NOVEL EUROPEAN PRRSV STRAIN

FIELD OF THE INVENTION

[0001] The present invention relates to a live attenuated strain of a European Porcine Reproductive and Respiratory Syndrome Virus (PRRSV), methods for the production of such strains, vaccines based thereon and methods for the production of such vaccines and the use thereof in the treatment of swine.

BACKGROUND OF THE INVENTION

[0002] Porcine reproductive and respiratory syndrome (PRRS) is viewed by many as the most important disease currently affecting the pig industry worldwide. The syndrome first was described in 1987 in the United States as "mystery swine disease" and rapidly spread across the globe. It causes severe reproduction losses, is associated with increased mortality due to secondary infections, and is linked to reduced feed conversion and average daily weight gain. Unfortunately, control of the virus that causes PRRS has proven to be difficult.

[0003] PRRS virus (PRRSV) is an enveloped single stranded RNA virus classified in the family Arteriviridae (Cavanaugh, 1997). It causes a widespread disease of swine that was first described as `mystery swine disease` in the USA in 1987 (Hill, 1990). The disease manifests as respiratory illness in all age groups of swine leading to death in some younger pigs and severe reproductive problems in breeding age females.

[0004] Transmission of the PRRSV can, and often does, occur through direct contact between infected and susceptible pigs. Transmission over very short distances by air or through semen also may occur. Once infected, the virus can remain in the blood of adults for about two weeks, and in infected pigs for one to two months or more. Infected boars may shed the virus in the semen for more than 100 days. This long period of viremia significantly increases the possibility of transmission. In addition, the PRRS virus can cross the placenta during the last third of the gestation period to infect piglets in utero and cause stillbirth or weak-born piglets.

[0005] All types and sizes of herds, including those with high or ordinary health status or from either indoor or outdoor units, can be infected with PRRS virus. Infected herds may experience severe reproductivity losses, as well as, increased levels of post weaning pneumonia with poor growth. The reproductive phase typically lasts for two to three months; however, post weaning problems often become endemic. The reproductive disease is characterized by an abortion outbreak that affects both sows and gilts in the last term of gestation. Premature farrowings around 109 and 112 days of gestation occur. The number of stillbirths and weak-born piglets increases and results in a considerable increase in pre-weaning mortality.

[0006] The respiratory phase traditionally has been seen in the nursery, especially in continuous flow nurseries. However, respiratory problems caused by PRRS virus can also be seen in the finisher as part of the porcine respiratory disease complex (PRDC). A reduction in growth rate, an increase in the percentage of unmarketable pigs, and elevated post weaning mortality can occur. Diagnostic findings indicate high levels of pneumonia that associate with the PRRS virus together with a wide variety of other microbials commonly seen as secondary infectious agents. Bacterial isolates may include *Streptococcus suis, Haemophilus suis, Actinobacillus pleuropneumoniae, Actinobacillus suis, Mycoplasma hyopneumoniae,* and *Pasteurella multocida* among others. Viral agents commonly involved include swine influenza virus and porcine respiratory corona virus. Affected pigs rarely respond to high levels of medication, and all-in/all-out systems have failed to control the disease.

[0007] PRRSV virus exists as two genotypes referred to as "US" and "EU" type which share about 50% sequence homology (Dea S et al. (2000). Arch Virol 145:659-88). These two genotypes can also be distinguished by their immunological properties. Most sequencing information on various isolates is based on the structural proteins, namely the envelope protein GP5 which accounts for only about 4% of the viral genome, while only little is known on the non-structural proteins (nsp). Isolation of PRRSV and manufacture of vaccines have

been described in a number of publications (WO 92/21375, WO 93/06211, WO93/03760, WO 93/07898, WO 96/36356, EP 0 676 467, EP 0 732 340, EP 0 835 930).

[0008] Vaccination is the key method for alleviating the burden of PRRS as pigs that recover from a PRRS infection will develop an immune response, which under normal circumstances will protect them from being infected again by the same virus strain. However, PRRS virus has the ability to change (by mutation or recombination); and therefore, new viral strains may arise. In such cases, cross protection between strains may not exist, and new outbreaks may be observed in farms that had been infected previously. Thus there is a continuing need for additional vaccines.

BRIEF SUMMARY OF THE INVENTION

[0009] The present invention is related to improved modified live PRRS vaccines of European genotype and new PRRSV strains which can be used for the manufacture of such vaccines. In particular, the invention provides improved PRRS virus strains that have been deposited with the European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012501 and ECACC 11012502 each deposited on January 25, 2011 in accordance with the provisions of the Budapest Treaty, or any descendant or progeny of one of the aforementioned strains.

[0010] In particular embodiments, the present invention describes a Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) of a European type, which is of the strain deposited with European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012501 or Accession Numbers ECACC 11012502.

[0011] The PRRSV is characterized in that the virus is attenuated by passaging at least 36 times in cell culture such that when the modified virus is administered to a swine or other mammal prone to PRRSV, it fails to cause clinical

signs of PRRSV disease but is capable of inducing an immune response that immunizes the mammal against pathogenic forms of PRRSV.

[0012] Also contemplated is a method for the preparation of the live attenuated PRRSV deposited with European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012502 or one attenuated from a parental strain deposited at Accession Numbers ECACC 11012501, comprising adapting an MA 104-grown PRRSV of a European type to non-MA 104 mammalian cells.

[0013] Another aspect of the invention contemplates a vaccine for the protection of pigs against PRRSV infection, comprising the live attenuated PRRSV deposited with European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012502 or one attenuated from a parental strain deposited at Accession Numbers ECACC 11012501 and a pharmaceutically acceptable carrier. Such a vaccine may advantageously further comprise one or more non-PRRSV attenuated or inactivated pathogens or antigenic material thereof. For example, the non-PRRSV pathogens may be selected from Pseudorabies virus, Porcine influenza virus, Porcine parvovirus, Transmissible gastroenteritis virus, Escherichia coli, Erysipelo rhusiopathiae, Bordetella bronchiseptica, Salmonella cholerasuis, Haemophilus parasuis, Pasteurella multocida, Streptococcus suis, Mycoplasma hyopneumoniae and Actinobacillus pleuropneumoniae.

[0014] In other embodiments, the vaccine may further comprise one or more additional European PRRSV strains selected from the group consisting of a PRRSV strain deposited under the Accession Numbers Lelystad virus strain (Lelystad Agent (CDI-NL-2.91), or other strains such as those deposited under the Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, CNCM Accession No I-1388, ATCC VR 2332, VR 2385, VR 2386, VR 2429, VR 2474, and VR 2402; CNCM I-1102, CNCM I-1140, CNCM I-1387, CNCM I-1388, or ECACC V93070108 or indeed may be a U.S. strain such as North American PRRS virus, pT7P129A; ATCC deposit VR-2332, ATCC deposit VR-2368; ATCC VR-2495;

ATCC VR 2385, ATCC VR 2386, ATCC VR 2429, ATCC VR 2474, and ATCC VR 2402.

[0015] It is contemplated that the vaccine may comprise a carrier that is suitable for intradermal or intramuscular application. In some embodiments, the vaccine is in freeze-dried form. In specific embodiments, the vaccine comprises at least about 107 virus particles.

[0016] Another aspect of the invention relates to a method for the preparation of a live attenuated vaccine for combating PRRS, comprising admixing a live attenuated PRRSV virus deposited with European Collection of Cell Cultures (ECACC) under the Accession Number ECACC 11012502 or one attenuated from a parental strain deposited at Accession Numbers ECACC 11012501 with a pharmaceutically acceptable carrier. In such methods the live attenuated PRRSV may preferably further comprise one or more additional European PRRSV strains selected from the group consisting of a PRRSV strain deposited under the Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, and CNCM Accession No I-1388.

[0017] In some embodiments, the live attenuated PRRSV may further comprise an adjuvant.

[0018] Also contemplated is a method of immunizing swine against porcine reproductive and respiratory syndrome (PRRS), the method comprising the step of administering to swine a vaccine composition including a live porcine reproductive and respiratory syndrome virus mixed with a pharmacologically compatible carrier agent, the virus comprising PRRS 94881 virus passaged at least 36 times in cell culture to modify the virus such that when the modified virus is administered to a swine or other mammal prone to PRRS, it fails to cause clinical signs of PRRS disease but is capable of inducing an immune response that immunizes the mammal against pathogenic forms of PRRS.

[0019] In some embodiments, the method is performed wherein the swine presents no lung lesions after vaccination. In other embodiments, the swine presents fewer lung lesions after vaccination as compared to vaccination with Porcilis vaccine.

[0020] Another aspect of the invention relates to a PRRS virus having a nucleotide sequence that is at least 95% homologous with the sequence set forth in either SEQ ID NO:1 or SEQ ID NO:10.

[0021] Also contemplated is a PRRS virus that comprises at least one ORF that encodes a protein that is at least 98% identical to any of the sequences set forth in SEQ ID NO: 2 to 9 or SEQ ID NO:11 to SEQ ID NO:18.

[0022] Also contemplated is a PRRS virus that has a nucleotide sequence of SEQ ID NO:1 or SEQ ID NO:10 or a fragment of either SEQ ID NO:1 or SEQ ID NO:2 wherein the fragment encodes an ORF selected from the group consisting of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18.

[0023] The invention further relates to a subunit vaccine for vaccination of a porcine animal wherein the vaccine comprises one or more nucleotides selected from the group consisting of a nucleotide that encodes an ORF selected from the group consisting of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18.

[0024] Another aspect of the invention relates to a subunit vaccine for vaccination of a porcine animal wherein the vaccine comprises one or more nucleotides selected from the group consisting of SEQ ID NO:19; SEQ ID NO:20; SEQ ID NO:21; SEQ ID NO:22; SEQ ID NO:23; SEQ ID NO:24; SEQ ID NO:25;

SEQ ID NO:26; SEQ ID NO:27; SEQ ID NO:28; SEQ ID NO:29; SEQ ID NO:30; SEQ ID NO:31; SEQ ID NO:32; SEQ ID NO:33; and SEQ ID NO:34.

[0025] Also contemplated is a composition comprising one or more proteins selected from the group consisting of a protein having the sequence of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18.

[0026] Also contemplated is an isolated nucleic acid comprising a sequence selected from the group consisting of SEQ ID NO:19; SEQ ID NO:20; SEQ ID NO:21; SEQ ID NO:22; SEQ ID NO:23; SEQ ID NO:24; SEQ ID NO:25; SEQ ID NO:26; SEQ ID NO:27; SEQ ID NO:28; SEQ ID NO:29; SEQ ID NO:30; SEQ ID NO:31; SEQ ID NO:32; SEQ ID NO:33; SEQ ID NO:34.

[0027] The invention further relates to a recombinant expression vector and/or vaccine comprising such expression vectors, wherein said vectors comprise a nucleic acid sequence that encodes one or more PRRSV ORFs selected from the group consisting of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18 operably linked to a promoter. In such embodiments, the nucleic acid encoding the ORFs may preferably be selected from the group consisting of SEQ ID NO:19; SEQ ID NO:20; SEQ ID NO:21; SEQ ID NO:22; SEQ ID NO:23; SEQ ID NO:24; SEQ ID NO:25; SEQ ID NO:26; SEQ ID NO:27; SEQ ID NO:28; SEQ ID NO:29; SEQ ID NO:30; SEQ ID NO:31; SEQ ID NO:32; SEQ ID NO:33; and SEQ ID NO:34.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0028] Figure 1A: Clinical observation of cough score in respiratory challenge model using European challenge strain.

[0029] Figure 1B: Clinical observation of total clinical score in respiratory challenge model using a European challenge strain.

[0030] Figure 2: Rectal temperature measurements in respiratory challenge model using a European challenge strain.

[0031] Figure 3: Average daily weight gain measurements in respiratory challenge model using a European challenge strain.

[0032] Figure 4: PRRS viremia as indicated through quantitative PCR in respiratory challenge model using a European challenge strain.

[0033] Figure 5: PRSS Serology as indicated by ELISA in respiratory challenge model using a European challenge strain.

[0034] Figure 6: Macroscopic examination of lung lesions in in respiratory challenge model using a European challenge strain.

[0035] Figure 7A-C: Histopathology measurements. Figure 7A shows means macroscopic lung lesions; Figure 7B shows control animal histopathology; Figure 7B shows PRRS infected animal histopathology.

[0036] Figure 8: Shows RT-PCT Time PCR results depicting % viremia in animals vaccinated with EU PRRS 94881.

[0037] Figure 9: Concurrent process for large-scale production of EU PRRS 94881.

DETAILED DESCRIPTION OF THE INVENTION

[0038] The present invention provides methods of treating or reducing the severity of porcine reproductive and respiratory syndrome virus (PRRSV) infection, as well as, methods of preventing PRRSV infection. Generally, the method is for treating or reducing the severity of or incidence of porcine reproductive and respiratory syndrome virus (PRRSV) infection. "Treating or reducing the severity of or incidence of" refers to a reduction in the severity of clinical signs, symptoms, and/or pathological signs normally associated with infection, up to and including prevention of any such signs or symptoms. "Pathological signs" refers to evidence of infection that is found microscopically or during necropsy (e.g. lung lesions).

[0039] The method generally includes the step of administering a therapeutic amount of a PRRSV antigen to a swine of a defined age or age range. For example, in one aspect of the invention, one therapeutic amount of a PRRSV antigen may be administered to a piglet about three-weeks-old or younger, and different therapeutic amounts of the antigen may be administered to a pig between about 3 weeks of age and 4 weeks of age. Similarly, an even different therapeutic amount might be administered to a pig between about four weeks and sixteen weeks of age (or any age within this range, e.g. five weeks to six weeks of age, nine weeks to fifteen weeks of age, seven weeks to ten weeks of age, etc), or to pig older than sixteen weeks, such as an adult sow.

[0040] In specific embodiments, the present invention relates to an attenuated, atypical PRRSV strain and corresponding improved modified-live vaccines which confer effective immunity to this newly discovered typical PRRSV strain. "Effective immunity" refers to the ability of a vaccine to prevent swine PRRSV infections, including atypical PRRSV infections, which result in substantial clinical signs of the disease. It should be understood that the immunized swine may or may not be serologically positive for PRRSV, but the swine do not exhibit any substantial clinical symptoms.

[0041] In preferred forms, the vaccine of the invention includes a live European type PRRS live virus which has been attenuated in virulence. The resulting attenuated virus has been shown to be avirulent in challenged controlled host animal studies and to confer effective immunity. This particular strain of EU PRRS is not as virulent as others and hence, it is an attractive option as a vaccine candidate. The PRRSV 94881 parental strain does not cause severe, atypical PRRS disease in the pregnant sow nor severe lung lesions in young pigs. This strain was initially isolated from in the North Rhine Westphalia, Germany from a 3 week old piglet with severe respiratory disorder. The strain was subsequently attenuated via continuous passage in MA 104 cells. The attenuated strain was deposited by Bioscreen GmbH, Mendelstrasse 11, 48149, Muenster, Germany, in the European Collection of Cell Cultures (ECACC), Porton Down, Salisbury,

Wiltshire, SP4 0JG, Great Britain, on January 25 2011 and was accorded Accession No. 11012502. This attenuated virus is a preferred Master Seed Virus (MSV) which has been subsequently passaged and developed as an effective PRRSV vaccine. The virulent parent strain denominated 94881 also was deposited in accordance with the Budapest Treaty by Bioscreen GmbH, Mendelstrasse 11, 48149, Muenster, Germany at the European Collection of Cell Cultures (ECACC), Porton Down, Salisbury, Wiltshire, SP4 0JG, Great Britain, on January 25 2011 and was accorded Accession No. 11012501.

[0042] In certain exemplary embodiments the modified live virus vaccine was tested at a dosage of 1ml for pigs and 2 ml for sows via intramuscular injection and was shown to be efficacious in producing protective immunity.

[0043] Passaging of the virus to attenuation was accomplished using classical virology methods. Specifically, the parental isolate PRRS 94881 was attenuated in vitro through continuous passing in MA 104 cells to achieve a maximum passage of 108 passes past initial isolation. Briefly, the material was passed at roughly 1 to 2 passes per week for a total of 108 passes in T-25cm^2 or T-75cm^2 flasks. Confluent MA 104 cell cultures with approximately 12 - 30 mL of Minimal Essential Medium (MEM) supplemented with 6% fetal bovine serum (FBS) were inoculated with 100 to 300 µl of the virus. Cultures were incubated for 3 - 7 days in a humidified chamber incubator at 37°C with 4 - 6% CO_2. Once cultures reached > 25% cytopathic effect (CPE), the flask was harvested by extracting the supernatant. A portion of the supernatant was passed into a new flask and 2 mL of the harvest was aliquoted for storage at -60°C to -80°C.

[0044] The skilled person using standard techniques in the art will be able to determine the underlying nucleic acid sequence of the attenuated virus has been deposited ECACC under Accession No. 11012502. The present invention therefore further embraces a nucleic acid sequence specific for the attenuated PRRSV 94481 deposited at ECACC under Accession No. 11012502. Preferably, the invention further embraces PRRS virus nucleic acid sequences that share at least 95% sequence homology with the sequence of SEQ ID NO:1 or SEQ ID

NO:10 as such viruses may likely be effective at conferring immunity upon animals vaccinated with attenuated viruses containing such homologous sequences. The sequence shown in SEQ ID NO:1 is the full length sequence of the attenuated PRRS 94881 MSV and has a full length sequence of 14843 bp. The ORFS 1 through 7 have been annotated for this sequence as follows:

ORF Number	CDS in SEQ ID NO:1	Protein encoded
ORF1a	178 to 7227	SEQ ID NO:2
ORF1b	7209 to 11600	SEQ ID NO:3
ORF2	11611 to 12360	SEQ ID NO:4
ORF3	12219 to 13016	SEQ ID NO:5
ORF4	12761 to 13312	SEQ ID NO:6
ORF5	13309 to 13914	SEQ ID NO:7
ORF6	13902 to 14423	SEQ ID NO:8
ORF7	14413 to 14799	SEQ ID NO:9

[0045] The sequence shown in SEQ ID NO:10 is the full length sequence of the parental PRRSV 94881 strain, passage 5 and has a full length sequence of 14843 bp. The ORFS 1 through 7 have been annotated for this sequence as follows:

ORF Number	CDS in SEQ ID NO:10	Protein encoded
ORF1a	178 to 7227	SEQ ID NO:11
ORF1b	7209 to 11600	SEQ ID NO:12
ORF2	11611 to 12360	SEQ ID NO:13
ORF3	12219 to 13016	SEQ ID NO:14
ORF4	12761 to 13312	SEQ ID NO:15

ORF5	13309 to 13914	SEQ ID NO:16
ORF6	13902 to 14423	SEQ ID NO:17
ORF7	14413 to 14799	SEQ ID NO:18

[0046] With the isolation of this new attenuated European PRRS virus strain it is possible to produce improved PRRS vaccines containing a most recent PRRS strain that is reflective of virulent PRRS strains found currently in the field. In particular, the new attenuated European PRRS virus may be used to prepare modified live vaccines (MLV). A modified live vaccine is characterized in that it contains live virus which can replicate in pigs, but does not exert clinical disease of PRRS. Furthermore, upon administration it induces an immunological response in pigs which generally leads to a significant extent of protection against subsequent infection with pathogenic PRRS virus. Virus showing such characteristics is usually called attenuated virus. In addition, the present invention provides details of the sequences of the ORFs of both the parental and the attenuated strains of PRRSV 94881. Thus, it is contemplated that the skilled person may employ the sequences of any one or more of the ORFs shown herein in a subunit vaccine.

[0047] As noted above, in general, attenuation of virus may be generated from pathogenic virus isolates by repeated passaging in suitable host cells that are permissive to the virus until the virus shows the desired properties (WO 92/21375 , WO 93/06211, WO93/03760, WO 93/07898, WO 96/36356, EP 0 676 467, EP 0 732 340, EP 0 835 930). Alternatively, it may be generated by genetic reengineering through use of an infectious clone, normally a full-length complementary DNA transcript of the viral genome (WO 98/18933, EP 1 018 557, WO 03/062407, Nielsen et al, J Virol 2003, 77:3702-371 1). In a preferred embodiment, the present invention relates to a MLV containing attenuated PRRS virus of European genotype 94481 that is attenuated from a parental virus that is deposited at ECACC under Accession No. 11012501. A preferred MLV contains

the attenuated virus of the present invention that is deposited at ECACC under Accession No. 11012502.

[0048] In another aspect, the present invention contemplates preparation and isolation of a progeny or descendant of a PPRS virus that has been deposited on Janaury 25 2011 with the European Collection of Cell Cultures (ECACC), Porton Down, Salisbury, Wiltshire, SP4 0JG, Great Britain, under the Accession Numbers ECACC 11012502 (attenuated strain for MLV) and 11012501 (parental strain). The invention therefore extends to PRRS virus strains which are derived from the deposited strains through propagation or multiplication in an identical or divergent form, in particular descendants which possess the essential characteristics of the deposited strains. Upon continued propagation, the strains may acquire mutations most of which will not alter the properties of these strains significantly.

[0049] The strains of the invention may also be further modified to impart further desirable properties to them. This may be achieved by classical propagation and selection techniques, like continued propagation in suitable host cells to extend the attenuated phenotype. Alternatively, the strains may be genetically modified by directed mutation of the nucleic acid sequence of the genome of these strains by suitable genetic engineering techniques. The genome of PRRSV was completely or partly sequenced (Conzelmann et al., 1993; Meulenberg et al., 1993a, Murtaugh et al, 1995) and encodes, besides the RNA dependent RNA polymerase (ORFs 1a and 1b), six structural proteins of which four envelope glycoproteins named GP2 (ORF2), GP3 (ORF3), GP4 (ORF4) and GP5 (ORF5), a non-glycosylated membrane protein M (ORF6) and the nucleocapsid protein N (ORF7) (Meulenberg et al. 1995, 1996; van Nieuwstadt et al., 1996). Immunological characterization and nucleotide sequencing of European and US strains of PRRSV has identified minor antigenic differences within strains of PRRSV located in the structural viral proteins (Nelson et al., 1993; Wensvoort et al., 1992; Murtaugh et al., 1995). The PRRS 94881 MSV of the present invention has been compared with the European Reference Virus strain Lelystad Virus (LV)

revealed nucleotide homologies ranging from 85.40 to 95.09 percent in the 8 different viral genes and amino acid identities from 86.39 to 97.27 percent between both virus strains. Two deletions in the ORF 1a of 94881 MSV could be identified compared to LV. For example, ORF1a of 94881 MSV has 85.40% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 86.39%; ORF1b of 94881 MSV has 92.12% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 97.27%; ORF2 of 94881 MSV has 91.07% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 90.76%; ORF3 of 94881 MSV has 90.98% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 89.43%; ORF4 of 94881 MSV has 90.58% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 87.43%; ORF5 of 94881 MSV has 90.43% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 88.56%; ORF6 of 94881 MSV has 95.02% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 97.11%; ORF7 of 94881 MSV has 95.09% nucleotide homology to Lelystad Virus resulting in an amino acid identity of 92.97%;

[0050] Indeed, the PRRS 94881 virus of the present invention may be made into a chimeric virus wherein the backbone of the PRRS virus under ECACC Accession No. 11012502 or indeed the parent strain deposited under ECACC Accession No 11012501 is modified to replace the endogenous sequence of one or more of ORF 1a, ORF 1b, ORF 2, ORF 3, ORF 4, ORF 5, ORF 6, or ORF 7 with the corresponding ORF from a different strain of PRRS virus. For example, the different strain of the PRRS virus may be a different European strain such as Lelystad virus strain (Lelystad Agent (CDI-NL-2.91), or other strains such as those deposited under the Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, CNCM Accession No I-1388, ATCC VR 2332, VR 2385, VR 2386, VR 2429, VR 2474, and VR 2402; CNCM I-1102, CNCM I-1140, CNCM I-1387, CNCM I-1388, or ECACC V93070108 or indeed may be a U.S. strain such as North American PRRS virus, pT7P129A; ATCC deposit VR-2332, ATCC deposit VR-2368; ATCC

VR-2495; ATCC VR 2385, ATCC VR 2386, ATCC VR 2429, ATCC VR 2474, and ATCC VR 2402.

[0051] Recombinant techniques for preparing modified sequences are well known to those of skill in the art and usually employ construction of a full-length complementary DNA copies (infectious clones) of the viral genome which may then be modified by DNA recombination and manipulation methods (like site-directed mutagenesis etc.). This way, for example antigenic sites or enzymatic properties of viral proteins may be modified. Infectious clones of PRRS virus strains of European and North American genotype have been reported in the literature.

[0052] The PRRS virus strains of the present invention are suitable for vaccines of the invention can be grown and harvested by methods known in the art, e.g. by propagating in suitable host cells like the simian cell line MA-104, Vero cells, or porcine alveolar macrophages. PRRSV preferentially grows in alveolar lung macrophages (Wensvoort et al., 1991). A few cell lines, such as CL2621 and other cell lines cloned from the monkey kidney cell line MA-104 (Benfield et al., 1992; Collins et al., 1992; Kim et al., 1993) are also susceptible to the virus.

[0053] Vaccines comprising any one of PRRSV strain PRRS virus under ECACC Accession No. 11012501, 11012501 Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, and CNCM Accession No I-1388 as well as any combination of these strains or their descendants are thus preferred embodiments of the present invention. In specific embodiments, the PRRS virus 94881 is grown in a process wherein there is a concurrent seeding of the virus and the host cells together on the same day into a bioreactor as shown in Figure 9. Additional features of a method of production of PRRS virus 94881 may be as described in concurrently filed herewith as U.S. Provisional entitled “A Commercial scale process for production of PRRSV” filed concurrently with the instant application under application number 61/444,071. While this is one method of growing the

PRRSV 94881, it should be understood that the virus may be propagated according to any conventional method known to those of skill in the art.

[0054] Preferably, vaccines according to the present invention are modified live vaccines comprising one or more of these strains alive in a suitable carrier, but inactivated virus may also be used to prepare killed vaccine (KV). MLV are typically formulated to allow administration of 10^1 to 10^7 viral particles per dose, preferably 10^3 to 10^5 particles per dose, more preferably 10^4 to 10^5 particles per dose (4.0-5.0 $\log_{10}$ $TCID_{50}$). KV may be formulated based on a pre-inactivation titre of 10^3 to 10^{10} viral particles per dose. The vaccine may comprise a pharmaceutically acceptable carrier, for example a physiological salt-solution.

[0055] Pigs can be infected by PRRSV via the oronasal route. Virus in the lungs is taken up by lung alveolar macrophages and in these cells replication of PRRSV is completed within 9 hours. PRRSV travels from the lungs to the lung lymph nodes within 12 hours and to peripheral lymph nodes, bone marrow and spleen within 3 days. At these sites, only a few cells stain positive for viral antigen. The virus is present in the blood during at least 21 days and often much longer. After 7 days, antibodies to PRRSV are found in the blood. The combined presence of virus and antibody in PRRS infected pigs shows that the virus infection can persist for a long time, albeit at a low level, despite the presence of antibody. During at least 7 weeks, the population of alveolar cells in the lungs is different from normal SPF lungs.

[0056] A vaccine according to the present invention may be presented in form of a freeze-dried preparation of the live virus, to be reconstituted with a solvent, to result in a solution for injection. The solvent may e.g. be water, physiological saline, or buffer, or an adjuvanting solvent. The solvent may contain adjuvants. The reconstituted vaccine may then be injected into the a pig, for example as an intramuscular or intradermal injection into the neck. For intramuscular injection, a volume of 2 ml may be applied, for an intradermal injection it is typically 0.2 ml. In a further aspect, the present invention therefore is a vaccine product, comprising in separate containers a freeze-dried composition of

the virus, and a solvent for reconstitution, and optionally further containing a leaflet or label comprising instructions of use.

[0057] A vaccine according to the present invention may not only comprise one or more of the aforementioned strains, but may include further components active against PRRS or other porcine viral or bacterial diseases, like porcine circovirus or classical swine fever virus. Therefore, the invention further relates to a vaccine as described, characterized in that it contains at least one further antigen active against a porcine disease which is not PRRS. For example, such further antigens may include Mycoplasma hyopneumoniae, PCV2, SIV, H. parasuis, E. rhusiopathiae, S. suis, A. suis, Leptospira sp. Parvovirus and the like. In addition, the vaccine may comprise certain pharmaceutically or veterinary acceptable adjuvants. The invention provides new vaccine compositions, in particular, PRRS virus vaccines comprising PRRSV 94881 that further comprise adjuvants that enhance the efficacy of the vaccine such that a better clinical response/outcome is seen with the administration of the combination of the adjuvant and the vaccine as compared to administration of the vaccine alone. For example, the vaccine compositions of the invention may comprise a PRRSV 94881 virus vaccine and an adjuvant selected from the group consisting of MCP-1, α–tocopherol (e.g., α–tocopherol acetate, an exemplary version of which is sold as Diluvac Forte®), Haemophilus sonmus fractions, carbopol and combinations thereof. In some embodiments, the virus vaccine comprising PRRS 94881 virus vaccine, which may be a recombinant subunit vaccine or alternatively may be a live attenuated virus vaccine. An exemplary live vaccine that exists is Ingelvac®PRRS MLV and the PRRS 94881 may be formulated in a manner similar to Ingelvac®PRRS MLV.

[0058] In addition to the above, the immunogenic compositions of the invention may contain other ingredients so long as the other ingredients do not interfere with the adjuvants or the underlying virus vaccine. Such other ingredients include, for example, binders, colorants, desiccants, antiseptics, wetting agents, stabilizers, excipients, adhesives, plasticizers, tackifiers, thickeners, patch

materials, ointment bases, keratin removers, basic substances, absorption promoters, fatty acids, fatty acid ester, higher alcohols, surfactants, water, and buffer agents. Preferred other ingredients include buffer agents, ointment bases, fatty acids, antiseptics, basic substances, or surfactants.

[0059] The content or amount of the adjuvants used in the invention may vary and can be determined by taking into consideration, for example, the properties of the PRRS virus vaccine being used, and the dosage form. The adjuvant may comprise, for example, 1 to 100% by weight. The PRRSV 94881-based compositions of the invention are produced by mixing together the adjuvant component and the virus vaccine component, either alone or with various other ingredients. The compositions may be such that the virus vaccine and the adjuvant are presented as one formulation or alternatively, the adjuvant and the vaccine are presented in distinct formulations that can be administered simultaneously or sequentially.

[0060] The adjuvant component of the immunogenic compositions of the invention thus may be administered separately from the virus vaccine in the administration to organisms. Alternatively, the adjuvant according to the present invention, together with the virus vaccine, can be administered as a single vaccine composition. The virus vaccine may be any virus vaccine. More specific embodiments contemplate the use of a PRRS virus vaccine comprising PRRSV 94881. In addition such a vaccine may be combined with other vaccines such as Ingelvac® PRRS MLV and/or Porcilis®. This is merely one exemplary PRRS virus combination vaccine and other such vaccine combinations can be readily prepared.

[0061] The immunogenic compositions described herein are particularly advantageous in the induction of the production of an antibody response to PRRS virus. Administration of the vaccines preferably will produce a lessening of the severity of one or more clinical symptoms, such as lung lesions, anorexia, skin discolorations, lethargy, respiratory signs, mummified piglets, coughing, diarrhea and combinations thereof, that are associated with PRRSV infection.

[0062] The compositions thus particularly enhance the clinical outcome in a diseased animal as compared to the outcome from administration of PRRS virus vaccine alone. In specific embodiments, the enhanced clinical outcome is a reduction of the percentage of lung lesions by at least 50% when compared to animals not receiving the immunogenic composition in combination with said adjuvant. In other embodiments, the enhance clinical outcome is a reduction of viremia in animals by at least 45% when compared to animals not receiving the immunogenic composition in combination with said adjuvant.

[0063] Thus, in one aspect, the invention relates to an improved vaccine, more particularly and improved PRRS virus vaccine, wherein the improvement comprises admixing with the virus vaccine an adjuvant selected from the group consisting of MCP-1, Haemophilus sonmus fractions, carbapol and combinations thereof. The vaccine composition of the invention may further comprise a pharmaceutically acceptable carrier.

