view is required. The YHH does not have its four diseases classified as notifiable, nor are they going to be, and without legislation demanding a census on the location of all pig herds it has to use other methods to gain this information. It can still use the tools previous eradication schemes have used however, and it seems to have overlooked some of the tools it already has available. For example, the Swiss EP programme utilised, the SPHS. This could be transferred into the British pig industry by tying the YHH to the Farm Assurance Scheme or BPEX’s BPHS scheme. This would have been of great use in finding units and getting the producers involved because around 90% percent of commercial farms in England are Farm Assured (BPEX, 2010a).

In each management led eradication scheme the serological assessment of samples was used as this is believed to be a reliable means of determining whether a disease has been present in a herd or not. Serological tests prevent a large number of disputes over presence of disease, as it is less likely the results can be misconstrued unlike the subjective opinion of veterinarians.

Another interesting aspect of these schemes is the matter of compensation; in all of the management led schemes any down time was compensated to the producers. In the Swiss scheme, any reinfection after the programme was put in place also led to compensation for the producer. The YHH has not disclosed that this would happen if depopulations are required but it has suggested that depopulations be used; this could be a significant reason why producers are slow at joining the scheme. Perhaps what is needed are clearer guidelines from the YHH regarding what will happen if a unit had to depopulate and repopulate and whether the producer could expect any monetary compensation.

The BB Group provides an alternative to large scale disease eradication methods. It provides the YHH with an impressive example of how producers working together towards a common goal can achieve great things. Perhaps this group should be asked to attend a YHH cluster meeting. Here the group could answer producer concerns over knowledge transfer and demonstrate how collaborating with other
producers can be profitable for both the health and welfare of the pigs and for the productivity of the unit.

To conclude, when drawing from these previously successful schemes the YHH could consider altering its approach to involve more producers. One solution could be amalgamating the YHH with another already established scheme such as the BPHS. This could boost producer involvement by increasing awareness about the YHH scheme and increasing trust for the scheme through its association with an already established and credible source. BPHS works by routinely assessing carcasses in the slaughter house on a range of health conditions, including lung lesion scoring, a method of detecting potential presence of EP. If the YHH were to become involved in the BPHS it has an excellent opportunity of obtaining blood samples from the slaughter house and performing serological tests on them. This would provide the scheme and the producer with knowledge on the disease status of their unit for EP and PRRS.

These previous eradication schemes have proved invaluable tools towards the creation and implementation of the YHH. Hopefully, the YHH will be equally as successful and can be used in the future as an aid for implementation of other eradication programmes.
3 Introduction to the Diseases

The Yorkshire and Humberside Health project has chosen to focus on four diseases to eradicate throughout the Yorkshire and Humber region; Porcine Reproductive and Respiratory Syndrome (PRRS), Enzootic Pneumonia (EP), Swine Dysentery and Sarcoptic Mange. These diseases were chosen on veterinary recommendations that were based upon their perceived prevalence in the region, feasibility of potential control and the diagnostic tests currently available. Each in turn will be addressed, as a review into the history of these diseases is required in order to fully understand their potential transmission and how they can be controlled or eliminated.

3.1 Porcine Reproductive and Respiratory Syndrome (PRRS)

3.1.1 The History of PRRS

Porcine Reproductive and Respiratory Syndrome is a relatively new disease to the pig industry, being first reported in 1987 in North Carolina, USA (Hill & Sainsbury, 1995) and termed ‘mystery swine disease’ (Perlman et al. 2008). It has been recognised as the most important infectious agent causing reproductive failure in sows and severe pneumonia in piglets (Hanada et al. 2005). There are conflicting views on the emergence of the syndrome, however, retrospective serological studies now suggest that the virus first appeared in North America in 1979, then Asia in 1985 and finally reaching Europe in 1987 (Perlman et al. 2008).

PRRS only affects domestic pigs, Sus scrofa and is caused by the PRRS virus (PRRSv) (Perlman et al. 2008). The virus has been classified to the order Nidovirales, in the family Arteriviridae and genus Arterivirus (Rossow, 1998; Hanada et al. 2005). The first PRRS virus (PRRSv) was isolated in 1991 in the Netherlands and termed the ‘Lelystad virus’ (Meredith, 1994). Sequence and antigenic analysis suggest that the current European isolates are closely related to this with only minor genomic variations (Taylor, 1999). At around the same time the Lelystad virus was isolated, the North American strain was also isolated. It was determined that the Lelystad and North American strains were the two predominant strains of PRRSv. They are antigenically and genetically distinguishable strains of
the virus, sharing less than 60% amino acid homology (Hanada et al. 2005; Knipe and Howley, 2007). This suggests that the two PRRSv genotypes evolved separately, possibly from non-disease causing viruses and are only distantly related to a common ancestor (Knipe and Howley, 2007). However, it is a remarkable coincidence that both strains of the virus became infective less than half a decade apart and on separate continents, suggesting that perhaps full understanding of the PRRS emergence is not fully determined. Perlman et al. (2008) have inferred that this coincidence may be due to changes in swine husbandry; pigs were reared outdoors in relatively small groups unlike present day densely populated indoor confinement.

It is not known how the disease first entered the UK; it arrived in the summer of 1991 and spread almost exclusively via pig to pig contact. This is known because the first herds affected all had a common multiplier herd supplying them (Meredith, 1994). By tracing the movement of breeding stock sold it was determined that all outbreaks before August 1991 were from this common source. After this the disease appeared to settle in ‘clumps’ around infected premises of up to 20 miles depending on the wind and positioning of these premises (Hill and Sainsbury, 1995), thus suggesting other means of disease transmission than just through direct contact, such as airborne transmission. Post-outbreak the British State Veterinary Service introduced restrictions on pig movements in affected areas and on affected farms in an attempt to control the spread of the disease and develop appropriate diagnostic treatments. Most of the infected herds were located in the counties of Humberside and North Yorkshire as these had the densest pig population (Meredith 1994). It therefore seems fitting that an eradication scheme for this disease should first be trialled in the same counties where it had such a high prevalence in the original outbreak.

3.1.2 The PRRS Virus

PRRSv primarily targets macrophages in the lungs and then spreads to susceptible lymphoid organs, lung tissue and occasionally other tissues (Zimmerman et al. 2006). PRRSv binds specifically to the outer membrane of the alveolar macrophages and uptake into the cell follows via endocytosis (Nauwynck, 1999). The virus grows in the cytoplasm of the macrophages, budding into the smooth endoplasmic reticulum and accumulating in it (Taylor, 1999); this induces lesions in the cell and causes apoptosis (Zimmerman, 2006) with infected cells generally
lysing within 12 hours of infection (Taylor, 1999). This can also cause bystander apoptosis in non-infected cells that are in close proximity to infected cells, however the mechanisms that cause this are still unknown (Suarez, 2000). Pigs become viremic between 12-24 hours post exposure (Knipe and Howley, 2007).

In relation to the strain of the virus, it has been concluded that the infection of susceptible pigs with highly virulent strains of PRRSv results in longer periods of viremia, increased severity of clinical signs (described in Chapter 3.1.4) and mortality, and significantly higher viral loads in blood and tissues than those that were infected with mildly virulent strains (Cho and Dee, 2006).

3.1.3 Immunological Responses to PRRSv

In comparison to other immune responses against RNA virus infected cells, PRRSv elicits only a minimal response at the site of infection (Murtaugh et al. 2002). Generally a rather weak innate immune response is initiated from the alveolar macrophages towards the PRRSv. In response to other RNA viruses a cell would typically mount a series of cellular resistance events starting with the induction of interferons (primarily IFN-α/β) and going on to include inflammatory cytokines (TNF) and interleukins (IL-1). The PRRSv seems to have evolved a successful evasion strategy that prevents these from being produced. Due to the weak innate immune response, the humoral response that follows is equally as inadequate which is generally why the virus is believed to have such a long viremic period and variable clinical manifestations. From this, its success as a pathogen is believed to be due to its ability to replicate for months in monocyte-derived cells in the face of any active response the immune system may be attempting to combat it (Murtaugh et al, 2002; Zimmerman et al, 2006).

3.1.4 Clinical Signs of PRRS

The consequences of infection with PRRSv can range widely; it can be asymptptomatically subclinical, persistent or acute (Knipe and Howley, 2007) and is dependent upon a multitude of factors including the strain of the virus, the immune status of the herd and herd management (OIE, 2008). PRRSv can cause infection throughout all stages of the pig herd, affects pigs of different ages in different manners (see Table 3.1) and the problems associated with it may persist for months or even years (Desrosiers, 2002).
The primary clinical signs include severe reproductive losses and increased levels of post weaning pneumonia with decreased growth rates (Dee and Joo, 1997). The reproductive phase generally lasts only a few months, but the post-weaning problems in piglets often become endemic. Infection with PRRSv often leads to concurrent infection from other opportunistic bacterial pathogens. This demonstrates another difficulty in defining consistent clinical signs for the disease and truly establishing the presence or absence of the disease in a herd.

Table 3-1 The clinical signs of PRRS infection in pig herds from farrow through to finish. Adapted from OIE (2008)

<table>
<thead>
<tr>
<th>In sows:</th>
<th>In affected litters:</th>
<th>In weaned pigs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature farrowing and</td>
<td>Stillborn pigs</td>
<td>Laboured or rapid breathing</td>
</tr>
<tr>
<td>abortion</td>
<td>High pre-weaning mortality</td>
<td>and/or respiratory distress</td>
</tr>
<tr>
<td>Fever</td>
<td>Mummified pigs</td>
<td>Obvious failure to thrive</td>
</tr>
<tr>
<td>Reduced appetite</td>
<td>Variably sized weak born pigs</td>
<td>Loss of appetite and lethargy</td>
</tr>
<tr>
<td>Death in up to 10% or more of sows</td>
<td>Oedema around the eyes</td>
<td>Blotchy reddening of the skin</td>
</tr>
<tr>
<td>Loss of balance, circling and falling to one side</td>
<td>Rough hairy coats</td>
<td></td>
</tr>
</tbody>
</table>

Acute PRRS initially manifests as anorexia and lethargy in affected pigs. Aside from the clinical symptoms the virus causes per se, the incidence of other opportunistic infections can lead to a mortality rate of up to 12-20% (Perlman et al. 2008).

3.1.5 Transmission of PRRS

The PRRS virus can be transmitted both directly and indirectly, further complicating the eradication process. Primarily direct transmission occurs horizontally via pig to pig contact with the virus being shed in urine, saliva, faeces, semen and milk. It can circulate indefinitely; Dee and Joo (1994) found that between 80-100% of all pigs within a herd were infected by 8-9 weeks of age, whilst Maes (1997) found that 96% of slaughter pigs tested positive for the virus; thus demonstrating the virus’ capability at circulating throughout the herd.

Direct vertical transmission between a sow and foetuses can also occur. This usually occurs in the final trimester of gestation. It is uncertain as to why it only affects later gestation. It has been suggested that this may be because the foetus
has developed some form of immune system by the third trimester, thus the virus can infect the alveolar macrophages (Meredith, 1994).

Indirect horizontal transmission can occur through many mediums; any fomites such as equipment, food, water and inanimate objects can potentially hold PRRSv and it can also be through airborne spread (Zimmerman et al. 2006). Otake et al (2002) found that the virus could be present on workers overalls, boots and hands after sixty minutes with an acutely infected pig. The PRRSv has been demonstrated to travel up to 4.7km from a positive unit depending upon wind speed and direction, and although this has proven difficult to document it does explain long distance infection. Torrelmerell et al (2004) found that 80% or more of new infection occurring in US commercial systems was spread by infected transport between neighbouring units, from a lack of biosecurity compliance, or possibly via insects.

It has also been suggested that seasonal changes may affect transmission of the disease (Hill and Sainsbury, 1995). In the Netherlands there was an increase in spread in the winter; it is hypothesised that this is due to an increase in humidity that could prolong the survival of the virus, and an increase in wind speed (Hill and Sainsbury, 1995). It is unknown whether these seasonal changes affect the British pig industry, but certainly the increase in wind speed could explain some transmission. It could also explain how, as seen in the first emergence of the disease, infected units often form into geographical ‘clumps’.

3.1.6 Prevention, Control and Eradication Protocols

Preventing rather than curing a PRRS infection should always be the preferable option. How this is tackled will depend on the unit in question. Vaccination programmes are an option. However, these can be expensive, with one dose being around 75p (BPEX,2010b). Yet Melinchauk et al (2003) found that sanitation was sufficient to stop the virus entering a herd. Many studies, such as the Torrelmerell et al's (2004) study, have found that a lack of biosecurity compliance can have a profound effect upon transmission of the PRRSv. These studies emphasise the importance of strict biosecurity measures; through an increase in unit hygiene the transmission cycle could be broken, as could the emergence of reinfections in herds that have successfully previously eradicated PRRS.
3.1.6.1 Biosecurity Measures

There are many vectors for the transmission of disease, both within and between units. By implementing biosecurity measures the risk of infection on a unit can be greatly reduced. The biosecurity measures set out below are not specific to tackling the PRRSv and should become an intrinsic part of the YHH’s strategy for eradicating all four diseases. Basic biosecurity measures include:

- Displaying clear signs at the entrance of a unit directing all visitors to a farm office, which will prevent any unnecessary visitors entering a unit. Whilst at the entrance, requesting all necessary visitors shower and providing them with overalls, boots and hair nets. Ensuring that visitors have not been in contact with any other pigs for 48 hours before entering the unit. This will prevent many diseases from being transmitted as the majority will not survive for this long without a host.

- Placing disinfection baths at the entrance to a unit and outside all pig houses. This will help stop the spread of disease from off site also limit spread within the unit. However, these disinfection baths should be regularly cleaned and restocked to prevent the build up of any particularly aggressive infections.

- Having regular pest control systems in place to remove any rodents that may carry disease; also actively controlling bird presence where possible. This can be as simple as making sure feed bins are covered and any feed spills are cleaned up.

- Vehicles that are required on a unit should be specific for that unit and not shared with other units. If this is not possible, ensuring the vehicles are cleaned down thoroughly when leaving one unit and again cleaned down when entering another.

- This cleaning regime should also be used for any lorries that enter a unit, and where possible these lorries should not enter a unit. This may require alterations on a unit, for example moving feed bins and loading bays to a unit perimeter.

- For dead pig disposal, have the collection point away from pig housing, on the perimeter of the unit and provide disinfection facilities for lorries and personnel. Change the disinfectant after each use.
• Ensure incoming stock is from a reliable and safe source. Create quarantine protocols for new stock for acclimatisation; this may include testing and vaccinations of new stock.

3.1.6.2 Control Methods
Specific medication for PRRS is currently unavailable. Because of this and the fact that the disease can circulate throughout a herd indefinitely, the best way to tackle a PRRSv infected herd will depend upon the unit type. In breeding herds and farrow to finish herds, vaccinating sows can protect piglets from infection and provide them with immunity. Using replacement gilts that have already been exposed to the PRRSv and developed immunity will provide the herd with piglets that have antibodies towards the disease. Eichorn and Frost (1997) found that PRRS antibodies were found at the same concentration level in colostrum as in blood, thus providing piglets with immunity.

In weaning and finishing unit types, control and eradication is much more challenging. Initially, a unit should only use reliable sources for new stock and should always learn the health status of any incoming stock. Using stock that has already developed immunity towards PRRS is useful if it is entering a PRRS infected herd. An effective strategy to tackle PRRS is through total or partial depopulation of the herd, however, total depopulation is costly when tackling one disease alone, this would only be attempted as a last resort or if other infections could be eradicated simultaneously. Partial depopulation prevents the spread of the disease through different ages of pigs on a unit. This is achieved by testing and segregating current stock into infected and non-infected groups and by rearing any new incoming stock away from the original stock until they have been sold. Thoroughly disinfecting pig houses and allowing them to dry out will remove any infection, after which restocking the unit with the new stock can begin. Coupling this with vaccination of incoming stock the disease should be eliminated from a unit. However, total and partial depopulation may not always be an option. In these situations vaccinating the herd can be used although this would only be effective at stabilising the infection, not eradicating it.

Since its emergence PRRS has proven to be a persistent and insidious threat to the health and productivity of the British pig herd (Kinpe and Howley, 2007;
Meredith, 1994). The costs to producers of battling the virus are great, making it imperative to control and eradicate the disease.

### 3.2 Swine Dysentery

Swine Dysentery produces a mucohaemorrhagic colitis that predominantly affects grower pigs (Robertson et al. 1992) and leads to significant economic losses on individual units. Mortality can reach 30% dependent upon the effectiveness of treatment (Hampson et al. 2006). It greatly affects growth, causes a poor feed conversion and is highly transmissible (Hampson et al. 2006). It is difficult to completely and confidently eradicate due to its cyclical reappearance as it can often remain sub-clinical and re-appear when an animal is stressed (Hampson et al. 2006). It also causes economic loss on a larger scale due to the disruption to supply and movement of pigs when disease is found in large breeding herds, and because of the preventative measures swine dysentery negative units have to implement in order to remain disease free.

#### 3.2.1 The Bacteria: *Brachyspira hyodysenteriae*

A large Gram negative, beta-haemolytic anaerobic intestinal spirochete, *Brachyspira* (formerly *Serpulina* or *Treponema*) *hyodysenteriae* causes swine dysentery (Taylor 1999; Hampson et al. 2006). Infection with *B. hyodysenteriae* is primarily via the ingestion of infected faeces. The organism is protected from stomach acid by mucus in dysenteric faeces and travels through the digestive tract until it enters the large intestine. In the large intestine the bacterium begins invasion into the lining of the mucosal wall and colonising the crypts. It invades goblet and epithelial cells damaging or disrupting them. Colonisation is aided by species of anaerobic bacteria that are normally involved in the gut micro-flora acting synergistically with *B. hyodysenteriae* (Joens et al. 1982; Jacobson et al. 2004). There is a shift in the composition of the gut micro-flora from Gram positive bacteria in healthy pigs to Gram negative bacteria in pigs with dysentery (Pohlenz et al. 1984). Spirochetes can be found in the faeces of infected pigs up to 4 days before diarrhoea is seen (Kinyon et al. 1977). Once colonisation has occurred an inflammatory response is induced which leads to colonic malabsorption and dysenteric faeces are passed from the pig (Taylor, 1999).
3.2.2 Clinical Signs of Swine Dysentery

The occurrence and severity of the clinical signs of swine dysentery is due to a number of contributing factors: the amount of infectious inoculums, the stress levels of the pig, diet, group size, age and weight of the pig (Jacobson et al. 2004). Younger or lighter pigs have more severe clinical signs, perhaps because the immunity in these pigs is less established and not as efficient at fighting infection. Pigs in larger grouped housing also have more severe symptoms compared to pigs in single pens. This is suspected to be due to increased ingestion of infected faeces. However, it may also be due to extra stresses placed upon the pigs in group housing making the gut of the individual pigs more susceptible to the opportunistic bacterium (Jacobson et al. 2004). It has been demonstrated that avirulent isolates of *B. hyodysenteriae* can colonise pig guts but do not induce disease (Hampson et al. 2006).

Diarrhoea is the most common sign of swine dysentery but the severity can vary greatly. The faeces are generally very soft and yellow to gray in colour. As the severity of the infection increases mucus and flecks of blood can also be seen in the faeces and eventually watery stools containing blood, mucus and intestinal fibres are passed (Taylor, 1999). This severe form can lead to dehydration and emaciation and if not caught and treated effectively it can become fatal.

Due to the synergism between the gut micro-flora and the bacterium, the composition of the diet a pig is receiving can greatly affect the clinical symptoms a pig demonstrates. This is because the diet can influence the density and composition of the gut micro-flora. Studies have found that feeding pigs highly digestible diets will result in reduced fermentative activity in the large intestine. This could limit the colonization of the gut with *B. hyodysenteriae* by reducing the concentration of gram-negative bacteria that are required to aid *B. hyodysenteriae* colonisation (Durmic et al. 1998; Leser et al. 2000). However, it is acknowledged that this relationship is highly complex and should not be viewed as a fail-safe method for combating the disease. Nonetheless it could be incorporated into a swine dysentery positive herd as a means to reduce clinical symptoms and animal suffering. More work is required in this field to determine specifically what form of diet would be most effective; Jacobson et al’s (2004) study proposed that the feeding of high quantities of soybean induced swine dysentery.
3.2.3 Infection Sources and Transmission of Swine Dysentery

Infection occurs primarily through ingestion of infected faecal material. As previously mentioned, the methods of initial transmission of *B. hyodysenteriae* into piggeries and individual pigs vary. Most new outbreaks are associated with the introduction of asymptomatic carrier pigs into a herd, especially when these are not quarantined on entry to a herd and screened for SD presence. However, a study by Robertson *et al.* (1992) found other forms of transmission onto a piggery, including contaminated feed, trucks, or visitors who had had recent contact with pigs on infected farms. This study demonstrated the importance of high biosecurity; it showed that providing visitors with gumboots and overalls was protective, as was home-mixed feed, having a footbath at the entrance to the piggery, a security fence around the piggery and always purchasing breeders from the same reliable source. There was an extremely high correlation between the presence of swine dysentery on a unit and the purchasing of unknown health status pigs from sale yards. However, the study did find that some management factors such as all-in all-out systems, autofeeders, in-feed antibiotics and the disinfection of pens had no correlation with the presence or absence of swine dysentery on a unit. This emphasises how difficult it can be to eradicate the disease once it is present on a unit, and although these husbandry procedures can decrease the chance of reinfection they are not capable of eradicating it entirely. The less effective biosecurity measures found by Robertson *et al.*'s (1992) study should still be applied on all farms regardless of presence or absence of SD as good management practices as even if they do not specifically have an impact on SD transmission, they may prevent other diseases entering the unit.

Mice represent a risk for recycling infection, along with other small animals and rodents. Joens *et al.* (1980) demonstrated that mice can shed *B. hyodysenteriae* for up to 180 days post experimental inoculation. The study also showed that when pigs were exposed to the faeces of these infected mice they developed symptoms of swine dysentery within 11 days of first contact. There has also been some unpublished data that has isolated *B. hyodysenteriae* from the feet and faeces of seagulls (J.R. Thomson, cited in Hampson *et al.* 2006). If this is proven then the implications are great as it suggests the potential transmission of swine dysentery between neighbouring units by birds, which will be very difficult to control especially in outdoor farming systems.
3.2.3.1 Prevention, Control and Eradication of Swine Dysentery

Vaccinations are not available to tackle swine dysentery; medications such as tiamulin and lincospectin can be used to reduce the clinical symptoms of swine dysentery. However, these medications merely suppress the clinical symptoms and will not combat the infection directly, but act on behalf of the animals’ welfare by reducing suffering.

Section 3.1.6.1 demonstrated biosecurity measures that should be implemented to reduce the risk of infection. These measures still apply with regards to SD and an improvement in biosecurity measures could reduce the risk of infection of \textit{B. hyodysenteriae}. However, this is a highly infectious bacterium and if disease is suspected in a unit’s neighbouring area the biosecurity should become even more stringent.

When SD is found on farms, elimination should always be attempted. This is because of the implications on animal welfare and the huge effect it can have on feed conversion efficiency (FCE) and the impact this will have on a unit’s profitability. Eradication by total depopulation and repopulation of stock is one method, and is the most successful means of removing \textit{B. hyodysenteriae} from a unit. This method includes removing all stock from a unit to an offsite ‘dirty’ unit where they will remain until slaughter and then disinfecting the entire evacuated unit and allowing it to dry before restocking it with known SD free stock. Alternatively, partial depopulation and repopulation can occur. This follows the same protocols as defined in the PRRS section (Chapter 3.1.6.1) although this is less successful than a total depopulation and repopulation in the eradication of SD.

Hampson \textit{et al} (2006) provide an amalgamation of guidelines from numerous studies. These are:

- Verifying SD presence by more than one diagnostic method
- Determine the specific isolate of the bacteria present on the unit and test the isolate against the available medications to determine the most effective medication
- Eradicate during the summer; the warmer months improve disinfectants effectiveness at eradicating the bacteria
- Stop all replacement stock until after the eradication program
• Reduce herd numbers to as few as possible, ideally have only breeding sows and boars remaining on a unit
• Medicate all of remaining herd
• Piglets born during medication should be weaned and finished on an alternative ‘dirty’ unit.

3.3 Enzootic Pneumonia

Enzootic Pneumonia (EP) is a disease of the respiratory tract that causes significant economic losses to the pig industry due to its substantial negative effect on growth rate and reductions in feed conversion efficiency of up to 10%. It is estimated that it is present clinically or sub-clinically in around 80% of the pig herds in the UK. Losses from EP can be as high as £3 per pig (AHDB, 2010).

It is primarily characterised by infection with *Mycoplasma hyopneumoniae*; but when this bacterium is solely identified the disease is referred to as Mycoplasmal pneumonia. Enzootic pneumonia is referred to when *M. hyopneumoniae* is isolated along with a combination of other pathogenic bacteria or secondary agents such as *Streptococcus suis* or *Actinobacillus pleuropneumoniae* (Thacker, 2006). This is the most common form of pneumonia among pigs. EP causes chronic respiratory problems that lead to a predisposition for the pigs to obtain other opportunistic infections (Belschner and Love, 1984). If EP is not present in the growing population then the effects of the other respiratory pathogens are greatly reduced. It is therefore considered a primary pathogen that makes the lung susceptible to other infections.

3.3.1 The Bacterium: *Mycoplasma hyopneumoniae*

*M. hyopneumoniae* is one of the smallest bacteria in nature, between 200-500nm in size. It has a small genome and lacks a cell wall. *M. hyopneumoniae* causes EP in the lung in two ways. Firstly it colonises the airways. Secondly, the immune system of the respiratory tract becomes altered with an infiltration of B and T lymphocytes that form nodules restricting the respiratory tract (Thacker, 2006).

3.3.2 Clinical Signs of Enzootic Pneumonia

The onset of mycoplasmal pneumonia depends on the intensity of infection, the number of organisms that colonize the respiratory tract and the presence of other pathogens in the respiratory tract that contribute to disease (Thacker, 2006). EP
generally has a high morbidity, but a low mortality (Jackson and Cockroft, 2007). It is characterised by a non-productive cough or wheezing in pig herds. This is intensified by exercise or if a secondary agent is present. The cough usually occurs 10-15 days post infection, although this can vary greatly under field conditions (Maes et al. 2008). A common clinical sign also includes a gradual development of uneven size amongst animals of the same weaning weight because of unequal infection throughout the litters, possibly due to low viability pigs being more susceptible to infection (Taylor, 1999).

When *M. hyopneumoniae* enters the body it adheres to the ciliated cells of the trachea, bronchi and bronchioles. The infected ciliated cells undergo ciliostasis, and then shed; this then leads to epithelial cell death (Taylor, 1999). The shedding and decrease in number of these ciliated cells lead to a prevention of clearance of secretory products from the respiratory tract (Taylor, 1999).

Lesions occur at sites of cell death. They are usually seen in the lower parts of the lung lobes and can determine the degree of infection based upon their size and colour. The earliest macroscopic lesions occur around 3 days after experimental infection; these are small and dark red in colour. They gradually enlarge as the infection increases, losing their colour until a dull purple-grey can be seen and then finally a grey colour. The lesions then begin to decrease in size as the infection abates until they have completely disappeared (Taylor, 1999). Because the clinical signs of infection diminish post-infection, determining the presence of infection in a herd through lung scoring can be difficult (Wallgren, 1998). If slaughter has occurred once the macroscopic lesions have abated, specific infection of EP in the herd will not be determined, even though it may still be present in younger pigs. Between 30-70% of infected herds will show lesions at slaughter (thepigsite.com, 2010). This wide range makes using lung scoring alone an unreliable determinant for EP. These lesions are not specific to *M. hyopneumonia*, other respiratory pathogens can cause these symptoms again making diagnosis difficult (Thacker, 2006).

Microscopic lesions can also be seen in chronic pneumonia and are characterized by infiltration of lymphocytes and monocytes into the lung. This has an impact upon macrophages from the innate immune system and B and T lymphocytes of the adaptive immune system (Thacker, 2006). It is believed to be an evasion strategy by the bacteria; through invading macrophages it has been found to
reduce their phagocytic activity rendering them less capable of engulfing bacterium that have not yet invaded host cells. Similarly, pro-inflammatory cytokines are also induced by the lymphocytes; these further reduce the respiratory immune systems effectiveness (Thacker et al. 2000).

Aside from these clinical signs, pigs can also demonstrate anorexia, dehydration, heavy breathing, respiratory distress and fever in acute forms of EP. These severe signs usually only occur when the disease is being encountered for the first time and not on subsequent reinfections, as it is well established that protective immunity developed in animals recovering from the disease produces antibodies that reduce the adhesion of the microbe to the ciliated cells of the respiratory tract in reinfections (Wallgren, 1998).

3.3.3 Transmission of the Disease

The transmission of this disease is similar to transmission of both PRRS and SD. It can occur directly, through vertical transmission with piglets acquiring it in-utero and through horizontal transmission between pen-mates. It can also occur indirectly through vectors such as inanimate objects and the bacterium can be carried on the wind. Once an animal has recovered from an infection with *M. hyopneumoniae* it can still remain a carrier of the bacterium. This makes transmission easy and a cyclical pattern with re-emergences of the disease can sometimes be seen. In highly intensive units endemic infections of EP may be much more difficult to control (Hill and Sainsbury, 1995) due to the methods of transmission. It is most prevalent and at the highest severity in overcrowded and ill-kept piggeries with poor ventilation (Belschner and Love, 1984).

Vertically transmitted infections through sows or gilts to piglets can be difficult to control as there is no placental immunity against the infection. However, a small study was carried out for this thesis (Chapter 6) to assess the concentration of specific EP antibodies found in colostrum and whether they would be of a high enough concentration to provide naïve piglets with some immunity. The results of this study have shown that colostrum does contain EP specific antibodies. Perhaps vaccinating all replacement gilts against EP could reduce the prevalence of disease on a unit.

The most important route of transmission is direct horizontal transmission between pen-mates. This is because once *M. hyopneumoniae* is on a piggery, horizontal
spread can occur through infected pigs coughing, in nasal secretions, mixing of pigs from different sources, overcrowding, and inadequate cleaning of housing (Thacker, 2006). Because there are so many forms of transmission there are also lots of alternatives to reduce the risk of transmission on site. Rigorous cleaning of housing before and after pigs have been held there can reduce the chance of infection by eliminating any bacteria that may have been previously present. *M. hyopneumoniae* is rendered inactive within 48 hours of drying so this is intrinsic to prevent the disease from remaining after cleaning (Taylor, 1999).