[0064] The vaccine compositions of the invention may be formulated by any method known in the art of formulation, for example, into liquid preparations, suspensions, ointments, powders, lotions, W/O emulsions, O/W emulsions, emulsions, creams, cataplasms, patches, and gels and is preferably used as medicaments. Thus, according to another aspect of the present invention, there is provided a pharmaceutical composition comprising the above vaccine composition. The vaccine composition according to the present invention, when dermally administered, can significantly induce antibody production. Accordingly, in another preferred embodiment of the present invention, the vaccine composition can be provided as a transdermal preparation.

[0065] Further, as described above, the virus and adjuvant in the present invention may be administered, to an organism, together as a single vaccine composition, or as an adjuvant preparation separate and distinct from the antigenic PRRS virus component of the vaccine, whereby the adjuvant acts in a manner such that amount of an antibody produced in the organism in response to

the PRRS virus vaccine can be significantly increased as compared to administration of the PRRS virus vaccine alone.

[0066] When the adjuvant and the PRRS virus vaccine are administered to an organism, the clinical outcome of the animal is enhanced. The effective amount of the adjuvant and the immunologically effective amount of the PRRS virus vaccine may be readily determined by a person having ordinary skill in the art by taking into consideration, for example, the type and properties of the antigenic substance, the species of organisms, age, body weight, severity of diseases, the type of diseases, the time of administration, and administration method and further using the amount of an antibody produced against the antigenic substance in the organism as an index.

[0067] The PRRS virus vaccine, the adjuvant, or combinations thereof can be administered to organisms by any suitable method selected depending, for example, upon the condition of animals and properties of diseases. Examples of such methods include intraperitoneal administration, dermal administration for example, subcutaneous injection, intramuscular injection, intradermal injection, and patching, nasal administration, oral administration, mucosal administration (for example, rectal administration, vaginal administration, and corneal administration). Among them, intramuscular administration is preferred.

[0068] An exemplary therapeutic dose of PRRSV MLV is about two milliliters (2 mLs). Skilled artisans will recognize that the dosage amount may be varied based on the breed, size, and other physical factors of the individual subject, as well as, the specific formulation of PRRSV MLV and the route of administration. Preferably, the PRRSV MLV is administered in a single dose; however, additional doses may be useful. Again, the skilled artisan will recognize through the present invention that the dosage and number of doses is influenced by the age and physical condition of the subject pig, as well as, other considerations common to the industry and the specific conditions under which the PRRSV MLV is administered.

[0069] In certain other embodiments, the vaccine may be a multivalent vaccine that comprises two or more PRRS viruses where at least one of the PRRS viruses is the attenuated 94881 virus deposited under ECACC Accession No. 11012502. The other PRRS viruses may be one or more selected from the group consisting of PRRSV strain Lelystad virus (Lelystad Agent (CDI-NL-2.91), or other strains such as those deposited under the Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, CNCM Accession No I-1388, ATCC VR 2332, VR 2385, VR 2386, VR 2429, VR 2474, and VR 2402; CNCM I-1102, CNCM I-1140, CNCM I-1387, CNCM I-1388, or ECACC V93070108 or indeed may be a U.S. strain such as North American PRRS virus, pT7P129A; ATCC deposit VR-2332, ATCC deposit VR-2368; ATCC VR-2495; ATCC VR 2385, ATCC VR 2386, ATCC VR 2429, ATCC VR 2474, and ATCC VR 2402.

[0070] The vaccines based on PRRS viruses may be used to vaccinate both piglets and sows. In one aspect of the invention, a particular dose regimen is selected based on the age of the pig and antigen selected for administration. This will permit pigs of any age to receive the most efficacious dose. In a preferred method, a therapeutic amount of PRRSV 94881 MLV is administered to a pig or piglet that is about two weeks old $\pm$ 5 days of age. The amount selected will vary depending upon the age of the pig. Alternatively, a different therapeutic amount of such an MLV is administered to a pig or piglet that is older than about 3 weeks, and this amount will also change as the pig receiving such an administration ages or becomes older. Accordingly, pigs about four weeks old, six weeks old, eight weeks old, ten weeks old, twelve weeks old, fourteen weeks old, sixteen weeks old, a gilt, or a sow will all receive different amounts. Therapeutic dose to be used will be optimized in the field and is typically, determined in clinical studies in which a minimal immunizing dose is defined based on protection against a virulent heterologous PRRSV challenge in susceptible swine. Preferably, the PRRSV MLV produced according to the methods described herein is administered intramuscular administration; however, other methods of administration such as

intradermal, intranasal, intraretinal, oral, subcutaneous, and the like, that are well-known and used in the art may be used.

[0071] The skilled person will recognize that the vaccination methods may involve determining the proper timing and dosage for vaccination of a pig against PRRSV. Such methods generally comprises the steps of determining at least one variable selected from the group consisting of age, health status, innate immunity level and active immunity level, of the pig, and adjusting a standard dosage level to account for these variables. Generally, the innate immunity level and active immunity level will be determined by referring to a standard comprised of average levels from a population of pigs of similar age and health status. In a particularly preferred method, all variable are considered prior to determining the optimum dosage level and timing of administration.

[0072] In preferred embodiments, the present invention also relates to isolated nucleic acids that code specific open reading frames of attenuated 94881 virus deposited under ECACC Accession No. 11012502 and the parent virulent 94881 virus deposited under ECACC Accession No. 11012501. For example, the complete nucleotide sequence of the attenuated 94881 virus deposited under ECACC Accession No. 11012502 has a sequence of SEQ ID NO:1 which encodes ORF1a, ORF1b, ORF2, ORF3, ORF4, ORF5, ORF6, ORF7 protein sequences of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, and SEQ ID NO:9, respectively. The complete nucleotide sequence of the parent virulent 94881 virus deposited under ECACC Accession No. 11012501 has a sequence of SEQ ID NO:10 which encodes ORF1a, ORF1b, ORF2, ORF3, ORF4, ORF5, ORF6, ORF7 protein sequences of SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18, respectively.

[0073] The PRRSV 94881 vaccine can be administered in any conventional fashion and in some preferred methods the administration is intramuscularly. It is preferred that the administered PRRSV vaccine provide its benefits of treating or reducing the severity of or incidence of PRRSV infection after a single dose, as

with Ingelvac®, however, if other antigens or combination or multivalent vaccines are selected, it should be understood that they can be administered in their conventional fashion, which may include one or more booster doses after the initial administration. Those of skill in the art will be able to determine appropriate dosing levels based on the PRRSV vaccine selected and the age range of the animal to which the antigen will be administered.

[0074] In specific examples presented herein below pigs and sows were challenged with a new European derived strain of PRRSV that was able to reproducibly produce respiratory disease in piglets. Historically, European-derived PRRSV strains have been unable to reproduce respiratory disease in piglet model and hence respiratory challenge models relied on infection with non-European strains. Because of high genetic diversity there is a demand in Europe for a new vaccine based on an European strain. In additional examples, the animals were challenged with a strain that produced reproductive failure in gilts/sows challenge models. It has been found that the the efficacy of the MLV vaccines based on attenuated 94881 virus deposited under ECACC Accession No 11012502 or any virus prepared from this strain or from the parental strain deposited at ECACC Accession No 11012501 can be shown using a variety of challenge models because this strain also is effective in other models of PRRS virus-induced respiratory or reproductive failure.

[0075] EXAMPLES

[0076] Example 1: Description of PRRSV Respiratory Challenge Model

[0077] As noted above, historically, EU-derived PRRSV strains are unable to reproduce respiratory disease in piglet model. Because of the high genetic diversity there is a demand in Europe for a new vaccine based on an European strain and a good, reproducible respiratory challenge model utilizing virulent an European-derived PRRSV strain is necessary for the conduction of the studies. In the following example, the inventors show that challenge of pigs with low passage European challenge strain (passage 4) reliably produced respiratory symptoms.

[0078] In this study, 3 groups with 12 animals, 3 weeks of age at allocation and appr. 10 weeks of age at challenge were used:

[0079] Group 1: Control group

[0080] Group 2: Challenge group (SD 35)

[0081] Group 3: Vaccinated with Porcilis®PRRSV (SD 0) and then challenged (SD 35).

[0082] The study was conducted over a 56 day period necropsy of 6 animals from each group was measured 10 days after challenge; necropsy of all remaining animals 21 days after challenge. Daily investigated parameters included: rectal temperature, respiratory and other clinical signs. Further parameters investigated included: body weight, mortality, viremia, seroconversion, pathological and histological examination of the lungs.

[0083] At study day -7 the groups of pigs were allocated to each group. At study day 0, Group 3 was vaccinated with Porcilis®PRRSV. At study day 35 group 2 and group 3 were challenged with a European challenge strain. At day 45 6 animals from each group were euthanized. The remaining animals were euthanized at day 56.

[0084] Figure 1A shows coughing measurements as a meanscore per animal and week. It was seen that there was an increase in coughing after challenge in both the challenge alone (Group 2) and the Porcilis group (Group 3). Figure 1B shows the total clinical score which was taken from dyspnoea, coughing, nasal and eye discharge and behaviour. These data showed that there was an overall increase in total clinical score after challenge in the challenge and Porcilis group. Rectal temperature of the animals was monitored before and after challenge and shows that there was an increase rectal temperature in the challenge and Porcilis group after Challenge (SD > 35 group 1-2 $p \leq 0.001$; group 1-3 $p \leq 0.001$) (Figure 2).

[0085] Measurement of average daily weight (Figure 3) showed that after challenge until first and until second necropsy the ADW was significantly less in

the challenge (SD35-44 p≤ 0.001 and SD35-56 p≤ 0.01) and in the Porcilis vaccinated group (SD35-44 p≤ 0.05 and SD35-56 p≤ 0.05).

[0086] Viremia was monitored using PCR (Figure 4) and ELISA assays (Figure 5). PCR showed that in Group 1: all animals from the control group remained negative. In Group 2: all animals were positive for PRRSV after challenge; in Group 3: all animalls were positive for PRRSV after vaccination. ELISA revealed: that in Group 1: all animals remained negative; in Group 2: all animals were positive for PRRSV AB after challenge in Group 3: all animals were positive for PRRSV AB after vaccination.

[0087] Macroscopic examination of the lungs was also performed (Figure 6) where lungs were evaluated for tan mottled areas and areas of consolidation: In comparison to the control group significant macroscopic changes could be observed in the challenge and Porcilis group (group 1-2 p≤0.001; group 1-3 p ≤ 0.05). In histopathological examination, the data also showed efficacy of vaccination (Figure 7A through 7C). Mean lung lesion score was significantly higher in the challenge and Porcilis group in comparison to the control group (group 1-2 p≤ 0.001; group 1-3 p ≤ 0.001). Microscopic lesions were stronger 10 days post infection.

[0088] In summary, coughing, total clinical scores and rectal temperatures increased after challenge in the challenge controls and Porcilis vaccinated groups. Body weight was significantly ($p<0.05$) less in the challenge controls and Porcilis group in comparison to the negative control group. All animals from the Porcilis group were positive for PRRS virus and antibodies after vaccination. All animals from the challenge controls were positive for PRRS virus and antibodies after challenge. Macroscopical and histological analysis of the lungs showed severe macroscopic and microscopic lung lesions in the challenge controls and Porcilis group in comparison to the negative control group.

[0089] This study thus confirmed that the European challenge strain used does induce significant ($p<0.05$) disease when compared to the negative control

group: fever, coughing, reduced weight and severe macroscopic and microscopic lung lesions.

[0090] In addition, the European challenge strain has successfully demonstrated consistent and reproducible PRRSV-specific respiratory disease in the pig challenge model and therefore, is suitable for use as a challenge virus in future efficacy studies. Porcilis PRRS shows a lack of efficiency against the European challenge strain within the parameters of this study.

[0091] Example 2: Evaluation of Minimum Immunizing Dose of attenuated PRRS virus 94881 in Susceptible 2 week old piglets following challenge with heterologous European PRRS isolate.

[0092] A vaccination-challenge study was performed to evaluate the minimum immunizing dose (MID) of Porcine Reproductive and Respiratory Syndrome Vaccine European-derived isolate 94881, Modified Live Virus (PRRS 94881 MLV) at three different titer levels, administered to Porcine Reproductive and Respiratory Syndrome (PRRS) susceptible piglets, that were approximately 14 days of age, to provide relevant reduction in lung lesions following challenge with a heterologous European isolate of PRRS. Fifteen piglets were included in each vaccinated group (Groups 1-3) as well as in the challenge control group (Group 4). Ten piglets were included in the negative control group (Group 5).

[0093] The vaccine groups and the challenge control groups were monitored for a number of parameters including: viremia post-challenge, clinical assessments post-vaccination, PRRS serology, viremia post-vaccination, clinical observations post-challenge, average daily weight gain (ADWG), rectal temperatures and PRRS virus detection in the lungs. A negative control group (Group 5), which was not challenged, was also included in the study for study validation purposes by demonstrating that biosecurity was not breached throughout the duration of the study.

[0094] The challenge control and negative control groups were PRRS negative up to the day of challenge (D28) and the negative control group remained PRRS negative for the remainder of the study (D38), thus validating the study.

[0095] Challenge was at 4 weeks post-vaccination. At this time, only 2 animals in low titer vaccine group, 1 animal in the medium titer vaccine group and 3 animals in the high titer vaccine group were PRRS qPCR positive in serum.

[0096] The challenge control group exhibited significant lung lesions typical of PRRS post-challenge. Post-challenge, the low, medium and high titer vaccine groups had median total lung lesion scores of 0.13%, 0.55%, and 0.40%, respectively; while the challenge control group had a median total lung lesion score of 33.40%. The median total lung lesion scores for the three vaccine titer groups were significantly lower than the challenge control group ($p<0.0001$). There were no statistical differences between vaccine titer groups ($p\geq0.1484$) for total lung lesion scores. The negative control group had a median total lung lesion score of 0.00%.

[0097] On study Days 31, 35 and 38 of the post-challenge period, the three vaccine titer groups had significantly less viremia than the challenge control group (**$p\leq0.0093$**). There were no statistical differences between vaccine titer groups for viremia post-challenge except on D35, when the high titer vaccine group exhibited significantly lower viremia than the medium titer vaccine group ($p=0.0442$). Negative control piglets were negative for viremia on D31, D35 and D38.

[0098] Clinically, severity ($p\leq0.0082$) and frequency ($p\leq0.0268$) of coughing was less severe in the three vaccine titer groups than the challenge control group during the post-challenge period; Day 29 - Day 38. Pyrexia was more prominent in the challenge control group than in the three vaccine titer groups post-challenge. ADWG was significantly higher for the three vaccine titer groups compared with the challenge control group (**$p\leq0.0027$**).

[0100] The MID of PRRS 94881 MLV as determined in this study is associated with the low titer vaccine level of $1 \times 10^{2.77}$ $TCID_{50}$/mL, based on a

relevant reduction in gross lung lesions for all three titer levels in comparison to the challenge controls after receiving a virulent heterologous European-derived PRRS challenge. When secondary parameters were examined, all three vaccine titer levels were associated with efficacy and no clear distinctions between titer groups were evident.

[0101] General Design of Study:

[0102] This was a blinded randomized design study conducted in 70 weaned, PRRS susceptible piglets, 14-16 days of age on Day 0 (D0). A description of treatment groups is shown below in Table 2.1:

Table 2.1 Treatment Groups

Group	No. of Animals on D0	Treatment on Day 0
1	15	IVP No. 1 (mean titer of 1 x $10^{2.77}$ of PRRS 94881 MLV)
2	15	IVP No. 2 (mean titer of 1 x $10^{4.42}$ of PRRS 94881 MLV)
3	15	IVP No. 3 (mean titer of 1 x $10^{5.84}$ of PRRS 94881 MLV)
4	15	CP (Placebo matched product without PRRS 94881 MLV)
5	10	CP (Placebo matched product without PRRS 94881 MLV)

[0103] Eighty-three piglets met the study inclusion criteria, of which the first 70 numerical numbers were randomly assigned to one of five groups on D-3 by a biostatistician. Piglets were assigned 15 per group to Groups 1-4 and ten piglets to Group 5. All 83 piglets were PRRS seronegative.

[0104] Piglets were observed from D-1 to D26 for clinical assessments post-vaccination and observations will be recorded on the Clinical Assessment Record form.

[0105] **Serology**: Venous whole blood was collected from piglets on D0, D7, D14, D21, D28. Sample collections were recorded. Blood samples were spun down and serum was harvested from each tube, split and transferred to appropriately labeled tubes. One set of serum samples were held at 2-8 ºC and the other set of serum samples were held at -70 ± 10 °C. The set of serum

samples collected on days 0, 7, 14, 21, 28 and 38 and held at 2-8 ºC were tested for PRRS antibodies. Results were reported as negative (ELISA S/P ratio of < 0.4) or positive (ELISA S/P ratio of ≥ 0.4).

[0106] **PRRS Viremia**: The set of serum samples collected on days 0, 7, 14, 21, 28, 31, 35, and 38 and held at -70 ± 10 °C were tested for PRRSv RNA by qPCR (Addendum 1, Attachment 7). Results were reported as n.d. (not detected), positive (EU PRRSv detected, but not quantifiable, GE/mL (genome equivalent) = < 3.3 log) or a reported value (log GE/mL). For statistical purposes, "not detected" was assigned a value of 0 log GE/mL and a "positive" value was assigned a value of 3.0 log GE/mL.

[0107] **Average Daily Weight Gain (ADWG):** Each pig was weighed on a calibrated scale and individual body weights were recorded. The average daily gain was determined from the D0 to D28 and from D28 to D38.

[0108] **Clinical Observations Post-Challenge**: Piglets were observed by the Study Investigator or designees for clinical signs of disease from D27 to D38 and were recorded on the Clinical Observation Record form. Observations included respiration, behavior and cough based on the clinical observation scoring system as shown below in Table 2.2

Table 2.2 Clinical Observation Scoring System

Respiration Score	Behavior Score	Cough Score
0 = normal respiration 1 = panting/rapid respiration 2 = dyspnea 3 = dead	0 = normal 1 = mild to moderate lethargy 2 = severely lethargic or recumbent 3 = dead	0 = no coughing 1 = soft or intermittent cough 2 = harsh or severe, repetitive cough 3 = dead

[0109] A daily total clinical observation score for each piglet was determined by the summation of its daily respiration, behavior and cough scores.

[0110] Rectal temperatures were collected from D27 to D38.

[0111] **Total Lung Lesion Score**: All piglets that died before D38 and remaining piglets that were euthanized on D38 were necropsied. Each set of

lungs was examined for any gross lung pathology and determination of the % pathology for each lung lobe. If pathology of other organs were noted, these were described and noted as well.

[0112] **Lung qPCR for PRRSV**: For each set of lungs, two samples from the Left and Right Apical lobes, the Left and Right Cardiac lobes, the Left and Right Diaphragmatic lobes and the Intermediate lobe, were retained. For one set of lung samples, all three samples from the left side were combined into one container; while all three samples from the right side and the Intermediate lung lobe sample were combined into another container. Each container was filled with a sufficient amount of 10% formalin solution. For the other set of lung samples, all three lung samples from the left side were combined into one Whirlpak®; while all three samples from the right side and the Intermediate lung lobe sample were combined into another Whirlpak®.

[0113] Frozen lung tissue samples were held at -70 ± 10 °C until further analysis. For each piglet, all left lung samples were homogenized and tested as a single combined sample; and all right lung tissues and the intermediate lung lobe sample were homogenized and tested as a single combined sample. Results were reported as n.d. (not detected), positive (EU PRRSv detected, but not quantifiable, GE/mL (genome equivalent) = < 3.3 log) or a test value (log GE/mL) for left and right lung samples. For analysis purposes for each piglet, the mean of left and right lung sample qPCR results were noted. For statistical purposes, "not detected" was assigned a value of 0 log GE/mL and a "positive" value was assigned a value of 3.0 log GE/mL.

[0114] RESULTS

[0115] **Total Lung Lesion Score Post-Challenge**: A summary of group minimum, maximum, median, 95% confidence interval, Q range and mean for total lung lesion scores showed that the low, medium and high titer vaccine groups had median total lung lesion scores of 0.13%, 0.55%, and 0.40%, respectively; while the challenge control group had a median total lung lesion score of 33.40%. The median total lung lesion scores for the three vaccine titer groups were significantly

lower than the challenge control group ($p<0.0001$). There were no statistical differences between vaccine titer groups ($p\geq0.1484$) for total lung lesion scores. The negative control group had a median total lung lesion score of 0.00%.

[0116] For one of the animals (high titer vaccine group), histologically mild suppurative interstitial pneumonia with copious fibrinopurulent pleuritis was noted. Airways and alveoli were relatively unremarkable except for scattered neutrophils. Lung tissue was IHC negative for *M. hyo*, PCV2, PRRSv and SIV antigens. Lung lesions were consistent with serositis generally associated with bacterial agents (Addendum 12; Accession 2009030254). Several pure bacterial cultures from lung tissue were isolated and identified as *Bordetella bronchiseptica* and a coagulase negative *Staphylococcus*. Although two types of bacteria were isolated from lung tissues, this piglet was not removed from Group 3 total lung lesion score analyses.

[0117] Two of 10 negative control piglets exhibited very minor lung lesions (No. 1767, 0.55%; No. 1789, 0.61%). These lesions were considered insignificant and not indicative of PRRS. Two of 10 negative control piglets exhibited very minor lung lesions (No. 1767, 0.55%; No. 1789, 0.61%). These lesions were considered insignificant and not indicative of PRRS.

[0118] **PRRS Viremia Post-Challenge**: Individual PRRS viremia post-challenge results (D31-D38) were tabulated and it was found that all piglets were viremic post-challenge in the three vaccine titer groups and the challenge control group. At all three time points post-challenge, the three vaccine titer groups had significantly less viremia than the challenge control group ($p\leq0.0093$). There were no differences between vaccine titer groups for viremia post-challenge except on D35, when the high titer vaccine group exhibited a lower mean viremia than the medium titer vaccine group ($p=0.0442$). Negative control piglets were negative for viremia on D31, D35 and D38. Area under curve (AUC) represents both the quantity and duration of viral load and is a good assessment tool for examining viremia. Significant differences were also detected between the three vaccine titer groups and the challenge control group with respect to AUC at both D28 to D38

(p≤0.0162), and D31 to D38 (p<0.0001). No differences were detected between vaccine titer groups with respect to AUC (p≥0.3669) at both time intervals.

[0119] The group frequency of viremic positive piglets was also summarized for D31 to D28 and is shown in Table 2.3. Since all vaccine and challenge control piglets were viremia positive post-challenge, the frequency viremia positive piglets was 100% for each group at each time point. Hence, no analyses were conducted on post-challenge frequency for viremia.

Table 2.3 Summary of Group Frequency of Viremic Positive Piglets – D31 to D38

Study Day	Group*	No. Positive	% Positive	95 % CI		Total No.
31	1	14	100	76.8	100.0	14
	2	15	100	78.2	100.0	15
	3	15	100	78.2	100.0	15
	4	14	100	76.8	100.0	14
	5	0	0	0.0	30.8	10
35	1	14	100	76.8	100.0	14
	2	15	100	78.2	100.0	15
	3	15	100	78.2	100.0	15
	4	14	100	76.8	100.0	14
	5	0	0	0.0	30.8	10
38	1	14	100	76.8	100.0	14
	2	15	100	78.2	100.0	15
	3	15	100	78.2	100.0	15
	4	14	100	76.8	100.0	14
	5	0	0	0.0	30.8	10

* Group 1 = Low titer PRRS 94881 MLV; Group 2 = Medium titer PRRS 94881 MLV; Group 3 = High titer PRRS MLV; Group 4 = Challenge control group; Group 5 = Negative control group

Lung qPCR Results: Individual lung virus isolation results post-challenge were summarized as was the frequency of qPCR positive lung sample test results (p-values) for differences between groups. Lung tissues from piglets in all three vaccine titer groups and the challenge control group were qPCR positive for PRRSv post-challenge. There were no significant differences detected between vaccine titer groups and the challenge control group (p=1.0000). Since all vaccine titer piglets were qPCR positive for PRRSv, no tests were conducted between vaccine titer groups.

[0120] Although no differences were detected between vaccine titer groups and the challenge control group for frequency of qPCR positive lung tissues, differences were evident for viral load in lung tissues. Indeed, the low, medium and high titer vaccine groups had median lung qPCR values of 6.88, 6.80 and 6.81 $\log_{10}$ GE/mL, respectively; while the challenge control group had a median lung qPCR value of 8.13 $\log_{10}$ GE/mL. The differences between the vaccine titer groups and the challenge control group were significant ($p \leq 0.0001$). Conversely, no differences were detected between vaccine titer groups for median lung qPCR values ($p \geq 0.7379$).

[0121] **Clinical Observation Scores Post-Challenge**: Abnormal respiration and behaviour were not severe post-challenge, as evidenced by median maximum clinical scores of 0 (a score of 0 represented normal respiration or normal behavior) for all five groups. In addition, no significant differences were detected between vaccine titer groups and the challenge control group for both abnormal respiration and behavior ($p \geq 0.0996$).

[0122] Coughing was noted in all three vaccine titer groups and the challenge control, but was more severe in the challenge control group. For the three vaccine titer groups, each group had a maximum cough score of 1, which represented soft or intermittent coughing and median maximum cough score of 0. Conversely, the challenge control group had a maximum cough score of 2, which represented harsh or severe, repetitive coughing, and a median maximum cough score of 1. The three vaccine titer groups had significantly less severe coughing than the challenge control group ($p \leq 0.0082$). Coughing was not noted in the negative control group.

[0123] All three vaccine titer groups had maximum total scores of 1 and median maximum scores of zero. Conversely, the challenge control group had a maximum total score of 4 and a median maximum score of 1. The three vaccine groups had significantly lower maximum total clinical scores than the challenge control group ($p \leq 0.0047$). Again, the negative control group had a maximum total clinical score of zero and a median maximum total clinical score of zero.

[0124] The frequency of abnormal respiration or behavior for at least one day from D29 to D38 was low for all groups. Indeed, no abnormal respiration was noted in low and medium vaccine titer groups from D29 to D38. The high titer vaccine group had one of 15 (7%) piglets and the challenge control group had 3 of 14 (21%) piglets with abnormal respiration. Abnormal behavior was not noted in any vaccine titer group; while 2 of 14 (14%) challenge control piglets exhibited abnormal behavior for at least one day post-challenge. No significant differences were detected between vaccine titer groups and the challenge control group for frequency of abnormal respiration or behavior for at least one day post-challenge ($p \geq 0.0996$). Abnormal respiration or behavior was not noted in the negative control group.

[0125] The frequency of coughing was much higher in the challenge control than in the three vaccine titer groups. In deed, the frequency of coughing for at least one day post-challenge was 14%, 13% and 27% for the low, medium and high titer vaccine groups, respectively. Conversely, the frequency of coughing for at least one day post-challenge for the challenge control group was 71%. The three vaccine titer groups had significantly less frequency of coughing than the challenge control group ($p \leq 0.0268$).

[0126] The frequency of any clinical sign post-challenge, as represented by a total clinical score > 0, was higher in the challenge control group than in the three vaccine titer groups. Similar to the frequency of cough, the frequency of any clinical sign for at least one day post challenge was 14%, 13%, and 33% for the low, medium, and high titer vaccine groups, respectively; while 79% of piglets in the challenge control group had a least one clinical sign post-challenge. The three vaccine groups had significantly lower frequency of any clinical sign post-challenge than the challenge control group ($p \leq 0.0253$). No clinical signs were noted in the negative control group during this same time period.

[0127] Mean scores for abnormal respiration or behavior from D29 to D38 were low for all groups. Indeed, the mean respiration scores for the low and medium vaccine titer groups were 0.00 (normal), the high titer vaccine had a mean

respiration score of 0.01 and the challenge control had a mean respiration score of 0.03. The mean score for behavior was 0.00 for all three vaccine titer groups; while the challenge control had a mean behavior score of 0.01. No significant differences were detected between vaccine titer groups and the challenge control group for mean respiration and behavior scores ($p \geq 0.0996$). Respiration and behavior mean scores for the negative control group were 0.00.

[0128] The challenge control group had a higher mean cough score than the three vaccine titer groups. In deed, the mean cough scores were 0.01, 0.01 and 0.04 for the low, medium and high titer vaccine groups, respectively. Conversely, the mean cough score for the challenge control group was 0.28. The three vaccine titer groups had significantly lower mean cough scores than the challenge control group ($p \leq 0.0077$).

[0129] The mean total score was higher in the challenge control group than in the three vaccine titer groups. Similar to the mean cough scores, the mean total scores post challenge were 0.01, 0.01, and 0.04 for the low, medium, and high titer vaccine groups, respectively; while the mean total score for the challenge control group was 0.32. The three vaccine groups had significantly lower mean total scores than the challenge control group ($p \leq 0.0025$).

[0130] **Rectal Temperatures Post-Challenge**: The maximum group mean rectal temperatures for low, medium, and high titer vaccine groups between D29 to D38 were 40.20 °C (D33), 40.33 °C (D35), and 40.20 °C (D37), respectively. The maximum group mean rectal temperature for the challenge control group and the negative control group between D29 and D38 were 40.51 °C (D33) and 39.95 °C (D33), respectively.

[0131] The low titer vaccine group had significantly lower rectal temperatures than the challenge control group on D29 (39.47 vs. 39.90 °C), D31 (39.85 vs. 40.20 °C), D35 (39.80 vs. 40.22 °C) and D38 (39.86 vs. 40.32 °C) ($p \leq 0.0317$); while the low titer vaccine had a significantly higher rectal temperature than the challenge control group on D30 (40.08 vs. 39.58 °C; $p=0.0003$). No

significant differences were detected between the low titer vaccine group and the challenge control group on D32-D34 and D36-D37 ($p \geq 0.0545$).

[0132] The medium titer vaccine group had significantly lower rectal temperatures than the challenge control group on D31 (39.62 vs. 40.20 °C), D33 (40.15 vs. 40.51 °C), and D38 (39.58 vs. 40.32 °C) ($p \leq 0.0227$). No significant differences were detected between the medium titer vaccine group and the challenge control group on D29-D30, D32, and D34-D37 ($p \geq 0.0580$).

[0133] The high titer vaccine group had a significantly lower rectal temperature than the challenge control group on D33 (40.12 vs. 40.51 °C), D35 (39.79 vs. 40.22 °C), and D38 (39.55 vs. 40.32 °C) ($p \leq 0.0147$); while the high titer vaccine group had a significantly higher rectal temperature than the challenge control group on D32 (40.31 vs. 39.90 °C; $p=0.0063$). No significant differences were detected between the high titer vaccine group the challenge control group on D29-D31, D34 and D36-37 ($p \geq 0.0708$).

[0134] There was less frequency of pyrexia in the three vaccine titer groups post-challenge compared with the challenge control group. The frequency of pyrexia was low overall and similar between vaccine titer groups.

[0135] **Average Daily Weight Gain (ADWG):** The least square mean ADWG from D0 to D28 for the low, medium and high titer vaccine groups were 0.4, 0.3, and 0.4 kg/day, respectively. The least square mean ADWG during this same time period for the challenge control group was 0.3 kg/day. The low titer vaccine group had a significantly higher least square mean ADWG than the challenge control group from D0 to D28 ($p=0.0292$); while no other significant differences were detected between vaccine titer groups and the challenge control group ($p \geq 0.1262$), or between vaccine titer groups ($p \geq 0.1293$), for least square mean ADWG. During this same time period, the negative control group had mean ADWG of 0.5 kg/day.

[0136] The least square mean ADWG from D28 to D38 for the low, medium and high titer vaccine groups were 0.5, 0.5 and 0.4 kg/day, respectively. The least

square mean ADWG during this same time period for the challenge control group was 0.3 kg/day. The three vaccine titer groups significantly out gained the challenge control group post-challenge ($p \leq 0.0027$). During this same time period, the negative control group had a mean ADWG of 0.6 kg/day.