The slow growth of the bacterium when away from a host would suggest that transmission between herds is difficult as it is unlikely to survive, however, studies have demonstrated that this can occur. Bacterial infections are less likely to be airborne, possibly due to the larger particles; however it has been demonstrated that *M. hyopneumoniae* can travel up to 3 km on the wind (Hill and Sainsbury, 1995). The disease could also be brought onto a unit through other fomites as seen with PRRS and SD. Again, ensuring that biosecurity measures are adhered to and that everything washed down is also dried before entering a unit is important.

3.3.4 Prevention, Control and Eradication of EP

As with the previous two diseases discussed, biosecurity is a key component to reducing the risk of infection on a unit and this still applies regarding the introduction of *M. hyopneumoniae*.

Antibiotics are available, such as tylosin, to tackle the clinical symptoms of EP, but they do not eliminate the organism in the respiratory tract or aid in healing any lesions (Thacker *et al.* 2001). It may be suggested therefore that they are only used to alleviate the symptoms in mildly affected animals, or are used in conjunction with other means of control. Vaccinations are also available to tackle EP, Thacker *et al* (2000) found that some vaccines for EP also helped in alleviating symptoms of PRRS induced pneumonia, thus, in units where both infections are believed to be present, use of the vaccine could help to tackle both diseases without having the cost of two vaccination programs. However, the study did find that some specific PRRS vaccines did not have the same effect upon EP and actually led to an increased severity of pneumonia caused by *M. hyopneumoniae* symptoms. This may be due to the EP bacterium utilising the opportunity of a compromised immune system induced by the PRRS vaccine to proliferate.
A regional eradication scheme directed specifically towards EP in Switzerland has been discussed in Chapter Two. This regional eradication programme by Stark et al (2007) can provide the YHH with guidelines that should be utilised in order to eradicate not only EP but also the other three YHH diseases in the Yorkshire and Humber. These are:

1. Farms that cannot provide evidence that they are EP negative should be assumed to be EP positive
2. Partial depopulation should be used on all breeding and breeding finishing farms suspected to be positive
3. Empty housing to be cleaned and disinfected
4. Medication for sows and gilts
5. Transport companies to be provided with specific codes of practice when dealing with herds of different health status
6. Increasing biosecurity measures both on individual units and throughout the rest of the industry; for example movement of feed pipes to unit perimeters to prevent lorries entering units, providing lorries with washing facilities and ensuring washing is carried out.

3.4 Mange

Mange, a parasitic skin disease of pigs, is considered the most important swine skin disease, having the greatest economic impact on the pig industry (Belschner, 1976; Davies, 1995). It can be categorised into two forms determined by the causative mite: demodectic and sarcoptic mange. In the YHH sarcoptic mange is being tackled, as this is the most common form of mange, which is caused by the ectoparasitic mite *Sarcoptes scabiei var suis* (Cargill and Davies, 2006; Taylor 1999). Demodectic mange is relatively unimportant to pigs, causing little clinical effect and is only occasionally reported at meat inspection (Cargill and Davies, 2006). In contrast, sarcoptic mange can cause considerable morbidity and can lead to significant economic losses in the pig industry, through depressing feed conversion efficiency and thus depressed weight gain which can be as great as 10% in pigs (Cargill and Davies, 2006).

3.4.1 The Life Cycle of *Sarcoptes scabiei var suis*

*Sarcoptes scabiei*, class *Arachnidia*, order *Acariana* and family *Sarcoptidae* is host specific (Mellanby, 1972). *S. scabiei var suis* is found in pigs. The mite is around...
0.5 mm long and can be visible to the naked eye when fully grown if placed on a
dark background (Mellanby 1972; Taylor, 1999). The mite and its gender are identified by the arrangement of its sucker and bristle bearing legs, with suckers being present in the first two pairs of legs in the female and the first two and fourth pairs of legs in the male. These legs aid in the burrowing of the parasite, as not only do the mouth parts ‘bite’ the epidermal layers, the suckers on the front two pairs of legs adhere to the skin whilst the ‘elbows’ dig through the layers of the epidermis (Mellanby, 1972). Additionally, entrance into the skin is aided by the mite secreting saliva onto the unbroken skin which causes the cells of the skin to lyse and the mite then begins ‘eating’ its way in and burrows along under the keratinized layers of skin (Marquardt et al. 2000).

The mite life cycle occurs wholly in the epidermal layers of the pig. The mite cannot reproduce away from the host (Taylor, 1999). Females come into contact with the host epidermis and burrow into it. A male finds an unfertilized female and they mate. Then the female lays around 50 eggs into these pre-carved burrows. The eggs hatch after around 4 days, with larvae being distinguished by having only 3 pairs of formed legs molting to nymph, with four pairs of legs, and then nymph into either mature male adults or immature ovigerous females (Mellanby, 1972; Heukelbach and Feldmeicer, 2006). Transformation of immature females into ovigerous females is presumed to occur after fertilization when the ovary swells and distends the body (Mellanby, 1972). The entire process only takes between 10 and 25 days and proliferation of the infestation can be quick in the correct climatic conditions (Jackson and Cockroft, 2007).

3.4.2 Immune Response to an infection of Sarcoptic Mange

Following exposure the pig immune system goes through a specific sequence:

1. Non-responsive phase
2. Delayed type hypersensitivity phase
3. Delayed and immediate type hypersensitivity phase
4. Immediate type hypersensitivity phase

The clinical signs are usually delayed in comparison with the day of primary infection; the non-responsive phase (phase 1).

By between 3 and 4 weeks post infection the mites multiply causing a sensitisation against them; the delayed type hypersensitivity phase (phase 2). The mite
infestation generally begins in the ear canals, which will often lead to head shaking before any skin lesions can be seen (Chaneet, 1972). There is then an accumulation of dark ear wax and brown crusty exudates can be seen in the ear canal (Jackson and Cockroft, 2007).

After a delay the adaptive immune response begins to work against the infection; the delayed and immediate type hypersensitivity phase (phase 3). Once the infection progresses, a common indicator of its presence is pigs rubbing themselves against the side of the pen as the mite causes pruritus (Belschner and Love, 1984). Pruritus is defined as the itch or sensation that makes a pig want to scratch (Mellanby, 1972). In sarcoptic mange this is caused by a hypersensitive reaction to components of the mites saliva, eggs, and faecal material. It is also caused by a reaction to the release of histamines produced by the adaptive immune response (Heukelback and Feldmeicer, 2006). The intensity of the pruritus is dependent upon the number of mites in the initial exposure (Cargill and Davies, 2006).

If the pruritus is considerably acute it can then lead to the skin thickening and becoming dry and keratinized. Keratinisation occurs because of the liberation of fluid from vesicles in the skin near to the burrows of the mites. The serum coagulates and dries blocking the mites burrows at around 6-7 weeks post infection (Taylor, 1999). The skin lesions produced are thought to have an immunological basis and occur after the period of sensitisation. At 12-18 weeks post infection the lesions that began in the ear start to regress and focal erythematous papules (small, raised red bumps) associated with hypersensitivity occur on the rump, flank and abdomen (Cargill and Davies, 2006); mites are not usually found in these lesions. Secondary bacterial infection can also be seen in severe cases (Belschner and Love, 1984). In severely acute pigs, head shaking can lead to aural haematomas on the pinna of the ear (Jackson and Cockroft, 2007).

In concurrent infections phases 1, 2 and 3 are bypassed and hypersensitivity develops within a day and the immune response against the infection is rapid; phase 4, immediate hypersensitivity (Cargill and Dobson, 1979; Marquardt et al, 2000; Cargill and Davies, 2006).

Aside from these clinical lesions, the infection can also cause other detrimental and economic effects on pig herds. This includes effects on reproductive efficiency,
including decreased lactation and maternal behaviour. These effects appear due to reduced efficiency of food utilization through a reduction in food intake (Sykes, 1994) as the pigs spend more time scratching than eating. The reduced feed intake can then alter the pigs reproductive hormone patterns; for example a reduction in luteinizing hormone secretion during early pregnancy is witnessed when feed intake is reduced (Peltoniemi, 2000). This can then lead to a reduction in embryonic survival as it is critical for the maintenance of the corpus lutea (Peltoniemi, 2000). Furthermore, an increase in opportunistic disease can be seen as the pigs’ immune system is compromised. Reduced market value and carcass downgrading can also occur if there is severe skin damage. Additionally, there can be an increased cost in maintenance in units due to damage to piggery fixtures by pigs rubbing against the side of the pens (Davies, 1995; Jackson and Cockroft, 2007). Mortality in infected herds is rarely due to the infestation of the mite, although it has been noted to happen in pigs with severe hyperkeratotic lesions (Mellanby, 1972).

### 3.4.3 Transmission
Transmission occurs by close, or direct skin-to-skin contact, with fomites believed to play only a minor role (Marquardt et al. 2000). Because close contact is required for transmission, in crowded areas infection is likely to proliferate (Marquardt et al. 2000) and in the intensive farming seen today it is generally acknowledged that infection on a few individual pigs should warrant treatment of the whole herd. The mites are not airborne but can survive in a damp environment for 2-3 weeks (Jackson and Cockroft, 2007), emphasising, as with *M. hyopneumoniae*, the need for ensuring facilities are properly dried before restocking.

### 3.4.4 Diagnosis
Due to the nature of the non-responsive phase, merely looking for lesions on the individual animals is not enough to determine presence or absence. A study by Chaneet (1972) found that only 45% of infected pigs demonstrated lesions on the pinnate of the ear. There is also a link between the age of the pig and the level of infestation; younger pigs with immature immunity generally show a more invasive infestation compared to older infested pigs, as would be expected in primary infections to a naive immune system. However, the older pigs do show more keratinisation over time if repeatedly subjected to infestation, which could potentially be used as an indicator (Chaneet, 1972).
The most common method to determine the presence of sarcoptic mange in a herd, which minimises the chance of a skin infection being from another source, is through locating a mite on a pig.

### 3.4.5 Prevention, Control and Eradication of Mange

Prevention, as with the previous three diseases is primarily through biosecurity measures. The mites need to be brought directly onto a unit in order for infection to take place. With the correct biosecurity procedures in place this should prevent infection occurring. This emphasises the need to quarantine any new pigs brought onto a unit until treatment and decontamination can occur.

As transmission only occurs through direct contact, treatment is relatively straightforward. Once on a unit mange symptoms can be treated in various methods. Spraying of acaricides such as amitraz can be used. These kill off any parasites and should be used in two doses to ensure all larvae have also been eradicated. Injecting avermectins subcutaneously is another alternative that only needs to be administered once. These interfere with the mites nervous system and lead to paralysis and mite death (Cargill and Davies, 2006).

To eradicate mange entirely the whole herd needs to be treated simultaneously to ensure no mites remain. This can be through a depopulation and repopulation programme. This is considered an excessive programme to combat mange alone but if a programme were already in place to tackle another disease, mange could also be tackled.

Because of the readiness of transmission within herds, sarcoptic mange is considered a ubiquitous parasite of swine herds, unless it specifically has had measures set towards its elimination (Davies, 1995).

As noted throughout this Chapter, one of the most important means to ensure a disease free health status of a unit is through preventative measures. The best way to do this is by applying strict biosecurity measures to a unit and complying with them. It is much harder to eliminate a disease than to prevent it.
4 The Mapping Service

4.1 Purpose

The YHH’s definitive goal is to successfully eradicate four chosen diseases from the Yorkshire and Humber region. To achieve this substantial task it needs to work with producers and provide them with a suitable support network to utilise. This support network includes increasing publicity of the scheme, the creation of clusters and their respective health districts, validating veterinary knowledge and creating protocols for the eradication of disease. However, without the inclusion of as many farms as possible in the region the scheme would not be as effective in eliminating disease. Because of this, locating farms in the region was of prime importance and a considerable amount of time was spent generating methods to locate the farms. Locating the farms was a great ambition and will continue indefinitely throughout the implementation of the scheme.

Initially, the project was provided with a database of possible pig units in the region from the Farm Assurance Scheme. Cold calling the listed producers began as a method of advertising the project and inviting producers to the initial Good Will meeting on July 1st 2009. At this point the scheme discovered its first problem regarding the location of farms; many of the contacts on the databases were incorrect or out of date. Phone numbers were inaccurate for units, some units were no longer in existence and commercial units that were contracted to a larger company could not confirm their owners involvement into the scheme. The database was from a reliable source yet still highly inaccurate; this demonstrated how difficult it is to find all the units in the region. In order to ensure the scheme had as many units as possible involved, further methods of attainment were necessary.

One solution was to utilise the knowledge of producers already involved in the scheme. It was proposed that when the veterinary questionnaires were being completed there should also be a section for producers to complete where they provided addresses of the three closest units to their farms. The scheme could then contact these farms directly, hopefully filling gaps in the databases. However, the questionnaire was already considerably lengthy in collecting information regarding the clients own units, without requesting more information on the location...
of others. Perhaps in the future this approach could be used to find more farms. It was decided that the veterinary practices in the area would be used as a channel to contact their clients regarding involvement in the YHH. This at least ensured that all the larger producers were made aware of the scheme by their veterinarians and offered a chance to participate.

Locating larger producers is relatively straightforward, as they can be easily traced through veterinarians, feed companies and other allied trades. It is more difficult to locate the smaller ‘hobby farms’ that only have a small number of animals and may not use the large industry companies for supplies. Nonetheless, these pigs still need to be located and their health status determined. They may pose very little threat to the success of disease eradication, but this threat cannot be assessed until they are located. It is hoped that as the scheme progresses these will be located, perhaps through approaching farm shows to get addresses of competitors or advertising the scheme in small holder magazines. Further work has gone into locating these smaller units, through working with companies that may supply them.

Finding the locations of the farms is continuing. The YHH will be unable to say with total confidence that it is 100% accurate regarding the location of all units in the region, as farms are continually going in and out of business. Nonetheless, striving to locate all the units should still be attempted.

David Thelwall was overseer of the mapping service. It has been available on the YHH website since November 2009. ‘TLR’ and ‘Everysite’ were web-design manufacturers used to create the website and mapping service. They used BPEX’s assurance scheme database and Google Maps to create the initial mapping service.
4.2 Demonstration

Figure 4.1 depicts the mapping service home screen when logged in as an administrator or cluster manager. From here various choices can be made which will determine the outcome of the map. These choices can include the data to be plotted on the map, which part of the map to focus on and any practices or businesses in the area.

Directly under the map to the right are four buttons; V, P, C and M. These refer to view, polyclonal, cluster and move modes respectively. View mode gives an overview of the units in the chosen area, polyclonal mode allows the individual to create clusters, cluster mode shows formed clusters of producers and move mode allows for these clusters to be altered. These options are not available to everyone, only cluster managers and administrators. Anonymous mode will be in place for all other members when not viewing their own cluster. The YHH does not aim to ‘name and shame’ producers as this would be detrimental to its goals as many would not want to be involved. Because of this, specific information on units is not available to all producers; a pyramid system demonstrates the level of access...
granted to those involved (Figure 4.2). Administrators can alter other aspects of the YHH website, not just the mapping service. Cluster managers can create, amend and view their own clusters but cannot view specific details regarding other clusters; only the traffic light grids (see Figure 4.3). Cluster members can view information regarding their own cluster, but cannot amend the cluster and cannot view specifics regarding other clusters.