[0137] **Clinical Assessments Post-Vaccination**: In the low titer vaccine group, one piglet (1735) was noted as thin from D0 to D10. In addition, one piglet beginning on D6 was noted as thin for 16 days, exhibited cough for 2 days and depression for 9 days, and was euthanized on D21 for animal welfare reasons due to poor health. Piglet 1727 had a total lung lesion score of 10.8%. Since this value was determined pre-challenge, it was not included in post-challenge total lung lesion analysis. In addition, areas of red/purple consolidation in the cranioventral areas of the lungs were noted, the liver was pale and kidneys had multiple red/purple areas in the renal pelvis. The pathologist noted fatty infiltration in central lobules in the liver, commonly seen in cases of negative energy balance and consequent lipolysis. No other lesions were observed in sections of liver, kidney and lung. Lung tissue was positive for EU PRRS by PCR. No growth was detected for routine bacterial culture.

[0138] In the medium titer vaccine group, one piglet was excluded from the study on D0 prior to treatment due to poor health and was replaced by another piglet. Two Piglets exhibited coughing for one and three days, respectively, beginning on D12. Four piglets were noted as thin on D2, D3 or both D2 and D3.

[0139] In the high titer vaccine group, one piglet (1728) exhibited lameness or lameness and swelling in one leg from D7 to D26. Beginning 18 days post-vaccination, one piglet was noted as thin for 6 days, and exhibited coughing for one day and rough hair coat for 4 days. Another Piglet was noted as thin on D2. Two Piglets exhibited coughing for two days and one day, respectively, beginning on D9. One piglet exhibited diarrhea for one day (D14).

[0140] In the challenge control group, six piglets exhibited periodic coughing for a cumulative of one to six days, beginning with a first piglet on D7 and ending with three piglets on D21. Two piglets were noted as thin for two and 11 days,

respectively, beginning on D1 for one of these piglets. The second of these two Piglets also exhibited depression and rough hair coat for 4 days, weak on legs for one day and was found dead on D15. At necropsy for this piglet there were no lung lesions (lung lesion score of 0%) noted, no feed in the stomach and no abdominal fat, and diagnosed starvation as the cause of death. Since this lung lesion score was determined pre-challenge, it was not included in post-challenge lung lesion analysis.

[0141] The group test results (p-values) were summarized for any abnormal clinical assessment for at least one day from D1 to D26. No significant differences were detected between vaccine titer groups and the challenge control group ($p \geq 0.0502$); nor between vaccine titer groups ($p \geq 0.3898$). No piglets in the negative control group exhibited an abnormal clinical assessment from D-1 to D26.

[0142] **PRRS Serology**: Individual piglet PRRS ELISA serology results were summarized. Piglets in the negative control group remained PRRS seronegative throughout the study. Seroconversion could be observed in the 3 vaccine titer groups by 14 days post-vaccination; while the challenge control group remained PRRS seronegative until post-challenge. Ten days post-challenge (D38) all piglets in the low and high titer vaccine groups and the challenge control group were PRRS seropositive; while 14 of 15 piglets in the medium titer vaccine groups were PRRS seropositive.

[0143] PRRS ELISA positive serology test results (p-values) were determined for differences between groups. The three vaccine titer groups had significantly higher frequencies of PRRS ELISA positive piglets than the challenge control group on D14, D21 and D28 ($p<0.0001$). No significant differences were detected between the three vaccine titer groups and challenge control on D38 ($p=1.0000$ or no test conducted) nor between the three vaccine titer groups at any time point ($p=1.0000$ or no test conducted).

[0144] **PRRS Viremia Post-Vaccination**: Individual PRRS viremia results post-vaccination were determined. For statistical purposes, a “not detected” result was assigned a value of 0 log GE/mL and a “positive” value was assigned a value

of 3.0 log GE/mL. All groups were PRRS viremia negative on D0. The group viremia (qPCR) – D7 to D28 post-vaccination titer (log GE/mL) data was assessed. Piglets in the three vaccine titer groups reached peak mean viremia on D7, after which titers levels for all three groups slowly declined prior to challenge (SD28). Conversely, the challenge control group and the negative control group remained negative for viremia during the pre-challenge phase of the study. From the group test results (p-values) for D7, D14, D21 and D28 qPCR results it was seen that all three vaccine titer groups had significantly higher median qPCR values than the challenge control group for D7-D28 ($p \leq 0.0159$). The medium vaccine titer group had a significantly higher qPCR median value than the low titer vaccine group ($p=0.0193$); otherwise, no differences were detected for qPCR median values between vaccine groups pre-challenge ($p \geq 0.0594$).

[0145] Four weeks post-vaccination, the frequency of viremia was low in the three vaccine titer groups.

[0146] The following conclusions can be made based upon these study results:

- The absence of any break of biosecurity during the study and the confirmation of piglet's susceptibility to PRRS confirmed the validation of the study and its suitability for interpretation
- Substantial PRRS clinical disease was evident in the challenge control group, thus validating this challenge model as an adequate laboratory tool to evaluate PRRS vaccine efficacy and more specifically, the MID of PRRS 94881 MLV
- All three dose levels of PRRS 94881 MLV were associated with significant reduction in lung lesions, as well as significant reduction in viremia post-challenge, viral load in lung tissues, coughing, total clinical observation scores, pyrexia and ADWG
- The MID of PRRS 94881 MLV as determined in this study is associated with the low titer vaccine level of $1 \times 10^{2.77}$ $TCID_{50}$/mL, based on a relevant

reduction in gross lung lesions for all three titer levels in comparison to the challenge controls after receiving a virulent heterologous European-derived PRRS challenge.

[0147] Further depiction of Results

[0148] Clinical observations were taken every day. Quantitative RT- PCR was performed using PRRSV European specific primers for samples form blood, oral, faecal, and nasal swab, as well as lung lavages.

[0149] From these studies data showed that the piglets showed normal health except for a few pigs that were lame. Post-mortem there were no abnormalities at necropsy except that 1-2 animal showed signs of mildly enlarged inguinal lymph notes. Importantly, it was seen that there were no lung lesions observed with the vaccinated group.

[0150] Figure 8 shows the percentage of viremic animals in the sentinel group as compared to the group vaccinated with a composition containing the attenuated PRRS virus strain deposited at ECACC Accession No. 11012502. This Figure shows the spread of the vaccine strain from vaccinated animals to sentinels. At the peak of PRRS viraemia (SD21) as detected by quantitative RT-PCR, the viral load was 78.47% lower in sentinel infected pigs (mean viral load of 3.347 GE/ml) than in vaccinated animals (mean viral load of 4.014 GE/ml). In the room where the PRRS naïve sows were commingled with their vaccinated offspring, only 3 sows out of 8 were tested positive for PRRSV in blood by RT-PCR thus confirming limited and ineffective PRRS MLV vaccine exposure to naïve adult animals. The vaccine virus 94881 MLV was primarily excreted in the faeces in this study. Indeed, in faeces, the virus could be detected from one day to 21 days post vaccination. At five days post vaccination, almost 30% of the vaccinated animals excreted virus in faeces. The PRRS virus was not detected in nasal secretions and in only a few animals via oral secretions (2 out of the 56 sampled animals at 5 days post vaccination).

[0151] Example 3: Exemplary Materials and Methods For Use in Testing Vaccine Efficacy using Porcilis® PRRS as an example.

[0152] A selected number, for example, fourteen healthy pregnant sows from a confirmed PRRSV negative herd (tested virologically and serologically) were used in this study. Sows faced first or second parturition and were confirmed to be pregnant at the time of vaccination/challenge infection on day 94 of gestation. The sows were divided into three treatment groups. The first group was treated with a commercial dose of Porcilis™ PRRS of 2 ml containing at least $10^{4.0}TCID_{50}$ via intramuscular administration at day 94 of gestation. The challenge control group (group 2) received a dose of $10^{4.72}$ $TCID_{50}$ in 2 ml cell culture medium of the pathogenic European field isolate (passage 4) intranasally. Group 3 was vaccinated with a dose of 2 ml containing $10^{7.6}TCID_{50}$ i.m. PRRS MLV containing attenuated PRRS strain deposited at ECACC Accession No. 11012502 on January 25 2011 seven days before insemination and was challenged with the European field isolate (passage 4) ($10^{4.72}$ $TCID_{50}$ in 2 ml cell culture medium i.n.) at day 94 of gestation.

[0153] Animals from group 1 were monitored until day 5 post-farrowing. Animals from group 2 and 3 were monitored until day 28 post farrowing.

[0154] Animal Phase: All sows were accustomed to the animal facilities 1 week before vaccination. Sows and piglets were observed for their general health status by the investigator on a daily basis. Every animal that died or was euthanised was subjected to post-mortem examination and subsequent laboratory analysis.

[0155] Pregnancy was confirmed with ultrasound examination. Serum from sows was obtained on study days 0, 7, 14 and at farrowing for PCR and ELISA investigations. Any material that was associated with abortion was subjected to laboratory investigations.

[0156] Routine gross pathology was performed on all deadborn piglets. Lung tissue samples from all lung lobes were collected from deadborn piglets and

from mummies. Samples for PCR testing were stored at -70° C. 2 ml of precolostral blood from each piglet was collected on the day of birth. Serum was prepared and aliquots were stored at -70°C. Serum was used to test for viremia to evaluate the transplacental infection. All piglets of group 1 that survived until day 5, were euthanized at 5 days of age.

[0157] Clinical and Reproductive Performance Parameters: The following criteria are exemplary criteria that may be investigated (priority order): number of live born piglets per litter, number of stillborn piglets per litter, number of mummified fetuses per litter and number of piglets surviving through day 5 or 28 of age, respectively. The number of piglets born viremic was determined using pre-colostral serum. The frequency of PCR positive blood and tissue samples from sows and/or piglets was investigated to evaluate the epidemiology and course of infection.

[0158] Field Samples: The field samples investigated in this study were taken from routine PRRSV diagnostics and consisted of blood, serum and various organ materials, mostly lungs and lymph nodes, from different European countries. The samples were stored at -20° C for a maximum of 3 days before RNA preparation and residual material was subsequently transferred to -70° C. for long term storage. RNA and RT-PCR products were stored at -20°C.

[0159] Cell Culturing: MA104 cells (clone CL2621) were grown in MEM (Dulbecco, Germany) supplemented with 10% FCS and antibiotics.

[0160] Porcine alveolar macrophages were harvested using a method described by Wensvoort et al. (Wensvoort, G. et al. Vet. Quat. 1991, 13:121-130) and modified as follows: each lung lobe was infused with 50-100 ml PBS and subsequently massaged for 3 to 5 min. Then the fluid was rescued from the lobe and passed through a gaze filter. This procedure was repeated until the lavage fluid was clear. The pooled lavage fluid was centrifuged at 500 g for 15 min at room temperature. The pellet was washed in PBS and aliquots of $1x10^7$ cells in 50% RPMI 1640 (Biochrom), 40% FCS and 10% DMSO were frozen at -196°C.

For further use the PAMs were cultured in RPMI 1640 medium supplemented with 10% FCS and antibiotics.

[0161] Preparation of Organ Material for Virus Isolation in Cell Culture: About 0.5 cm^3 of tissue material was transferred into a tube containing one steel homogenizer ballet in 1.8 ml of sterile PBS. The tubes were agitated for 10 min until the organ material was homogenized. Cell debris was pelleted by centifugation for 2 min at 450 g and room temperature. The supernatant was passed through a 0.45 .mu.m pore sterile filter and stored at -70°C. Aliquots of 30 µl were used to inoculate one semiconfluent cell culture monolayer using 24 well microtitre plates.

[0162] RNA Isolation: RNA from organ material was extracted with the RNeasy Mini Kit and from serum, plasma, cell culture supernatant and vaccine solution with the QTAamp Viral RNA Mini Kit (both Qiagen) according to the manufacturer's recommendations, using approximately 100 mg organ material and 140 µl fluid material, respectively, for each preparation. The RNA was finally eluted in 65 µl buffer as recommended by the manufacturer.

[0163] Plaque Purification of Virus: Confluent monolayers of Ma104 cells in cell culture dishes of 10 cm seeded 48 hours before were infected with the respective virus at tenfold dilutions from 10^{-1} to 10^{-4}. The cells were incubated for 1 hour with the virus dilutions which were then removed, and the cells were overlaid with 30 ml of Ma104 medium containing 5% methylcellulose (Sigma). Plaques were picked after five to seven days and were transferred to Ma104 monolayers in 24 well plates. Virus from these plates was harvested at about 50% CPE and was subjected to further analysis.

[0164] Immunofluorescence Assay: Cells were fixed at -20° C. for 15 min using ice-cold aceton:methanol (1:1) and air-dried thereafter. After rehydration in PBS, cells were incubated with the PRRSV specific monoclonal antibody SDOW17 (Rural Technologies Inc., USA) diluted 1:1000 in PBS for 1 hour. After 3 washes with PBS, cells were incubated with goat anti-mouse FITC conjugated secondary antibody (Dianova, Hamburg, Germany) (1:150 in PBS) for another

hour. After 3 final washes with PBS, cells were overlaid with glycerine:PBS solution (1:1) and subjected to immunofluorescence microscopy.

[0165] Diagnostic nRT-PCR: A diagnostic RT-nPCR can be carried out to check the samples for the presence of PRRSV-EU virus.

[0166] An exemplary diagnostic RT-nPCR can be carried out with the Titan One Tube Kit (Roche Molecular Biochemicals) as follows: [5 µl total RNA preparation, 1*RT-PCR buffer, 0.4 mM dNTPs, 20 pmol of primers PLS and PLR, 5 mM dithiothreitol, 1 mM $MgCl_2$, 2.5-5 U RNasin (Promega Ltd), 1-2.5 U enzyme mixture, adjusted to a final volume of 25 µl with DEPC treated aqua dest]. Routine cycling conditions used can be: 45° C. for 1 hour, 94°C. for 2 min and 30 cycles of 94° C. for 30 sec, 58° C. for 45 sec and 68° C. for 45 sec, final elongation step at 68° C. for 5 min. The nested PCR reaction was carried out with Qiagen Taq (Qiagen AG) as follows: [1 µl RT-PCR product, 1*PCR buffer, 10 µl Q-solution, 3.5 mM $MgCl_2$, 0.3 mM dNTPs, 20 pmol of each EU-7-n-s and EU-7-n-as primers, 2.5 U Taq polymerase, adjusted to a final volume of 50 µl with aqua dest]. Cycling conditions were as follows: 7 cycles with 94° C. for 1 min, 58° C. for 1 min and 72° C. for 1 min, followed by 30 cycles with 94° C. for 1 min and 70° C. for 1.5 min (no annealing step), final elongation step at 70° C. for 5 min.

[0167] Nucleotide Sequencing: Nucleotide sequencing can be performed on the nested PCR products which had been generated with primers that contained an M13 tag, either directly from the PCR reaction or from PCR products that had been excised from agarose gels and purified with the JETsorb gel extraction kit (Genomed). Sequencing was done using the automated sequencer LI-COR DNA Analyzer GENE READIR 4200® (LI-COR Inc., Lincoln, Nebr., USA). Nucleotide and deduced amino acid sequences can be analyzed with AlignIR®, vs1.1 (LI-COR Inc., Lincoln, Nebr., USA) and the DNASIS.RTM. 2.6 software package (Hitachi Software Genetic Systems Inc., San Francisco, USA).

[0168] Example 4: Determination of the full length genome sequence PRRSV 94881

[0169] The present example shows the determination of the full length genome nucleotide sequences of the attenuated 94881 strain and its parental strain 94881, passage 5. These sequences did not show any unclear nucleotide position what indicates the presence of a homogeneous viral content. The comparison of the 94881 Master Seed Virus with the European Reference Virus strain Lelystad Virus (LV) revealed nucleotide homologies ranging from 85.40 to 95.09 percent in the 8 different viral genes and amino acid identities from 86.39 to 97.27 percent between both virus strains. Two deletions in the ORF 1a of 94881 MSV could be identified compared to LV. The comparison between 94881 Master Seed Virus and its parental strain, passage 5, showed 26 nucleotide exchanges between both resulting in a total number of 14 amino acid exchanges.

[0170] For the full length genome sequence determination of the 94881 Master Seed Virus a total number of 1 reverse transcription, 17 external PCRs and 58 internal PCRs was performed, resulting in 40 PCR products which were used for sequencing. In case of 94881, passage 5, 1 reverse transcription, 17 external PCRs and 67 internal PCRs were performed, resulting in 40 PCR products, also, used for sequencing.

[0171] Overlapping sequence alignment analyses resulted in a full length sequence of 14843 nucleotides for both virus isolates comprising the complete open reading frames (ORFs) 1a to 7, each. Additionally, 177 nucleotides of the 5´-non translated region (5´NTR) and 43 nucleotides of the 3´-non translated region (3´NTR) could be determined, each. Compared with the European PRRSV reference virus isolate Lelystad (LV) (GenBank Assession no. M96262) 44 nucleotides of the 5´NTR and 83 nucleotides of the 3´NTR could not be determined as those regions were used for primer annealing regions.

[0172] The sequencing reactions resulted for both virus strains in a clear nucleotide sequence without any wobbles or any other indication on a mixed sequence. After translation into amino acids clear amino acid sequences without any questionable amino acid were available for sequence comparison of 94881 MSV with the LV and with the parental strain 94881 passage 5. The alignments

and comparisons of the nucleotide sequences between 94881 MSV and Lelystad virus were performed and showed that there were substantial differences at the nucleotide and amino acid level. Alignments also were performed between 94881 MSV and its parental strain, passage 5.

[0173] Sequence comparisons with LV resulted in nucleotide homologies from 85.40 to 95.09 percent in the 8 different viral genes and amino acid identities from 86.39 to 97.27 percent between both virus strains. Two deletions in the ORF 1a of 94881 MSV can be identified compared to LV. One deletion of 138 nucleotides is located at position 2154 to 2292 of LV and results in 46 missing amino acids. At position 2686 to 2688 a further triplet is deleted resulting in the missing amino acid Phenylalanine. An arrangement of all nucleotide homologies and amino acid identities between LV and both 94881 strains is shown in Table 4.1.

Table 4.1: Arrangement of nucleotide and amino acid sequence comparisons of the 94881 Master Seed Virus to the European Reference Virus Lelystad Virus

ORF	length of the viral gene/protein nn/aa	no. of nucleotide deviations to Lelystad Virus	genetic homology to Lelystad Virus in percent	no. of amino acid deviations to Lelystad Virus	amino acid identity to Lelystad Virus in
5´NTR	177*/ ---	9	94.92	---	---
1a	7050** / 2349	1050	85.40	326	86,39
1b	4392 / 1463	346	92.12	40	97.27
2	750 / 249	67	91.07	23	90.76
3	798 / 265	72	90.98	28	89,43
4	552 / 183	52	90.58	23	87.43
5	606 / 201	58	90.43	23	88.56
6	522 / 173	26	95.02	5	97.11
7	387 / 128	19	95.09	9	92.97
3´NTR	44***/ ---	2	95.45	---	---

NTR : non translated region

* = Only 177 nucleotides were compared between Lelystad Virus and 94881 MSV. The remaining 44 nucleotides, located upstream, had not been determined.

** = The isolate 94881 MSV shows two deletions in the ORF 1a, one with 138 nucleotides and one with 3 nucleotides, respectively. The complete nucleotide and amino acid sequences of the Reference virus LV were used for the homology and identity calculations, deletions are assessed as deviations. The length of the corresponding viral gene of LV is 7191 nucleotides and the corresponding polyprotein 2396 amino acids, calculations of genetic homology and amino acid identity refer to the numbers of 7191 nucleotides and 2396 amino acids, respectively.

*** = Only 44 nucleotides were compared between Lelystad Virus and 94881 MSV. The remaining 83 nucleotides, located downstream, had not been determined

[0174] The sequence comparison of the full length nucleotide sequences of 94881 Master Seed Virus and 94881 Parental Strain, passage 5, revealed a total number of 26 nucleotide exchanges between both. The nucleotide exchanges were distributed as follows: 15 in the ORF 1a, 4 in the ORF 1b, 2 in the ORF 2, none in the ORF 3, 1 in the ORF 4, 3 in the ORF 5, 1 in the ORF 6 and none in the ORF 7. These nucleotide exchanges resulted in a total number of 14 amino acid exchanges which were distributed as follows: 8 in the polyprotein 1a, 1 in the polyprotein 1b, 1 in the glycoprotein 2, none in the glycoprotein 3, 1 in the glycoprotein 4, 2 in the glycoprotein 5 and 1 in the matrix protein. Both strains showed the same deletions compared to Lelystad Virus in ORF 1a. An arrangement of all nucleotide exchanges and resulting amino acid exchanges including the positions in the vial genes and corresponding proteins is shown in detail in Table 4.2.

[0175] Example 5 – Culture of Deposited Virus and MSV

[0176] As noted above, PARENT (low passage) 94881 is deposited at European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012501, 94881 Master Seed Virus (MSV) is deposited at European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012502. The growth and culture conditions for the parent virus and the MSV are provided in the present example.

[0177] **Parent 94881**: This is a virus of a genotype which is PRRSV type 1, as such it is a European genotype PRRSV. The virus has a porcine host. The

parent virus deposited at 11012501 was deposited at a titer of 5.81 Log10 $TCID_{50}$/mL. Host cells for virus propagation are MA 104 cells. These cells are cultured Minimal Essential Medium (MEM) with 3.7 g/L sodium bicarbonate containing 6% irradiated Fetal Bovine Serum at 37±1°C. The cells are plated in T-flasks (75 cm^2) with a plating density of 2 x 10^4 to 2 x 10^5 cells/cm^2 and cultivated for 3 to 7 days until 100% confluent prior to passage. For virus growth, the virus is added to the cells at a MOI of 0.001-0.01 in T-flasks. The cells infected are at a confluency of about 80-100%, typically 1-3 days post cell planting. The infected cells are cultivated at 37±1°C for 3-10 days post infection and the virus is then harvested. The harvest is performed when monolayer cells exhibit approximately 80-100% cytopathic effect (CPE) at 3-10 days post infection. The supernatant of infected MA104 tissue cultures (spent media + PRRSV from a culture with 80-100% CPE) is harvested and contains the virus that has been propagated. This supernatant may be stored at -70°C/-80°C for several months until use. The virus is assessed for $TCID_{50}$ with Spearman and Kaerber calculation to determine log10 $TCID_{50}$/mL of sample.

[0178] Vaccine (high passage) 94881 Master Seed Virus (MSV): This is a virus of a genotype which is PRRSV type 1, as such it is a European genotype PRRSV. The virus has a porcine host. The MSV deposited at 11012502 was deposited at a titer of 6.43 Log10 TCID50/mL. Host cells used for the propagation of the MSV are MA 104 cells. These cells are cultured Minimal Essential Medium (MEM) with 1.4g/L sodium bicarbonate and containing 10% irradiated Fetal Bovine Serum at 36±2°C. The cells are plated in T-flasks (75-150 cm2) or 850 cm2 roller bottles with a planting density of 1 x 104 to 1 x 105 cells / cm2 and cultivated for 3 to 7 days until 100% confluent prior to passage. For virus growth, the virus is added to the cells at a MOI of 0.001-0.01 in T-flasks or roller bottles. The cells infected are at a confluency of about 80-100%, typically 1-3 days post cell planting. The infected cells are cultivated at 36±2°C for 3-14 days post infection and the virus is then harvested. The harvest is performed when monolayer cells exhibit approximately 80-100% cytopathic effect (CPE) at 3-14 days post infection. The supernatant of infected MA104 tissue cultures (spent media + PRRS from a

culture with 80-100% CPE) is harvested and contains the virus that has been propagated. This supernatant may be stored at 2-8°C for 5-10 days, -70°C for several months until use. The MSV is assessed for TCID50 with Reed and Muench calculation to determine log10 TCID50/mL of sample.

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Table 4.2: Arrangement of nucleotide and amino acid sequence comparisons of the 94881 Master Seed Virus to 94881 Parental strain

ORF	no. of deviating nucleotides	position in viral gene	exchange (nn) from parental strain to MSV	synonymous /non synonymous	no. of deviating amino acids	position in viral protein	exchange (aa) from parental strain to MSV
1a	15	309	C to T	synonymous	8	---	---
		753	G to T	non synonymous		251	E to D
		1474	G to A	non synonymous		492	V to I
		1789	G to A	non synonymous		597	V to I
		2094	C to T	synonymous		---	---
		2987	T to C	non synonymous		996	L to S
		3034	A to G	non synonymous		1012	T to A
		3065	A to G	non synonymous		1022	E to G
		3736	A to G	non synonymous		1246	T to A
		3966	C to T	synonymous		---	---
		4101	T to C	synonymous		---	---
		5803	C to T	non synonymous		1935	L to F
		6354	T to G	synonymous		---	---
		6519	C to T	synonymous		---	---
		6588	T to C	synonymous		---	---
1b	4	591	T to C	synonymous	1	---	---
		1833	C to T	synonymous		---	---
		1932	C to T	synonymous		---	---
		3682	G to A	non synonymous		1228	V to I
2	2	13	C to T	non synonymous	1	5	H to Y
		195	C to T	synonymous		---	---
3	0	---	---	---	0	---	---
4	1	529	T to C	non synonymous	1	177	F to L
5	3	109	A to G	non synonymous	2	37	N to D
		364	C to T	non synonymous		122	L to F
		570	C to T	synonymous		---	---
6	1	214	C to T	non synonymous	1	72	L to F
7	0	---	---	---	0	---	---

[0179] Example 6: PRRS 94881 $_{ML}$V Gilt MID Study

[0180] Summary

[0181] The objective of this vaccination-challenge study was to evaluate the minimum immunizing dose (MID) of Porcine Reproductive and Respiratory Syndrome Vaccine European-derived Isolate 94881, Modified Live Virus, Code 19T1.U_ (PRRS 94881 MLV) in gilts. Two different titer levels were administered to PRRS seronegative gilts approximately 28 days pre-breeding (Day 0; D0), gilts were challenged with a heterologous European isolate of PRRSv at approximately 90 days of gestation (D118) and gilts were evaluated for the total number of live born piglets or percentages of live born piglets and weaned piglets at 20 days of age to determine the MID. At the time of challenge on Day 118 (D118), the challenge control group consisted of 8 pregnant gilts (Group 1, Placebo), the low titer group consisted of 8 pregnant gilts (Group 2, 1 x $10^{2.43}$ $TCID_{50}$/dose), the high titer group consisted of 8 pregnant gilts (Group 3, 1 x $10^{3.90}$ $TCID_{50}$/dose), and the negative control group consisted of 5 pregnant gilts (Group 4, Placebo, not challenged).

[0182] Both the low titer and the high titer groups were associated with higher percentages of live piglets per litter at farrowing (**P≤0.0455**) and higher percentages and numbers of live piglets per litter at weaning (**P≤0.0203**) in comparison to the challenge control group.

[0183] With regard to supportive efficacy parameters, the high dose group was associated with a higher percentage and number of healthy piglets per gilt at farrowing (**P≤0.0211**), a lower percentage and number of weak and mummified feti (**P≤0.0090**), a lower percentage of qPCR positive gilts and lower viral load in gilts post-challenge on D125, DOF 0 and DOF+13 (**P≤0.0155**), a lower percentage of piglets per gilt qPCR positive and lower piglet viral load on DOF 0 (**P≤0.0030**), a lower percentage of piglets per gilt with clinical disease (**P<0.0001**), and higher

piglet body weights on DOF+20 and ADWG (**P<0.0013**), in comparison with the challenge control group.

[0184] The low dose group was associated with a higher percentage of healthy piglets per gilt at farrowing (**P=0.0138**), a lower percentage and number of mummified feti (**P≤0.0190**), a lower percentage of qPCR positive gilts and lower viral load in gilts post-challenge on D125, D132, DOF 0 and DOF+13 (**P≤0.0290**), a lower percentage of piglets per gilt qPCR positive on DOF 0 (**P=0.0381**), a lower percentage of piglets per gilt with clinical disease (**P<0.0001**), and higher piglet body weight on DOF+20 and ADWG (**P<0.0028**), in comparision to the challenge control group.

[0185] In conclusion, the study objective was met and data from this study establishes the MID of PRRS 94881 MLV in gilts as $1 \times 10^{2.43}$ $TCID_{50}$/2 mL. In addition, this study establishes duration of immunity (DOI) in gilts of approximately 4 months.

[0186] OBJECTIVE(S)/PURPOSE OF THE STUDY

[0187] The objective of this vaccination-challenge study was to evaluate the minimum immunizing dose (MID) of Porcine Reproductive and Respiratory Syndrome Vaccine European-derived Isolate 94881, Modified Live Virus, Code 19T1.U_ (PRRS 94881 MLV), at two different titer levels (Group 2, low titer; Group 3, high titer), administered to PRRS seronegative gilts pre-breeding to provide higher percentages of live born piglets and weaned piglets at 21 days of age, following challenge of gilts with a heterologous European isolate of Porcine Reproductive and Respiratory Syndrome virus (PRRSv) at approximately 90 days of gestation. The primary criteria to satisfy this objective was that one or both vaccine groups must demonstrate relevantly higher percentage or number of live born piglets and weaned piglets at 20 days of age (DOF +20), compared with the challenge control group (Group 1).

[0188] Other parameters analyzed between the vaccine groups and the challenge control group included gilt clinical assessments post-vaccination, gilt

PRRS serology, gilt viremia, gilt clinical observations, piglet viremia, total piglets per litter, healthy live piglets per litter, weak live piglets per litter, mummies per litter, stillborns per litter, crushed/mortalities piglets per litter, piglet clinical observations, and piglet average daily weight gain (ADWG). These parameters were analyzed as supportive parameters and did not serve as primary parameters to satisfy the study objective.

[0189] SCHEDULE OF EVENTS

Table 6.1 Gilt Schedule of Events

Study Day(s)	Dates	Key Study Event
-2 or -1	20-Jul-2010 to 21-Jul-2010	Health examination
-1 to 21	21-Jul- 2010 to 12-Aug-2010	Groups 1-4: Daily Clinical Assessments
0	22-Jul-2010	Groups 1-4: Blood collection; Vaccinated Groups 1 and 4 with Control Product (CP); Vaccinated Group 2 with Investigational Veterinary Product (IVP) No. 1 (low titer vaccine group); and vaccinated Group 3 with IVP No. 2 (high titer vaccine group)
8 to 21	30-Jul-2010 to 12-Aug-2010	Groups 1-4: Treated gilts once daily with Matrix™ to synchronize estrus cycles
7, 14, 21, 56 and 84	29-Jul-2010, 05-Aug-2010, 12-Aug-2010, 16-Sep-2010, 14-Oct-2010	Groups 1-4: Blood collection
22 to 113	13-Aug-2010 to 12-Nov-2010	Groups 1-4: Clinical Assessments at least three times a week
26 to 32	17-Aug-2010 to 23-Aug-2010	Groups 1-4: Observed for heat detection and bred gilts by artificial insemination (AI)
84	14-Oct-2010	Groups 1-4: Pregnancy check by ultrasound
116 to 20 days after farrowing	15-Nov-2010 to 05-Jan-2011	Groups 1-4: Clinical Observations, recorded abortions, stillbirths, mummies, live piglets, weak born piglets
118 (approx. 90 days of gestation)	17-Nov-2010	Groups 1-4: Blood collection Groups 1-3: Challenged with PRRSv isolate 190136
125, 132, farrowing/ abortion (DOF*), DOF +7, DOF +13	24-Nov-2010, 01-Dec-2010, 03-Dec-2010 to 16-Dec-2010, 10-Dec-2010 to 23-Dec-2010, 16-Dec-2010 to 29-Dec-2010	Groups 1-4: Blood collection
DOF+20	23-Dec-2010 to 05-Jan-2011	Groups 1-4: Blood collection from remaining gilts; Euthanized remaining gilts; Disposal
DOF+20 or later	25-Dec-2010 to 05-Jan-2011	Groups 1-4: Euthanized remaining gilts; Disposal

*DOF = Day of Farrowing

Table 6.2 Piglet Schedule of Events

Study Day(s)	Dates	Key Study Event
DOF	03-Dec-2010 to 16-Dec-2010	All dead piglets: Weighed; Necropsied; Collected blood/body fluid if possible; Collect lung samples All live piglets: Weighed; Blood collection (pre-colostral or peri-natal (within 12 hours of birth))
DOF +1 to DOF +20	04-Dec-2010 to 05-Jan-2011	All live piglets: Clinical Observations Dead piglets: Weighed; Necropsied; Collected blood/body fluid if possible; Collected lung samples
DOF +7	10-Dec-2010 to 23-Dec-2010	All live piglets: Blood collection
DOF +13	16-Dec-2010 to 29-Dec-2010	All live piglets: Blood collection
DOF +20	23-Dec-2010 to 05-Jan-2011	All live piglets: Weighed; Blood collection;
DOF+20 or later	25-Dec-2010 to 05-Jan-2011	Group 1-3 piglets: Euthanized remaining piglets, Disposal; Group 4 piglets: Assigned to another BIVI project

[0190] STUDY DESIGN

Table 6.3 Study Design

Group	**Number of gilts on D0**	**Treatment on D0 (approximately 28 days prior to breeding)**	**Number of gilts on D118**	**Challenged on D118 with 6.0 mL (2 mL/nostril; 2 mL IM) of 1 x $10^{6.30}$ $TCID_{50}$ of PRRSv 190136**
1 (Challenge control group)	28	2.0 mL IM of Control Product (Placebo matched product without PRRS 94881 MLV)	16	Yes
2 (Low titer group	28	2.0 mL IM of IVP No. 1 (1 x $10^{2.43}$ $TCID_{50}$ of PRRS 94881 MLV)	16	Yes
3 (High titer group)	28	2.0 mL IM of IVP No. 2 (1 x $10^{3.90}$ $TCID_{50}$ of PRRS 94881 MLV)	16	Yes
4 (Negative control group)	10	2.0 mL IM of Control Product	5	No

[0191] BLINDING CRITERIA

[0192] The Study Investigator and designees were blinded with regard to gilts assigned to Groups 1-4. To maintain blinding of the Study Investigator and designees, a person not collecting data administered the IVPs and CP to assigned gilts on D0. Laboratory personnel were blinded to the treatment each gilt received while conducting their respective tasks.

[0193] MATERIALS

[0194] INVESTIGATIONAL VETERINARY PRODUCTs (IVP) AND CONTROL PRODUCT (CP)

Table 6.4 Investigational Veterinary Products (IVPs)

Generic Product Name:	Porcine Reproductive and Respiratory Syndrome, Modified Live Virus
Isolate:	Isolate 94881
Formulation:	The Manufacturer's Batch Protocol (MBP) for PRRS 94881 MLV vaccine, Lot 390-005 (cake) is presented in Appendix 1. The MBP for Sterile Carbopol Adjuvanted Diluent, Lot 808-002 (diluent) is presented in Section 15.1, Appendix 1. D0 just prior to vaccination, BIVI-Ames reconstituted/diluted PRRS 94881 MLV vaccine, Lot 390-005 with Sterile Carbopol Adjuvanted Diluent, Lot 808-002 to formulate the two IVPs. IVP No. 1 was formulated to a targeted titer level of approximately 1 x $10^{3.0}$ $TCID_{50}$/2 mL and IVP No. 2 was formulated to a targeted titer level of approximately 1 x $10^{4.5}$ $TCID_{50}$/2 mL. An adequate volume of each IVP was formulated for vaccination and testing.
IVP Lot/Serial Nos.:	IVP No. 1: N270-142 IVP No. 2: N270-143
Manufacturer:	Boehringer Ingelheim Vetmedica, Inc. 2621 North Belt Highway St. Joseph, MO 64506
Expiration Date:	An expiration date of 22 Jul 2010 was assigned to each IVP for study purposes only.
Storage Requirements:	Rehydrated/diluted IVP was stored at 2-8 ºC or on ice
Testing:	PRRS 94881 MLV, Serial 390-005 and Sterile Carbopol Adjuvanted Diluent, Lot 808-002 were tested by BIVI-QC. At the start and end of the vaccination procedure, BIVI-Ames was contacted. BIVI-Ames tested pre- and post-vaccination aliquots of each IVP for virus titer in accordance with the PRRSv Titer Procedure (Section 15.1).
Test Results:	Test results for PRRS 94881 MLV, Serial 390-005 and for Sterile Carbopol Adjuvanted Diluent, Lot 808-002 were satisfactory IVP No. 1 had an average titer of 1 x $10^{2.43}$ $TCID_{50}$/2 mL and IVP No. 2 had an average titer of 1 x $10^{3.90}$ $TCID_{50}$/2 mL
IVP Transfer:	Two vials containing 35 mL of each IVP were transferred to the study site on D0 just prior to vaccination.
IVP Retention:	A retention sample of each IVP is currently stored at -70 ± 10 ºC at BIVI-Ames until the final report has been signed.

Table 6.6 Control Product (CP)

Generic Product Name:	Placebo
Formulation:	BIVI-Production produced lyophilized placebo product containing inert material comprised in the vaccine serial without PRRS 94881 MLV (Lot N240-191-062409, On D0, BIVI-Ames reconstituted Lot N240-191-062409 with Sterile Carbopol Adjuvanted Diluent, Lot 808-002 to formulate the CP, Lot No. 270-141.
Manufacturer:	Boehringer Ingelheim Vetmedica, Inc. 2621 North Belt Highway St. Joseph, MO 64506, USA
Lot Number:	N270-141
Expiry Date:	An expiration date of 22 Jul 2010 was assigned to the CP for study purposes only.
Storage Conditions:	Lyophilized vaccine: 2-8 °C Rehydrated CP: 2-8 °C or on ice
Testing:	CP was tested by BIVI-QC for EP sterility in accordance with Special Outline No. 96
Test Results:	CP was determined to be sterile
CP Transfer:	Two vials containing 50 mL each of CP were transferred to the study site on D0 just prior to vaccination.
CP Retention:	CP was formulated for this study only and was not retained.

[0195] CHALLENGE MATERIAL

Table 6.7 Challenge Material

Name/number of isolate	Porcine Reproductive and Respiratory Syndrome virus
Location and date of isolation incl. clinical symptoms	Isolate 190136, Passage 2. Isolate #190136 was obtained from lung tissue of a new born piglet from a farm showing typical reproductive signs of PRRS (abortions in gilts and weakness in new born piglets) during an outbreak in Lower Saxony, Germany, in April 2004. The attending veterinarians submitted the samples to bioScreen (sample arrived on 21 April, 2004). Isolate #190136 could directly be propagated on AK-MA104 cells.
Formulation:	Challenge virus was thawed and diluted with MEM (Minimum Essential Medium) to a targeted titer of approximately 1 x 10^6 $TCID_{50}$/3 mL on D118. An adequate volume of challenge material was prepared. Two aliquots were removed from challenge material.
Lot Number:	N289-034
Manufacture:	Boehringer Ingelheim Vetmedica, Inc. - USA
Storage conditions	Bulk challenge material was stored at -70 ± 10°C. Once prepared, diluted challenge material was maintained on ice until it was administered.
Testing:	At the start and end of the challenge procedure, BIVI-Ames was contacted. BIVI-Ames laboratory personnel tested pre- and post-challenge aliquots for virus titer in accordance with the PRRSv Titer Procedure
Test Results:	The challenge material had a mean titer of 1 x $10^{6.30}$ $TCID_{50}$/6 mL dose
Challenge material transfer:	Three vials containng 101mL each of challenge material were transferred to the study site on D118 just prior to administration.
Administration route	2.0 mL/nostril and 2.0 mL IM in the left neck (administered to all gilts in Groups 1, 2 and 3 on D118).
Challenge material retention:	Challenge material was formulated for this study only and was not retained.

[0196] ADDITIONAL TREATMENTS

[0197] Matrix™ (6.8 mL; Alternogest; Intervet/Schering Plough Animal Health) was administered in each gilt's feed from D8 to D21 to synchronize estrus cycles.

[0198] Oxytocin (VetTek) was administered at parturition to assist gilts with farrowing, but not for initiation of farrowing. At farrowing, all live piglets received 1.0 mL iron injection (Phoenix or Durvet), IM, in the right ham for prevention of iron deficiency anemia shortly after birth. Additionally, all live piglets received gentamicin (SparHawk Laboratories Inc) as a scour preventative shortly after birth. All treatments were recorded on the Biological & Pharmaceutical Treatment Record form.

[0199] TREATMENTS

[0200] DOSING JUSTIFICATION

[0201] Each IVP was administered as a 2.0 mL dose to assigned gilts to evaluate the MID of PRRS 94881 MLV. A 2.0 mL dose of the CP was administered to gilts assigned to groups 1 and 4.

[0202] DOSING REGIMEN

[0203] On D0, each IVP or CP was administered to each respective gilt IM in the right neck region using a sterile 3.0 mL Luer-lock syringe and a sterile 18g x 1 inch (2.54 cm) needle by a person not collecting study data. The dosing regimen is shown below in Table 6.8.

Table 6.8 Dosing Regimen

Group	Number	Treatment	Dose/Route	Study Day
1	28	CP	2.0 mL IM	D0
2	28	IVP No. 1 (low titer dose)	2.0 mL IM	D0
3	28	IVP No. 2 (high titer dose)	2.0 mL IM	D0
4	10	CP	2.0 mL IM	D0

[0204] METHODS AND PRECAUTIONS FOR STUDY PERSONNEL

[0205] Personnel administering IVPs, the CP and challenge material adhered to safety precautions and wore personal protective equipment as outlined for the specific study site.

[0206] ANIMAL INFORMATION

[0207] DETAILS OF STUDY ANIMALS

Table 6.9 Animal Information

Source:	Wilson Prairie View Farms N5627 Highway DD Burlington, WI 53105	
Number of gilts:	94	
Arrival date:	Gilts arrived at the Veterinary Resources, Inc. facilities in two shipments on 15 Jul 2010 (D-7) and 20 Jul 2011 (D-2).	
Identification:	Individually ear tagged with unique number	
Species:	Porcine	
Breed:	Commercial crossbred	
Gender:	Females	
Age range:	Approximately 8 months of age on D0	
Ownership of test animals:	Boehringer Ingelheim Vetmedica, Inc.	
Physiological status:	All gilts were PRRS ELISA seronegative on D0. Gilts selected for assignment to the study were observed by the Study Investigator on D-2 or D-1 and determined to be in good health and nutritional status.	
Pregnancy results:	Gilts were checked for pregnancy on D84.	
Group –Gilt Assignments on D0	Group 1 (n=28): 1, 3, 5, 6, 8, 11, 15, 18, 19, 34, 35, 39, 40, 52, 54, 68, 79, 82, 88, 90, 95, 96, 98, 101, 102, 107, 109 and 110	Group 2 (n=28): 12, 26, 31, 32, 41, 47, 49, 56, 58, 59, 60, 64, 67, 69, 70, 72, 73, 75, 76, 77, 78, 85, 89, 93, 94, 100, 103 and 104
	Group 3 (n=28): 2, 7, 14, 22, 23, 25, 27, 28, 30, 33, 36, 42, 46, 48, 51, 53, 57, 61, 62, 65, 66, 80, 84, 86, 91, 92, 105 and 106	Group 4 (n=10): 4, 10, 13, 16, 17, 20, 21, 24, 29, and 108
Group-Gilt Nos. Remaining in the Study On D118	Group 1 (n=16): 1, 6, 11, 18, 19, 40, 54, 68, 79, 82, 88, 95, 96, 98, 102, and 107	Group 2 (n=16): 12, 26, 31, 32, 41, 47, 49, 58, 64, 67, 72, 85, 89, 93, 100, and 104
	Group 3 (n=16): 7, 14, 23, 27, 33, 36, 46, 48, 57, 61, 62, 65, 66, 84, 92, and 106	Group 4 (n=5): 4, 13, 16, 17, and 108

[0208] INCLUSION/EXCLUSION CRITERIA

[0209] All gilts enrolled in this study were PRRS ELISA negative, non-bred and were healthy at the time of vaccination as determined by observation.

[0210] POST-INCLUSION REMOVAL OF GILTS

[0211] Five (5) – Group 1 gilts (Nos. 5, 15, 34, 35 and 52), two (2) - Group 2 gilts (Nos. 77 and 94), three (3) - Group 3 gilts (Nos. 2, 25, and 30) and one (1) - Group 4 gilt (No. 20) did not display estrus and were subsequently not bred. These gilts were removed from the study by D47.

[0212] Two (2) – Group 1 gilts (Nos. 109 and 110), nine (9) – Group 2 gilts (Nos. 56, 59, 60, 69, 73, 75, 76, 78, and 103), four (4) – Group 3 gilts (Nos. 22, 28, 51 and 53) and one (1) – Group 4 gilt (No. 21) were removed from the study by D89 due to lameness, not pregnant, or late breeding.

[0213] The study protocol stated that if > 16 pregnant gilts per group for Groups 1-3 were still in the study prior to challenge, extra gilts would be randomly selected for removal from the study; thus leaving 16 pregnant gilts per group for Groups 1-3. Five (5) – Group 1 gilts (Nos. 3, 8, 39, 90 and 101), one (1) - Group 2 gilt (No. 70) and five (5) - Group 3 gilts (Nos. 42, 80, 86, 91, and 105) were removed from the study by D104 based on randomizations by the statistician or selection by non-study person, reducing the group size to 16 gilts for Groups 1-3.

[0214] Due to space limitations, the Study Investigator requested that the size of Group 4 be reduced from eight (8) to five (5). The statistician randomly selected three (3) gilts (Nos. 10, 24 and 29) for removal from the study, which were removed on D109.

[0215] ANIMAL MANAGEMENT AND HOUSING

[0216] Animal Housing

[0217] Low IVP titer gilts were housed in Rooms 1 and 2, and high IVP titer gilts were housed in Rooms 3 and 4, in Building CB at VRI-Cambridge from D-1 to study completion. Gilts assigned to the challenge control and negative control groups were housed in a single room at VRI-Risdal from D-1 to D85. On D85, remaining gilts in the challenge control and negative control groups were moved to

VRI-Cambridge. Sixteen (16) – challenge control gilts were housed in Building CB, Rooms 5-8 and eight (8) - negative control gilts were housed in Building CA, Room 12, for the remainder of the study. From D85 onward, each room was identical in layout with two rows of 4 farrowing crates per row. Each crate held one gilt and her progeny. Each crate was approximately 5 feet x 7 feet in size, was elevated off of the floor, metal rod panels for sides and plastic-mesh for flooring. There was no nose-to-nose contact between adjacent crates. The floor of each crate was washed down at least once daily to remove excrement and waste. Each room had separate heat and ventilation, preventing cross-contamination of air between rooms. Each room was cleaned and disinfected prior to use for this study. Animal Services staff showered and donned clean clothes before entering each room.

[0218] Treatment group isolation was necessary in this study as it is well known within the scientific community that PRRSv readily spreads from pig to pig via various mechanisms including aerosolization. This includes avirulent live PRRS vaccines as these biological products include attenuated virus particles that mimic the characteristics of virulent wild-type PRRS without the capability to cause disease. Proper methods were in place to ensure that biosecurity was maintained and that vaccinated animals did not accidentally cross-contaminate non-vaccinated, PRRSv naïve negative control animals.

[0219] Each room in the facility has fans and heaters to aid in sufficient air circulation and heating. The ventilation system is separate yet identical for each room, so air is not shared between rooms. Solid feed was stored in bags, free from vermin. Water was *ad libitum* from a well located at the animal facility. Gilts were fed a commercially prepared, non-medicated gestation or lactation ration (Heart of Iowa Cooperative, Roland, IA) appropriate for their size, age, and condition.

[0220] Gilts were in good health and nutritional status before initiation of the study as determined by the Study Investigator. During the study, two gilts were observed with mild lameness and one gilt was observed with a swelling in the left

neck region. The Study Investigator considered all of these to be non-specific conditions that commonly occur in groups of gilts housed in confinement. The Study Investigator determined that concomitant treatments were not required for any animals during this study.

[0221] All gilts and their pigs assigned to Groups 1-3 were disposed of by commercial incineration after euthanasia. Gilts assigned to Group 4 were disposed of by rendering after euthanasia. Group 4 piglets were not euthanized and disposed of, but were assigned to another BIVI project. No food products from animals enrolled in this study entered the human food chain.

[0222] ASSESSMENT OF EFFICACY

[0223] To assess the MID of PRRS 94881 MLV, low titer group (Group 2) and the high titer group (Group 3) were challenged on D118 and reproductive performance and weaned piglets post-challenge were evaluated. The primary criteria to satisfy this objective were that one or both vaccine groups must demonstrate statistically higher percentage or number of live born piglets and weaned piglets at 20 days of age (DOF +20), compared with the challenge control group (Group 1).

[0224] Other parameters analyzed to support efficacy between vaccine groups and the challenge control group included gilt clinical assessments post-vaccination, gilt PRRS serology, gilt viremia, gilt clinical observations post-challenge, piglet viremia at farrowing, total number of piglets per litter, healthy live piglets per litter, weak live piglets per litter, mummies per litter, stillborns per litter, crushed/mortalities piglets per litter, piglet clinical observations, and piglet ADWG.

[0225] CRITERIA FOR A VALID TEST

[0226] The negative control group (Group 4) was not included in any analyses. The negative control group was included in the study to demonstrate that source gilts were PRRS negative at the time that the other three groups were challenged. Furthermore, the negative control group had to remain PRRS

negative until study completion to exclude a possible introduction of a field PRRSv or accidental cross contamination from challenged groups.

[0227] Pre-purchase and D0 serum samples were all required to be negative for PRRS antibodies. Serum samples collected from Groups 1 and 4 up to the day of challenge and from Group 4 until study completion had to be free of PRRS antibodies for the study to be valid.

[0228] PRIMARY OUTCOME PARAMETERS

[0229] The primary efficacy variables for statistical evaluation were live piglets per gilt at birth (mean number or percentage) and live piglets per litter at DOF +20 (mean number and percentage).

[0230] 9.2.1 Percentage of Live Piglets at Birth Per Gilt

[0231] Farrowing data was recorded for each gilt during the study. The day of farrowing (DOF) for each gilt was defined as the day that the first piglet was born. At the time of farrowing, each piglet was classified into one of five categories listed below in Table 6.10. A live piglet at birth was defined as any piglet that received an observation rating at birth as healthly live piglet, weak live piglet or crushed/mortality piglet (death due to crushing was confirmed at necropsy as described below). Observations were conducted by the Study Investigator or a designee and were recorded on the Farrowing/Litter Processing Record form.

Table 6.10 Farrowing Result Categories

Term	Definition
Mummy	A mummified fetus that is not completely developed and is exhibiting severe autolysis or a completely developed fetus exhibiting a shiny gun metal green appearance and with no or very little hair
Stillborn Piglet	A completely developed dead piglet with hair
Weak Live Piglet	A poor-doing piglet that cannot nurse or walk
Healthy Live Piglet	A healthy, nursing piglet that is able to walk
Crushed/Mortality	A fully developed piglet that appears to have died shortly after farrowing due to being crushed by the gilt

[0232] Live piglets per Litter at DOF +20

[0233] Piglets were observed for clinical signs of disease as outlined below in Table 6.11 from DOF+1 to DOF+20. Observations were conducted by the Study Investigator or designees and were recorded on the Clinical Observations Record form.

Table 6.11 Clinical Observation Scoring System

Respiration	Behavior	Cough
0 = normal respiration 1 = panting/rapid respiration 2 = dyspnea 3 = dead	0 = normal 1 = mild to moderate lethargy 2 = severely lethargic or recumbent 3 = dead	0 = none 1 = soft or intermittent cough 2 = harsh or severe, repetitive cough 3 = dead

[0234] A daily total clinical observation score was determined as a summation of respiration, behavior and cough scores by the statistician using SAS program. Any piglet receiving a clinical score of zero to eight on DOF+20 was evaluated as alive on DOF+20.

[0235] SUPPORTIVE PARAMETERs

[0236] Other parameters analyzed between vaccine groups and the challenge control group included gilt clinical assessments post-vaccination, gilt PRRS serology, gilt viremia, gilt clinical observations, piglet viremia, total piglets per litter, healthy live piglets per litter, weak live piglets per litter, mummies per litter, stillborns per litter, crushed/mortalities piglets per litter, piglet clinical observations, and piglet average daily weight gain (ADWG).

[0237] Gilt Daily Assessments

[0238] All gilts were observed once daily from D-1 to D21 and from D22 to 115 at least three times a week for daily assessments post-vaccination by the Study Investigator or designees. Observations were recorded on the Daily Assessment Record form.

[0239] Gilt PRRS Serology

[0240] Venous whole blood was collected from gilts prior to purchase and on D0, D7, D14, D21, D56, D84, D118, D125, D132, DOF 0, DOF+7, DOF+13 and DOF+20. Blood collections from gilts at the time of farrowing/abortions (DOF 0) were conducted immediately after farrowing/abortions were completed or up to 8 hours post-farrowing/abortion.

[0241] Briefly, approximately 10 mL of blood was collected from each gilt into an appropriate sized Serum Separator Tube(s) (SST). Sample collections were recorded on the Sample Collection Record form. Blood in SSTs was allowed to clot at room temperature. Blood samples collected on weekdays were delivered to BIVI-Ames on the day of collection. Blood samples collected on weekends were processed by VRI personnel on the day of collection. Serum samples at VRI were held at 2-8 ºC. At either BIVI-Ames or VRI, blood samples were spun down and serum was harvested, split and transferred to appropriate tubes. Each tube was labeled with the gilt's ID number, the study number, the date of collection, the study day and the sample type. Serum samples at VRI were delivered to BIVI-Ames at the earliest convenient time. A completed Specimen Delivery Record form was included with each shipment. At BIVI-Ames, one set of serum samples were held at 2-8 ºC and the other set of serum samples were held at -70 ± 10 °C.

[0242] The set of gilt serum samples held at 2-8 ºC were tested by BIVI-Ames for PRRS antibodies. Results were reported as negative (ELISA S/P ratio of < 0.4) or positive (ELISA S/P ratio of ≥ 0.4).

[0243] Gilt Clinical Observations Post-Challenge

[0244] Gilts were observed for clinical signs of disease from D116 to DOF+20. Observations were conducted by the Study Investigator or designees. Gilts were observed each day for respiration, behavior and cough based on the clinical observation scoring system outlined above in Table 6.11.

[0245] 9Piglet PRRS Viremia

[0246] Venous whole blood was collected from piglets on DOF 0, DOF+7, DOF+13 and DOF+20, or when a piglet was found dead. Pre-colostral blood collection was preferred from newborn piglets, but was not mandatory. If pre-colostral blood could not be collected, peri-natal blood within 12 hours of farrowing was permissible. Samples not collected before first suckling were labeled as "Peri-natal" and kept separately from pre-colostral samples.

[0247] Briefly, approximately 2.0 to 2.5 mL of blood was collected from each live piglet into an appropriate sized Serum Separator Tube(s) (SST). A minimum of 5.0 mL of blood was collected from each piglet on DOF +20 just prior to euthanasia. Blood was collected from each mummy or stillbirth or if blood could not be collected from a dead fetus, thoracic or abdominal fluid was collected. Sample collections were recorded on the Sample Collection Record form.

[0248] Piglet Average Daily Weight Gain

[0249] Individual piglets were weighed on DOF 0 and DOF+20, or on the day a piglet was found dead by the Study Investigator or designees. Individual body weights on DOF 0 were recorded on the Farrowing/Litter Processing Record form and body weights after DOF 0 were recorded on the Body Weight Record form.

[0250] PRRS Virus Quantitation in Lung Tissue

[0251] All piglets dead at delivery or dying before DOF+20 were necropsied by the Study Investigator. Necropsy results and a diagnosis were recorded on the Necropsy Report form. Two lung samples were collected from each necropsied piglet. One sample was placed into a separate Whirlpak® container and another sample was placed into an appropriate container filled with a sufficient volume of 10% formalin. Sample collections were recorded on the Necropsy Report form.

[0252] Whirlpaks® and formalin containers were appropriately labeled with animal number, study number, date of sampling, study day, sample type and whether the samples were from the left side, right side or both. Samples in Whirlpaks® were stored at -70 ± 10 °C and samples in 10% formalin were stored

at room temperature until delivered to BIVI-Ames. A completed Specimen Delivery Record form was included with each delivery of samples. At BIVI-Ames, samples in Whirlpaks® were stored at -70 ± 10 °C until shipped from BIVI-Ames to Germany, and formalin fixed samples were stored at BIVI-Ames at room temperature.

[0253] After the study was completed, frozen tissue samples in Whirlpaks® were shipped and tested as described above.

[0254] Formalin fixed tissue samples were submitted to ISU VDL within one week of collection for embedding in paraffin blocks). Tissues in paraffin blocks were returned to BIVI and are currently held by BIVI-Ames at room temperature for possible future testing. A decision of whether to retain these samples or discard them will be made by the Study Sponsor and Monitor after the study report is completed.

[0255] ADVERSE EVENTS

[0256] No adverse events attributed to the IVPs were reported during this study. For more information on adverse events, see Section 12.6, Gilt Assessments Post-Vaccination.

[0257] STATISTICAL METHODS

[0258] EXPERIMENTAL UNIT

[0259] Treatment groups had to be housed in separate rooms in this study to avoid transmission of live PRRSv vaccine to non-vaccinated groups. Therefore, room was the experimental unit. However, for the purposes of this analysis, possible bias due to confounding “room” and “treatment” effects were ignored, and gilt and her corresponding litter were analyzed as the experimental unit.

[0260] RANDOMIZATION

[0261] Ninety-four (94) PRRS seronegative gilts from a pool of 107 test-eligible gilts were randomly assigned to one of 4 groups prior to D0. Groups 1-3 each consisted of 28 gilts. Group 4 consisted of 10 gilts. For Group 1, Nos. 45

and 55 were excluded by the farm manager prior to shipment due to health reasons and were replaced by two extra gilts, Nos. 15 and 18, respectively. For Group 3, gilt No. 44 was excluded by the farm manager prior to shipment due to health reasons and was replaced by extra gilt No. 25.

[0262] Due to space limitations at the time of challenge, Groups 1-3 were restricted to 16 gilts per group and Group 5 was restricted to 5-8 gilts. On D85, 16 gilts per group were randomly selected to remain in the study for Groups 1-3. Since Group 4 consisted of 8 gilts on D85, this group was not further reduced by randomization. Afterwards, the Study Investigator requested that Group 4 be reduced from 8 gilts to 5 gilts. On D109, 5 gilts were randomly selected to remain in the study for Group 4.

[0263] All randomizations procedures were conducted by a biostatistician..

[0264] ANALYSIS

[0265] The statistical analyses and data summaries were conducted by Dr. rer. hort. Martin Vanselow, Biometrie & Statistik, Zum Siemenshop 21, 30539 Hannover, Germany, +49(0) 511 606 777 650, m.vanselow@t-online.de.

[0266] The main objective of the statistical analysis was the comparison of two PRRS 94881 MLV vaccine groups (Groups 2 and 3) to an unvaccinated challenged control group (Group 1). All data were imported into SAS for management and evaluation. The data were received from the study sponsor in the form of verified SAS data sets. Cases which had been withdrawn from the study were considered for the respective parameter of analysis until date of exclusion. All data were summarised descriptively (n, minimum, maximum, mean, median, standard deviation, interquartile range, or frequency distributions, confidence interval) based on the type of the variable. The statistical analyses were performed using SAS software release 8.2 (SAS, 2001, Cary, North Carolina, USA: SAS Institute Inc.).

[0267] Variables for the Statistical Evaluation of the Study:

[0268] Primary variables

[0269] Proportions of live piglets at farrowing/abortion (DOF+0)

[0270] Proportions of live piglets at 20 days of age (DOF+20)

[0271] Supportive variables

[0272] Gilt clinical assessments post-vaccination

[0273] Gilt PRRS serology

[0274] Gilt viremia

[0275] Gilt clinical observations

[0276] Piglet viraemia

[0277] Reproductive performance

[0278] Piglet clinical observations

[0279] Piglet average daily weight gain (ADWG)

[0280] Hypothesis to be Tested and Assumptions Made:

[0281] The unchallenged negative control group (Group 4) was excluded from statistical tests. The low titer and high titer groups (Groups 2 and 3, respectively) were compared to the challenge control group (Group 1). All tests between groups were designed as two-sided tests on differences. In the case of all tests, differences were considered as statistically significant only if $P \leq 0.05$. Efficacy was demonstrated if the percentage or number of live born piglets and the percentage or number of weaned piglets at DOF+20 were significantly higher for one or both vaccine groups compared with the challenged control group.

[0282] Details on Data Manipulations and Evaluation:

[0283] Clinical Assessments of Gilts Post-Vaccination

[0284] Frequency tables of animals with at least one positive finding between study days 1 and 21 and between study days 1 and 113 were generated. Differences between the challenge control and vaccine groups were tested by Fisher's exact test.

[0285] Clinical Observations of Gilts Post-Challenge

[0286] Frequency tables of animals with at least one positive finding between study day 116 and DOF+20 were generated. Differences between the challenge control group and vaccine groups were tested by Fisher's exact test.

[0287] Serology of Gilts

[0288] Frequency tables of "positive" ELISA results on study days 7, 14, 21, 56, 84, 118, 125, 132 (pre-farrowing) and DOF+0, DOF+7, DOF+13 and DOF+20 were generated. Differences between the challenge control and vaccine groups were tested by Fisher's exact test.

[0289] Viremia of Gilts

[0290] Viremia data were evaluated for each day of investigation separately (pre-farrowing study days 7, 14, 21, 56, 84, 118, 125, 132 and DOF+0, DOF+7, DOF+13 and DOF+20). For the qualitative evaluation of the qPCR data the analytical results 'not detected' ('n.d.') and 'negative' were classified as 'negative' and the analytical results 'positive' and a measured value were classified as 'positive'. For the quantitative evaluation 'not detected' ('n.d.') and 'negative' were replaced by a $\log_{10}$ GE/mL value of 0.0 and 'positive' was replaced by 3.0. The quantitative PCR data (PRRS viral load [$\log_{10}$ GE/mL]) were used for comparisons between challenge control (group 1) and treatment groups 2 and 3 using the Wilcoxon Mann-Whitney test. Frequency tables of 'positive' qPCR results were generated. Differences between the challenge control group and vaccine groups were tested by Fisher's exact test.

[0291] Reproductive Performance

[0292] Absolute frequencies per gilt of total number, alive, healthy, weak, stillborn, dead and alive piglets at DOF+20 were determined and used as single values for the comparisons between groups. Relative frequencies per gilt of alive, healthy, weak, stillborn and dead piglets were calculated in relation to the total number of piglets at farrowing and used as single values for the comparisons between groups. The percentage of live piglets per litter at DOF+20 was

calculated in relation to the number of live piglets at farrowing minus number of mortalities and crushed piglets. Differences between the challenge control group and vaccine groups were tested by the Wilcoxon Mann-Whitney test.

[0293] Viremia of Piglets

[0294] Viremia data were evaluated for each day of investigation separately (DOF+0, DOF+7, DOF+13 and DOF+20). For the qualitative evaluation of the qPCR data the analytical results 'not detected' ('n.d.') and 'negative' were classified as 'negative' and the analytical results 'positive' and a measured value were classified as 'positive'. The percentages of 'positive' piglets per litter were calculated and used as single values for the comparisons between groups by the Wilcoxon Mann-Whitney test. For the quantitative evaluation 'not detected' ('n.d.') and 'negative' were replaced by a $\log_{10}$ GE/mL value of 0.0 and 'positive' was replaced by 3.0. The median qPCR values per litter were calculated and used as single values for the comparisons between groups by the Wilcoxon Mann-Whitney test. For the summary statistics the individual qPCR data were used. The viral loads in lung samples were evaluated descriptively only.

[0295] Body Weight and Average Daily Weight Gain of Piglets

[0296] Individual average daily weight gains (ADWG) were calculated for the time periods between DOF+0 and DOF+20. Differences between treatment groups were tested by analysis of variance (ANOVA) and subsequent t-tests. Least squares means of the groups and differences between least squares means with 95 % confidence intervals were derived from the ANOVA. The analysis for DOF+20 and ADWG was repeated with weight at DOF+0 as a covariate. The weight data of piglets per gilt were summarised descriptively.