Figure 4-2 Hierarchy of information access to YHH mapping service users

Figure 4-3 The Mapping Service in View and Anonymous mode demonstrating the traffic light grid system. Taken from www.yyh.org.uk cited on 12/01/2010
Figure 4.3 demonstrates the traffic light system grid. This is what cluster members will see when they log in to the mapping service. For example, the traffic light sequence in Figure 4.3 demonstrates the presence of PRRS in 5km square grids in Yorkshire and Humber. Red grids show where disease is present, amber shows where disease is present but actions are in place to combat it, green shows disease free area and grey where health status is undisclosed. The map is in ‘view’ and ‘anonymous’ mode as no units are listed. This will be in place if you are not designated to a cluster.

The mapping service’s main function is to demonstrate to producers the health status of the units in the region. It is striving for an ‘all green’ coded map, where through veterinary disclosure and diagnostic testing the presence of the four diseases is eradicated from the region. As can be seen from this screenshot, taken in August 2010, there is still plenty of work to do before this will be achieved.

4.3 Further Uses of the Mapping Service

The mapping service could be used in conjunction with the inclusion of mobile trackers in transit vehicles to determine their location. Many feed companies already use mobile tracking devices in their vehicles; coupling this with a map such as the YHH’s could make feed movements more efficient. For example, units within clusters or in close proximity to one another could coordinate with the feed companies to have deliveries synchronised. Pairing this with increased biosecurity on farms, such as moving feed pipes to the perimeters, providing lorry wash facilities and ensuring they are correctly used could decrease the chance of disease spread. This could also decrease the carbon footprint of both units and allied trades in a world which is increasingly environmentally aware. Tracking could also be useful when transporting animals of different health statuses. Producers can utilise the map for the good of their own units, ensuring transport vehicles avoid ‘red’ high risk zones as much as possible.

4.3.1 Example of the Influence of Animal Movement on transmitting disease

In 2006 and 2007 East Anglia’s pig units faced a serious battle as numerous units were diagnosed with Swine Dysentery. The endemic began with the transport of 400 infected pigs into the region; it is believed that the causes of the spread of the swine dysentery outbreak throughout the region were due to:
1. Pig movement 44%
2. Management 13%
3. Local Spread 10%
4. Pig Transport 10%
5. Birds 7%
6. Contractors 3%
7. Dead Pig Transport 3%
8. Feed Lorries 3%
9. Unknown 3%

(Waddilove, 2009). These results show the many possible ways the disease can spread, they also show how improving biosecurity based around these mediums could greatly reduce the risk of disease spread. The majority of disease transmissions here were through transportation. Utilising a mapping service such as the YHH’s to coordinate transportation along with an improvement in biosecurity measures could help reduce disease transmission.

4.4 Evaluation

On a technical note, the mapping service is often slow and ‘crashes’; it requires a fast Internet connection to run smoothly and often can only be used on a computer when the PC has little else running simultaneously. When choosing options to view on the map it takes a considerable length of time to accept the choices and produce the correct map. When trying to assess the mapping service it has been difficult to regularly access it because of this. This has made determining the level of commitment from the region difficult. It was initially hoped that taking screenshots of the map on a monthly basis would demonstrate an increase in producer involvement and hopefully provide evidence on disease eradication as more of the ‘grids’ turned green. However, this has not been achieved yet, partly because it is too early in the scheme to determine such changes in disease presence and partly because the mapping service was too unpredictable to provide such evidence.

Disappointingly, there are issues regarding compliance over data protection on the mapping service. Disclosures of data and terms and conditions of use of the mapping service were assessed by legal advisors, but concerns still remain. This
seriously discredited the YHH, although knowledge transfer is a key component of the scheme, data protection from sources outside the YHH is imperative. The mapping service is under pressure to resolve this; if this cannot be achieved then the future of the service is uncertain.

The mapping service was available by the beginning of November 2009. This fast implementation was a good start; the technology provided a good incentive to demonstrate the scheme to new producer and the resources that would be available. The map went ‘live’ on the YHH website shortly before a YHH meeting with producers and a demonstration was provided for those that attended. It showed the ease with which the mapping service AND be used once it is understood. However, it could be useful if the website provided a step-by-step guide on how to use the mapping service for those that have not witnessed a demonstration. It may be unclear what the options on the map mean; for example the names of the possible modes of viewing ‘view, polygonal, cluster, move and anonymous modes’ do not provide the user with information on what each individual viewing mode entails. This could lead to disparities in understanding, those attempting to access information may not be provided with the information they require.

The map’s full potential has not yet been established; it could become an excellent way of communication between all aspects of the industry. Having the information of all the producers in the area in one hub could reduce disease spread. All producers in the scheme would be aware of any disease breakdown and could impose an increase in biosecurity measures to prevent it entering their units. It could also become a way of transferring knowledge on positive matters, such as how units combated diseases or examples of clusters working together to increase biosecurity.

The mapping service provides an excellent demonstration of technology available to the industry and the implications for its use are vast. Not only can it be used in the YHH with direct relation to disease eradication, but it has been suggested as a useful tool for other sections of the industry. However, merely having the mapping service in place is not going to decrease disease transmission. In order for the mapping service to be as successful as possible it needs to become more accessible, with improvements in its speed. It then needs to be utilised by
producers, incorporating it into their work to decrease the risk and spread of disease.
5 The Veterinary Pilot Study

5.1 Introduction

The Veterinary Pilot Scheme (VPS) was created to assess pig specialist and general veterinarians for their knowledge and capability at determining disease status on pig units. The assessment was conducted by comparing the veterinarian knowledge on a clients unit with results from diagnostic sampling of the unit. It was hoped that the results would demonstrate a veterinarian’s accuracy in diagnosing disease on a unit thereby confirming the YHH’s reliance upon veterinary opinion of disease status in the region. This was deemed a necessary task to undertake before fully implementing the scheme because of concerns over the knowledge of non-specialist veterinarians and how accurately they could diagnose units. Non-specialist veterinarians that perhaps only deal with smaller hobby farms could be provided with more information through the YHH for a correct assessment of disease presence or absence. It was deemed necessary to utilise the veterinarians into the scheme to determine pig units disease status as this would be more cost effective than taking blood and faecal samples from each unit and running diagnostic testing on the samples.

A further result obtained from this VPS was the knowledge of many pig farm locations and their presumed disease status. This logistical information was used to update the mapping service and is intrinsic for the future of the scheme.

5.1.1 The Veterinary Questionnaire

The questionnaire was designed to gain relevant information about each unit in the region (see Appendix 1a). The initial idea was to run the questionnaire and sample collection simultaneously; however, this proved difficult as some farmers were uncertain whether they wanted their units to be sampled. It was unknown at first whether the questionnaires should be completed by the producers themselves, or whether it would be more productive to have the veterinarians complete the questionnaires on behalf of the producers. After some deliberation it was decide that the latter would be easier, most likely whilst on their quarterly visits to the units and this would also allow the producers to sign a disclosure form allowing the YHH access to the farms information.
Following much debate the final questionnaire was created. It required answers on unit location details, medication and treatment details, presence/absence of the four focal diseases, evidence to support this information and the impact the diseases had on herd performance. The questionnaire also requested details of mortality percentage and sow output.

5.1.2 The Diagnostic Assessment
The diagnostic tests used were the current ‘gold standards’ in the industry. This provides evidence to producers that the scheme is supported by the best diagnostic procedures. The tests were deemed appropriate based upon their specificity, sensitivity, availability and expense. Many producers were concerned about the diagnostic tests currently used and the chance of type one errors; specifically the chance of false positives regarding swine dysentery. These false positive may seriously discredit and disrupt a producer’s unit by falsely implicating disease presence on the unit and this has made some producers unwilling to participate in diagnostic sampling. To counter this, if swine dysentery was deemed positive on an initial diagnostic test then an alternative, further test was carried out to clarify the result. Equally the need to prevent false negatives is also necessary, as this would seriously undermine the scheme and if left undetected would prevent the region from eradicating disease or potentially lead to re-infection of units that thought they had successfully completed eradication programmes.

5.2 Hypotheses
It was hypothesised that veterinarian knowledge and diagnostic testing would be highly compatible with each other and could provide sufficient evidence to determine the disease status of units within the YHH region.

The aim of the VPS research was to assess the standard of veterinary and diagnostic conclusions regarding the disease status of units. It also aimed to determine the quality of veterinary knowledge when assessed against ‘gold standard’ diagnostic testing.

5.3 Methods

5.3.1 The Questionnaire
Electronic copies of the questionnaire were available on the YHH website. These were printed off by veterinarians that had joined the scheme. Veterinarians that
registered with the scheme were given individual login details to the website and they uploaded the completed questionnaires into a database. This database was only accessible to coordinators of the YHH and those with login details. The veterinarians only had access to their own clients information to ensure client confidentiality. In the future it is hoped that information on disease status will be shared between producers. Along with the questionnaire a declaration form was provided. Signing this declaration form gave the YHH consent to:

- Disclose the disease status of the said unit in reference to PRRS, EP, swine dysentery and mange. This information can be disclosed too:
  - BPEX
  - The relevant Cluster Manager in the YHH

It is understood that this information will only be available to those registered in the YHH and included in clusters. Producers that are registered, but not involved in clusters will not be able to obtain information regarding disease status about specific units. Instead, they will be able to access a map of the region that works on the Traffic Light System for disease status (see Chapter 4).

5.3.2 The Sampling

Initially it was hoped that all units who submitted questionnaires would have faecal and blood samples obtained from their herds. However, as the number of questionnaires submitted by veterinarians grew, it became impossible to accommodate sampling because there were too many units, not enough people and not enough ‘pig-free days’ (any visitor to a unit must have not been on any other pig unit for 48 hours prior to the visit to prevent disease transmission). Also, many producers were unwilling to be the ‘guinea-pigs’, having their units tested for disease and declared to the YHH members first. Instead, the few units who were willing to participate were used. If at all possible, samples were taken across a time period of more than a month from these units. This measure was taken to assess the likelihood of incorrect results from samples. For example, if on a first occasion a unit was positive for a disease but on a further occasion it was negative and no eradication programme had been initiated then it would be concluded that the initial test was a false positive. Alternatively, further sampling still could be carried out, as was seen when swine dysentery was found on a unit. Two types of sample were collected, blood and faeces.
5.3.2.1 Blood Sampling

Blood samples were required for diagnostic testing of EP and PRRS antibody presence on a unit. As it would not be cost effective to hire veterinarians to sample all the units, and many units do not have qualified technicians that can blood sample, obtaining blood from abattoirs as the pigs were being slaughtered was used as an alternative method. Once in the abattoir the blood sampling was relatively straightforward, as soon as the pigs had been stuck the blood was collected into a 30ml sample tube that contained an anti-coagulant and the tube labelled with the corresponding herd slapmark. The blood was then taken directly to the VLA for analysis by IDEXX ELISA kits or DAKO ELISA kits. These ELISA kits are considered the most sensitive on the market currently, and demonstrate the presence of any antibodies to PRRSv or *M. hyopneumoniae* respectively (Zimmerman et al. 2006). If the unit does not vaccinate for either and the result is positive then it is presumed that at some point the pig has been in contact with the disease. This is a useful retrospective analysis of the batch of pigs going to slaughter; it means that the producer can further investigate presence of the disease on their unit and aim to eradicate it. More information on IDEXX ELISA testing and DAKO ELISA testing can be found in Sections 5.3.4.1 and 5.3.4.2. However, blood samples were not taken from units that had vaccinated for PRRS and EP as the ELISA tests cannot distinguish between antibodies created by a vaccine or by natural infection.

5.3.2.2 Faecal Sampling

For swine dysentery, testing faecal samples was required. This sampling consisted of faecal collections from units throughout all age pens and including any hospital pens. On average 5 samples per age group were collected from as many different pens as possible to obtain an accurate representation of the units. Individual samples were collected by picking up faeces in a gloved hand then turning the glove inside-out, air was squeezed out of the gloves before they were tied to prevent contamination. Wherever possible loose stools were sampled from units, these were most likely to contain infection as they showed the clinical symptoms of disease (Taylor, 1999). After samples were collected they were taken directly to the VLA where polymerase chain reaction (PCR) tests were performed. If the results from the PCR were positive then culture testing was performed. The cultures can differentiate between the virulent isolate *B. hyodysenteriae* and all the four non-
pathogenic species of *Brachyspira*. There is a dispute over how effective the PCR is at differentiating between these five *Brachyspira* species. More information on these tests can be found in Section 5.3.4.3.

### 5.3.3 Criteria for Unit Involvement

The units used for sampling the diseases were chosen based upon:

- Completion of the veterinary questionnaire
- Unit being in production
- Unit permission to allow sampling and testing for disease presence
- Unit not vaccinating against the diseases in question (this would show positive on serological tests)
- Unit not using suppressive medications (the organism may be present but suppressed and may not be detected by the tests)

### 5.3.4 The Testing

As previously mentioned there has been some concern over the accuracy of the diagnostic tests in use. The next section will analyse and provide supporting evidence for why these diagnostic tests were chosen in the YHH.

#### 5.3.4.1 PRRS Testing

IDEXX ELISA kits were used to determine presence or absence of antibodies to the PRRS virus. ELISA testing was chosen as culture and lung scoring was not applicable. According to Zimmerman *et al* (2006) ELISA’s have a high specificity and sensitivity and can be used throughout all stages of infection. ELISA’s can determine presence of antibodies from 9 days post infection (dpi) up to 10 months post infection. Hence they were ideal for this pilot as samples were obtained at the slaughterhouse. Blood serum is also a useful sample as it can be collected in high volumes and easily stored for future use, with no requirement for specialised containment or disposal (Jones, 2006).

The IDEXX ELISA is considered the ‘gold standard’ for detecting PRRS antibodies (Zimmerman *et al* 2006) and was used here for testing. It is an antibody indirect ELISA, and results are expressed as S/P (sample/positive) ratios. These S/P ratios are calculated through the following equation:
(OD Sample – OD negative control) / (OD positive control – OD negative control)

OD denotes optical density.

S/P values of 0.4 and above are interpreted as positive. Values of 0.2 or below are negative and values between 0.2 and 0.4 are deemed inconclusive until further assessment. However, as previously stated, serology and ELISA tests are invalid for use on herds that are known to be previously infected or have vaccinated against PRRS as they cannot differentiate between antibodies from an initial infection, reinfection and vaccination. This means any units that declared vaccination use or previous infection could not be sampled for the veterinary pilot scheme.

5.3.4.2  EP Testing

Similar processes apply for EP as for PRRS. *M. hyopneumoniae* is a very slow growing organism (Thacker, 2006) therefore culture is inappropriate as the chance of contamination is too high. PCR’s will only determine the presence of bacterial DNA and not whether it is currently an active bacterium, thus cannot predict whether the bacterium is a causative agent on a unit at the time of testing. ELISA is the most effective technique in determining the presence of EP in herds (Thacker, 2006). At the VLA the blocking ELISA (DAKO) was used. It has a 93% sensitivity and 96% specificity (Strugnell, 2009) this is based upon an antigenic internal protein (Thacker, 2006). The same problems with PRRS ELISA test apply to EP ELISA tests; vaccinated herds and those known to have been previously infected cannot be included as the ELISA testing cannot determine between antibodies generated against current infection, previous infection or vaccination. Another issue with using ELISA’s for EP is that seroconversion may be slow due to *M. hyopneumoniae*’s slow growth (Thacker, 2006). If infection has only recently occurred antibodies may not have been generated yet. Because of this, sampling more than once, across a time period was carried out; this allowed for seroconversion to occur and antibodies could be detected in later samples. Yet, even with further sampling, if the herd does not become infected until the late finisher stage the seroconversion may not occur before slaughter, when blood samples were obtained. This could lead to infections going undetected. The chance
of this is relatively small considering the number of samples taken and the temporal sampling regime.