[0297] Clinical Observations of Piglets

[0298] The percentage of piglets per litter with at least one positive finding between study days DOF+1 and DOF+20 were calculated and used as single values for the comparisons between groups by the Wilcoxon Mann-Whitney test.Data were analyzed assuming a completely random design structure.

[0299] RESULTS

[0300] GILT REPRODUCTIVE PERFORMANCE

[0301] Mean percentages of live piglets per litter at farrowing (healthy + weak + crushed/mortality) were 54.4%, 75.1%, 72.3%, and 93.0% for the challenge control, low titer, high titer, and negative control groups, respectively. The low titer and high titer groups had significantly higher percentage of live piglets per litter at farrowing compared to the challenge control group (**P≤0.0455**). Mean number of live piglets per litter at farrowing were 6.5, 8.3, 8.6 and 10.8 for the challenge control, low titer, high titer, and negative control groups, respectively. No significant differences were detected between groups for the number of live piglets per litter at farrowing (P≥0.1039).

[0302] Mean percentages of healthy live piglets per litter were 41.4%, 65.8%, 67.9%, and 93.0% for the challenge control, low titer, high titer, and negative control groups, respectively. The low titer and high titer groups had significantly higher percentages of healthy live piglets per litter at farrowing compared to the challenge control group (**P≤0.0138**). Mean number of healthy live piglets per litter at farrowing were 4.9, 7.2, 8.1 and 10.8 for the challenge control, low titer, high titer, and negative control groups, respectively. The high titer group had a significantly higher number of healthy live piglets per litter at farrowing (**P=0.0211**), while no difference was detected for the low titer group in comparison with the challenge control group (P=0.0640).

[0303] Mean percentages of weak live piglets per litter at farrowing were 7.4%, 7.1%, 0.4%, and 0.0% for the challenge control, low titer, high titer, and negative control groups, respectively. Mean number of weak live piglets per litter at farrowing were 0.9, 0.8, 0.1 and 0.0 for the challenge control, low titer, high titer, and negative control groups, respectively. The high titer group had significantly lower percentage and number of weak live piglets per litter at farrowing compared to the challenge control group (**P≤0.0090**). Conversely, no differences were detected between the low titer group and the challenge control group for percentage or number of weak live piglets at farrowing (P≥0.8569).

[0304] Mean percentages of mummies per litter at farrowing were 28.1%, 14.1%, 8.7%, and 0.0% for the challenge control, low titer, high titer, and negative control groups, respectively. Mean number of mummies per litter at farrowing were 3.1, 1.6, 0.9, and 0.0 for the challenge control, low titer, high titer, and negative control groups, respectively. Both the low titer and high titer groups had significantly lower percentages and numbers of mummies per litter at farrowing compared with the challenge control group (**P≤0.0190**).

[0305] No significant differences were detected between the two vaccine titer groups and the challenge control group for percentage or number of stillborn or mortalities/crushed piglets per litter at farrowing (P≥0.1681).

[0306] A summary of group reproductive performance results (% piglets per litter and number of piglets per litter) on the DOF is shown below in Tables 6.12 and 6.13.

Table 6.12 Summary of Group Reproductive Performance Results **(% piglets per litter)** on the DOF

Piglets	Group *	N	Min.	Max.	Median	Mean	95 % CI		SD	P
Alive	1	16	0	92	57.3	54.4	41.1	67.7	24.91	
	2	16	33	100	81.9	75.1	64.5	85.7	19.88	**0.0184**
	3	16	17	100	75.6	72.3	59.5	85.1	24.01	**0.0455**
	4	5	83	100	91.7	93.0	84.2	101.8	7.11	
Healthy	1	16	0	92	48.1	41.4	27.5	55.3	26.13	
	2	16	8	92	71.4	65.8	52.2	79.5	25.57	**0.0138**
	3	16	17	100	71.8	67.9	54.4	81.3	25.25	**0.0082**
	4	5	83	100	91.7	93.0	84.2	101.8	7.11	
Weak	1	16	0	25	3.6	7.4	2.6	12.2	9.04	
	2	16	0	25	0.0	7.1	2.1	12.2	9.43	0.9441
	3	16	0	7	0.0	0.4	-0.5	1.3	1.67	**0.0024**
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
Stillborn	1	16	0	50	9.5	17.5	8.5	26.4	16.83	
	2	16	0	42	3.8	10.7	3.3	18.2	13.94	0.1965
	3	16	0	83	10.6	19.0	7.0	31.0	22.54	0.9033
	4	5	0	17	8.3	7.0	-1.8	15.8	7.11	
Mummies	1	16	0	63	25.8	28.1	18.8	37.4	17.50	
	2	16	0	55	9.1	14.1	6.0	22.3	15.25	**0.0190**
	3	16	0	50	3.3	8.7	1.2	16.3	14.14	**0.0006**
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
Mortalities / Crushed	1	16	0	27	0.0	5.6	1.1	10.2	8.55	
	2	16	0	18	0.0	2.1	-0.6	4.8	5.07	0.2276
	3	16	0	25	0.0	4.0	0.1	7.8	7.25	0.6108
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
Alive on DOF+20	1	15	0	100	33.3	43.6	23.0	64.3	37.28	
	2	16	13	100	84.5	73.8	58.5	89.2	28.80	**0.0203**
	3	16	44	100	86.6	83.8	75.1	92.5	16.37	**0.0022**
	4	5	100	100	100.0	100.0	100.0	100.0	0.00	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

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Table 6.13: Summary of Group Reproductive Performance Results **(No. of piglets per litter)** on the DOF

Piglets	Group *	N	Min.	Max.	Median	Mean	95 % CI		SD	P
Total	1	16	6	15	12.0	11.6	10.4	12.9	2.31	
	2	16	9	13	11.0	11.1	10.4	11.7	1.24	0.1857
	3	16	7	15	12.0	11.6	10.3	12.9	2.42	0.9623
	4	5	10	14	12.0	11.6	9.5	13.7	1.67	
Alive	1	16	0	11	6.0	6.5	4.7	8.3	3.35	
	2	16	4	12	8.0	8.3	7.0	9.5	2.27	0.1543
	3	16	2	13	9.0	8.6	6.6	10.6	3.77	0.1039
	4	5	9	14	10.0	10.8	8.4	13.2	1.92	
Healthy	1	16	0	11	5.5	4.9	3.1	6.7	3.36	
	2	16	1	12	7.0	7.2	5.7	8.7	2.83	0.0640
	3	16	2	13	8.5	8.1	6.1	10.1	3.76	**0.0211**
	4	5	9	14	10.0	10.8	8.4	13.2	1.92	
Weak	1	16	0	3	0.5	0.9	0.3	1.5	1.09	
	2	16	0	3	0.0	0.8	0.2	1.4	1.11	0.8569
	3	16	0	1	0.0	0.1	-0.1	0.2	0.25	**0.0090**
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
Stillborn	1	16	0	6	1.0	2.0	0.9	3.1	2.03	
	2	16	0	5	0.5	1.3	0.4	2.1	1.65	0.1681
	3	16	0	10	1.0	2.1	0.8	3.5	2.58	0.9478
	4	5	0	2	1.0	0.8	-0.2	1.8	0.84	
Mummies	1	16	0	7	3.0	3.1	2.1	4.1	1.89	
	2	16	0	6	1.0	1.6	0.7	2.5	1.67	**0.0125**
	3	16	0	4	0.5	0.9	0.2	1.5	1.20	**0.0003**
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
Mortalities / Crushed	1	16	0	3	0.0	0.7	0.1	1.2	1.01	
	2	16	0	2	0.0	0.3	-0.1	0.6	0.58	0.2200
	3	16	0	2	0.0	0.4	0.0	0.8	0.73	0.6115
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
Alive on DOF+20	1	16	0	10	2.0	2.9	1.2	4.7	3.21	
	2	16	1	10	6.5	6.2	4.5	7.9	3.19	**0.0063**
	3	16	2	12	7.5	6.9	5.0	8.9	3.71	**0.0026**
	4	5	9	14	10.0	10.8	8.4	13.2	1.92	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0307] LIVE PIGLETS AT DOF+20

[0308] These scores highlight the number of live piglets at weaning (20 days of age). A summary of group percentage and number of live piglets per litter on DOF+20 is shown above in Tables 6.12 and 6.13.

[0309] Mean percentages of live piglets per litter at weaning (DOF+20) were 43.6%, 73.8%, 83.8%, and 100.0% for the challenge control, low titer, high titer, and negative control groups, respectively. Mean number of live piglets per litter at weaning were 2.9, 6.2, 6.9 and 10.8 for the challenge control, low titer, high titer, and negative control groups, respectively. Both the low titer and high titer groups had significantly higher percentages and numbers of alive piglets per litter at weaning (DOF+20) compared with the challenge control group (**P≤0.0203**).

[0310] GILT qPCR VIREMIA

[0311] All gilts were qPCR negative for PRRSv RNA on D0. All challenge control and negative control gilts remained qPCR negative for PRRSv RNA up to and including the day of challenge (D118). The negative control group remained qPCR negative for the remainder of the study, with exception of gilt No. 108, which was "positive" on DOF+7. Gilt No. 108 was negative at other time points for PRRSv RNA by qPCR testing.

[0312] Post-vaccination, 50% and 36% of low titer and high titer gilts, respectively, were qPCR positive for PRRSv RNA (**P≤0.0007**) on D7. From D14 to D56, only 4% of low titer gilts remained qPCR positive while up to 4% of high titer gilts were qPCR positive intermittently during this observation period. No differences were detected between vaccine groups and the challenge control group from D14 to D56 for the percentage of gilts qPCR positive for PRRSv RNA (P=1.0000 or no test conducted). All vaccinated gilts were qPCR negative for PRRSv RNA on D84 and D118 (day of challenge).

[0313] Post-challenge, the low titer and higher groups had statistically lower percentages of gilts qPCR positive for PRRSv RNA compared with the challenge control group on Days 125, DOF 0, and DOF+13 (**P≤0.0155**). On D132, the low titer group had a significantly lower percentage of gilts qPCR positive for PRRSv

RNA (**P=0.0290**); while no statistical difference was detected between the high titer group and the challenge control group (P=0.1556). No significant differences were detected between vaccine groups and the challenge control group on DOF+7 and DOF+20 for the percentage of gilts qPCR positive for PRRSv RNA (P≥0.1719).

[0314] A summary of group percentage of gilts qPCR positive for PRRSv RNA from D7 to DOF +20 is shown below in Tables 6.14 and 6.15.

Table 6.14 Summary of Group Percentage of Gilts qPCR Positive for PRRSv RNA from D7 to D132

Study Day	Group*	N	%	95 % CI		Total	P
7	1	0	0	0.0	12.3	28	
	2	14	50	30.6	69.4	28	**<0.0001**
	3	10	36	18.6	55.9	28	**0.0007**
	4	0	0	0.0	30.8	10	
14	1	0	0	0.0	12.3	28	
	2	1	4	0.1	18.3	28	1.0000
	3	0	0	0.0	12.3	28	n.a.
	4	0	0	0.0	30.8	10	
21	1	0	0	0.0	12.3	28	
	2	1	4	0.1	18.3	28	1.0000
	3	1	4	0.1	18.3	28	1.0000
	4	0	0	0.0	30.8	10	
56	1	0	0	0.0	14.8	23	
	2	1	4	0.1	19.6	26	1.0000
	3	1	4	0.1	20.4	25	1.0000
	4	0	0	0.0	33.6	9	
84	1	0	0	0.0	14.8	23	
	2	0	0	0.0	13.2	26	n.a.
	3	0	0	0.0	13.7	25	n.a.
	4	0	0	0.0	33.6	9	
118 (Day of challenge)	1	0	0	0.0	20.6	16	
	2	0	0	0.0	20.6	16	n.a.
	3	0	0	0.0	20.6	16	n.a.
	4	0	0	0.0	52.2	5	
125	1	16	100	79.4	100.0	16	
	2	5	31	11.0	58.7	16	**0.0001**
	3	4	25	7.3	52.4	16	**<0.0001**
	4	0	0	0.0	52.2	5	
132	1	10	63	35.4	84.8	16	
	2	3	19	4.0	45.6	16	**0.0290**
	3	5	31	11.0	58.7	16	0.1556
	4	0	0	0.0	52.2	5	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS94881 MLV group; Group 4 = Negative control group; n.a. = not appicable, no test conducted

[0099] Table 6.15: Summary of Group Percentage of Gilts qPCR Positive for PRRSv RNA from DOF 0 to DOF+20

Study Day	Group*	N	%	95 % CI		Total	P
DOF+0	1	15	94	69.8	99.8	16	
	2	4	25	7.3	52.4	16	**0.0002**
	3	1	6	0.2	30.2	16	**<0.0001**
	4	0	0	0.0	52.2	5	
DOF+7	1	5	31	11.0	58.7	16	
	2	2	13	1.6	38.3	16	0.3944
	3	1	6	0.2	30.2	16	0.1719
	4	1	20	0.5	71.6	5	
DOF+13	1	7	47	21.3	73.4	15	
	2	0	0	0.0	20.6	16	**0.0024**
	3	1	6	0.2	30.2	16	**0.0155**
	4	0	0	0.0	52.2	5	
DOF+20	1	3	19	4.0	45.6	16	
	2	3	19	4.0	45.6	16	1.0000
	3	0	0	0.0	20.6	16	0.2258
	4	0	0	0.0	52.2	5	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0315] Both vaccine groups had significantly higher median viral loads compared with the challenge control group on D7 (**P≤0.0007**). No differences were detected between vaccine groups and the challenge control group from D14 to D56 for viral load (P=1.0000). All vaccinated gilts had zero viral load on D84 and D118 (day of challenge).

[0316] Post-challenge, the low titer and higher groups had statistically lower median viral loads compared with the challenge control group on D125, DOF 0, and DOF+13 (**P≤0.0155**). On D132, the low titer group had a significantly lower median viral load **(P=0.0230)**; while no statistical difference was detected between

the high titer group and the challenge control group (0.94 and 1.97 log_{10} GE/mL respectively; P=0.1144). No significant differences for viral load were detected between vaccine groups and the challenge control group on DOF+7 and DOF+20 (P≥0.1719).

[0317] A summary of group mean gilt qPCR GE/mL results from D7 to DOF +20 is shown below in Tables 6.16 and 6.17.

Table 6.16: Summary of Group Gilt qPCR Results (log_{10} GE/mL) From D7 to D132

Study Day	Group *	N	Min.	Max.	Median	95 % CI		QRange	Mean	P
7	1	28	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
	2	28	0.00	3.00	1.500	0.000	3.000	3.000	1.500	**<0.0001**
	3	28	0.00	3.00	0.000	0.000	3.000	3.000	1.071	**0.0007**
	4	10	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
14	1	28	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
	2	28	0.00	3.00	0.000	0.000	0.000	0.000	0.107	1.0000
	3	28	0.00	0.00	0.000	0.000	0.000	0.000	0.000	1.0000
	4	10	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
21	1	28	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
	2	28	0.00	3.00	0.000	0.000	0.000	0.000	0.107	1.0000
	3	28	0.00	3.00	0.000	0.000	0.000	0.000	0.107	1.0000
	4	10	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
56	1	23	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
	2	26	0.00	3.00	0.000	0.000	0.000	0.000	0.115	1.0000
	3	25	0.00	3.00	0.000	0.000	0.000	0.000	0.120	1.0000
	4	9	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
84	1	23	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
	2	26	0.00	0.00	0.000	0.000	0.000	0.000	0.000	1.0000
	3	25	0.00	0.00	0.000	0.000	0.000	0.000	0.000	1.0000
	4	9	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
118 (Day of challenge)	1	16	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
	2	16	0.00	0.00	0.000	0.000	0.000	0.000	0.000	1.0000
	3	16	0.00	0.00	0.000	0.000	0.000	0.000	0.000	1.0000
	4	5	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
125	1	16	3.00	5.38	4.495	4.130	4.880	0.765	4.419	
	2	16	0.00	6.46	0.000	0.000	3.000	3.000	1.293	**0.0001**
	3	16	0.00	3.00	0.000	0.000	3.000	1.500	0.750	**<0.0001**
	4	5	0.00	0.00	0.000	0.000	0.000	0.000	0.000	

132	1	16	0.00	4.47	3.000	0.000	3.000	3.000	1.967	
	2	16	0.00	3.00	0.000	0.000	0.000	0.000	0.563	**0.0230**
	3	16	0.00	3.00	0.000	0.000	3.000	3.000	0.938	0.1144
	4	5	0.00	0.00	0.000	0.000	0.000	0.000	0.000	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

Table 6.17: Summary of Group Gilt qPCR Results (log_{10} GE/mL) From DOF 0 to DOF+20

Study Day	Group *	N	Min.	Max.	Median	95 % CI		QRange	Mean	P
DOF+0	1	16	0.00	3.00	3.000	3.000	3.000	0.000	2.813	
	2	16	0.00	3.00	0.000	0.000	3.000	1.500	0.750	**0.0002**
	3	16	0.00	3.00	0.000	0.000	0.000	0.000	0.188	**<0.0001**
	4	5	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
DOF+7	1	16	0.00	3.00	0.000	0.000	3.000	3.000	0.938	
	2	16	0.00	5.55	0.000	0.000	0.000	0.000	0.534	0.3944
	3	16	0.00	3.00	0.000	0.000	0.000	0.000	0.188	0.1719
	4	5	0.00	3.00	0.000	0.000	3.000	0.000	0.600	
DOF+13	1	15	0.00	3.00	0.000	0.000	3.000	3.000	1.400	
	2	16	0.00	0.00	0.000	0.000	0.000	0.000	0.000	**0.0024**
	3	16	0.00	3.00	0.000	0.000	0.000	0.000	0.188	**0.0155**
	4	5	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
DOF+20	1	16	0.00	3.00	0.000	0.000	0.000	0.000	0.563	
	2	16	0.00	6.45	0.000	0.000	0.000	0.000	0.903	0.7924
	3	16	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.2258
	4	5	0.00	0.00	0.000	0.000	0.000	0.000	0.000	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0318] GILT CLINICAL OBSERVATIONS SCORES POST-CHALLENGE

[0319] From D116 to DOF+20, 25%, 25%, 38% and 60% of challenge control, low titer, high titer and negative control gilts, respectively, exhibited clinical disease for at least one day from D116 to DOF+20. No significant differences were detected between vaccine groups and the challenge control group for the frequency of gilts positive for clinical disease from D116 to DOF+20 (P≥0.7043).

[0320] A summary of group percentage of gilts positive for clinical disease (a clinical observation score of > 0) for at least one day from D116 to DOF +20 is shown below in Table 6.18.

Table 6.18: Summary of group percentage of gilts positive for clinical disease (a clinical observation score of > 0) for at least one day from D116 to DOF +20

Study Days	Group*	N	%	95 % CI		Total	P
116 –	1	4	25	7.3	52.4	16	
DOF+20	2	4	25	7.3	52.4	16	1.0000
	3	6	38	15.2	64.6	16	0.7043
	4	3	60	14.7	94.7	5	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0321] GILT PRRS ELISA SEROLOGY

[0322] All gilts were PRRS seronegative on D0 and D7. All challenge control and negative control gilts remained PRRS seronegative up to and including the day of challenge (D118); while the negative control group remained PRRS seronegative for the remainder of the study (DOF+20).

[0323] On D14, 18% and 21% of low titer and high titer gilts, respectively, were PRRS seropositive. The high titer group had a significantly higher percentage of PRRS seropositive gilts on D14 (**P=0.0232**), while no difference was detected for the low titer group in comparison with the challenge control group (p=0.0515). These percentages reached group highs of 65% and 60% for the low titer and high titer groups, respectively on D56 (**P<0.0001**). On the day of the challenge (D118), 56% and 50% of low titer and high titer gilts were PRRS seropositive (**P≤0.0024**). On D125, 6%, 88%, and 100% of challenge control, low titer and high titer gilts, respectively, were PRRS seropositive; and the difference between the vaccine groups and the challenge control group were significant (**P<0.0001**). After D125, all remaining challenge control, low titer and high titer gilts were PRRS seropositive for the remainder of the study (no test conducted).

[0324] A summary of group PRRS ELISA serology results from D14 to DOF+20 is shown below in Tables 6.19 and 6.20.

Table 6.19: Summary of Group Gilt PRRS ELISA Serology Results from D14 to Day 132

Study Day	Group*	N	%	95 % CI		Total	P
7	1	0	0	0.0	12.3	28	
	2	0	0	0.0	12.3	28	n.a.
	3	0	0	0.0	12.3	28	n.a.
	4	0	0	0.0	30.8	10	
14	1	0	0	0.0	12.3	28	
	2	5	18	6.1	36.9	28	0.0515
	3	6	21	8.3	41.0	28	**0.0232**
	4	0	0	0.0	30.8	10	
21	1	0	0	0.0	12.3	28	
	2	13	46	27.5	66.1	28	**<0.0001**
	3	11	39	21.5	59.4	28	**0.0003**
	4	0	0	0.0	30.8	10	
56	1	0	0	0.0	14.8	23	
	2	17	65	44.3	82.8	26	**<0.0001**
	3	15	60	38.7	78.9	25	**<0.0001**
	4	0	0	0.0	33.6	9	
84	1	0	0	0.0	14.8	23	
	2	15	58	36.9	76.6	26	**<0.0001**
	3	14	56	34.9	75.6	25	**<0.0001**
	4	0	0	0.0	33.6	9	
118	1	0	0	0.0	20.6	16	
	2	9	56	29.9	80.2	16	**0.0008**
	3	8	50	24.7	75.3	16	**0.0024**
	4	0	0	0.0	52.2	5	
125	1	1	6	0.2	30.2	16	
	2	14	88	61.7	98.4	16	**<0.0001**
	3	16	100	79.4	100.0	16	**<0.0001**
	4	0	0	0.0	52.2	5	
132	1	16	100	79.4	100.0	16	
	2	16	100	79.4	100.0	16	n.a.
	3	16	100	79.4	100.0	16	n.a.
	4	0	0	0.0	52.2	5	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group.
n.a. = not appicable, no test conducted

Table 6.20 Summary of Group Gilt PRRS ELISA Serology Results from DOF 0 to DOF+20

Study Day	Group*	N	%	95 % CI		Total	P
DOF+0	1	16	100	79.4	100.0	16	
	2	16	100	79.4	100.0	16	n.a.
	3	16	100	79.4	100.0	16	n.a.
	4	0	0	0.0	52.2	5	
DOF+7	1	15	100	78.2	100.0	15	
	2	16	100	79.4	100.0	16	n.a.
	3	16	100	79.4	100.0	16	n.a.
	4	0	0	0.0	52.2	5	
DOF+13	1	16	100	79.4	100.0	16	
	2	16	100	79.4	100.0	16	n.a.
	3	16	100	79.4	100.0	16	n.a.
	4	0	0	0.0	52.2	5	
DOF+20	1	16	100	79.4	100.0	16	
	2	16	100	79.4	100.0	16	n.a.
	3	15	100	78.2	100.0	15	n.a.
	4	0	0	0.0	52.2	5	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group.

**No test conducted on sample from Gilt No. 106. n.a. = not appicable, no test conducted

[0325] GILT ASSESSMENTS POST-VACCINATION

[0326] No abnormal assessments from D1 to 21 were detected in any groups and no test was conducted. From D1 to D113, 4%, 4%, 0% and 10% of challenge control, low titer, high titer and negative control gilts, respectively, exhibited an abnormal assessment for at least one day from D1 to D113. No significant differences were detected between vaccine groups and the challenge control group for abnormal assessments from D1 to D113 (P=1.0000).

[0327] Individually, No. 109 (challenge control group) exhibited lameness of the right rear leg on D85, No. 12 (low titer group) exhibited a swelling in the left neck region from D78 to D89, and No. 21 (negative control group) exhibited lameness from D81 to D83.

[0328] A summary of group percentage of gilts that exhibited an abnormal assessment for at least one day from D1 to D21 and from D1 to D113 is shown below in Table 6.21.

Table 6.21 Summary of Group Abnormal Assessments for At Least One Day from D1 to D113

Study Days	Group*	N	%	95 % CI		Total	P
1 – 21	**1 – 4**	no 'positive' findings					
1 – 113	**1**	1	4	0.1	18.3	28	
	2	1	4	0.1	18.3	28	1.0000
	3	0	0	0.0	12.3	28	1.0000
	4	1	10	0.3	44.5	10	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0329] PIGLET CLINICAL OBSERVATIONS SCORES

[0330] Mean percentages of piglets per litter positive for clinical disease (a clinical observation score of > 0) for at least one day from DOF+1 to DOF+20 were 91.6%, 32.5%, 33.4% and 3.2% for the challenge control, low titer, high titer, and negative control groups, respectively. Low and high titer groups had significantly lower percentages of piglets per litter positive for clinical disease for at least one day from DOF+1 to DOF+20 compared with the challenge control group (**$p \leq 0.0001$**).

[0331] A summary of group percentage of piglets per litter that were positive for clinical disease (a clinical observation score of > 0) for at least one day from DOF+1 to DOF+20 is shown below in Table 6.22.

Table 6.22: Summary of group percentage of piglets per litter positive for clinical disease (a clinical observation score of > 0) for at least one day from DOF+1 to DOF+20

Study Days	Group *	N	Min.	Max.	Median	Mean	95 % CI		SD	P
DOF+1	1	15	56	100	100.0	91.6	82.9	100.4	15.78	
to	2	16	0	100	25.0	32.5	15.6	49.4	31.64	**<0.0001**
DOF+20	3	16	0	100	25.0	33.4	19.0	47.9	27.16	**<0.0001**
	4	5	0	9	0.0	3.2	-2.3	8.8	4.50	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0332] PIGLET SERUM/BODY FLUIDS qPCR RESULTS

[0333] A mean of 86.3%, 58.1%, 55.0% and 0% of piglets per litter for the challenge control, low titer, high titer and negative control groups, respectively, were qPCR positive for PRRSv RNA on DOF 0. The low titer and higher groups had statistically lower percentages of piglets per litter qPCR positive for PRRSv RNA compared with the challenge control group on DOF 0 (**P≤0.0381**). On DOF+7, again the low titer and high titer groups had significantly lower percentages of piglets per litter qPCR positive for PRRSv RNA compared with the challenge control group (**P≤0.0293**). On DOF+13, only the low titer group had a significantly lower percentage of piglets per litter qPCR positive (**P=0.0216**); while no significant differences were detected for the high titer group and the challenge control for the percentage of piglets per litter qPCR positive (P=0.0860). No significant differences were detected between groups on DOF+20 (P≥0.0614).

[0334] A summary of group percentage of serum/body fluid qPCR PRRSv positive piglets per gilt is shown below in Table 6.23.

Table 6.23: A Summary of Group Percentage of Serum/Body Fluid qPCR PRRSv Positive Piglets per Gilt

Study Day	Group*	N	Min.	Max.	Median	Mean	95 % CI		SD	P
DOF+0	1	16	50	100	96.4	86.3	76.8	95.8	17.87	
	2	16	0	100	68.3	58.1	37.3	78.9	39.07	**0.0381**
	3	16	0	100	60.0	55.0	37.0	73.0	33.77	**0.0018**
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
DOF+7	1	12	100	100	100.0	100.0	100.0	100.0	0.00	
	2	16	10	100	100.0	76.6	57.1	96.0	36.51	**0.0293**
	3	16	0	100	100.0	78.6	60.6	96.6	33.83	**0.0175**
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
DOF+13	1	11	100	100	100.0	100.0	100.0	100.0	0.00	
	2	16	0	100	100.0	75.4	55.0	95.8	38.31	**0.0216**
	3	16	0	100	100.0	84.0	68.2	99.9	29.75	0.0860
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	
DOF+20	1	11	0	100	100.0	90.9	70.7	111.2	30.15	
	2	16	0	100	93.8	75.3	55.6	95.0	36.97	0.0614
	3	16	0	100	100.0	81.6	65.0	98.1	31.06	0.1832
	4	5	0	0	0.0	0.0	0.0	0.0	0.00	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0335] The high titer group had a significantly lower median qPCR result compared with the challenge control group on DOF 0 (**P=0.0030**); while no difference was detected between the low titer group and the challenge control group (P=0.0620). On DOF+7, DOF+13 and DOF+20, both vaccine groups had significantly lower median qPCR values compared with the challenge control group (**p≤0.0122**).

[0336] A summary of group piglet serum/body fluid qPCR GE/mL results per gilt is shown below in Table 6.24.

Table 6.24: Summary of Group Piglet Serum/Body Fluid qPCR results (log_{10} GE/mL) per Gilt (P values for differences between groups based on median qPCR values)

Study Day	Group *	N	Min.	Max.	Median	95 % CI		QRange	Mean	P
DOF+0	**1**	180	0.00	8.69	6.400	6.080	6.790	3.195	5.556	
	2	176	0.00	8.47	3.000	3.000	4.420	6.945	3.560	0.0620
	3	183	0.00	8.76	3.000	0.000	3.000	6.580	3.049	**0.0030**
	4	58	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
DOF+7	**1**	58	4.47	8.76	6.950	6.610	7.370	1.300	6.914	
	2	103	0.00	8.12	3.000	3.000	4.930	5.640	3.337	**<0.0001**
	3	115	0.00	6.91	4.280	3.000	4.630	2.120	3.642	**<0.0001**
	4	54	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
DOF+13	**1**	52	4.19	8.62	6.835	6.430	6.970	0.995	6.549	
	2	100	0.00	8.22	3.000	3.000	3.000	4.530	2.678	**<0.0001**
	3	113	0.00	6.54	3.000	3.000	3.000	1.580	3.413	**<0.0001**
	4	54	0.00	0.00	0.000	0.000	0.000	0.000	0.000	
DOF+20	**1**	46	0.00	6.94	5.595	5.270	6.520	1.770	5.554	
	2	98	0.00	6.59	3.000	3.000	3.000	4.000	2.502	**0.0122**
	3	111	0.00	6.28	3.000	3.000	3.000	1.160	3.218	**0.0005**
	4	54	0.00	0.00	0.000	0.000	0.000	0.000	0.000	

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0337] PIGLET ADWG

[0338] No differences were detected between groups for LS Mean body weights on DOF 0 (P≥0.2972). Both vaccine groups had higher least square mean body weights compared with the challenge control group on DOF+20 (**P<0.0028**), with or without DOF 0 body weights factored as a covariate in the analyses.

[0339] Mean ADWG from DOF 0 to DOF+20 were 0.1 kg/day, 0.2 kg/day, 0.2 kg/day and 0.2 kg/day for the challenge control, low titer, high titer, and negative control groups, respectively. Both vaccine groups had significantly higher ADWG compared with the challenge control group (**P<0.0028**), with or without DOF 0 body weights factored as a covariate in the analyses.

[0340] A summary of group DOF 0 and DOF+20 piglet body weights and DOF 0 to DOF+20 ADWG (kg/day) is shown below in Tables 6.25 and 6.26.