Abattoir lung scoring is also applicable for EP, however in weaner producer units is irrelevant. Lung scoring does not determine specifically the presence of EP, merely that there is an infective respiratory agent in the herd. The BPHS provides a lung scoring service for all units that are members. It was not used in the YHH Veterinary Pilot Scheme as it requires a veterinarian to assess lungs at the abattoir for potential presence of EP and this would not be cost effective. However, in the future the information gained from the BPHS would be amalgamated with the YHH as a further form of assessing disease prevalence.

### 5.3.4.3 Swine Dysentery Testing

When sampling for swine dysentery loose faeces were chosen; this initial visual assessment provides samples that were most likely to have some form of pathogen, which, could potentially be the causative agent of swine dysentery; *B. hyodysenteriae*. The samples were pooled per age group and diagnosed by PCR at the VLA, Thirsk. Where possible a unit was tested twice, each testing was at minimum one month apart. This PCR technique still causes worry amongst producers over the potential for false positives where atypical isolates or strains of *B. hyodysenteriae* with low pathogenicity can create a positive result. It has been demonstrated that avirulent isolates of *B. hyodysenteriae* can colonise pig guts but do not induce disease (Hampson *et al.* 2006). As with vaccination in PRRS and EP, any suppressive medication such as tiamulin, lincompectin, valnemulin or tylvalosin could potentially ‘hide’ an infection and as such, any units that use suppressive medications were not included in the pilot.

However, other forms of diagnostics were ruled out due to a higher increase in chance of obtaining false positives. Analysis through culture can be achieved, but is difficult as high numbers of the pathogen are needed on a medium. Also, if an individual is simply an asymptomatic carrier, any shedding is periodical and may not always give an accurate indication of presence of the agent in a herd. Similarly, seroconversion can vary greatly from pig to pig with regards to swine dysentery (Joens, 1980). This renders ELISA’s inadequate as they will show poor sensitivity and poor specificity due to a lack of sufficient antibodies to test. A further problem with the ELISA’s, they cannot distinguish between pathogenic and non-pathogenic
strains of *Brachyspira*. In pigs there are 5 *Brachyspira* species, *B. hyodysenteriae* is highly beta-haemolytic; the other four (*B. innocens*, *B. pilosicoli*, *B. intermedia* and *B. murdochii*) are weakly haemolytic and generally believed to be non-pathogenic, although a study by Ohya *et al.* (2008) hypothesised that they may induce enterocolitis.

5.3.4.4  Mange Testing

There were no protocols provided for the testing of mange in the veterinary pilot scheme and mange was not assessed. This is because of the relative ease of sub-clinical control or elimination of mange on units. The mange mite *Sarcoptes scabiei* has to be directly brought onto a unit for transmission to occur, unlike the other three diseases where transmission can occur much more readily. This low transmission rate makes eradicating mange on a regional basis less of a challenge in comparison. Because of this, in the YHH implementation it will be decided between the veterinarian and producer whether an eradication programme is necessary per unit. This will depend upon the severity of the infestation, the negative effect it has on production and how plausible it would be to create an eradication programme.

A unit involved in the YHH will be tested for mange if its veterinarian and client deem it necessary. Rubbing index scores are generally the first tests undertaken. Observing the level of pruritus across a herd allows the veterinarian and producer to determine an appropriate control programme per herd. The most accurate diagnostic test for mange is achieved through skin scrapings taken from the ear and then locating the mites in these scrapings (Cargill and Davies, 2006). Serology tests are often inconclusive with variable sensitivity and specificity; however slaughter checks on the skin can be effective and are conducted as part of the BPHS. If the incidence of mange increased substantially it may become necessary to perform slaughter checks on the skin in order to determine more accurately the prevalence of mange in the region and whether it would be necessary to implement more stringent measures to eradicate it.

If an eradication programme is to be implemented for mange on a unit it will generally run simultaneously with a partial or full depopulation and repopulation that will be conducted against other diseases. It will involve cleaning out unit housing and allowing it to dry for at least two weeks to prevent any mites from surviving.
However, if a form of depopulation and repopulation is not already being carried out, then these measures to eradicate mange are too extreme, instead keeping the infection to a sub-clinical level through increasing biosecurity on farm and use of chemical sprays to kill the mites should be used.

5.4 Results

5.4.1 Qualitative Analysis of the Veterinary Questionnaires
This section assesses the information received from the Veterinary Questionnaires. The veterinarian practices remain anonymous in this research but the same veterinary practice identification number corresponds with the same veterinary practice throughout analysis so assessment of individual practices can occur.

5.4.2 Overview of the Whole Questionnaire
By the end of April 2010, 367 producers had been recorded on the questionnaire database. However, only 175 of these were both in production and gave permission to be part of the YHH pilot, making 48% of the questionnaires eligible to be used for diagnostic and veterinary assessment.

Figure 5-1 Veterinary practice responses to questionnaires
Figure 5.1 demonstrates the variation in veterinary responses the YHH pilot scheme. However, it should be taken into consideration that some practices may have more clients than others. Unfortunately, this makes the data difficult to assess reliably. It also demonstrates the number of questionnaires submitted that provided useful information for assessment. Very few of the questionnaires submitted were fully completed. For future reference it should be noted that inputting a high number of questionnaires and successfully completing a high number of questionnaires are both intrinsic for databases to be useful and this should be monitored throughout the time of questionnaire submission.

Noticeably, Figure 5.1 does not demonstrate that veterinary practice ten inputted any useful questionnaires, yet, this had caused two peaks in questionnaire submissions in early 2010 (see Figure 5.2). It did not provide the database with any units that gave full disclosure to the YHH scheme and were currently in production. This practice could provide feedback to the YHH in the future regarding why clients were not providing full disclosure to the scheme or what the problems were with the format of the questionnaire.
Figure 5.1 demonstrates that veterinary practice three that was the most successful at getting in production units to participate in the YHH. It provided 55% of the full disclosure units that were in current production to the database. This veterinary practice could provide invaluable information into how it was able to get producers to agree to participate in the YHH, something the scheme has struggled with from the start.

Figure 5.2 demonstrates individual veterinary practices’ flux in submitting questionnaires over time. Late 2009 saw the majority of veterinary practices completing questionnaires, completions then slowed over the Christmas period and apart from veterinary practice identification number four never reached the same levels as prior to Christmas.

It shows the need to continually press veterinarians to complete the questionnaires. From Figure 5.2 a trend in completions per veterinary practice can be assumed as follows; a practice joins the scheme, has a period of completing a high quantity of questionnaires, then input trails off. This could be because questionnaires have been completed for all of the veterinary practices pig clients. However Veterinary Practice Identification Number Four does not follow this trend. Therefore, it could be assumed that there are still units unaccounted for on the database that may participate in future if asked. One way to determine this would be through further work with individual veterinary practices to determine which of their clients have completed questionnaires and which have not, then approaching those currently unaccounted for.

Furthermore, it was additionally hoped that these questionnaires would be completed at every quarterly visit to a unit, as a means of assessing any changes in disease prevalence. Thus, we would have expected to see a continuous flow of submissions from veterinary practices as opposed to the initial peaks, perhaps this needed to be expressed to the veterinarians more clearly.
Figure 5.3 provides information on the completion of individual questions from each veterinary practice. The graph identifies which questions remained unanswered consistently (see Appendix 1a for the questionnaire and Appendix 1b for the questionnaire key). There is a visible trend that as the questionnaire progressed fewer questions were fully completed. The questions at the beginning of the questionnaire were straightforward and related mainly to the veterinary practice rather than the clients' units. In the future, questions like this could be placed at the end of the questionnaire; they are undemanding to answer and even if the contributor has lost interest in the questionnaire by this time they will be more likely to complete these simple questions.

At the end of this questionnaire were statistical questions that may require input from other resources. If questions like this were placed at the beginning then the veterinarian would know what resources were required and could be organised to answer them. This may contribute to an increase in completions. Additionally, veterinarians could be informed on the YHH website whilst downloading the questionnaires what resources will be required per client unit to complete the questionnaires fully. Although the questions were specific, they were not difficult. Veterinarians would have had access to the data necessary to complete these
questions. Thus leaving the questions incomplete was not due to a lack of capability but rather willingness.

All this information could be useful in the future when creating questionnaires. By approaching the practices that often left questionnaires incomplete and obtaining feedback on improvements of the questionnaire. Figure 5.1 demonstrated that of the 11 veterinary practices that contributed to the database, only seven practices actually signed clients up fully to the YHH, it is unknown why the other four could not. As only 18 units declared they were out of production it is to be assumed that some other factor prevented the producers from granting permission. However, this may be a problem with the questionnaire formatting; 145 units did not disclose their production status and as such could not be used in the analysis. Problems like this were seen throughout the questionnaire. When questions were left unanswered it was uncertain whether this was because the veterinarian deemed the answer obvious, the answer was no, or the producer did not wish to disclose the answer.

5.4.3 Results from units giving full disclosure to the scheme and are in production dataset (175 units)

The following information is taken from the questionnaire submissions from units that were both in production and gave permission for sampling from their units; 175 units fall into this category. From the information provided in the questionnaires the YHH included:

- Number of sows = 25895
- Number of Finishing places = 196853
- Sow output (weaned/sow/yr) = 23.03 average, 18-27.7 range
- Herd size (average) = 130 sows, 1050 finishers
- Herd size range = 90-1250 sows, 300-8000 finishers

Average percentage mortalities:

- Pre-weaned = 10.47
- Growers = 3.42
- Finishers (>60kg) = 2.16
- Sows = 5.56 however, this is the national average due to culling (BPEX, 2010a)
Figure 5.4 demonstrates that of the 175 permission granted and in production units 82 were eligible for diagnostic testing for PRRS. 10 units had blood samples obtained for PRRS testing, when including these with the 91 units that vaccinate it gives 101/175= 58% of the units in the YHH accounted for and their disease status regarding PRRS determined.
Figure 5.5 demonstrates that 56 units were eligible for diagnostic testing, blood samples were obtained from 9 units, these were assessed for presence of EP; a further 72 units already vaccinate for EP giving a total of 81. This means the 81/175=46% of eligible units were accounted for and their disease status determined.
Figure 5.6 is slightly more complex than the previous two disease breakdowns. Rather than utilising whether vaccinations were used and declaring these units positive based upon their vaccinations, suppressive medications are used for swine dysentery instead. Eleven faecal samples were obtained from the 109 units eligible for testing. Sixty-two units were classified as positive on the basis of the presence of potentially suppressive medication. Additionally 3 units were positive for SD on the basis of veterinary declaration on the survey. This gives a total of 76 units, or 43% of units were accounted for and their disease status determined.
5.4.4 Quantitative Analysis of the Blood and Faecal Sampling

This section of the VPS aimed to determine whether the veterinary diagnosis corresponded with the diagnostic results from sampling units. Blood and faecal samples were obtained from units that had agreed to partake in diagnostic testing. Blood samples were analysed by the VLA in Thirsk for PRRS specific antibodies and *M. hyopneumoniae* specific antibodies. Faecal samples were assessed via reverse transcriptase-PCR (RT-PCR) and cultures to determine the presence of *B. hyodysenteriae*. The results are as follows:

5.4.4.1 PRRS

Table 5.1 Breakdown of blood serum sampling results for PRRS antibodies

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. samples</th>
<th>No. +ve</th>
<th>% +ve</th>
<th>No. -ve</th>
<th>% -ve</th>
<th>No. Inc</th>
<th>% Inc</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
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<td>+ve</td>
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<td>15</td>
<td>9</td>
<td>60</td>
<td>6</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>INC</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>8</td>
<td>11</td>
<td>11</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>93</td>
<td>1</td>
<td>7</td>
<td>-ve</td>
</tr>
<tr>
<td>10</td>
<td>13</td>
<td>12</td>
<td>92</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>+ve</td>
</tr>
<tr>
<td>Total</td>
<td>144</td>
<td>122</td>
<td>84.7</td>
<td>20</td>
<td>13.8</td>
<td>2</td>
<td>1.4</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.3 summarises the results from diagnostic tests on 10 units for the presence of PRRS antibodies. IDEXX ELISA kits 2x and 3x were used. From Table 5.3 it can be seen that eight units were found to be serum positive for PRRS antibodies (one unit was negative for PRRS antibodies and one unit was inconclusive). The results were expressed as a sample-to-positive ratio (S/P). Values of 0.4 and above were interpreted as positive. Values of less than 0.2 were considered negative. Values between 0.2 and 0.4 were inconclusive. This equates to around 85% of the units sampled were positive for PRRS antibodies.
### 5.4.4.2 Enzootic Pneumonia

Table 5-2 Break down of blood serum results for *M. hyopneumoniae* antibodies

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. Samples</th>
<th>No. +ve</th>
<th>% +ve</th>
<th>No. -ve</th>
<th>% -ve</th>
<th>No. inc</th>
<th>% inc</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>14</td>
<td>93</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>6.7</td>
<td>+ve</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>14</td>
<td>93</td>
<td>1</td>
<td>6.7</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>6</td>
<td>40</td>
<td>4</td>
<td>26.7</td>
<td>5</td>
<td>33</td>
<td>INC</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>77</td>
<td>3</td>
<td>20</td>
<td>-ve</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>-ve</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>10</td>
<td>67</td>
<td>2</td>
<td>13.3</td>
<td>3</td>
<td>20</td>
<td>INC</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>1</td>
<td>6.7</td>
<td>14</td>
<td>93</td>
<td>0</td>
<td>0</td>
<td>-ve</td>
</tr>
<tr>
<td>8</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+ve</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>-ve</td>
</tr>
<tr>
<td>10</td>
<td>13</td>
<td>6</td>
<td>46</td>
<td>7</td>
<td>53.8</td>
<td>0</td>
<td>0</td>
<td>INC</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>148</strong></td>
<td><strong>66</strong></td>
<td><strong>45</strong></td>
<td><strong>68</strong></td>
<td><strong>47</strong></td>
<td><strong>12</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

Table 5.4 suggests that the unit status for EP is harder to determine compared to PRRS. Three units remained inconclusive, four were negative for *M. hyopneumoniae* antibodies and three units were positive for *M. hyopneumoniae* specific antibodies. These results could show that the incidence of EP across the region may be much lower than PRRS; around 50% if we assume that inconclusive scores will be deemed positive until they can be proven negative. Alternatively it may show that it is harder to determine whether EP is present or absent on a unit through ELISA test alone and that perhaps combining these tests with other diagnostic tests such as with lung scoring may be necessary in cases that are difficult to interpret.
### 5.4.4.3 Swine Dysentery

Table 5-3 Breakdown of faecal results for presence of *B. hyodysenteriae*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Clinical Signs?</th>
<th>PCR Results</th>
<th>Culture Results</th>
<th>SD Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>5</td>
<td>No</td>
<td>+ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
<tr>
<td>6</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>7</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>8</td>
<td>No</td>
<td>+ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
<tr>
<td>9</td>
<td>No</td>
<td>+ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
<tr>
<td>10</td>
<td>No</td>
<td>-ve</td>
<td>-</td>
<td>-ve</td>
</tr>
<tr>
<td>11</td>
<td>No</td>
<td>+ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
</tbody>
</table>

Total 100% No 36% +ve 100% -ve 100% -ve

Table 5.5 demonstrates that all units tested were deemed negative for presence of the swine dysentery causing bacteria *B. hyodysenteriae*. RT-PCR's were conducted on all samples; if the result was positive then further analysis through culture was performed. None of the cultures were found to be positive and from this it is assumed that the original positive PCR results were false. However, this information cannot be deemed as representative of the YHH region, as there will be some cases of swine dysentery in the area. The eleven samples are too few to be deemed representative of the YHH region which is believed to contain around 450 pig units (DEFRA, 2010). Although this may undermine the results the testing was still necessary to determine the reliability of the PCR testing. The implications caused by being swine dysentery positive are extensive and because of this many units were unwilling to participate in testing for the bacteria. It can be seen here that 4 out of the 11 units were first deemed positive for swine dysentery based on the RT-PCR’s, this undermines the reliability of the RT-PCR’s. These four units were then cleared through culture, however if this were to be used on a representative...
scale then for every 100 RT-PCR tests, 36 of them would be incorrect. One possible reason the level of inaccuracy is so high when testing for the *B. hyodysenteriae* bacteria is because there are another four *Brachyspira* species that do not cause dysentery, it can be difficult for the RT-PCR to determine between these.

5.4.5 Qualitative and Quantitative Comparisons

5.4.5.1 Assessing the questionnaires and diagnostics simultaneously

Table 5-4 Summary of results from diagnostic testing and veterinary opinions

<table>
<thead>
<tr>
<th>Disease</th>
<th>Sampling Method</th>
<th>Basis</th>
<th>Unit Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>PRRS</td>
<td>Questionnaire</td>
<td>Vet Declaration</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Diagnostics</td>
<td>Vaccination</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slaughter Bloods</td>
<td>8</td>
</tr>
<tr>
<td>EP</td>
<td>Questionnaire</td>
<td>Vet Declaration</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>Diagnostics</td>
<td>Vaccination</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slaughter Bloods</td>
<td>3</td>
</tr>
<tr>
<td>SD</td>
<td>Questionnaire</td>
<td>Vet Declaration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Diagnostics</td>
<td>Suppressive Meds</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faeces Sampling</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5.6 summarises results from both the veterinary opinions of units and the diagnostic tests for each disease. The table provides specific information on how many units were determined positive or negative for disease presence and which form of testing declared this. All of the units that had samples for diagnostic testing obtained also had questionnaires completed by their veterinarians. When we compare the assumptions of the veterinarians with the results from the diagnostic sampling regarding disease status on units the veterinary results conform 100% to the diagnostic sampling. This result dispels any concerns over the accuracy of veterinarian assessment regarding disease status on units and is what the YHH hoped to achieve. However, this is not unexpected as to date only specialist veterinarians have submitted questionnaires into the database and they would be expected to accurately assess units.
5.4.5.2 Regional Disease Prevalence

According to DEFRA in 2009 there were 460 pig units registered in the Yorkshire and Humber region. From this we can infer that of these 460 units

- 68% of units in the region were approached by the scheme and are aware of its targets (313/460)
- 43% of units in the area have completed questionnaires, are in production and will fully participate in the scheme (198/460)

These figures are promising considering the scheme was only initiated at the start of 2009. By utilising DEFRA's statistics on the total number of units in the region and assuming that the data provided in the veterinary questionnaires is correct as proven through diagnostic comparisons, the incidence of each disease can be deduced for the entire region.

Table 5-5 Estimated incidence of disease in the Yorkshire and Humber region.

<table>
<thead>
<tr>
<th>Disease</th>
<th>% of units positive for disease</th>
<th>Estimated number of units infected in region</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRRS</td>
<td>59</td>
<td>272</td>
</tr>
<tr>
<td>EP</td>
<td>62</td>
<td>286</td>
</tr>
<tr>
<td>SD</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

If the disease prevalence from the questionnaire is assumed to be representative of the region the data can be scaled up to determine suspected disease prevalence in the region. The potential number of infected units in the region can then be estimated as seen in Table 5.7. The table provides information on the percentage of disease found in the veterinary questionnaire. Section 5.4.5 proved that the assumptions of the questionnaires should be correct. Therefore, from the data provided in the questionnaires and the data provided by DEFRA (2010) the approximate amount of disease per unit can be assumed for the region. This is potentially a highly useful tool. By making producers aware of the prevalence of disease and the risk of disease infecting units, producers will hopefully be more likely to become involved in the YHH as they will want to be involved in a scheme that is trying to combat disease.
5.5 Discussion
The VPS has demonstrated 100% compliance between the veterinary questionnaires and the diagnostic samples subsequently carried out. This result provides the YHH with supporting evidence into the capability of veterinarians to accurately determine disease presence on a unit.

However, before too many assumptions could be made from this result, there were some limiting factors to the implementation of the VPS which may influence this high level of accuracy, and therefore need to be considered. The veterinary questionnaires provided the YHH with a vast amount of information on many of the units in the region. However, gaining this knowledge was sometimes an uphill struggle. Initially, cold calling the producers, sending them letters requesting their participation in the YHH and getting them to ask their veterinarians to become members of the YHH was not very particularly successful. After this a different tactic was employed and instead focused on involving the veterinarians directly, on the assumption that producers are more likely to trust their veterinarians rather than unknown people telephoning them. The task was then to involve more veterinarians; what was required was a broad spectrum of veterinarians, from pig specialists to general vets with perhaps only a couple of hobby farms as clients. However only specialist pig veterinarians became involved, the inclusion of non-specialist veterinarians could be useful in future work.

Firstly, as only specialist pig veterinarians completed the questionnaires. It would be assumed that these veterinarians would already be highly capable of determining disease status. It had been hoped that the VPS would be able to compare the effectiveness of specialist veterinarians and general veterinarians at assessing disease. It was then hoped that any recurrent problems found with general veterinarian assessment could be dealt with, for example through training workshops similar to those seen in the Classical Swine Fever eradication program in the United States (Food and Agriculture Organization of the United Nations, 2000). Unfortunately, because there were no submissions of questionnaires from general veterinarians, this could not be determined. However, the results do provide a platform for future research and will still be useful in the next stages of the YHH.
Furthermore, sampling only occurred on a small number of units which may have hindered the significance of the sampling results, as they may not have been a true representation of the population. Ideally, the VPS wanted to sample a large proportion of the units involved in the YHH. This did not occur mainly due to the time restraints, which were affected by the requirement of ‘pig-free days’ between site visits; verifying that those who were entering units had not been in contact with other pigs in the prior 48 hours. This was a biosecurity measure to ensure that the potential transmission of disease was minimised, and as the YHH was promoting an increase in biosecurity, it was necessary that its advisories also complied with its own recommendations. In addition, the substantial use of vaccination and medication in pig units, made many herds ineligible for diagnostic testing and therefore could not be included. Again this reduced the sample size available and thus the significance of the results produced. Perhaps in the future the use of alternative diagnostic testing could increase the amount of units eligible for sampling, for example, PCR testing in place of antibody detection for PRRS and EP (Zimmerman et al. 2006). Whether this is a cost effective approach would need to be determined.

The format of the questionnaire also posed considerable problems when it came to analysis. Fully completed questionnaires were rare. It was assumed that this was because the questionnaire was too long, making it time consuming to complete. When the questionnaire was created by the Steering Committee it underwent many changes, some veterinarians had an input into the creation, however it became apparent through analysis that it still was flawed. It was anticipated to take around 5 minutes to complete alongside other paperwork the veterinarians carry out at quarterly visits but in reality it was believed to take around 15 minutes. The phrasing of questions also made analysis difficult. In some instances the lack of an answer could be construed in different ways, for example, if a question remained unanswered, it was not always clear whether this was because the veterinarian deemed it obvious, or because the producer wished to withhold the information. In the future, lessons could be taken from this format; providing shorter questionnaires with closed ended questions, or alternatively yes/no flow charts could yield better results. This should prevent blank answers, therefore allowing for differentiation between ‘no’ and ‘undisclosed’ answers. A large proportion of the questionnaire could not be incorporated into subsequent analysis because the veterinarians did not declare the units production status. This may have seemed obvious to the
veterinarian, yet, it was not possible to check all of the submissions with no declared production status, given the time restraints. In the future perhaps these units could be approached by the YHH and have their production status determined. This would considerably increase the number of units involved in the YHH, and, as the database has provided the YHH with contact details, would not be too difficult to perform.

Additionally, in order to gain these results the veterinarians were provided with monetary compensation as an incentive for completing questionnaires. When looking at the level of questionnaires completed it can be seen that as the chance to receive this compensation came to a close, the number of complete questionnaires increased. This proves the incentive was worthwhile. However, now that compensation is no longer available, it would be interesting to see whether questionnaires would still be completed. Perhaps another incentive needs to be provided, especially if the YHH wants to entice non-specialist veterinarians to partake, for example their inclusion into pig specialist workshops and societies.

Considering the problems with the VPS, the YHH was still able to acquire some valuable outcomes. It ensured that many producers in the area were aware of the YHH scheme and how they could become involved through their veterinarians. It also provided logistical information on many units in the area including their geographical location, the potential prevalence of disease, the prevalence of medication in the area and the measures producers were taking to try and tackle disease.

To conclude, the VPS provided invaluable information to the YHH regarding the knowledge base of the veterinarians, the potential disease prevalence in the area and information of many farms in the area (unit type, size, etc). Although in retrospect there are flaws in the VPS' implementation, especially regarding the format of the questionnaire, the results it has provided are of great importance to the YHH. The results will assist in the creation of eradication protocols and the potential geographic location of future clusters.
6 Alternative Sampling Method: Colostrum

6.1 Introduction

A small scale study running parallel to the VPS aimed to assess a new sampling technique. It was proposed that colostrum could be used as an alternative sample to blood serum for assessing presence of disease antibodies in a herd. The study aimed to determine whether colostrum could be a good enough indicator of antibody presence in farrowing sows and hence used instead of blood sampling live sows. Literature suggests that specific antibodies are capable of being detected in colostrum. Eichorn and Frost (1997) found that anti-PRRSv antibodies were found in the same concentrations in colostrum as they were in the blood serum. The study also aimed to determine whether there was a change in antibody and IgG concentration in colostrum in the 12 hours prior to farrowing. The antibodies tested were specific to either PRRSv or \textit{M. hyopneumoniae}. Total IgG concentration was also determined. Total IgG was assessed as it is the predominant immunoglobulin found in colostrum, and therefore the most likely to be detected in ELISA testing (Klobasa and Butler, 1982).

Blood sampling live pigs often requires a veterinarian or a qualified technician, and many units do not have the resources to blood sample themselves. However collecting colostrum is a relatively quick and easy alternative. This has the potential of becoming a way for farmers to provide samples from their own units, simply by collecting the colostrum as close to farrowing as possible and sending it into their veterinarians. This would be more efficient and cost effective than requiring a vet to come and collect blood samples from the sows. Live blood sampling is invasive, stressful for the pigs and difficult for the technician but colostrum is readily available at farrowing and easy to collect.

6.2 Hypotheses

It was hypothesised that colostrum would be an alternative sampling method to blood serum sampling to determine the presence of specific PRRSv and \textit{M. hyopneumoniae} antibodies via ELISA testing.
The aim of the colostrum sampling research was to demonstrate that colostrum provided an accurate and more efficient means of sampling sows than blood serum sampling.

6.3 Methods

Colostrum and serum sampling was conducted at the University of Leeds pig farm. Colostrum samples were taken from 10 sows on average 12 hours prior to farrowing, 6 hours prior to farrowing and at farrowing from the most accessible anterior teat upon arrival of the first piglet. To determine whether the concentrations of PRRSv antibodies and *M. hyopneumoniae* antibodies and IgG were of a detectable and consistent level ELISA tests were performed on colostrum samples. Two data points were unavailable for analysis for IgG concentration levels due to problems with the colostrum samples taken. The samples from G3537 and G1114 at -12 hours pre-farrowing were too thick a consistency to be used in the ELISA testing.

To determine whether there was a significant difference in the concentration of IgG present in colostrum samples in the 12 hours pre farrowing statistical analysis occurred. Normality testing would demonstrate that this data is not normal due to the small sample size. However because the data focuses on IgG levels in colostrum and the large amounts of literature that prove its presence, it is assumed that the data would fall on a normal curve were the sample size larger (Murphy *et al.* 2005). Because of an unbalanced data set a repeated measures ANOVA could not be carried out. Therefore, a specific analysis of variance linear model was created in the statistical program R2.12.1 (R Development Core Team, 2009) to analyse the concentration of IgG over time for individual pigs.

The experiment progressed to determine whether colostrum can also be used specifically towards detecting disease antibodies. These specific antibodies were expected to be present in a lower concentration than the IgG protein and thus more difficult to detect in colostrum. ELISA tests were conducted by the VLA in Weybridge for *M. hyopneumoniae* antibodies and PRRSv antibodies in the colostrum samples. Unfortunately, the results provided were in the S/P Ratio format, so it was not possible to conduct any statistical analyses on the data and only descriptive comparisons between sample statuses were possible. S/P Ratio
values of 0.4 and above were interpreted as positive. Values of less than 0.2 were considered negative. Values between 0.2 and 0.4 were inconclusive.

Serum samples were obtained for some of the sows by blood sampling one week post farrowing by a veterinarian. This time gap was chosen to minimise disruption to early lactation in the sow and the growth of the piglets. It also prevented the sow seroconverting between the colostrum and blood sampling points. The blood serum samples and colostrum samples were stored at -20°C before being dispatched to the VLA for the detection of PRRSV and *M. hyopneumoniae* antibodies using IDEXX ELISA’s. These ELISA kits are considered to be the best for the detection of specific antibodies.

### 6.4 Results

Table 6.1 provides results from the analysis for total IgG concentration in colostrum (mg/ml). Samples were analysed via ELISA kit (product number can be found in Appendix 2), in duplicate, and the average for each sample determined. The concentration of total IgG in each sample was then calculated from the standard curve formula of $y=0.411\ln(x)-0.4491$ with $R^2=0.9521$ (see Appendix 2). Descriptive statistics showed that two of the data-points were outliers; sow H0709 at -12 hours and sow H2380 at farrowing. These data-points were removed from further analysis.