Table 6.25: Summary of Group DOF 0 and DOF+20 Piglet Body Weights and DOF 0 to DOF+20 ADWG (kg/day)

Study Day(s)	Group*	N	Min.	Max.	Median	Mean	95 % CI		SD
DOF+0 Body Weights	1	47	0.9	2.0	1.40	1.34	1.274	1.411	0.234
	2	99	0.9	2.1	1.40	1.43	1.388	1.479	0.227
	3	111	0.9	2.0	1.40	1.40	1.360	1.448	0.234
	4	54	0.9	1.9	1.40	1.39	1.335	1.454	0.218
DOF+20 Body Weights	1	47	1.5	6.1	3.70	3.80	3.462	4.146	1.164
	2	99	2.4	8.3	5.50	5.42	5.168	5.673	1.266
	3	111	2.1	8.2	5.30	5.19	5.000	5.388	1.032
	4	54	2.4	6.9	5.20	5.26	5.008	5.511	0.922
ADWG (DOF+0 to DOF +20)	1	47	0.015	0.235	0.1150	0.1231	0.10649	0.13968	0.05653
	2	99	0.065	0.340	0.2000	0.1993	0.18770	0.21099	0.05837
	3	111	0.055	0.330	0.1950	0.1895	0.18078	0.19823	0.04638
	4	54	0.060	0.260	0.1925	0.1932	0.18305	0.20343	0.03733

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

Table 6.26: Summary of Group LS Mean Body Weights and DOF 0 to DOF+20 ADWG (kg/day) – Test Results (P values) on Differences between Groups

Study Day(s)	Group*	LS Mean	95 % confidence interval		P
DOF+0 Body Weights	1	1.32	1.169	1.477	
	2	1.42	1.318	1.522	
	3	1.41	1.317	1.497	
	Diff. 1-2	-0.10	-0.281	0.088	0.2972
	Diff. 1-3	-0.08	-0.262	0.094	0.3467
DOF+20 Body Weights	1	3.82	3.072	4.567	
	2	5.32	4.827	5.819	
	3	5.35	4.910	5.785	
	Diff. 1-2	-1.50	-2.401	-0.606	**0.0016**
	Diff. 1-3	-1.53	-2.394	-0.662	**0.0010**
DOF+20** Body Weights	1	4.01	3.341	4.685	
	2	5.28	4.843	5.727	
	3	5.34	4.950	5.728	
	Diff. 1-2	-1.27	-2.078	-0.466	**0.0028**
	Diff. 1-3	-1.33	-2.103	-0.550	**0.0013**
ADWG (DOF+0 to DOF+20)	1	0.125	0.0903	0.1594	
	2	0.195	0.1722	0.2181	
	3	0.197	0.1768	0.2172	
	Diff. 1-2	-0.070	-0.1118	-0.0289	**0.0014**
	Diff. 1-3	-0.072	-0.1122	-0.0322	**0.0008**
ADWG (DOF+0 to DOF+20**)	1	0.130	0.0969	0.1640	
	2	0.194	0.1720	0.2161	
	3	0.197	0.1773	0.2162	
	Diff. 1-2	-0.064	-0.1039	-0.0233	**0.0028**
	Diff. 1-3	-0.066	-0.1052	-0.0275	**0.0013**

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group.

** weight at DOF+0 was used as a covariate

[0341] PIGLET NECROPSY OBSERVATIONS and DIAGNOSES

[0342] Feti listed as stillborns, mummies or crushed at farrowing were confirmed at necropsy as correctly categorized with the exception of 8 feti. Two-challenge control feti were listed as stillborns (40-S1, 66-S1), but necropsy results

revealed inflated lungs indicating they were alive at the time of birth. Two-challenge control feti were listed as crushed (1-C1, 79-C2), but necropsy results revealed non-inflated lungs for both feti, indicating they did not breath. One-low titer fetus was listed as a stillborn (85-S2), but necropsy results revealed inflated lungs indicating the piglet was alive at the time of birth. Three-high titer piglets were listed as crushed (36-C1, 36-C2, 65-C1), but necropsy results revealed non-inflated lungs for both feti, indicating they did not breath. Due to the low number of feti incorrectly listed at time of farrowing, no changes were made to gilt performance analyses.

[0343] One-challenge control piglet 102-428 died subsequently to blood collection, which was confirmed by necropsy.

[0344] PIGLET LUNG qPCR RESULTS

[0345] Of the feti and dead piglets necropsied, the mean lung qPCR results were 4.68, 4.09, 3.55 and 0.0 $\log_{10}$ GE/mL for the challenge control, low titer, high titer, and negative control groups, respectively. No statistical analyses were conducted on these data.

[0346] A summary of group lung PRRSv qPCR results ($\log_{10}$ GE/mL) is shown below in Table 6.27.

Table 6.27: Summary of Group Piglet Lung PRRSv qPCR Results ($\log_{10}$ GE/mL)

Group	N	Min.	Max.	Median	95 % CI		QRange	Mean
1	141	0.00	7.95	5.140	4.810	5.390	2.990	4.676
2	79	0.00	7.45	4.780	3.000	5.260	2.620	4.092
3	75	0.00	6.84	4.220	3.000	5.100	5.620	3.547
4	4	0.00	0.00	0.000	0.000	0.000	0.000	0.000

*Group 1 = Challenge control group; Group 2 = Low titer PRRS 94881 MLV group; Group 3 = High titer PRRS 94881 MLV group; Group 4 = Negative control group

[0347] DISCUSSION/CONCLUSION

[0348] To achieve the study objective, four groups of PRRS susceptible gilts were included in the study design on D0: a challenge control group that received

control product (Group 1); a low titer vaccine group that received 1 x $10^{2.43}$ $TCID_{50}$ of PRRS 94881 MLV (IVP No. 1, Group 2); a high titer vaccine group that received 1 x $10^{3.90}$ $TCID_{50}$ of PRRS 94881 MLV (IVP No. 2, Group 3); and a negative control group (Group 4) that also received control product. Each treatment was administered as a 2.0 mL dose IM at approximately 28 days prior to breeding (D0).

[0349] To determine the minimum immunizing dose of PRRS 94881 MLV, the two vaccine titer groups and the challenge control group were challenged on D118 (approximately 90 days of gestation) with a heterologous European isolate of PRRSv (isolate 190136) and evaluated post-challenge for percentage and number of live piglets per litter at birth (day of farrowing, DOF) and percentage and number of live piglets per litter at 21 days of age (DOF +21).

[0350] Validation of the study (Negative Control Group 4)

[0351] To ensure that source gilts were free of PRRSv and that no extraneous PRRSv exposure or cross-contamination among treatment and control groups occurred during the study, a negative control group (Group 4) was included in the study design. Negative control gilts were negative for PRRS antibodies throughout the study. In addition, this group of gilts and their progeny were also negative for PRRSv viremia (qPCR) at all tested time points with exception of No. 108 on DOF+7. Gilt No. 108 was "positive" on DOF+7, while qPCR negative at all other time points and her piglets were negative for PRRSv RNA as well. This result was considered an error due to sample contamination and not due to PRRSv infection. These results support that the negative control group remained free of PRRS infection during the study and validate the results of this trial.

[0352] Validation of the PRRSv reproductive challenge model (Challenge Control Group 1)

[0353] A challenge model involving a virulent EU-derived strain of PRRSv that induces sufficient and reproducible PRRS clinical disease is necessary to adequately evaluate PRRS vaccine efficacy in a laboratory setting. Following inoculation with European PRRS isolate 190136 (1 x $10^{6.30}$ $TCID_{50}$/6mL), the

challenge control group exhibited only 54.4% live piglets per litter at birth (93.0% for the negative control group), 17.5% and 28.1% per litter of stillborns and mummies, respectively (7.0% and 0.0%, respectively, for the negative control group), 91.6% piglets per litter exhibited clinical disease for at least one day from DOF+1 to DOF+20 (3.2% piglets per litter for the negative control group), a mean of 2.9 live piglets per litter at 20 days of age (a mean of 10.8 for the negative control group), and 86.3% of piglets per litter viremic at birth (0% for the negative control group). These results highlight that severe PRRS-specific clinical disease was induced in the unvaccinated, challenge control group of gilts and their progeny, thus validating this challenge model as an adequate clinical laboratory tool to evaluate PRRS vaccine efficacy and more specifically, the MID of PRRS 94881 MLV in gilts.

[0354] Determination of the minimum immunizing dose of PRRS 94881 MLV in gilts (low and high titer vaccine doses; Groups 2-3)

[0355] Determination of the MID of PRRS 94881 MLV in gilts was based upon the vaccine group that received the lowest titer of vaccine that resulted in higher percentages or number of live piglets per litter at birth and higher percentages of number of live piglets per litter at 20 days of age post-challenge compared with the challenge control group.

[0356] Live piglets per litter (either percent or number) at farrowing was selected as one of two key criteria for determining the MID of PRRS 94881 MLV. The first key criterion was based upon the fact that PRRSv infection in pregnant gilts and sows typically results in stillborns and mummies, with low numbers of live piglets at farrowing. Live piglets per litter at birth were defined as the summation of healthy live, weak live and crushed-mortality piglets at farrowing. Piglets listed as crushed or mortality were included in the “live” category because necropsy findings confirmed these piglets were alive at birth and died shortly thereafter due to trauma. Both the low titer and high titer groups exhibited significantly higher percentages of live piglets per litter at farrowing compared with the challenge control (**P≤0.0455**), thus this criterion for vaccine efficacy was met. Although no

significant differences were detected between the low and high titer vaccine groups and the challenge control group with respect to the mean number of live piglets per litter at farrowing (P≥0.1857), the low titer and high titer groups did exhibit considerably higher mean number of live piglets per litter at farrowing (mean 8.3 and 8.6 piglets per litter, respectively) in relationship to the challenge control group (mean 6.5 piglets per litter) thus, providing further evidence and support that a beneficial vaccine treatment effect was observed in these animals post-challenge.

[0357] Live piglets per litter (either percent or number) at 20 days of age was the second criterion for determining the MID of PRRS 94881 MLV because gilt PRRS immunity will influence *in utero* infection of piglets and shedding of virus from gilts to live piglets. Piglets infected with PRRS *in utero* and born alive or infected with virulent PRRS post-farrowing via shedding from the gilt usually die before weaning secondary to PRRS. In this study, the challenge control, low titer, high titer and negative control group exhibited 43.6%, 73.8%, 83.8% and 100% live piglets per litter, respectively, at 20 days of age (**P≤0.0203**). Likewise, the challenge control, low titer, high titer and negative control groups had a mean number of 2.9, 6.2, 6.9 and 10.8 piglets per litter, respectively, at 20 days of age (**P≤0.0063**). Both vaccine groups had significantly higher percentage and number of live piglets at weaning (**P≤0.0203**), thus this criterion of the study objective was met.

[0358] Further analyses of farrowing data revealed more information that supports vaccine efficacy following PRRSv challenge, especially with respect to the high titer group. The high titer group exhibited statistically a higher percentage and a higher mean number of healthy piglets at birth (**P≤0.0211**); while exhibiting significantly lower percentages and mean numbers of weak and mummified feti (**P≤0.0090**), in comparison with the challenge control group. These data support that the high vaccine dose induced protective immunity against a virulent and heterologous PRRSv challenge strain. The low titer group also exhibited vaccine efficacy at farrowing, as evident by a higher percentage of

healthy live piglets per litter (**P=0.0138**) and significantly lower percentages and mean numbers of mummified feti (**P≤0.0190**). Conversely, no differences were detected between groups for the percentage or number of stillborn feti or crushed/mortalities at farrowing (P≥0.1681).

[0359] Seven days after challenge (D125), the low titer and high titer groups had significantly lower percentages of gilts positive for PRRSv RNA by qPCR testing, as well as significantly lower viral load for both groups, in comparison to the challenge control group (**P≤0.0001**). These data further support that both vaccine dose levels induced adequate immunity in gilts to significantly lower viral replication following challenge. Likewise, the low and high titer groups had significantly lower percentages of gilts qPCR positive on DOF 0 and DOF+13, as well as lower viral load for both groups on these study days (**P≤0.0155**). The low titer group had significantly lower percentage of gilts qPCR positive and lower viral load on D132 (**P≤0.0290**); while no statistical differences were detected between the high titer and the challenge control group for the same set of parameters (P≥0.1144). No statistical differences were detected between vaccine groups and challenge control group for percentage of gilts qPCR positive or viral load on DOF+7 and DOF+20 (P≥0.1719).

[0360] Typically PRRSv does not induce clinical disease in gilts and sows, other than abortion. In this study 25%, 25%, 38% and 60% of challenge control, low titer, high titer and negative control gilts, respectively, exhibited clinical disease (received a clinical observation score > 0) for at least one day post-challenge. No significant differences were detected between the vaccine groups and the challenge control group with respect to percentage of gilts with clinical disease for at least one day from D116 to DOF +20 (P≥0.7043). Gilts that exhibited some form of clinical disease did so at peri-parturition and not immediately after challenge. The high percentage of negative control gilts (60%) that exhibited clinical disease and the fact that clinical disease was noted primarily around the time of farrowing for all groups in this study supports that clinical disease was not

attributed to PRRS disease but rather to physiological changes associated with parturition.

[0361] All gilts in the study were PRRS ELISA seronegative on D0 thus providing confirmation of the inclusion criteria for the test animals entering the study. Likewise, all gilts were PRRS ELISA seronegative on D7. Vaccinated gilts began to exhibit PRRS ELISA seropositive results on D14 and the low and high dose groups exhibited their highest rate of seroconversion of 65% and 60%, respectively, on D56 (**P<0.0001**). Conversely, the challenge control group remained PRRS ELISA seronegative until 7 days post-challenge (D125). From D132 to study conclusion, all low titer, high titer and challenge control gilts were PRRS ELISA seropositive. The percentage of viremia positive gilts post-vaccination peaked on D7 for both vaccine groups as evidenced by 50% and 36% for the low and high titer groups, respectively (**P≤0.0007**). Viremia quickly dropped to 4% (1 of 28, No. 64) and 0% (0 of 28) for the low titer and high titer groups, respectively on D14 (P=1.0000 or no test conducted). Viremia remained at 4% for low titer (1 of 28, No. 56) and high titer (1 of 28, No. 91) groups on D21. On D56, one of 26 (4%, No. 89) low titer gilts and one of 25 (4%, No. 66) high titer gilts were positive for viremia. All gilts were negative for viremia on D84 and D118.

[0362] No significant differences were detected between both vaccine titer groups and the challenge control group with respect to percentage of gilts per group post-vaccination with an abnormal clinical assessment for at least one day from D1 to D113 (P=1.0000). Individually, only three gilts exhibited any abnormal assessments during this time frame. Two gilts exhibited lameness (one challenge control gilt and one negative control gilt) and one - low titer gilt exhibited swelling in the left neck region. Since vaccine was administered in the right neck region, no adverse events associated with this vaccine were noted.

[0363] Piglet PRRS viremia results on the DOF gave further insight to the level of protection in gilts in preventing cross-placental infection of piglets. On the DOF, a mean of 58.1 % and 55.0% piglets per gilt in the low titer and high titer groups, respectively, were qPCR positive. Conversely, a mean of 86.3% piglets

per gilt in the challenge control group were qPCR positive in serum/body fluids, which was significantly higher than both vaccine groups (**P≤0.0381**). When piglet viral load on DOF 0 was examined, high titer piglets had significantly lower viral load in comparison to challenge control piglets (**P=0.0030**); while no difference was detected for viral load between low titer and challenge control piglets (P=0.0620). Significant reductions (P≤0.05) in the percentage of piglets per gilt positive for viremia indicate reduced vertical transmission of virulent PRRSv from vaccinated gilt to off-spring when immunized with either dose of EU PRRS 94881 MLV. In addition, the high titer group had a median qPCR piglet value per gilt of 3.00 $\log_{10}$ GE/ml on the DOF; while the challenge control group had a median qPCR piglet value per gilt of 6.40 $\log_{10}$ GE/mL in serum/body fluids (**P=0.0030**). No significant difference was detected between the low dose group and the challenge control group for piglet viral load on DOF (P=0.0620). This data further supports the efficacy of the high dose of PRRS 94881 MLV when administered to gilts and sows.

[0364] The low titer and high titer groups exhibited means of 32.5% and 33.4%, respectively, for piglets per litter with clinical disease (a clinical observation score of > 0) for least one day from DOF+1 to DOF +20. These results were significantly lower than for the challenge control group, which exhibited a mean of 91.6% piglets per litter for the same parameter (**P≤0.0001**), further supporting vaccine efficacy for both dose levels.

[0365] No significant difference was detected between groups for piglet mean body weights on DOF 0 (P≥0.2972); while both vaccine groups had significantly higher body weights on DOF+20 and ADWG from DOF 0 to DOF+20 (**P≤0.0028**). Once again, these results support the efficacy of both doses of PRRS 94881 MLV.

[0366] Necropsy results confirmed the correct categorization of almost all feti at farrowing. Due to the very small number of feti that were listed as crushed that were actually stillborns and stillborns that were actually crushed at farrowing, in comparison to the overall number of feti correctly categorgized at farrowing, no

changes were made to the gilt performance data before it was analyzed. One-challenge control piglet died subsequently to blood collection. Since this situation only involved one piglet in comparison to the large overall number of piglets in the challenge control group, this piglet was not removed from analyses.

[0367] Lung samples were collected from 141, 79, 75 and 4 dead feti/piglets from the challenge control, low titer, high titer, and negative control groups, respectively. A mean qPCR lung value of 4.68, 4.10, 3.55 and 0.00 log_{10} GE/mL was determined for the challenge control, low titer, high titer and negative control groups, respectively. No analyses were conducted on these data since piglets alive at 20 days of age were not necropsied, but these results highlight that gilts vaccinated with PRRS 94881 MLV resulted in lower viral load in the lungs of piglets when gilts were challenged with a virulent PRRSv.

[0368] In conclusion, results from this study demonstrated significantly higher percentages of live piglets per litter at farrowing (**P≤0.0455**) and higher percentages and numbers of piglets per litter at weaning (**P≤0.0203**) for both vaccine groups in comparison to the challenge control group. Thus, the study objective was met and data from this study establishes the MID of PRRS 94881 MLV in gilts as 1 x $10^{2.43}$ $TCID_{50}$/2 mL. These results were achieved 118 days days after vaccination, which in addition establishes duration of immunity (DOI) in gilts of approximately 4 months.

[0369] When supportive data was examined, the high dose of PRRS 94881 MLV (1 x $10^{3.90}$ $TCID_{50}$/2 mL) was associated with a higher percentage and number of healthy piglets per gilt at farrowing (**P≤0.0211**), a lower percentage and number of weak and mummified feti (**P≤0.0090**), a lower percentage of qPCR positive gilts and lower viral load in gilts post-challenge on D125, DOF 0 and DOF+13 (**P≤0.0155**), a lower percentage of piglets per gilt qPCR positive and lower piglet viral load on DOF 0 (**P≤0.0030**), a lower percentage of piglets per gilt with clinical disease (**P<0.0001**), and higher piglet body weights on DOF+20 and ADWG (**P<0.0013**).

[0370] The low dose group was associated with a higher percentage of healthy piglets per gilt at farrowing (**P=0.0138**), a lower percentage and number of mummified feti (**P≤0.0190**), a lower percentage of qPCR positive gilts and lower viral load in gilts post-challenge on D125, D132, DOF 0 and DOF+13 (**P≤0.0290**), a lower percentage of piglets per gilt qPCR positive on DOF 0 (**P=0.0381**), a lower percentage of piglets per gilt with clinical disease (**P<0.0001**), and higher piglet body weight on DOF+20 and ADWG (**P<0.0028**).

[0371] **Example 7** Evaluation of the onset of immunity PRRS 94881 MLV in susceptible piglets following challenge with a heterologous European isolate of PRRS at two weeks post-vaccination

[0372] The objective of this vaccination-challenge study was to assess the onset of immunity (OOI) two weeks after the administration of the vaccine candidate Porcine Reproductive and Respiratory Syndrome, European-derived Isolate 94881, Modified Live Virus (PRRS 94881 MLV) to 14 ± 3 days of age susceptible piglets. The primary efficacy criterion to satisfy an OOI of 2 weeks post vaccination was if the vaccinate group (Group 1) demonstrated a significant difference ($p \leq 0.05$) for lung lesions post-challenge compared to the unvaccinated challenge control group (Group 2). Secondary parameters included clinical assessments after vaccination, clinical observations after challenge, rectal temperatures, average daily weight gain, assessment of PRRS antibodies and viremia in serum samples and quantitation of PRRS virus in lung samples collected at necropsy.

[0373] Piglets were randomly assigned to either Group 1 (PRRS 94881 MLV-vaccine containing $1 \times 10^{3.82}$ $TCID_{50}$/mL and challenged; n=20), Group 2 (placebo vaccine and challenged; n=20) or Group 3 (placebo vaccine and not challenged; n=10). Piglets were housed in plastic pens with raised floors (n=5/pen). Each treatment group was housed in a different room to avoid transmission of PRRSv through mechanical routes, including aerosolization.

[0374] All animals assigned to this study completed the study. No adverse events were reported during this study. The mean lung lesion scores on D24 were

27.4% and 54.8% for the PRRS 94881 MLV-vaccinated pigs and the challenge controls, respectively. The mean lung lesion score for the PRRS 94881 MLV-vaccinated pigs was significantly lower than the challenge controls (**p=0.0002**), and therefore the primary efficacy variable was met and the OOI was established at 2 weeks following a single vaccination. A significantly higher proportion of PRRS 94881 MLV-vaccinated pigs had positive PRRS-antibody titers on D14, D17 and D21 compared to challenge controls (**p≤0.0012**). The mean AUC for viremia was significantly lower for PRRS 94881 MLV-vaccinated pigs compared to challenge controls for D17-D24 (50.72 and 54.61 log_{10} GE/mL, respectively; **p=0.0039**) post challenge. PRRS 94881 MLV-vaccinated pigs exhibited no signs of lethargy (0%) after challenge compared with 45% of the challenge control pigs (**p=0.0012**). PRRS 94881 MLV-vaccinated pigs had higher weight gains during the post-challenge phase (SD14-SD24) of the study compared to challenge controls (0.3 and 0.1 kg, respectively; **p=0.0003**).

[0375] The significant (p≤0.05) reduction of the lung lesions, clinical signs, replication of the virus in the blood and lungs post-challenge as well as the improvement of the growth performances in vaccinated animals demonstrate vaccine efficacy against virulent PRRSv when the challenge is performed 2 weeks post vaccination. It therefore supports the demonstration of an onset of immunity of at least 2 weeks post-vaccination with PRRS 94881 MLV.

[0376] Objectives/Purpose of Study

[0377] The objective of this vaccination-challenge study was to assess the onset of immunity (OOI) two weeks after the administration of the vaccine candidate Porcine Reproductive and Respiratory Syndrome, European-derived Isolate 94881, Modified Live Virus (PRRS 94881 MLV) to 14 ± 3 days of age susceptible piglets. The primary efficacy criterion to satisfy an OOI of 2 weeks post vaccination was if the vaccinate group (Group 1) demonstrated a significant difference (p≤0.05) for decreased lung lesions post-challenge compared to the unvaccinated, challenge control group (Group 2).

[0378] The secondary efficacy parameters analyzed between the vaccine group and the challenge control group included clinical assessments post-vaccination, PRRS serology, PRRS viremia post-challenge, clinical observations post-challenge, average daily weight gain (ADWG), rectal temperatures and lung PRRSv quantitation.

[0379] A negative control group (Group 3), which was not vaccinated or challenged, was included in the study to demonstrate the source herd was free of PRRSv infection throughout the trial period and that biosecurity was not breached during this trial.

[0380] Schedule of Events

[0381] Table 7.1 Schedule of Events

Study Day	Dates	Key Study Event
-8	14Dec09	Screen for negative PRRS ELISA status
-1	21Dec09	Arrival at VRI; Health Exam
-1 to 12	21Dec09 to 03Jan10	Clinical Assessments
0	22Dec09	Collect body weights Vaccinate Group 1 with IVP, Vaccinate Groups 2 & 3 with CP
7	29Dec09	Blood sample
13 to 24	04Jan10 to 15Jan10	Clinical Observations and Rectal Temperatures
14	05Jan10	Collect body weights and blood sample; Challenge Groups 1 & 2 with heterologous European PRRS isolate
17 and 21	08Jan10 and 12Jan10	Blood sample
24	15Jan10	Euthanize and necropsy pigs after data and sample collection; Score lungs for pathology; collect lung tissues

[0382] Study Design

[0383] Table 7.2 Study Design

Group	Number of Piglets on D0	Treatment on D0 (14 ± 3 days of age)	Challenge on D14 with 1 mL/nostril and 1 mL IM of PRRSv 205817	Euthanize and Necropsy on D24

1	20	1.0 mL IM of IVP (1 x $10^{3.82}$ $TCID_{50}$/mL)	Yes	Yes
2	20	1.0 mL IM of Control Product (CP; Placebo matched product without PRRS 94881 MLV)	Yes	Yes
3	10	1.0 mL IM of CP	No	Yes

[0384] Blinding Criteria

[0385] The Study Investigator and designees were blinded to the assigned treatment groups throughout the in-life phase of the study. To maintain this blinding, an individual who did not participate in assessments of the pigs (i.e., clinical assessments, clinical observations or necropsies) performed the randomization and administered the assigned IVP and CP treatments on D0. BIVI laboratory personnel were blinded to the treatment each pig received while conducting their respective tasks.

[0386] Materials

[0387] Investigational Veterinary Product (IVP) and Control Product (CP)

[0388] Table 7.3 IVP

Generic Product Name:	Porcine Reproductive and Respiratory Syndrome, Modified Live Virus
Strain:	94881
Production and Formulation:	BIVI-Production produced PRRS 94881 MLV, Lot 390-005 (Appendix 4) in accordance with Outline of Production, Code 19S1.U_ and EU Dossier Part 2b. On D0, BIVI-Ames reconstituted/diluted PRRS 94881 MLV vaccine Lot 390-005 (Appendix 4) with Phosphate buffered saline (PBS; Lot 809-003, Appendix 5) to formulate the IVP, Lot No. 257-086. Transcribed formulation records for the IVP are presented in Appendix 7 (original records available upon request).
Manufacturer:	Boehringer Ingelheim Vetmedica, Inc. 2621 North Belt Highway St. Joseph, MO 64506, USA
Lot No.:	N257-086
Expiry Date:	An expiration date of 22 Dec 09 was assigned to the IVP for study purposes only.
Storage Conditions:	Lyophilized vaccine: 2-8 °C Rehydrated/diluted IVP: 2-8 °C or on ice
Testing:	Batch 390-005 was tested by BIVI-QC in accordance with draft Outline of Production and EU dossier Part 2F. At the start and end of the vaccination procedure, BIVI-Ames personnel were contacted. BIVI-Ames laboratory personnel tested pre- and post-vaccination aliquots for the IVP for virus titer in accordance with the PRRSv Titer Procedure (Appendix 1, Attachment 6).
Test Results:	Serial 390-005: Results were satisfactory (Appendix 4). IVP Lot N257-086: Mean titer of $1 \times 10^{3.82}$ $TCID_{50}$/mL (Appendix 7).
IVP Retention:	IVP was formulated for this study only and was not retained.

[0389] Table 7.4 CP

Generic Product Name:	Placebo
Formulation:	BIVI-Production produced lyophilized placebo product containing inert material comprised in the vaccine serial without PRRS 94881 MLV (Lot N240-191-062409, Appendix 6). On D0, BIVI-Ames reconstituted Lot N240-191-062409 with Phosphate buffered saline (PBS; Lot 809-003, Appendix 5) to formulate the CP, Lot No. 257-085. Transcribed formulation records for the CP are presented in Appendix 7 (original records available upon request).
Manufacturer:	Boehringer Ingelheim Vetmedica, Inc. 2621 North Belt Highway St. Joseph, MO 64506, USA
Lot Number:	N257-085
Expiry Date:	An expiration date of 22 Dec 09 was assigned to the CP for study purposes only.
Storage Conditions:	Lyophilized vaccine: 2-8 °C Rehydrated CP: 2-8 °C or on ice
Testing:	CP was tested by BIVI-QC for EP sterility in accordance with Special Outline No. 96 (Appendix 1, Attachment 5).
Test Results:	CP was determined to be sterile (Appendix 7).
CP Retention:	CP was formulated for this study only and was not retained.

[0390] Challenge Material

[0391] Table 7.5 Challenge Material

Name/number of isolate	PRRS isolate 205817
Location and date of isolation incl. clinical symptoms	The European PRRS virus isolate 205817 was derived from isolate 190136 originally obtained from lung tissue of a newborn piglet from a farm showing typical reproductive signs of PRRS (abortions in sows and weakness in newborn piglets) during an outbreak in Lower Saxony, Germany, in April 2004. The attending veterinarians submitted the lung samples to bioScreen (sample arrived on 21 April, 2004) for diagnostic testing. Isolate #190136 was directly propagated on MA 104 cells and a pure culture challenge stock was prepared for use in future BIVI clinical trials. A pure culture of isolate 190136 was used to inoculate pigs for evaluation of its ability to reproduce PRRS-specific respiratory disease in a controlled, laboratory trial. Challenged animals exhibited respiratory distress and revealed evidence of interstitial pneumonia upon histopathological examination. PRRS virus was successfully re-isolated from lung lesions was given the isolate designation 205817. Isolate 205817 was directly propagated on MA104 cells and a pure culture challenge stock was prepared for use in future BIVI clinical trials.
Formulation:	Challenge virus was thawed and diluted with MEM (Minimum Essential Medium) to a targeted titer of approximately 1 x 10^6 $TCID_{50}$/3 mL on D14. An adequate volume of challenge material was prepared. Two aliquots were removed from challenge material.
Lot Number:	N257-093
Manufacture:	Boehringer Ingelheim Vetmedica, Inc. - USA
Storage conditions	Bulk challenge material was stored at -70 ± 10°C. Once prepared, diluted challenge material was maintained on ice until it was administered.
Testing:	At the start and end of the challenge procedure, BIVI-Ames was contacted. BIVI-Ames laboratory personnel tested pre- and post-challenge aliquots for virus titer in accordance with the PRRSv Titer Procedure
Test Results:	The challenge material had a mean titer of 1 x $10^{4.71}$ $TCID_{50}$/3 mL dose
Administration route	1.0 mL/nostril and 1.0 mL IM in the left neck (administered to all pigs in Groups 1 and 2 on D14).
Challenge material retention:	Challenge material was formulated for this study only and was not retained.

[0392] Treatments

[0393] Dosing Justification

[0394] The IVP was administered as a 1.0 mL dose to assigned pigs to evaluate OOI of PRRS 94881 MLV at 2 weeks post-vaccination. The CP was administered as a 1.0 mL dose to Groups 2 and 3 as a placebo vaccine.

[0395] Dosing Regimen

[0396] IVP or CP was administered to an assigned pig in the right neck region IM on D0 using a sterile 3.0 mL Luer-lock syringe and a sterile 20g x 1 inch (2.54 cm) or 18g x ¾ inch (1.91 cm) needle by a person not collecting study data. The dosing regimen is shown below in Table 7.6.

[0397] Table 7.6 Dosing Regimen

Group	Number	Treatment	Dose/Route	Study Day
1	20	IVP	1.0 mL IM	D0
2	20	CP	1.0 mL IM	D0
3	10	CP	1.0 mL IM	D0

[0398] Animal Information

[0399] Details of Study Animals

[0400] Table 7.7 Animal Information

Source:	Wilson Prairie View Farm N5627 Highway DD Burlington, WI 53105 USA		
Number of piglets:	50		
Arrival date:	Pigs arrived at the Veterinary Resources, Inc. (VRI) Cambridge facility on 21 December 2009 (D-1).		
Arrival treatment:	The 50 pigs assigned to the study were administered EXCEDE® at label dose IM in the right ham after arrival.		
Identification:	Individually ear tagged with unique number		
Species:	Porcine		
Breed:	Commercial crossbred		
Gender:	Mixed (females and castrated males)		
Age range:	11 to 17 days of age on D0		
Weight range:	3.2 to 5.5 to kg on D0		
Ownership of test animals:	Boehringer Ingelheim Vetmedica, Inc.		
Physiological status:	On D-1, pigs selected for assignment to the study were observed by the Study Investigator and determined to be in good health and nutritional status. Observations were recorded on the Animal Health Examination Record form.		
Group – Pig Assignments	Group 1 (n=20): 55, 56, 60, 72, 75,	Group 2 (n=20): 57, 61, 62, 68, 78,	Group 3 (n=10): 51, 69, 80, 85, 104,

	76, 77, 83, 87, 91, 99, 102, 116, 117, 124, 141, 142, 144, 156 and 162	81, 86, 89, 97, 110, 129, 132, 135, 150, 152, 154, 160, 165, 167 and 168	105, 128, 131, 133 and 155

[0401] INCLUSION/EXCLUSION CRITERIA

[0402] All piglets enrolled in this study were PRRS ELISA negative and were healthy at the time of vaccination as determined by observation.