**Table 6-1 Results from total IgG concentration (mg/ml) in colostrum for 12 hours pre farrowing**

<table>
<thead>
<tr>
<th>Sow</th>
<th>-12 hours</th>
<th>-6 hours</th>
<th>Farrowing</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0794</td>
<td>186</td>
<td>108</td>
<td>62</td>
</tr>
<tr>
<td>G3537</td>
<td>n/a</td>
<td>113</td>
<td>68</td>
</tr>
<tr>
<td>H2380</td>
<td>59</td>
<td>119</td>
<td>202</td>
</tr>
<tr>
<td>H0279</td>
<td>65</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>A0594</td>
<td>36</td>
<td>33</td>
<td>44</td>
</tr>
<tr>
<td>G1143</td>
<td>31</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>H2776</td>
<td>23</td>
<td>31</td>
<td>48</td>
</tr>
<tr>
<td>H1111</td>
<td>113</td>
<td>40</td>
<td>47</td>
</tr>
</tbody>
</table>
Figure 6-1 Average IgG concentration (mg/ml) in colostrum samples for up to 12 hours pre-farrowing, with standard error bars

Figure 6.1 uses the average from each time frame so that the trend of IgG concentration in the 12 hours prior to farrowing can be seen clearly. It shows that in these 12 hours the level of IgG is consistently detectable by ELISA tests. There was no significant difference between time and concentration of IgG levels in colostrum pre farrowing (P=0.19).
<table>
<thead>
<tr>
<th>Sow</th>
<th>-12 hours</th>
<th>-6 hours</th>
<th>0 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3218</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A4192</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>G3537</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>H2380</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>H0279</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A0594</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
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<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
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<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A0098</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A1732</td>
<td>-ve</td>
<td>-ve</td>
<td>-ve</td>
</tr>
<tr>
<td>G1598</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>H2776</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>H2889</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>G1114</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>Sow</td>
<td>-12hours</td>
<td>-6hours</td>
<td>0 hours</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>G3218</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A4192</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>G3537</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>H2380</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>H0279</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A0594</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>X100</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>G1143</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A0098</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>A1732</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>G1598</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
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<tr>
<td>H2776</td>
<td>inconclusive</td>
<td>inconclusive</td>
<td>inconclusive</td>
</tr>
<tr>
<td>H2889</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
<tr>
<td>G1114</td>
<td>+ve</td>
<td>+ve</td>
<td>+ve</td>
</tr>
</tbody>
</table>

From Tables 6.3 and 6.4 it can be seen that throughout the twelve hours prior to farrowing there is no change in the detection of antibody presence. If antibody is found at farrowing, then it is also present at a detectable level in the twelve hours prior to farrowing.

It has been determined that colostrum can provide an indication of IgG levels PRRSv antibody levels and *M. hyopneumoniae* levels in the twelve hours prior to farrowing. The next stage was to assess the accuracy of the colostrum results for the specific antibody detection with results from blood serum sampling. It is hoped that by comparing the colostrum and blood serum results it can be determined whether colostrum is a good enough indicator of specific disease antibodies.

Six of the ten sows had blood samples taken and analysed.
Table 6-4 Compliance between blood serum and colostrum results for EP

<table>
<thead>
<tr>
<th>Sow</th>
<th>Colostrum Status</th>
<th>Blood Status</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0279</td>
<td>+ve</td>
<td>+ve</td>
<td>YES</td>
</tr>
<tr>
<td>A0594</td>
<td>+ve</td>
<td>-ve</td>
<td>NO</td>
</tr>
<tr>
<td>X100</td>
<td>+ve</td>
<td>-ve</td>
<td>NO</td>
</tr>
<tr>
<td>A1732</td>
<td>-ve</td>
<td>-ve</td>
<td>YES</td>
</tr>
<tr>
<td>H2989</td>
<td>+ve</td>
<td>+ve</td>
<td>YES</td>
</tr>
<tr>
<td>G114</td>
<td>+ve</td>
<td>+ve</td>
<td>YES</td>
</tr>
</tbody>
</table>

Table 6-5 Compliance between blood serum and colostrum results for PRRS

<table>
<thead>
<tr>
<th>Sow</th>
<th>Colostrum Status</th>
<th>Blood Status</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0279</td>
<td>+ve</td>
<td>+ve</td>
<td>YES</td>
</tr>
<tr>
<td>A0594</td>
<td>+ve</td>
<td>+ve</td>
<td>YES</td>
</tr>
<tr>
<td>X100</td>
<td>+ve</td>
<td>+ve</td>
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<td>A1732</td>
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<tr>
<td>H2989</td>
<td>+ve</td>
<td>+ve</td>
<td>YES</td>
</tr>
<tr>
<td>G114</td>
<td>+ve</td>
<td>-ve</td>
<td>NO</td>
</tr>
</tbody>
</table>

The presence of IgG antibodies in colostrum can be readily determined in the twelve hours before farrowing, as can the presence of specific antibodies for PRRSv and *M. hyopneumoniae*. However, there is some doubt over the accuracy of the detection of specific disease antibodies from colostrum. When comparing the results from the blood serum and colostrum (Tables 6.4 and 6.5) the lack of compliance means it cannot be yet determined that colostrum is an appropriate indicator of antibody presence.
6.5 Discussion
In contrast to the findings of Eichhorn and Frost (1996) the study demonstrated that colostrum sampling was not an appropriate diagnostic method for determining the presence of PRRSv antibodies. However, this was not due to an inadequate concentration of PRRSv antibodies found in the colostrum. The issue with the colostrum sampling for specific antibodies was a lack of correspondence between the colostrum results and blood serum results. Blood serum is widely recognised as an appropriate measure to determine the presence of specific antibodies in pig herds (Zimmerman et al. 2006). Thereby correlating colostrum sample results against blood sample results was appropriate.

All of the incorrect results showed a positive colostrum result compared to a negative blood sample result; it is predicted that the incorrect results from the colostrum sampling may be due to non-specific binding in the ELISA test. This binding will enhance the optical density of the ELISA test, making the results positive. Because of this it is believed that the issue lies not with the use of colostrum but the specificity of the ELISA tests. The ELISA tests used have not been designed specifically for colostrum sampling. Perhaps in future work effort could be placed in creating blockers when using the ELISA tests to prevent non-specific binding.

However, when the presence of IgG, PRRSv and M. hyopneumoniae antibodies was established it was consistent throughout the 12 hour period prior to farrowing. The time frame was chosen as this demonstrates a working day, therefore farmers could sample from the sows as soon as colostrum became available. There was no significant difference seen between 12 hours prior to farrowing and farrowing in IgG concentration (p=0.19). Therefore, were an appropriate diagnostic test created in the future, colostrum could become an alternative method for diagnosis of specific antibody presence within sows. Colostrum sampling would be beneficial for the sow as it is less invasive than blood sampling and readily available at farrowing. As antibody concentration is consistently detectable for the twelve hours prior to farrowing it makes acquiring sampling easy for the producer too as they can obtain a sample as soon as colostrum is available, or at their convenience after it becomes available and at farrowing.
The ELISA tests used were the best currently available and will be used in the YHH. Because of this, it can be concluded, that colostrum does produce specific disease antibodies in the twelve hours prior to farrowing. Yet, until a means of accurately testing colostrum samples is devised, colostrum should not yet be used as a diagnostic method.
7 Discussion

How successful was the planning stage of the YHH?

It is widely understood that the reduction in disease prevalence in pigs has a positive effect on the animals' health and welfare (Taylor, 1999). Thus, the creation of an effective regional disease eradication scheme that would improve the health and welfare of the pigs would be of great benefit to the animal. Furthermore, it would lead to an increase in animal productivity and be of great profitability to the British pig industry. Hill and Sainsbury (1995) summarise this concept well; ‘If sound pig welfare can be built into an efficient system, disease will be low and profitability high.’ Therefore creating a successful regional disease eradication scheme is an area of considerable interest to the British pig industry. This thesis has provided insight into the mechanisms involved in the creation of a successful regional disease eradication scheme.

The aim of this study was to assess the planning stage of a regional disease eradication scheme and ascertain the likelihood of success. The YHH has now completed its planning stage. Because the YHH has received funding from Yorkshire Forward and the European Development Agency to progress to Stage Two, Stage One can be deemed a success. However, the effectiveness of Stage One throughout the year needs to be critically assessed. The planning of the scheme could have been more successful throughout the year had it been better organised and more efficient. The manner in which this first stage has been implemented will have a profound effect upon the success of Stage Two. Many changes need to be made to the structure of the YHH if its original goal of disease eradication is to be achieved.

7.1 Successes in Stage One

When considering the success of the planning stage of the YHH, various contributing factors emerge. Initially, the views of the producers at the Good Will Meeting on July 1st 2009 provided the YHH with a platform from which to build upon. All attendees were provided with hand-held interactive voting mechanisms
and it is from this polling data their initial opinions regarding the YHH can be determined.

The attendees understanding of the YHH was assessed as the meeting began. Fifty-four percent of attendees were producers; all further assessment will focus upon their views of the scheme as they have the most influence regarding the success of the YHH. Ninety-three percent of the producers said it was very important to decrease the cost of chronic diseases. At the beginning of the meeting 28% of producers committed to taking an active part in the YHH, by the end of the meeting this had increased to 55%, with a further 39% saying they were highly likely to become involved.

Table 7-1 Thoughts of producers regarding the YHH on July 1st 2009

<table>
<thead>
<tr>
<th>Question Posed to Producers</th>
<th>% Producers Agreed</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is VERY important to tackle Swine Dysentery</td>
<td>91</td>
</tr>
<tr>
<td>It is VERY important to tackle PRRS</td>
<td>57</td>
</tr>
<tr>
<td>It is VERY important to tackle EP</td>
<td>51</td>
</tr>
<tr>
<td>It is VERY important to tackle Mange</td>
<td>18</td>
</tr>
<tr>
<td>A regional collective effort is needed to achieve this</td>
<td>71</td>
</tr>
<tr>
<td>Willingness to declare disease status on map</td>
<td>75</td>
</tr>
</tbody>
</table>

Table 7.1 summarises some of the data taken at the July 1st meeting. From this it is clear to see that producers present at the meeting felt a regional collective effort was necessary to eradicate chronic disease. It is interesting to note that the importance of regionally eradicating mange was deemed a much smaller issue to the producers than the other three diseases. It is assumed that this is because of the low risk of transmission associated with mange between units (Marquardt et al, 2000). However, the pinnacle of results lies in the producers’ acceptance of the mapping service; surprisingly 75% of producers said they would be happy to declare their units disease status on the mapping service. This was unexpected because it is such an innovative and forthcoming idea; knowledge transfer of disease status is not currently common practice in the pig industry. It was expected that more persuasion would be required to get the majority of producers to agree to this. Had we got these producers to sign up to the scheme at this meeting it could have provided the YHH with a vast amount of information about the region, quickly
and efficiently. With the creation of two new regional schemes since the YHH this approach has been adopted. Any meeting that the schemes hold provides the necessary forms for producers to become involved. Additionally, producers expressed a wish for immediate action regarding the implementation of the eradication scheme. To accommodate this, additional resources were acquired; BPEX became more involved in the organisation of the scheme so that it would progress faster and more efficiently.

However, a major concern of the producers at the July 1st meeting was the honesty of health status declarations from other producers. Many producers were cynical of the openness of their competitors. The veterinary pilot scheme provided a solution. This required the producers to agree to allow their veterinarians to disclose their clients units health status in relation to the four diseases specified by the YHH. This also served a further purpose as veterinarian knowledge could be assessed through comparison with diagnostic sampling.

From the initial meeting on July 1st 2009 and throughout the following year the YHH had various other successful ventures. Positive media coverage detailing the YHH and providing producers with the necessary contacts should they have wanted to participate in the scheme was supplied throughout the year. Furthermore, the YHH was represented at the Yorkshire Agricultural Show, BPEX’s Pig and Poultry Fair and the Pig Veterinary Society. This aimed to increase awareness of the scheme throughout the industry and gain support of industry stakeholders. It succeeded, with many veterinarians from the region supporting the scheme, as can be seen through their willingness to participate in the VPS.

Moreover, the YHH provided meetings throughout the year in an effort to maintain the momentum created from the July 1st meeting. These meetings involved guest speakers from the industry and included interactive workshops, such as a demonstration of the mapping service, in an effort to encourage individuals to join. The meetings demonstrated to producers that the YHH had the support of many allied industry members and that the scheme was endowed with excellent resources. This meant that the producers could see firsthand the potential of participating in the scheme.

One highly important success of the YHH was the creation of its website (www.yhh.org.uk). This not only provided up to date information on the YHH and
access the mapping service (as described in Chapter 4) but also other interactive services that producers could utilise. These include decision tools that enable producers to investigate potential health improvement developments and a depopulation calculator that assesses costs of production. There were a few technical issues with the tools, but these are being dealt with. Nonetheless, these services have great potential use; those that trialled the decision tools provided positive recommendations on their usefulness, and committed to utilising the tool again once the technical issues have been resolved.

7.2 Problems in Stage One

The July 1st meeting highlighted concerns of producers regarding the YHH. High on the agenda was finding a means of recruiting producers unwilling to participate in the scheme. From the VPS results it can be seen that many producers have become involved in the scheme since its formation. Yet there are still producers that remain uninterested in joining the scheme. Through personal correspondence throughout the year it has been discovered that one reason these few producers remain resistant to joining is because they consider their units of a high enough health status that they see no benefit from joining the scheme. It is hoped, as the scheme progresses and these producers witness what is to be gained from the scheme that they will consent to join it. It is imperative that as many producers as possible join the YHH in order for it to be successful. Without these producers it will be difficult to ascertain the level of disease present in the region and determine with some certainty when the diseases have been eradicated.

Furthermore, as discussed in Chapter 5, the producers held concerns over ‘backyard’ small scale hobby farmers and their potential for disease transmission. Unfortunately, no further progress has been made in identifying these farms but it is hoped that this will change in Stage Two with the involvement of the British Pig Association, an association that works closely with small scale pedigree breeders. This should be a gateway to accessing the smaller farms in the region.

The scheme has struggled to maintain the momentum that was gained at the July 1st meeting in spite of considerable efforts. The timing of the initial meeting is believed to have contributed to this; as it was the beginning of the summer harvest, meaning little could be achieved immediately due to producers’ other commitments. It also meant that many producers could not attend the meeting because of their
prior commitments to harvest. This resulted in several months with little communication with the producers and no notable advances in the scheme. In the September Steering Committee meeting this problem was noted; producers that had attended the initial July 1st meeting were unsure what the next step was and had expressed their disappointment to their veterinarians, who were steering committee members. The future meetings that were held, although successful in their own right, never achieved the same response as was seen in the initial July 1st meeting and it was difficult to maintain the momentum witnessed in the first meeting.

The function of YHH Steering Committee was to provide solutions to planning problems encountered when trying to initiate the scheme. On a whole this was achieved, however the implementation was not efficient and much time wasted on retrospectively irrelevant issues was encountered, as discussed in Chapter 1. Furthermore, the time commitments of many members of the Steering Committee meant that there were only five meetings held over a period of eight months. Considering the size of the task at hand this was a very small number of meetings, especially in light of the important decisions that had to be made. Perhaps more could have been done to accommodate the time commitments of the committee. For the final two Steering Committee meetings there was an interactive email sent to all members where they could provide their availability; had this been implemented earlier, more frequent meetings could have occurred and these meetings may have been more effective.

Retrospectively, the Steering Committee was not utilised as well as it could have been. For example, in the VPS, there was considerable difficulty in gaining blood samples from abattoirs. However, a Steering Committee member was an employee of the Vion Food Group. Had this contact been utilised then entry into the abattoirs could have been facilitated easier, and as an outcome, more blood sampling could have occurred.

7.3 The Future of the YHH: Hopes and Recommendations

In order for Stage Two to be successful and progress made towards eradicating the four diseases, there needs to be alterations and improvements in the foundations laid in Stage One.
The YHH website needs addressing; this has the potential to be a fast and convenient way to communicate between all members of the YHH. However, the mapping service frequently crashes and issues over data protection need resolving. Additionally, further work on the decision tools is necessary.