[0403] POST-INCLUSION REMOVAL CRITERIA

[0404] No pigs were removed from the study.

[0405] ANIMAL MANAGEMENT AND HOUSING

[0406] Animal Housing

[0407] Piglets were housed at Veterinary Resources, Inc. (VRI) in Cambridge, IA for the duration of the study. Groups 1, 2 and 3 were housed in uniform but separate rooms to ensure biosecurity. Piglets were housed in multiple pens (5 piglets/pen) within each room. Group 1 was housed in 4 pens in Room 5, Group 2 was housed in 4 pens in Room 6 and Group 3 was housed in 2 pens in Room 4. Pens consisted of plastic tubs on raised stands with plastic slatted flooring. Each pen contained a plastic 6-hole feeder and a nipple waterer. Each isolation room was constructed identical to the others and all are biohazard level 2 (BL2) compliant, hepafiltered, mechanically ventilated with thermostat regulated temperature control.

[0408] Treatment group isolation was necessary in this study as it is well known within the scientific community that PRRSv readily spreads from pig to pig via various mechanisms including aerosolization. This includes avirulent live PRRS vaccines as these biological products include attenuated virus particles that mimic the characteristics of virulent wild-type PRRS without the capability to cause disease. Proper methods were in place to ensure that biosecurity was maintained and that vaccinated animals did not accidentally cross-contaminate non-vaccinated, PRRSv naïve negative control animals. Appropriate measures were

taken by test facility staff to adequately clean and disinfect each room prior to its usage for this study.

[0409] Each room in the facility has fans and heaters to aid in sufficient air circulation and heating. The ventilation system is separate yet identical for each room, so air is not shared between rooms.

[0410] Solid feed was stored in bags, free from vermin. Water was *ad libitum*. Piglets were fed a commercial ration (Lean Metrics Infant, Purina Mills, St. Louis, MO) medicated with tiamulin (35 gm/ton) and chlortetracycline (400 gm/ton) *ad libitum* appropriate for their size, age, and condition; according to acceptable animal husbandry practices for the region.

[0411] The pigs were in good health and nutritional status before initiation of the study as determined by the Study Investigator.

[0412] During the study, select animals were observed with mild loss of body condition, rough haired appearance, swollen joints and varying degrees of lameness. The Study Investigator considered all of these to be non-specific conditions that commonly occur in groups of pigs housed in confinement. Coughing, sneezing, rapid respiration, dyspnea and mild to moderate lethargy were also noted in select pigs after challenge and were considered typical clinical signs associated with pneumonia, although non-specific for etiology. The Study Investigator determined that concomitant treatments were not required for any animals during this study.

[0413] All pigs assigned to this study were disposed of by commercial incineration after euthanasia and necropsy on D24. No food products from animals enrolled in this study entered the human food chain.

[0414] ASSESSMENT OF EFFICACY

[0415] To assess the OOI of PRRS 94881 MLV at 2 weeks post-vaccination, Groups 1 & 2 were challenged on D14 and lung lesions post-challenge were evaluated. An OOI of 2 weeks post-vaccination was achieved if Group 1 (minimum immunizing dose of PRRS 94881 MLV) demonstrated

significantly decreased ($p \leq 0.05$) lung pathology post-challenge compared with the challenge control group (Group 2).

[0416]

[0417] The secondary efficacy parameters analyzed between the vaccine group and the challenge control group included clinical assessments after vaccination, clinical observations after challenge, rectal temperatures, body weight and average daily weight gain (ADWG), assessment of PRRS antibodies and viremia in serum samples and quantitation of PRRS virus in lung samples collected at necropsy.

[0418] A negative control group (Group 3), which was not challenged, was included in the study to demonstrate the source herd was free of PRRS infection and that biosecurity was maintained throughout the study.

[0419] CRITERIA FOR A VALID TEST

[0420] Pre-purchase and D0 serum samples were all required to be negative for PRRS antibodies.

[0421] Serum samples collected from Groups 2 and 3 up to the day of challenge and from Group 3 until study completion had to be free of PRRS antibodies for the study to be valid.

[0422] PRIMARY OUTCOME PARAMETER

[0423] The primary efficacy variable for statistical evaluation was total lung lesion scores at D24 of the study.

[0424] Total Lung Lesion Scores

[0425] On Day 24 after data and samples were collected and recorded, all study pigs were euthanized following VRI SOP PRC1027 (Appendix 1, Attachment 8). Each pig was necropsied in accordance with VRI SOP PRC 1028 The thoracic cavity was exposed by a designee and the heart and lungs were removed. The Study Investigator examined each set of lungs, described any gross pathology noted and determined the % pathology for each lung lobe.

Observations and data were recorded on the Necropsy Report Record form. A total lung lesion score was determined for each pig by using the EP formula.

[0426] SUPPORTIVE PARAMETERs

[0427] Other parameters to be analyzed between Group 1 and Group 2 included clinical assessments post-vaccination, PRRS serology, viremia post-vaccination, clinical observations post-challenge, ADWG, rectal temperatures and lung virus quantitation post challenge. These parameters were analyzed as supportive parameters and did not serve as primary parameters to satisfy the study objective.

[0428] Clinical Assessment

[0429] All pigs were observed on the days outlined in Table 7,1 for clinical assessments post-vaccination by the Study Investigator or designees. Observations were recorded on the Clinical Assessment Record form.

[0430] PRRS Serology

[0431] Venous whole blood was collected on the days outlined in Table 3. Briefly, approximately 2-5 mL of blood was collected from each piglet into an appropriate sized serum separator tube (SST). Sample collections were recorded on the Sample Collection Record form. Blood in SSTs was allowed to clot at room temperature. Blood samples were delivered to BIVI-Ames on the day of collection and Specimen Delivery Record form was completed. BloodBlood samples were spun down by BIVI-Ames and serum was harvested, split and transferred to appropriate tubes. Each tube was labeled with the piglet's ID number, the study number, the date of collection, the study day and the sample type. At BIVI-Ames, one set of serum samples was held at 2-8 ºC and the other set of serum samples was held at -70 ± 10 °C.

[0432]

[0433] The serum samples collected days 0, 7, 14, 17, 21 and 24 and held at 2-8 ºC were tested by BIVI-Ames for PRRS antibodies. Results were reported as negative (ELISA S/P ratio of < 0.4) or positive (ELISA S/P ratio of ≥ 0.4).

[0434] PRRS Viremia

[0435] The other set of serum samples collected on days 0, 7, 14, 17, 21 and 24 and held at -70 ± 10 °C at BIVI-Ames until the in-life phase of the study was completed.

[0436] A completed Specimen Delivery Record form was included with the shipment. bioScreen tested serum samples for PRRSv RNA by qPCR. Results were reported as genome equivalent/mL (log GE/mL).

[0437] Clinical Observations Post-challenge

[0438] Piglets were observed for clinical signs of disease on the days outlined in Table 7.1. Observations were conducted by the Study Investigator or designees and were recorded on the Clinical Observation Record form. Piglets were observed each day for respiration, behavior and cough based on the clinical observation scoring system outlined below in Table 7.8.

[0439] Table 7.8 Clinical Observation Scoring System

Respiration	**Behavior**	**Cough**
0 = normal respiration 1 = panting/rapid respiration 2 = dyspnea 3 = dead	0 = normal 1 = mild to moderate lethargy 2 = severely lethargic or recumbent 3 = dead	0 = none 1 = soft or intermittent cough 2 = harsh or severe, repetitive cough 3 = dead

[0440] Average Daily Weight Gain (ADWG)

[0441] Individual body weights were collected on the days outlined in Table 3. Each pig was weighed on a calibrated scale by the Study Investigator or designees. Results were reported in kg on the Body Weight Record form. Average daily weight gain was determined from the D0 to D14 and from D14 to D24.

[0442] Rectal Temperatures

[0443] Rectal temperatures were collected by the Study Investigator or designees on the days outlined in Table 6.1. Rectal temperatures were recorded in ºC on the Clinical Observation Record form.

[0444] PRRS Virus Quantitation in Lung Tissue

[0445] For each set of lungs, two samples from the Left and Right Apical lobes, the Left and Right Cardiac lobes, the Left and Right Diaphragmatic lobes and the Intermediate lobe, were retained. Each lung sample was approximately 1 inch (2.54 cm) x 1 inch (2.54 cm). For one set of lung samples, all three samples from the left side were combined into one container; while all three samples from the right side and the Intermediate lung lobe sample were combined into another container. Each container was filled with a sufficient amount of 10% formalin solution. For the other set of lung samples, all three lung samples from the left side were combined into one Whirlpak®; while all three samples from the right side and the Intermediate lung lobe sample were combined into another Whirlpak®. All containers and Whirlpaks® were appropriately labeled with animal number, study number, date of collection, study day, sample type and whether the samples are from the left or right side. Lung samples in Whirlpaks® were stored on dry ice until transported to BIVI-Ames while samples in formalin were stored at room temperature. Sample collections were recorded on the Necropsy Report Record form. Formalin fixed lung tissue samples and Whirlpak® lung samples were transferred to BIVI-Ames. A completed Specimen Delivery Record form was included with each shipment.

[0446] A completed Specimen Delivery Record form was included with the shipment. bioScreen tested lung samples for PRRSv RNA by qPCR (Appendix 1, Attachment 7). Left lung tissues were homogenized and tested. Right lung tissues and intermediate lung lobe samples were homogenized and tested. Results were reported as genome equivalent (log GE/mL) for left and right lung samples.

[0447] ADVERSE EVENTS

[0448] No adverse events were reported during this study.

[0449] STATISTICAL METHODS

[0450] EXPERIMENTAL UNIT

[0451] Treatment groups had to be housed in separate rooms in this study to avoid transmission of PRRSv to non-vaccinated groups. Therefore, room was the experimental unit. However, for the purposes of this analysis, possible bias due to confounding "room" and "treatment" effects were ignored, and piglet was used as the experimental unit.

[0452] RANDOMIZATION

[0453] Fifty (50) piglets were blocked by weight (n=5 piglets/block). Each pig was assigned a random number using the random number function in Excel. Within each weight block, pigs were ranked in ascending numerical order of the assigned random number. The treatment groups were then assigned to pigs in this numerical order: the 2 lowest random numbers were assigned to Group 1, the next 2 numbers were assigned to Group 2 and the highest number was assigned to Group 3. Groups 1 & 2 each contained 20 pigs and Group 3 contained 10 pigs.

[0454] ANALYSIS

[0455] The statistical analyses and data summaries were conducted by Dr. rer. hort. Martin Vanselow, Biometrie & Statistik, Zum Siemenshop 21, 30539 Hannover, Germany, +49(0) 511 606 777 650, m.vanselow@t-online.de.

[0456] Data were analyzed assuming a completely random design structure. The statistical analyses were performed using SAS software release 8.2 (SAS, Cary, USA/North Carolina, SAS Institute Inc. All tests on differences were designed as two-sided tests at $\alpha = 5\%$.

[0457] Total Lung Lesion Scores

[0458] The total lung lesion score on the day of necropsy (D24) was measured as the percentage of lung involvement calculated according to the weighting formula recommended in the draft monograph Porcine Enzootic Pneumonia Vaccine (inactivated). This formula takes into account the relative weight of each of the seven lung lobes. The assessed percentage of lung lobe area with typical lesions was multiplied by the respective factor per lung lobe

giving the total weighted lung lesions score. The factors for the respective lung lobes are presented in Table 7.9.

[0459] Table 7.9 Factors for Calculating Lung Lesion Scores

Lung lobe	Factor
Left apical	0.05
Left cardiac	0.06
Left diaphragmatic	0.29
Right apical	0.11
Cardiac	0.10
Right diaphragmatic	0.34
Right accessory/intermediate	0.05

[0460] The treatment groups were compared on differences using the Wilcoxon Mann-Whitney test.

[0461] Clinical Assessment Post-vaccination

[0462] Frequency tables of animals with at least one positive finding between D1 and D12 were generated. Differences between treatment groups were tested by Fisher's exact test.

[0463] PRRS Serology

[0464] Frequency tables of positive ELISA results were generated. Differences between treatment groups were tested by Fisher's exact test.

[0465] PRRS Viremia

[0466] The viremia data were evaluated separately for each day of investigation. Additionally, for viral load the areas under the individual response curves between D14 and D24 (AUC D14-D24) and between D17 and D24 (AUC D17-D24) were analyzed.

[0467] The quantitative PCR data (PRRS viral load [$\log_{10}$ GE/mL]) were used for comparisons between the treatment groups by the Wilcoxon Mann-Whitney test. Prior to the calculations the analytical result 'not detected' was replaced by a $\log_{10}$ GE/mL value of 0.0 and 'positive' was replaced by 3.0. The

treatment groups were tested on differences using the Wilcoxon Mann-Whitney test.

[0468] Clinical Observations Post-challenge

[0469] Frequency tables of animals with at least one positive finding between D15 and D24 were generated. Differences between treatment groups were tested by Fisher's exact test.

[0470] The maximum scores and the mean scores per animal from D15 to D24 for respiration, behavior, coughing and for all three added together (total) were used for the statistical evaluation. Differences between treatment groups were tested by the Wilcoxon Mann-Whitney test.

[0471] Body Weight and Average Daily Weight Gain

[0472] Individual daily weight gains were calculated for the time periods between D0 and D14 and between D14 and D24. For each day of investigation and for each time period descriptive statistics were calculated. Differences between treatment groups were tested using analysis of variance and subsequent t-tests. Least squares means of the groups and differences between least squares means with 95% confidence intervals were calculated from the analysis of variance.

[0473] Rectal Temperatures

[0474] Differences between treatment groups with respect to the original temperature data were tested using analysis of variance and subsequent t-tests. Least squares means of the groups and differences between least squares means with 95% confidence intervals were calculated from the analysis of variance.

[0475] PRRS Virus Quantitation In Lung Tissues

[0476] The quantitative PCR data (PRRS viral load [$\log_{10}$ GE/mL]) from lungs collected on D24 were used for comparisons between the treatment groups by the Wilcoxon Mann-Whitney test. The average ($\log_{10}$ GE/mL) of the left and right lung qPCR results were used for the evaluation. Prior to the calculations the

analytical result 'not detected' was replaced by log_{10} GE/mL of 0.0 and 'positive' was replaced by 3.0.

[0477] Frequency tables of positive qPCR results were generated. Differences between treatment groups were tested by Fisher's exact test.

[0478] RESULTS

[0479] Total Lung lesion Scores

[0480] A summary of the group total lung lesion scores and the associated p-value is shown below in Table 7.10.

[0481] Table 7.10 Total Lung Lesion Scores (%)

Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
1	20	0.06	59.30	27.550	12.270	40.600	29.515	27.368	**0.0002**
2	20	13.86	91.60	55.200	47.300	66.500	21.850	54.841	
3	10	0.00	0.06	0.000	0.000	0.000	0.000	0.006	NI

[0482] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NI = Not included in statistical analysis.

[0483] Mean piglet D24 total lung lesion scores were 27.368% and 54.841% for the PRRS 94881 MLV-vaccinated group and challenge controls, respectively. The lesion score for the PRRS-vaccinated pigs was significantly lower than the mean lesion score for the challenge controls (**p=0.0002**).

[0484] PRRS Viremia

[0485] A summary of the PRRSv RNA detected in serum by qPCR data is shown below in Table 7.11.

[0486] Table 7.11 PRRSv RNA Detected by qPCR in Serum (log_{10} GE/mL) by Day

Day	Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
7	1	20	0.00	5.34	3.00	3.00	3.79	0.82	3.17	**<0.0001**
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
14	1	20	0.00	4.29	3.32	3.00	3.77	0.84	3.30	**<0.0001**
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
17	1	20	5.54	8.07	6.72	6.47	7.08	0.80	6.78	**<0.0001**
	2	20	6.44	9.02	8.18	7.47	8.47	1.09	8.00	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
21	1	20	6.18	8.73	7.38	7.13	8.08	0.98	7.51	0.0565
	2	20	7.22	8.86	7.87	7.62	8.11	0.57	7.88	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
24	1	20	5.82	8.54	7.15	6.73	7.84	1.16	7.26	0.6251
	2	20	6.53	8.29	7.27	6.97	7.60	0.67	7.34	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
AUC 14-24	1	20	56.95	78.02	65.10	60.39	70.05	9.76	65.84	0.4945
	2	20	58.74	74.30	67.02	64.38	68.24	4.83	66.61	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
AUC 17-24	1	20	42.98	59.51	49.52	47.46	54.30	7.14	50.72	**0.0039**
	2	20	49.08	60.99	54.35	52.93	55.38	3.63	54.61	
	3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI

[0487] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NI = Not included in statistical analysis. AUC = Area under the curve; GE/ml per day

[0488] PRRSv RNA was not detected in the serum of any piglets on D0. PRRS 94881 MLV-vaccinated pigs had mean values of 3.17 and 3.30 $\log_{10}$ GE/mL on D7 and D14, respectively. The values were significantly higher than challenge controls on both of these days (**p<0.0001**), as challenge controls did not have any PRRSv RNA detected until D17. On that day, mean values were 6.78 and 8.00 $\log_{10}$ GE/mL for PRRS 94881 MLV-vaccinated piglets and challenge controls, respectively. The D17 value for challenge controls was significantly higher than the PRRS 94881 MLV-vaccinated piglets (**p<0.0001**). Mean values for PRRS 94881 MLV-vaccinated pigs on D21 and D24 were 7.51 and 7.26 $\log_{10}$ GE/mL on

D21 and D24 respectively, compared to 7.88 and 7.34 log_{10} GE/mL for challenge controls on the same days. There were no significant differences between PRRS 94881 MLV-vaccinated pigs on D21 or 24 ($p \geq 0.0565$). No PRRSv RNA was detected in serum from any negative control pig during this study.

[0489] There were no differences between the AUC 14-24 for PRRS 94881 MLV-vaccinated pigs and challenge controls pigs (65.84 and 66.61, respectively; p=0.4945). PRRS 94881 MLV-vaccinated pigs had a significantly lower AUC for D17-D24 compared to challenge controls (50.72 and 54.61, respectively; **p=0.0039**).

[0490] PRRS Virus Quantitation In Lung Tissues

[0491] Individual PRRSv qPCR results from lung tissues collected at necropsy on D24 are presented in Addendum 1, Table 30. A summary of the PRRSv RNA detected in lung tissues by qPCR data is shown below presented in Table 7.12 and a summary of the frequency of animals with positive qPCR at necropsy is shown below in Table 7.13.

[0492] Table 7.12 Lung Viruse Isolation, qPCR (mean log10 GE/mL) at Necropsy (D24)

Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
1	20	6.63	8.26	7.46	7.07	7.86	0.84	7.47	**0.0101**
2	20	6.55	8.67	7.99	7.69	8.14	0.54	7.88	
3	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI

[0493] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NA = Not applicable because of lack of variability. NI = Not included in statistical analysis.

[0494] Table 7.13 Frequency of Animals with Posible PRRSv RNA aPCR from Lung Tissues Collected at Necropsy (D24)

Day	Group	N	%	95 % CI		Total	P
24	1	20	100	83.2	100.0	20	NA
	2	20	100	83.2	100.0	20	
	3	0	0	0.0	30.8	10	NI

[0495] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NA = Not applicable because of lack of variability. NI = Not included in statistical analysis.

[0496] PRRSv RNA was detected in the lung tissues of all piglets in both the PRRS 94881 MLV-vaccinated group and all piglets in the challenge control group. There was no difference between these groups. PRRSv RNA was not detected in the lung samples of any negative control piglets.

[0497] Clinical Observations Post-challenge

[0498] The frequency of piglets with at least one positive clinical assessment score in the post-challenge period (D15-D24) is shown below in Table 7.14.

[0499] Table 7.14 Frequency of Piglets with a Positive Clinical Observation Post Challenge (D15-D24)

Parameter	Group[1]	N positive	% positive	95 % CI		Total	p value
Respiration	1	2	10	1.2	31.7	20	0.2351
	2	6	30	11.9	54.3	20	
	3	0	0	0.0	30.8	10	NI
Behaviour	1	0	0	0.0	16.8	20	**0.0012**
	2	9	45	23.1	68.5	20	
	3	0	0	0.0	30.8	10	NI
Coughing	1	6	30	11.9	54.3	20	0.2003
	2	11	55	31.5	76.9	20	
	3	0	0	0.0	30.8	10	NI
Total	1	6	30	11.9	54.3	20	0.0562
	2	13	65	40.8	84.6	20	
	3	0	0	0.0	30.8	10	NI

[0500] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NI = Not included in statistical analysis.

[0501] Abnormal respiration was observed in both the PRRS 94881 MLV-vaccinated group (10%) and in the challenge control group (30%), however, these values were not significantly different (p=0.2351).

[0502] Abnormal behavior was only observed in the challenge control group (45%), and not in the PRRS 94881 MLV-vaccinated group (0%). The PRRS 94881 MLV-vaccinated group had a significantly lower incidence of abnormal behavior than the challenge controls (**p=0.0012**).

[0503] Coughing was observed in both the PRRS 94881 MLV-vaccinated group (30%) and in the challenge control group (55%). These values were not significantly different (p=0.2003).

[0504] The percentages of piglets with total clinical scores > 0 were 30% and 65% for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. These values were not significantly different (p=0.0562).

[0505] No clinical signs were observed in the negative control group at any time after challenge.

[0506] A summary of the group maximum clinical observation scores for the post-challenge period (D15 through D24) is shown below in Table 7.15.

[0507] Table 7.15 Post-Challenge Maximum Clinical Scores, D15 through D24

Parameter	Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
Respiration	1	20	0	1	0	0	0	0	0.1	0.1872
	2	20	0	2	0	0	1	1	0.4	
	3	10	0	0	0	0	0	0	0.0	NI
Behaviour	1	20	0	0	0	0	0	0	0.0	**0.0012**
	2	20	0	1	0	0	1	1	0.5	
	3	10	0	0	0	0	0	0	0.0	NI
Coughing	1	20	0	1	0	0	1	1	0.3	0.1129
	2	20	0	2	1	0	1	1	0.7	
	3	10	0	0	0	0	0	0	0.0	NI
Total	1	20	0	1	0	0	1	1	0.3	**0.0072**
	2	20	0	4	1	0	2	2	1.2	
	3	10	0	0	0	0	0	0	0.0	NI

[0508] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NI = Not included in statistical analysis.

[0509] Abnormal respiration was observed in both the PRRS 94881 MLV-vaccinated group and the challenge controls after challenge administration, with maximum scores of 1 (panting/rapid respiration) and 2 (dyspnea), respectively. There was no significant difference between these respiration scores (**p=0.1872**). The median maximum respiration score was 0 for both groups.

[0510] No abnormal behavior was observed in the PRRS 94881 MLV-vaccinated group in the post-challenge period (maximum score = 0). In contrast, the challenge control group had a maximum behavior score of 1 (mild to moderate lethargy; p=0.0012) although the median score for this group was 0. The maximum score for the PRRS 94881 MLV-vaccinated group was significantly lower than the score for the challenge control group (**p=0.0012**). Median maximum behavior scores were 0 for both groups.

[0511] Coughing was observed in both the PRRS 94881 MLV-vaccinated group and in the challenge control group after challenge. Maximum scores were 1 (soft or intermittent cough) and 2 (harsh or severe, repetitive cough), and median scores were 0 and 1, for PRRS 94881 MLV-vaccinated and challenge controls, respectively. There were no significant differences between these groups (**p=0.1129**). Median maximum coughing scores were 0 and 1 for the PRRS 94881 MLV-vaccinated group and challenge control group, respectively.

[0512] Maximum total scores were 1 and 4 and median total scores were 0 and 1 for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. The maximum score for the PRRS 94881 MLV-vaccinated group was significantly lower than the score for the challenge control group (**p=0.0072**). Median total scores were 0 and 1 for the PRRS 94881 MLV-vaccinated group and challenge control group, respectively.

[0513] No clinical signs were observed from D15 through D24 in the non-challenged negative control group during this study. This group had a maximum score of 0 for each parameter.

[0514] A summary of the group mean clinical observation scores for the post-challenge period (D15 through D24) is shown below in Table 7.16.

[0515] Table 7.16 Post-Challenge Mean Clinical Scores, D15 through D24

Parameter	Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
Respiration	1	20	0.0	0.2	0.00	0.00	0.00	0.00	0.02	0.1394
	2	20	0.0	0.6	0.00	0.00	0.10	0.10	0.07	
	3	10	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI
Behaviour	1	20	0.0	0.0	0.00	0.00	0.00	0.00	0.00	**0.0012**
	2	20	0.0	0.8	0.00	0.00	0.10	0.10	0.12	
	3	10	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI
Coughing	1	20	0.0	0.4	0.00	0.00	0.10	0.10	0.07	0.0835
	2	20	0.0	0.7	0.10	0.00	0.30	0.35	0.17	
	3	10	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI
Total	1	20	0.0	0.4	0.00	0.00	0.10	0.15	0.08	**0.0103**
	2	20	0.0	1.4	0.25	0.00	0.40	0.50	0.35	
	3	10	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI

[0516] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NI = Not included in statistical analysis

[0517] Mean clinical observation scores followed a pattern similar to maximum clinical scores with significant differences only observed between the PRRS 94881 MLV-vaccinated group and the challenge control group for mean behavior score (**p=0.0012**) and mean total score (**p=0.0103**).

[0518] Mean respiration scores were 0.02 and 0.07 for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. Mean behavior scores were 0.00 and 0.12 for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. Mean coughing scores were 0.07 and 0.17 for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. Mean total scores were 0.08 and 0.35 for the PRRS 94881 MLV-vaccinated group and challenge control group, respectively.

[0519] No clinical signs were observed from D15 through D24 in the non-challenged negative controls during this study. This group had a mean score of 0 for each parameter.

[0520] Body Weight and Average Daily Weight Gain

[0521] A summary of the body weights on D0, D14 and D24 and ADWG for D0 to D14 and D14 to D24 are shown below in Table 7.17.

[0522] Table 7.17 Body Weight and Average Daily Weight Gain (kg and kg/d)

Day(s)	Group[1]	N	Min.	Max.	Median	Mean	SD
0	1	20	3.3	5.5	3.95	4.14	0.589
	2	20	3.2	5.2	4.05	4.17	0.603
	3	10	3.4	5.1	4.00	4.07	0.556
14	1	20	5.6	9.4	7.60	7.64	1.029
	2	20	6.0	8.9	7.30	7.39	0.909
	3	10	5.5	9.3	6.95	7.22	1.187
24	1	20	7.0	13.9	10.40	10.26	1.693
	2	20	6.4	10.9	8.80	8.87	1.328
	3	10	6.8	12.9	10.90	10.64	1.807
ADWG 0 – 14	1	20	0.164	0.343	0.2571	0.2500	0.05254
	2	20	0.179	0.307	0.2357	0.2304	0.03939
	3	10	0.150	0.307	0.2071	0.2250	0.04906
ADWG 14 – 24	1	20	0.090	0.460	0.2600	0.2620	0.08907
	2	20	-0.060	0.290	0.1600	0.1475	0.09060
	3	10	0.130	0.440	0.3700	0.3420	0.10130

[0523] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged.

[0524] Mean body weights on D0 were 4.1 and 4.2 kg for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. By D14, mean body weights were 7.6 and 7.4 kg for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. On D24, mean body weights were 10.3 and 8.9 kg for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. Average daily weight gains (ADWG) for the vaccination period (D0 to D14) were 0.25 and 0.23 kg/d for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. ADWGs for the challenge period (D14 to D24) were 0.26 and 0.15 kg/d for the PRRS 94881 MLV-vaccinated group and challenge control group, respectively. ADWGs for the negative controls were 0.23 and 0.34 kg/d for D0-D14 and D14-D24, respectively.

[0525] Negative control piglets had mean body weights of 4.1, 7.2 and 10.6 kg on D0, D14 and D28, respectively.

[0526] A summary of the LS Mean and statistical analysis of body weights and ADWG for the PRRS 94881 MLV-vaccinated group and the challenge control group is shown below in Table 7.18.

[0527] Table 7.18 LS Mean Body Weight and Daily Gain (kg)

Day(s)	Group[1]	LS Mean	95% confidence interval		p value
0	1	4.14	3.865	4.405	0.8743
	2	4.17	3.895	4.435	
	Diff. 1-2	-0.03	-0.411	0.351	
14	1	7.64	7.196	8.074	0.4297
	2	7.39	6.951	7.829	
	Diff. 1-2	0.25	-0.376	0.866	
24	1	10.26	9.566	10.944	**0.0063**
	2	8.87	8.176	9.554	
	Diff. 1-2	1.39	0.416	2.364	
ADWG 0 – 14	1	0.2500	0.22898	0.27102	0.1889
	2	0.2304	0.20934	0.25138	
	Diff. 1-2	0.0196	-0.01008	0.04937	
ADWG 14 – 24	1	0.2620	0.22133	0.30267	**0.0003**
	2	0.1475	0.10683	0.18817	
	Diff. 1-2	0.1145	0.05699	0.17201	

[0528] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged.

[0529] Day 0 LS Mean body weights were 4.14 and 4.17 kg for the PRRS 94881 MLV-vaccinated piglets and the challenge control group, respectively. The difference was -0.03 kg, which was not significantly different (p=0.8743). On D14, LS Mean body weights were 7.64 and 7.39 kg for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. The difference was 0.25 kg, which was also not significantly different (p=0.4297). On D24, the LS Mean body weights were 10.26 and 8.87 for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. The difference on this day

was 1.39 kg, and the vaccinated group weight was significantly higher than the challenge control group (**p=0.0063**).

[0530] LS Mean ADWGs for the vaccination period (D0-D14) were 0.25 and 0.23 kg/d for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. These values were not significantly different (p=0.1889). LS Mean ADWGs during the post-challenge period (D14-D24) were 0.26 and 0.15 for the PRRS 94881 MLV-vaccinated group and the challenge control group, respectively. The ADWG for the PRRS 94881 MLV-vaccinated group was significantly higher than the ADWG for the challenge control group (**p=0.0003**).

[0531] Rectal Temperatures

[0532] A summary of rectal temperatures is shown below in Tables 7.19 and 7.20. A summary of the LS Mean and statistical analysis of rectal temperature for the PRRS 94881 MLV-vaccinated group and the challenge control group is shown below in Tables 7.21 and 7.22.

[0533] Table 7.19 Rectal Temperature (ºC) Day 13-22

Day	Group[1]	N	Min.	Max.	Median	Mean	SD
13	1	20	39.3	40.3	39.80	39.77	0.247
	2	20	38.9	40.0	39.35	39.39	0.292
	3	10	39.0	39.7	39.15	39.26	0.267
14	1	20	39.4	40.2	39.75	39.76	0.226
	2	20	39.0	39.8	39.40	39.37	0.220
	3	10	39.1	40.3	39.40	39.51	0.375
15	1	20	39.3	40.4	39.65	39.69	0.258
	2	20	39.4	41.1	39.70	39.90	0.538
	3	10	39.1	40.3	39.40	39.52	0.371
16	1	20	39.9	41.3	40.80	40.68	0.417
	2	20	39.3	40.3	39.75	39.77	0.279
	3	10	39.1	39.9	39.45	39.46	0.263
17	1	20	39.2	40.6	39.80	39.89	0.363
	2	20	39.4	40.6	39.85	39.90	0.285
	3	10	39.2	40.0	39.50	39.53	0.226
18	1	20	39.3	41.0	39.95	39.99	0.492
	2	20	39.5	41.2	40.20	40.29	0.472
	3	10	38.9	39.7	39.30	39.30	0.211
19	1	20	39.7	41.6	40.35	40.40	0.464
	2	20	39.5	41.1	40.65	40.55	0.451
	3	10	39.0	39.6	39.20	39.22	0.199
20	1	20	39.7	41.5	40.50	40.52	0.449
	2	20	39.5	41.5	40.65	40.61	0.531
	3	10	39.1	40.1	39.40	39.49	0.281
21	1	20	39.6	41.1	40.30	40.22	0.413
	2	20	39.4	41.0	40.10	40.12	0.371
	3	10	39.2	40.2	39.45	39.59	0.351
22	1	20	39.8	41.0	40.20	40.34	0.391
	2	20	39.6	41.2	40.30	40.41	0.437
	3	10	39.0	40.0	39.40	39.45	0.276

[0534] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged.