It is hoped that the three pilot clusters in Boroughbridge, Mappleton and Melbourne successfully demonstrate the potential of the YHH to other producers. The funding should become available soon for the clusters to start implementing biosecurity measures. Because of these measures, it is hoped the lower risk of disease transmission will cause a decrease in disease prevalence in the clusters. This will be a great boost to the YHH and provide it with solid evidence of its potential as a disease eradication scheme and will lead to the creation of more clusters.

It is also hoped that in Stage Two the allied trades will still play an intrinsic part in the YHH implementation. This could be through cooperation with clusters, creating new accessible biosecurity measures or providing services in a new manner. For example, these services could be coordinating transportation within a cluster, such as feed deliveries and dead stock collections.

Throughout all these changes the YHH still needs to continue putting effort into obtaining participation from further producers. This could be through utilising tools already established in the industry, such as the BPHS scheme.

Furthermore, the YHH needs to be aware of changes outside the scheme specifically politically and economically. The change in government has already had a considerable effect on the YHH; the regional development agencies (RDA) have been disbanded. Yorkshire Forward was the RDA of the YHH region and was providing funding for Stage Two. Fortunately, it is understood that this money is safe, however further advances for the YHH will have to use a different funding body.

The recession has changed the attitudes of both the producers and consumers. Prior to the recession the economic boom saw people choosing to purchase organic foods and were more aware of welfare issues. Many were willing to pay extra money for organic produce and this market thrived. However, the recession saw an increase in job losses and uncertainty over the future economic stability of these produce lines. According to the Soil Association’s Organic Market Report
(2010); sales of organic produce decreased by 13% in 2009. The producer now needs to be more aware of the changes in the market and in order to remain profitable needs to provide the consumer with high quality meat, but at a lower cost than previously. This may be a further reason producers are unwilling to participate in the YHH scheme right now, they may view it as unnecessary risk taking. However, the long term goals of the scheme are hoped to provide a producer with higher production levels at a lower production cost. Although the initial investment may be steep; for example if they have to perform a depopulation and repopulation of stock, the profits gained from this could be great.

7.4 The Blueprint

The change in government has seen a request for disease eradication schemes such as the YHH to be implemented nationally; indeed, BPEX already has another scheme running in East Anglia. Therefore, from what has been learnt from Stage One of the YHH a highly useful ‘Blueprint’ can be proposed on how future eradication schemes could be organised. When creating protocols it is appropriate to utilise the experiences of the YHH implementation and all other information from previous eradication schemes.

These protocols provide guidelines on the most important features of an eradication scheme that make it a successful venture. These include:

1. Determining the likelihood that the producers will join the scheme. For example, the results from the July 1st meeting.

2. Providing producers with the opportunity to voice their concerns and gain their feedback on potential issues

3. Keep the momentum; make sure producers are aware of what is happening and how they can be involved, as seen in the creation of the YHH website.

4. Involve all aspects of the industry as this will provide credibility to an eradication scheme and will also ease in the implementation. For example, working with the allied trades to make changes to protocols; as seen with the BB Group in Chapter 3 and their coordination of feed deliveries. Utilising all available sources will increase the schemes chances of success.
5. Cooperation, coordination and most importantly commitment are needed from all branches of the industry throughout the creation of the scheme. This is the hardest part, but the better this is, the easier transition from creation to implementation will be.

A scheme should not:

1. Overestimate its results. Producers want a realistic view of the scheme

2. Lose focus. It is easy to become too involved in the minor details. Keep reminding participants of the ultimate goal of the scheme and what this will provide them with

3. Waste time. This goes hand in hand with losing focus. If a scheme loses time, it loses money and the support of those involved may begin to waver.

7.5 Conclusion

What needs to be considered throughout the problems and successes of Stage One, is that it was a naive pilot study aiming to achieve an enormous amount in a short space of time. This scheme, if successful could be the key to an improvement in the health and welfare of pigs and lead to greater profitability for the British pig industry. It is a huge challenge, but by focusing on the ultimate goal as opposed to any minor setbacks that are inevitable to happen in a pilot scheme, the YHH could be of great benefit to all involved.

Admittedly there have been issues with Stage One. It could have been attempted in a more efficient manner. Problems that have arisen in Stage One and will continue into Stage Two need to be addressed, such as improving the YHH website, especially in regards to the mapping service and decision tools.

In retrospect the VPS could have been implemented in a different manner. This could have resulted in a greater number of samples obtained from units in the region and an improved questionnaire could have provided the YHH with more information regarding the units in the region. The new government has requested that schemes such as the YHH are implemented nationally. Were future veterinary pilot studies put into action, their organisational bodies could benefit from the knowledge gained by this study and the way in which it was executed, hopefully helping them to implement their schemes more effectively.
It was unfortunate that colostrum sampling could not be determined in this study as an alternative sampling method. However, if further experiments into new diagnostic techniques were successful then colostrum sampling could become an intrinsic part of disease diagnosis in the pig industry.

In relation to the YHH the key now is to focus on these three pilot clusters and document what they achieve. It is also good to notice the opportunities the scheme has already created, especially the mapping service and what this technology could mean for other agricultural industries.
Appendix 1a

Baseline Vet Survey

Is your practice responsible for this unit?  Yes ☐ No ☐ VS.1

Is the unit currently in pig production?

☐ Yes
☐ No, temporarily out of production
☐ No, closed permanently

check this box when the information is complete

VS.2

Has the unit owner (or where applicable both the owner of the site and the owner of the pigs) given permission for their details to be included in the survey?  Yes ☐ No ☐ assessment guidelines

Click here to download a copy of the required permission form

VS.3

Please provide the following details.

Name of Unit

Unit Type

☐ Breeder Finisher
☐ 7kg weaner producer
☐ 30kg weaner producer
☐ Finisher

Production Type

☐ Continuous
☐ Batch

Responding Practice

Responding Vet

Date of Response

check this box when the information is complete

VS.4
Please provide the requested information about medication and treatments

certification guidelines
Please indicate if you are currently using any of the medicines or providing treatment for a disease on the unit.

If you are using the medicine or treatment please specify when treated; mark all that apply.

V3.5

Enzootic Pneumonia (Vaccine)
- Breeding Herd
- Growing Pigs
- Both

PRRS (Vaccine)
- Breeding Herd
- Growing Pigs
- Both

Tyllosin
- 7-20kg
- 20-40kg
- >40kg

Tiamulin
- 7-20kg
- 20-40kg
- >40kg

Lincospectin
- 7-20kg
- 20-40kg
- >40kg

Valnemulin
- 7-20kg
- 20-40kg
- >40kg

Tylvalosin
- 7-20kg
- 20-40kg
- >40kg

check this box when the information is complete

Enzootic Pneumonia

Evidence
- Pathology
- Serology
- Microbiology
- Clinical

Performance impact
- Please Select
  - 1
  - 2
  - 3
  - 4
  - 5

assessment guidelines
For performance impact please give an indication of the effect of the disease on the pigs on this farm. 1 is low, 5 is high.

If you are currently treating this disease with medication please answer yes to the “On Medication” question.

V3.6

On Medication?
- Please Select –
  - Yes
  - No
Please provide any details of the evidence you used to establish the absence of Mange, PRRS, Swine Dysentery, or Pneumonia.

Evidence

check this box when the information is complete

For those where disease is absent, please tick against the diseases where medication is still used:

- Enzootic Pneumonia
- Swine Dysentery
- PRRS
- Mange

check this box when the information is complete

assessment guidelines
This question is optional and can be used to inform us of any evidence or tests you completed when establishing the absence of the surveyed diseases.

VS.9.1

VS.9.2
**Please provide the following production details for the unit**

<table>
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<th>Details</th>
<th>Blank Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Sows</td>
<td></td>
</tr>
<tr>
<td>No. of Finishing Places</td>
<td></td>
</tr>
<tr>
<td>Sow Output (weaned/sow/yr)</td>
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</tr>
</tbody>
</table>

**Check this box when the information is complete**

**Assessment Guidelines**

If possible we would like you to add these production details.

It will be helpful to the project if we can get a picture of health status related to unit size, sow productivity etc.

**VS.10**

---

**Please provide the percentage mortality of the following:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Blank Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preweaning</td>
<td></td>
</tr>
<tr>
<td>Post weaning (growers)</td>
<td></td>
</tr>
<tr>
<td>Finishers (&lt;80kg)</td>
<td></td>
</tr>
<tr>
<td>Sow</td>
<td></td>
</tr>
</tbody>
</table>

**Check this box when the information is complete**

**Assessment Guidelines**

Enter a number between 0 - 100% for each answer.

**VS.11**
<table>
<thead>
<tr>
<th>Number</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Vet Practice</td>
</tr>
<tr>
<td>B</td>
<td>Herdmark</td>
</tr>
<tr>
<td>C</td>
<td>CPH</td>
</tr>
<tr>
<td>D</td>
<td>Postcode</td>
</tr>
<tr>
<td>E</td>
<td>Modified Date</td>
</tr>
<tr>
<td>1</td>
<td>VS.1-Is your practice responsible for this unit?</td>
</tr>
<tr>
<td>2</td>
<td>VS.2-Is the unit currently in pig production? ()</td>
</tr>
<tr>
<td>3</td>
<td>VS.3-Has the unit owner (or where applicable both the owner of the site and the owner of the pigs) given permission for their details to be included in the survey?</td>
</tr>
<tr>
<td>4a</td>
<td>VS.4-Name of Unit</td>
</tr>
<tr>
<td>4b</td>
<td>VS.4-Unit Type</td>
</tr>
<tr>
<td>4c</td>
<td>VS.4-Production Type</td>
</tr>
<tr>
<td>4d</td>
<td>VS.4-Responding Practice</td>
</tr>
<tr>
<td>4e</td>
<td>VS.4-Responding Vet</td>
</tr>
<tr>
<td>5a</td>
<td>VS.5-Enzootic Pneumonia (Vaccine)</td>
</tr>
<tr>
<td>5b</td>
<td>VS.5-PRRS (Vaccine)</td>
</tr>
<tr>
<td>5c</td>
<td>VS.5-Tylosin</td>
</tr>
<tr>
<td>5d</td>
<td>VS.5-Tiamulin</td>
</tr>
<tr>
<td>5e</td>
<td>VS.5-Lincospectin</td>
</tr>
<tr>
<td>5f</td>
<td>VS.5-Valnemulin</td>
</tr>
<tr>
<td>5g</td>
<td>VS.5-Tylvalosin</td>
</tr>
<tr>
<td>6a</td>
<td>VS.6-Enzootic Pneumonia</td>
</tr>
<tr>
<td>6b</td>
<td>VS.6-Enzootic Pneumonia (Evidence)</td>
</tr>
<tr>
<td>6c</td>
<td>VS.6-Enzootic Pneumonia (Performance impact)</td>
</tr>
<tr>
<td>6d</td>
<td>VS.6-Enzootic Pneumonia (On Medication?)</td>
</tr>
<tr>
<td>7a</td>
<td>VS.7-Swine Dysentery</td>
</tr>
<tr>
<td>7b</td>
<td>VS.7-Swine Dysentery (Evidence)</td>
</tr>
<tr>
<td>7c</td>
<td>VS.7-Swine Dysentery (Performance impact)</td>
</tr>
<tr>
<td>7d</td>
<td>VS.7-Swine Dysentery (On Medication?)</td>
</tr>
<tr>
<td>8a</td>
<td>VS.8-PRRS</td>
</tr>
<tr>
<td>8b</td>
<td>VS.8-PRRS (Evidence)</td>
</tr>
<tr>
<td>8c</td>
<td>VS.8-PRRS (Performance impact)</td>
</tr>
<tr>
<td>8d</td>
<td>VS.8-PRRS (On Medication?)</td>
</tr>
<tr>
<td>9a</td>
<td>VS.9-Mange</td>
</tr>
<tr>
<td>9b</td>
<td>VS.9-Mange (Evidence)</td>
</tr>
<tr>
<td>9c</td>
<td>VS.9-Mange (Performance impact)</td>
</tr>
<tr>
<td>9d</td>
<td>VS.9-Mange (On Medication?)</td>
</tr>
<tr>
<td>9e</td>
<td>VS.9.1-Please provide any details of the evidence you used to establish the absence of Mange, PRRS, Swine Dysentery, or Pneumonia.</td>
</tr>
<tr>
<td>10a</td>
<td>VS.10-Please provide the following production details for the unit (No. of Sows)</td>
</tr>
<tr>
<td>10b</td>
<td>VS.10-Please provide the following production details for the unit (No. of Finishing Places)</td>
</tr>
<tr>
<td>10c</td>
<td>VS.10-Please provide the following production details for the unit (Sow Output (weaned/sow/yr))</td>
</tr>
<tr>
<td>11a</td>
<td>VS.11-Please provide the percentage mortality of the following: (Preweaning)</td>
</tr>
<tr>
<td>11b</td>
<td>VS.11-Please provide the percentage mortality of the following: (Post weaning (growers))</td>
</tr>
<tr>
<td>11c</td>
<td>VS.11-Please provide the percentage mortality of the following: (Finishers (&gt;60kg))</td>
</tr>
<tr>
<td>11d</td>
<td>VS.11-Please provide the percentage mortality of the following: (Sow)</td>
</tr>
</tbody>
</table>
Appendix 2

ELISA Protocol

IgG Colostrum was analysed using a quantitative sandwich enzyme linked immunosorbent assay protocol provided by Bethyl Laboratories Inc, Montgomery Texas, USA. All antibodies used were also purchased from Bethyl. Product Number: E101-104.

Reagents

- Pig IgG Pre-Coated 96-well strip plate
- Pig IgG Standard; diluted 1000ng/1ml, 333.3ng/ml, 111.1ng/ml, 37ng/ml, 12.3ng/ml, 4.1ng/ml, 1.37ng/ml and 0ng/ml in dilution buffer B
- Pig IgG Detection Antibody
- Dilution Buffer B; diluted 25ml/225ml in deionised H₂O
- Wash Solution; diluted 50ml/950ml in deionised H₂O
- HRP Solution A; streptavidin-conjugated horseradish peroxide
- TMB Substrate; 3,3',5,5'-tetramethylbenzidine
- Stop Solution; dilute sulphuric acid

Assay

Colostrum was diluted 1:1,000,000 in Dilution Buffer B. 100µl of sample or standard was added to 74 wells of a 96 well plate, covered with sealing tape and left for 60 minutes at room temperature. The antibody was then removed by washing with washer buffer four times. 100µ of anti-IgG detection antibody was then added to each well, covered and left for 60 minutes at room temperature. This was then removed through washing, as previous. 100µl of HRP solution was then added to each well plate, covered and then left for 30 minutes at room temperature. Washing again, as previous. 100µl of chromogenic substrate TMB was added to each well, the plate was incubated in the dark for 30 minutes. The reaction was then stopped
by adding 100μl of dilute sulphuric acid to each well. Absorbency was measured on a plate reader at 450nm.
Figure 8-1 A standard curve of the average absorbance obtained for each standard concentration of IgG in colostrum samples

\[
y = 0.41 \ln(x) - 0.4491
\]

\[R^2 = 0.9521\]
References


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(Serpulina) pilosicoli." *Veterinary Microbiology* **73**: 75-84.


the Lacteal Secretion of Sows of Different Lactation Numbers." American Journal of Veterinary Research 48: 176-182.


Murphy, B. M., et al. (2005). "Cow serum and colostrum immunoglobulin (IgG1 concentration of five suckler breed types and subsequent immune status of their calves." Irish Journal of Agriculture and Food Research 44: 205-213


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