[0535] Table 7.20 Rectal Temperature (ºC) Day 23-24

Day	Group[1]	N	Min.	Max.	Median	Mean	SD
23	1	20	39.6	41.2	40.25	40.36	0.454
	2	20	39.5	41.6	40.60	40.60	0.482
	3	10	39.3	40.1	39.70	39.68	0.290
24	1	20	39.8	41.3	40.30	40.39	0.421
	2	20	39.7	41.6	40.30	40.50	0.531
	3	10	39.1	40.2	39.60	39.66	0.389

[0536] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged

[0537] Table 7.21 LS Mean Rectal Temperature (ºC) Day 13 – 20

Day	Group[1]	LSMean	95 % confidence interval		p value
13	1	39.77	39.648	39.892	**<0.0001**
	2	39.39	39.268	39.512	
	Diff. 1-2	0.38	0.207	0.553	
14	1	39.76	39.654	39.856	**<0.0001**
	2	39.37	39.269	39.471	
	Diff. 1-2	0.39	0.242	0.528	
15	1	39.69	39.494	39.876	0.1241
	2	39.90	39.704	40.086	
	Diff. 1-2	-0.21	-0.480	0.060	
16	1	40.68	40.514	40.836	**<0.0001**
	2	39.77	39.609	39.931	
	Diff. 1-2	0.91	0.678	1.132	
17	1	39.89	39.737	40.033	0.8852
	2	39.90	39.752	40.048	
	Diff. 1-2	-0.02	-0.224	0.194	
18	1	39.99	39.767	40.203	0.0528
	2	40.29	40.072	40.508	
	Diff. 1-2	-0.31	-0.614	0.004	
19	1	40.40	40.188	40.602	0.3065
	2	40.55	40.338	40.752	
	Diff. 1-2	-0.15	-0.443	0.143	
20	1	40.52	40.293	40.737	0.5659
	2	40.61	40.383	40.827	
	Diff. 1-2	-0.09	-0.405	0.225	

[0538] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged

[0539] Table 7.22 LS Mean Rectal Temperature (°C) Day 21 – 24

Day	Group[1]	LSMean	95 % confidence interval		p value
21	1	40.22	40.037	40.393	0.4489
	2	40.12	39.942	40.298	
	Diff. 1-2	0.10	-0.156	0.346	
22	1	40.34	40.152	40.528	0.6231
	2	40.41	40.217	40.593	
	Diff. 1-2	-0.07	-0.331	0.201	
23	1	40.36	40.143	40.567	0.1062
	2	40.60	40.388	40.812	
	Diff. 1-2	-0.25	-0.545	0.055	
24	1	40.39	40.168	40.602	0.4526
	2	40.50	40.283	40.717	
	Diff. 1-2	-0.12	-0.422	0.192	

[0540] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2= placebo-treated, challenged; Group 3 = placebo-treated, not challenged

[0541] Mean and LS Mean rectal temperature for the PRRS 94881 MLV-vaccinated piglets were 39.77 °C on the day before challenge, and ranged from 39.69 °C (D15) to 40.68 °C (D16) after challenge. Mean and LS Mean rectal temperature for the challenge controls were 39.39 °C on the day before challenge and ranged from 39.77 °C (D16) to 40.61°C (D20) after challenge. Least square Means rectal temperatures were significantly lower for challenge controls compared to PPRS 94881 MLV-vaccinated piglets before challenge administration (D13 and D14) and on D16 after challenge (**$p<0.0001$**). There were no other significant differences in rectal temperatures between PRRS 94881 MLV-vaccinated pigs and challenge controls in this study ($p \geq 0.0528$). Mean and LS Mean rectal temperatures for the negative controls remained ≤ 39.68 °C throughout the study.

[0542] Clinical Assessment Post-vaccination

[0543] A summary of the percentage of piglet with at least one positive assessment from D1 through D12 is shown below in Table 7.23.

[0544] Table 7.23 Percentage of Piglets With at Least One Positive Clinical Assessments from D1-D12

Group[1]	N positive	% positive	95 % CI		Total	p value
1	0	0	0.0	16.8	20	1.0000
2	1	5	0.1	24.9	20	
3	0	0	0.0	30.8	10	NI

[0545] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NI = Not included in statistical analysis.

[0546] No piglets in either the PRRS 94881 MLV-vaccinated group or the negative controls had any clinical assessment findings during the vaccination period D-1 through D12. Piglet 110 in challenge control group was observed with a sore behind the right front leg beginning on D9. There was no significant difference between PRRS 94881 MLV-vaccinated piglets and challenge controls for this parameter (p=1.0000).

[0547] PRRS Serology

[0548] A summary of the frequency of piglets with positive PRRS-antibody titers is shown below in Table 7.24.

[0549] Table 7.24 Frequency of Piglets with Positive PRRS-Antibody Titer by Dav

Day	Group[1]	N positive	% positive	95 % CI		Total	p value
7	1	0	0	0.0	16.8	20	NA
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	30.8	10	NI
14	1	17	85	62.1	96.8	20	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	30.8	10	NI
17	1	19	95	75.1	99.9	20	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	30.8	10	NI
21	1	20	100	83.2	100.0	20	**0.0012**
	2	11	55	31.5	76.9	20	
	3	0	0	0.0	30.8	10	NI
24	1	20	100	83.2	100.0	20	1.0000
	2	19	95	75.1	99.9	20	
	3	0	0	0.0	30.8	10	NI

[0550] [1] Group 1 = PRRS 94881 MLV vaccine at MID, challenged; Group 2 = placebo-treated, challenged; Group 3 = placebo-treated, not challenged. NA = Not applicable, no analysis conducted. NI = Not included in statistical analysis.

[0551] All piglets in all treatment groups were PRRS-antibody negative on D0 and D7. By D14, 85% of the PRRS 94881 MLV-vaccinated pigs had positive PRRS antibody titers. This number increased to 95% on D17 and was 100% on both D21 and D24. No pigs in the challenge control group developed positive PRRS-antibody titers until D21 (7 days after challenge administration) when 55% of the pigs had positive titers. This value increased to 95% by D24. On D14, D17 and D21, the PRRS 94881 MLV-vaccinated pigs had a significantly higher proportion of pigs with positive PRRS antibody titers compared to the challenge control group (**$p \leq 0.0012$**). No pigs in the negative control group developed PRRS antibody titers during this study.

[0552] DISCUSSION/CONCLUSION

[0553] To achieve the study objective, three groups were included in the study design on D0: a vaccine group that received 1 x $10^{3.82}$ $TCID_{50}$ of PRRS 94881 MLV (Group 1); a challenge control group that received control product (Group 2) and a negative control group (Group 3) that also received control product.

[0554] Twenty (20) healthy, PRRS susceptible and seronegative piglets were inoculated IM with 1 ml of PRRS 94881 MLV at approximately 14 days of age. Thirty (20 piglets – challenge control group and 10 piglets – negative control group) PRRS susceptible and seronegative piglets were inoculated IM with 1 ml of control product at approximately 14 days of age.

[0555] To determine if an onset of immunity of 2 weeks for PRRS 94881 MLV was achieved, the vaccine group and the challenge control group were challenged 14 days post-vaccination with a heterologous European isolate of PRRSv (isolate 205817) and evaluated post-challenge for relevant reduction in lung lesions.

[0556] Validation of the study (Negative Control Group 3)

[0557] To ensure that source piglets were free of PRRSv and that no extraneous PRRSv exposure or cross-contamination among treatment and control groups occurred during the study, a negative control group (Group 3) was included in the study design. Piglets in the negative control group were negative for PRRSv (viremia; qPCR) as well as for PRRS antibodies throughout the study, thus validating this trial.

[0558] Validation of the challenge model (Challenge Control Group 2)

[0559] A challenge model that induces sufficient PRRS clinical disease is necessary to adequately evaluate PRRS vaccine onset of immunity in a laboratory setting. Following inoculation with European PRRS isolate 205817 by the method described earlier, the challenge control group exhibited a mean rectal temperature of ≥ 40.50 °C on D19, D20 D23 and D24 (≤ 39.68 °C on same days, negative control group), a mean ADWG of 0.15 kg/day compared with a mean ADWG of

0.34 kg/day for the negative control group from D14 to D24, abnormal behavior, coughing, and a median lung lesion score of 55.2% (0.00%; negative control group). These results highlight that severe PRRS-specific clinical disease was induced in the challenge control group even though the challenge virus titer was slightly lower than the targeted dose, thus validating this challenge model as an adequate clinical laboratory tool to evaluate PRRS vaccine efficacy and more specifically, the OOI of PRRS 94881 MLV.

[0560] Determination of two week onset of immunity of PRRS 94881 MLV (Group 1)

[0561] Determination of an onset of immunity (OOI) for PRRS 94881 MLV of 2 weeks post-vaccination was based upon the vaccine group exhibiting a significant ($p \leq 0.05$) reduction in post-challenge lung lesions compared with the challenge control group.

[0562] Lung lesions were selected as the primary parameter for determination of 2 week OOI because this parameter provides the most clinically relevant and convincing evidence of efficacy when evaluating a new vaccine within the PRRS respiratory challenge model in pigs. Lung lesion development is one of the hallmarks of PRRS respiratory disease in pigs. Lung lesions are often accompanied by subsequent manifestations of secondary PRRSv disease characteristics such as clinical signs, pyrexia, decreased ADWG, etc.

[0563] The PRRS 94881 MLV-vaccinated group exhibited a significant reduction in gross lung pathology post-challenge, as evidenced by median total lung lesion score of 27.6% in comparison to the challenge control group, which exhibited a median total lung lesion score of 55.2% (**p=0.0002**). Thus, an OOI of 2 weeks for PRRS 94881 MLV at dosage of $1 \times 10^{3.82}$ $TCID_{50}$ was established based upon the primary parameter of a significant reduction for lung lesions post-challenge. This result was achieved with a vaccine dose slightly lower than the minimum immunizing dose of $1 \times 10^{4.5}$ $TCID_{50}$/dose.

[0564] Viremia post-challenge was selected as the most important secondary parameter because it represents the level of viral replication and persistence occurring within the host animal upon exposure. A significant ($p \leq 0.05$) reduction in viremia would correspond with a PRRS vaccine that induces adequate immunity to limit PRRS pathogenesis within the host. At 3 days post-challenge (D17), PRRS 94881 MLV-vaccinated group was associated with a significant reduction in median viremia (qPCR) compared with the challenge control group (6.72 GE/mL vs. 8.18 GE/mL; **$p \leq 0.0001$**). To further evaluate viremia post-challenge between groups, the quantity of the viral load over a specific duration of time post challenge was calculated, as represented as "area under curve" or AUC. The PRRS 94881 MLV-vaccinated group had a median AUC value from D17 to D24 of 49.52 GE/mL/day; while the challenge control group had a median AUC value of 54.35 GE/ml/day. The median AUC value was significantly lower for the vaccine group compared with the challenge control group from D17 to D24 (**$p=0.0039$**). Whether viremia was examined 3 days post-challenge or over the course of the post-challenge period, PRRS 94881 MLV administered 2 weeks prior to challenge with a virulent heterologous European strain of PRRS significantly ($p \leq 0.05$) reduced viremia after challenge inoculation.

[0565] In association with a reduction of PRRS viremia post-challenge, a significant ($p \leq 0.05$) reduction in the viral load in lung tissue would also be of great importance from the standpoint of PRRS vaccine immunity. A reduction of viral load in the lung tissue maybe associated with reduced viral stability, replication and persistence within the host and may secondarily lead to reduced shedding of PRRSv to other pigs. In this study, lung tissues from PRRS 94881 MLV-vaccinated group had a median lung qPCR result of 7.46 $\log_{10}$ GE/mL 10 days post challenge (D24) while the challenge control group had a median lung qPCR result of 7.88 $\log_{10}$ GE/mL. The difference between the vaccine group and the challenge control group was significant (**$p=0.0101$**), thus further supporting an OOI of 2 weeks.

[0566] A marked reduction in severity and frequency of clinical signs post-challenge in piglets would also be supportive of PRRS vaccine efficacy and establishment of an OOI of 2 weeks for PRRS 94881 MLV. Abnormal respiration of sufficient severity and frequency was not noted in either group post-challenge and no differences were detected ($p \geq 0.1394$). Conversely, the severity and frequency of coughing was about equal between groups and no differences were detected ($p \geq 0.0835$). Differences were detected between groups for severity and frequency of abnormal behavior (lethargy) post-challenge. Zero of 20 (0%) and 9 of 20 (45%), PRRS 94881 MLV-vaccinated and challenge control piglets, respectively, exhibited abnormal behavior for at least one day post-challenge (**$p=0.0012$**). Likewise, the PRRS 94881 MLV-vaccinated group exhibited lower maximum abnormal clinical scores and mean abnormal clinical post-challenge compared with the challenge control group (**$p=0.0012$**). Total clinical scores (summation of respiration, behavior and coughing scores) were significantly different between groups when maximum scores and mean scores from D15 to D24 were analyzed. Due to the influence of abnormal behavior scores on total scores, the PRRS 94881 MLV-vaccinated group had a significantly lower maximum total score and lower mean total score compared with the challenge control group (**$p \leq 0.0103$**). The differences between groups for severity and frequency of abnormal behavior further support an OOI of 2 weeks post-vaccination.

[0567] Pre-challenge, the PRRS 94881 MLV-vaccinated group had slightly higher mean rectal temperatures compared with the challenge control group on D13 (39.77 ºC vs. 39.39 ºC, respectively; **$p<0.0001$**) and on D14 (39.76 ºC vs. 39.37 ºC, respectively; **$p<0.0001$**). Although significant ($p \leq 0.05$) differences were detected between groups pre-challenge, these differences were not biologically relevant. Post-challenge, the only day in which a significant ($p \leq 0.05$) difference was detected between groups for mean rectal temperature was on D16 (2 days post-challenge). On D16, vaccinated and challenge control groups had mean rectal temperatures of 40.68 ºC and 39.77 ºC, respectively, and difference between groups was significant (**$p<0.0001$**). The mean rectal temperature 4-5

days post challenge elevated above 40°C and remained above 40°C until the end of the study for both groups.

[0568] The presence of significant abnormal behavior, viremia, lung pathology and viral load in lung tissues due to PRRS in the challenge control group resulted in significant ($p \leq 0.05$) differences between groups for ADWG post-challenge. In this study, the vaccinated and challenge control groups had mean ADWG from D14 to D24 of 0.3 kg/day and 0.1 kg/day, respectively, and the difference between groups was significant (**p=0.0003**). A significant ($p \leq 0.05$) difference between groups for ADWG post-challenge further supports the establishment of an OOI of 2 weeks post-vaccination.

[0569] Post-Vaccination Parameters Examined In This Study

[0570] No abnormal clinical assessments related to PRRS 94881 MLV vaccination or control product were observed in piglets following inoculation on D0. One-challenge control piglet exhibited a sore behind the right front leg beginning on D9 which appeared not to be associated with administration of the control product.

[0571] All piglets were PRRS ELISA serology negative on D0, thus confirming that all piglets met the inclusion criterion of being PRRS negative upon entry into the study. The majority of piglets receiving PRRS 94881 MLV PRRS sero-converted by D14 and all PRRS-vaccinated piglets were seropositive by 7 days post-challenge (D21). Conversely, the challenge control remained seronegative until 7 days post-challenge, when this group began to demonstrate PRRS seroconversion. The negative control group remained PRRS seronegative throughout the entire study.

[0572] At 7 and 14 days post-vaccination, the PRRS 94881 MLV-vaccinated group exhibited mean qPCR results of 3.17 and 3.30, $\log_{10}$ GE/mL, respectively. These results highlight that within 2 weeks post-vaccination, a dosage of $1 \times 10^{3.82}$ $TCID_{50}$ of PRRS 94881 MLV induced sufficient replication of the MLV that is often required to build protective immunity already at 2 weeks after vaccination.

Conversely, the challenge control group and the negative control group were negative for PRRSv viremia from D0 to D14.

[0573] Conclusion

[0574] The significant ($p \leq 0.05$) reduction of the lung lesions, clinical signs, replication of the virus in the blood and lungs post-challenge as well as the improvement of the growth performances support the establishment of a 2 week OOI following vaccination with a single dose of PRRS 94881 MLV at $1 \times 10^{3.82}$ $TCID_{50}$/mL in piglets at approximately 14 days of age.

[0575] Example 8 Evaluation of duration of immunity of PRRS 94881 MLV in susceptible two week old pigs following challenge with a heterologous European isolate of PRRS at 26 weeks post-vaccination

[0576] The objective of this vaccination-challenge study was to evaluate the duration of immunity (DOI) 26 weeks after the administration of the vaccine candidate Porcine Reproductive and Respiratory Syndrome, European-derived Isolate 94881, Modified Live Virus (PRRS 94881 MLV) to 14 ± 3 days of age PRRS seronegative pigs. The primary efficacy criterion to satisfy a DOI of 26 weeks post-vaccination was a significant reduction in ($p \leq 0.05$) lung lesions scores (gross or histological) post-challenge in the PRRS 94881 MLV vaccinate group (Group 1) compared to the challenge control group (Group 2).

[0577] On Day 0 (D0), 22 pigs assigned to the vaccinate group received 1.0 mL IM of PRRS 94881 MLV ($1 \times 10^{4.27}$ $TCID_{50}$) IM (Group 1), 22 pigs assigned to the challenge control group received 1.0 mL IM of control product (product-matched placebo without PRRS 94881 MLV, Group 2) and 12 pigs assigned to the negative control group also received 1.0 mL IM of control product (Group 3). Groups 1 and 2 were challenged on D179 (Day post-challenge {DPC} 0) with a virulent strain of European PRRSv and pigs were monitored 10 days post-challenge for clinical signs, average daily weight gain, and viremia. Pigs were necropsied on D189 (DPC 10) and gross and histological lung lesions, and lung viral load were determined.

[0578] Median gross lung lesion scores on D189 (DPC 10) were 0.1% and 13.8% for PRRS 94881 MLV-vaccinated pigs and challenge controls, respectively (**p<0.0001**). Median histological lung lesion scores on DPC 10 were 6.0 and 19.5 for PRRS 94881 MLV-vaccinated pigs and challenge controls, respectively (**p<0.0001**). PRRS 94881 MLV-vaccinated pigs had significantly less serum viral load at 3, 7 and 10 days post-challenge compared to challenge controls (**p≤0.0001**). The post-challenge area under the curve (AUC) analysis for viremia from DPC 0 to DPC 10 and DPC 3 to DPC 10 were also significantly lower for PRRS 94881 MLV-vaccinated pigs (15.54 and 8.88 $\log_{10}$ GE/mL per day, respectively) compared with the challenge control group (44.77 and 36.43 $\log_{10}$ GE/mL per day, respectively, **p<0.0001**). The median qPCR values for lung tissues collected at necropsy were 3.69 and 6.25 $\log_{10}$ GE/mL for PRRS 94881 MLV-vaccinated pigs and challenge controls, respectively (**p<0.0001**). There were no significant differences in clinical signs post-challenge (p≥0.4878).

[0579] A significant reduction (p≤0.05) of gross and histological lung lesions, viral load in lung tissues collected at necropsy and post-challenge viremia for PRRS 94881 MLV-vaccinated pigs compared to challenge controls supported vaccine efficacy against virulent PRRSv when challenged 26 weeks post-vaccination. The results of this study establish a 26 week duration of immunity post-vaccination in pigs vaccinated with PRRS 94881 MLV at 2 weeks of age. These results were achieved with a vaccine dose of $1 \times 10^{4.27}$ $TCID_{50}$/mL, which was slightly below the minimum immunizing dose ($1 \times 10^{4.5}$ $TCID_{50}$/mL) for this investigational veterinary product.

[0580] OBJECTIVE(S)/PURPOSE OF THE STUDY

[0581] The objective of this vaccination-challenge study was to evaluate the duration of immunity (DOI) of Porcine Reproductive and Respiratory Syndrome, European-derived Isolate 94881, Modified Live Virus, Code 19S1.U (PRRS 94881 MLV) administered to PRRS seronegative pigs, 14 ± 3 days of age against a virulent challenge with a heterologous European isolate of PRRS at 26 weeks post-vaccination. The primary efficacy criterion to satisfy a DOI of 26 weeks post-

vaccination was a significant reduction ($p \leq 0.05$) in lung lesions scores (gross or histological) post-challenge in the PRRS 94881 MLV vaccinate group (Group 1) compared to the challenge control group (Group 2)

[0582] Secondary efficacy parameters included post-vaccination and post-challenge viremia, clinical assessments after vaccination, PRRS serology, post-challenge clinical observations, average daily weight gain (ADWG), rectal temperatures and lung PRRSv quantitation. Viremia post-challenge was considered to be the most important secondary parameter since it is an objective and quantifiable parameter. Rectal temperature and clinical observations were then considered supportive in the DOI definition process. Lastly, growth performance, serology and virus detection in lungs were used as supportive parameters towards the primary parameters in satisfying the study objective.

[0583] Schedule of Events

[0584] Table 8.1 Schedule of Events

Study Day	Dates	Key Study Event
-7	04Feb10	Blood samples collected to screen for negative PRRS ELISA status
-2	09Feb10	Health Exam performed
-1 to 21	10Feb10-04Mar10	Clinical Assessments performed daily
0	11Feb10	Body weights recorded; Blood samples collected for serology and viremia; Group 1 vaccinated with IVP, Groups 2 & 3 vaccinated with CP
7	18Feb10	Blood samples collected for serology and viremia
13	24Feb10	Pigs vaccinated with 1.0 mL CircoFlex® vaccine Microchip inserted SC in the left neck of each study pig
14	25Feb10	Blood samples collected for serology and viremia
21	04Mar10	Blood samples collected for serology and viremia
22 to 177	05Mar10-07Aug10	Clinical Assessments at least 3 times/week
28	11Mar10	Blood samples collected for serology and viremia
56	08Apr10	Blood samples collected for serology and viremia
84	06May10	Blood samples collected for serology and viremia
112	03Jun10	Blood samples collected for serology and viremia
140	01Jul10	Blood samples collected for serology and viremia
168	29Jul10	Blood samples collected for serology and viremia
D178	08Aug10-	Daily Clinical Observations and Rectal Temperatures

Study Day	Dates	Key Study Event
(DPC-1) to D189 (DPC 10)	19Aug10	
D179 (DPC 0)	09Aug10	Body weights collected; Blood samples collected for serology and viremia; Groups 1 and 2 challenged with heterologous European PRRS isolate
D182 (DPC 3)	12Aug10	Blood samples collected for serology and viremia
D186 (DPC 7)	16Aug10	Blood samples collected for serology and viremia
D188 (DPC 9)	18Aug10	Body weights collected
D189 (DPC 10)	19Aug10	Blood samples collected for serology and viremia Pigs euthanized and necropsied Lung lesions scored for pathology Lung tissues collected for virus isolation and histopathology

[0585] Study Design

[0586] This was a blinded vaccination-challenge efficacy study conducted in 56 weaned, PRRS seronegative pigs, 14 ± 3 days of age on Day 0 (D0). A summary of the study is provided in Table 8.2.

[0587] Table 8.2 Study Design

Group	Number of Pigs on D0	Treatment on D0 (14 ± 3 days of age)	Challenged on D179 (DPC 0) with 1.0 mL/nostril and 1.0 mL IM of PRRSv 205817 (mean $1 \times 10^{6.27}$ $TCID_{50}$/3 mL)	Euthanized and Necropsied on D189 (DPC 10)
1	22	1.0 mL IM of IVP (PRRS 94881 MLV)	Yes	Yes
2	22	1.0 mL IM of Control Product (CP; Placebo matched product without PRRS 94881 MLV)	Yes	Yes
3	12	1.0 mL IM of CP	No	Yes

[0588] Blinding Criteria

[0589] The Study Investigator and designees were blinded to the assigned treatment groups throughout the in-life phase of the study. To maintain this blinding, the BIVI monitor performed the randomization and an individual who did not participate in assessments of the pigs (i.e., clinical assessments, clinical observations or necropsies) administered the assigned IVP and CP treatments on D0. BIVI laboratory personnel were blinded to the treatment each pig received while conducting their respective tasks.

[0590] Materials

[0591] Investigational Veterinary Product (IVP) and Control Product

[0592] Table 8.3 IVP

Generic Product Name:	Porcine Reproductive and Respiratory Syndrome, Modified Live Virus
Strain:	94881
Production and Formulation:	BIVI-St. Joseph Production produced PRRS 94881 MLV, Lot 390-005 (Section 15.4) in accordance with Outline of Production, Code 19S1.U_ and EU Dossier Part 2b. On D0, BIVI-Ames reconstituted/diluted PRRS 94881 MLV vaccine Lot 390-005 with Phosphate buffered saline (PBS; Lot 809-002, Section 15.5) to formulate the IVP, Lot No. N257-137 at a target dosage of approximately 1 x $10^{4.5}$ $TCID_{50}$/mL.
Manufacturer:	Boehringer Ingelheim Vetmedica, Inc. 2621 North Belt Highway St. Joseph, MO 64506, USA
Lot No.:	390-005, reconstituted to Lot N257-137
Expiry Date:	An expiration date of 11Feb10 was assigned to the IVP for study purposes only.
Storage Conditions:	Lyophilized vaccine: 2-8 °C Rehydrated/diluted IVP: on ice
Testing:	PRRS 94881 MLV, Lot 390-005 and PBS, Lot 809-002 were tested by BIVI-QC in accordance with draft Outline of Production (Section 15.1) and as further specified in the EU dossier Part 2.F. BIVI-Ames laboratory personnel tested pre- and post-vaccination aliquots of the IVP for virus titer in accordance with the PRRSv Titer Procedure (Section 15.1).
Test Results:	Lot 390-005: Results were satisfactory (Section 15.4). Lot 809-002: Results were satisfactory (Section 15.5). IVP Lot N257-137: Mean titer of 1 x $10^{4.27}$ $TCID_{50}$/mL (Section 15.7).
IVP Retention:	IVP was reconstituted / diluted for immediate use in this study only and was not retained beyond the vaccination event.

[0593] Table 8.4 CP

Generic Product Name:	Placebo
Formulation:	BIVI-Production produced lyophilized placebo product containing inert material comprised in the vaccine serial without PRRS 94881 MLV (Lot N240-191-062409, Section 15.6). On D0, BIVI-Ames reconstituted Lot N240-191-062409 with Phosphate buffered saline (PBS; Lot 809-002, Section 15.5) to formulate the CP, Lot No. N257-134
Manufacturer:	Boehringer Ingelheim Vetmedica, Inc. 2621 North Belt Highway St. Joseph, MO 64506, USA
Lot Number:	Lot N240-191-062409, reconstituted to Lot N257-134
Expiry Date:	An expiration date of 11Feb10 was assigned to the CP for study purposes only.
Storage Conditions:	Lyophilized vaccine: 2-8 °C Rehydrated CP: 2-8 °C or on ice
Testing:	Lot N240-191-062409 and Lot N257-134were tested by BIVI-QC for EP sterility
Test Results:	Lot N240-191-062409: Results were satisfactory for sterility (Section 15.6). Lot 809-002: Results were satisfactory for sterility CP was determined to be sterile (Section 15.7).
CP Retention:	CP was reconstituted for use in this study only and was not retained beyond the vaccination event.

[0594] Challenge Material

[0595] Table 8.5 Challenge Material

Name/number of isolate	PRRS isolate 205817
Location and date of isolation incl. clinical symptoms	The European PRRS virus isolate 205817 was derived from isolate 190136 originally obtained from lung tissue of a newborn pig from a farm with typical reproductive signs of PRRS (abortions in sows and weakness in newborn pigs) during an outbreak in Lower Saxony, Germany, in April 2004. The attending veterinarians submitted the lung samples to bioScreen (sample arrived on 21 April, 2004) for diagnostic testing. Isolate 190136 was directly propagated on MA 104 cells and a pure culture challenge stock was prepared. A pure culture of isolate 190136 was used to inoculate pigs for evaluation of its ability to reproduce PRRS-specific respiratory disease in a controlled, laboratory trial. Challenged animals exhibited respiratory distress and revealed evidence of interstitial pneumonia upon histopathological examination. PRRS virus successfully re-isolated from lung lesions was given the isolate designation of 205817. Isolate 205817 was directly propagated on MA104 cells and a pure culture challenge stock was prepared for use in future BIVI clinical trials.
Formulation:	Challenge virus was propagated in AK-MA104 cells and formulated to a targeted titer of approximately 1 x 10^6 $TCID_{50}$/3 mL dose on D179. An adequate volume of challenge material was prepared. Two x 5 mL aliquots were removed from challenge material for assay purposes before the challenge material was transported to VRI.
Lot Number:	N270-179
Manufacture:	Boehringer Ingelheim Vetmedica, Inc. - USA
Storage conditions	Bulk challenge material was stored at -70 ± 10 °C. Once prepared, diluted challenge material was maintained on ice until it was administered.
Testing:	BIVI-Ames laboratory personnel tested pre- and post-challenge aliquots for virus titer in accordance with the PRRSv Titer Procedure
Test Results:	The challenge material had a mean titer of 1 x $10^{6.27}$ $TCID_{50}$/3 mL dose
Administration route	1.0 mL/nostril and 1.0 mL IM in the right neck
Challenge material retention:	Challenge material was thawed / diluted for this study only and was not retained beyond the challenge event.

[0596] Treatments

[0597] Dosing Justification

[0598] The IVP was administered as a 1.0 mL dose to assigned pigs to evaluate DOI of PRRS 94881 MLV at 26 weeks post-vaccination. The CP was administered as a 1.0 mL dose to Groups 2 and 3 as a placebo vaccine.

[0599] Dosing Regimen

[0600] IVP or CP IVP or CP was administered was administered to an assigned pig in the right neck region IM on D0 using a sterile 3.0 mL Luer-lock syringe and a sterile 20 g x 1 inch (2.54 cm) needle by a person not collecting study data. The dosing regimen is shown below in Table 8.6

[0601] Table 8.6 Dosing Regimen

Group	Number	Treatment	Dose/Route	Study Day
1	22	IVP	1.0 mL IM	D0
2	22	CP	1.0 mL IM	D0
3	12	CP	1.0 mL IM	D0

[0602] Concomitant Treatments

[0603] Due to the fact that several pigs were found dead early in the study subsequent to bacterial infections, the Investigator and Study Monitor agreed upon the administration of the following additional concomitant treatments to all study animals (Section 15.10):

[0604] Day 20: Mu-Se® (Vitamin E/Selenium, Intervet/Schering Plough Animal Health, USA), 0.1 mL IM in the right ham

[0605] Day 21: EXCEDE® (Ceftiofur, Pfizer Animal Health, USA), 0.5 mL in the left ham

[0606] Day 35: EXCEDE® (Ceftiofur, Pfizer Animal Health, USA), 1.0 mL in the right ham.

[0607] Day 42: EXCEDE® (Ceftiofur, Pfizer Animal Health, USA), 1.0 mL in the left ham.

[0608] Day 47: BAYTRIL 100® (Enrofloxacin, Bayer Animal Health, USA), 1.5 mL SC in the left neck

[0609] Vitamin E/Selenium was administered for the prevention of mulberry heart disease and the antibiotic treatments were administered for the treatment/prevention of bacterial infections.

[0610] ANIMAL INFORMATION

[0611] Details of Animal Studies

[0612] Table 8.7 Animal Information

Source:	Prairie View Farms, N5627 Hwy DD, Burlington, WI 53105		
Number of pigs:	56		
Arrival day:	Pigs arrived at the Veterinary Resources, Inc. (VRI) Cambridge facility on D-2 (09Feb10).		
Identification:	Each animal was identified with individual double ear tags at arrival on D-2. Each animal also had an electronic microchip inserted SC in the left neck on D13.		
Species:	Porcine		
Breed:	Commercial crossbred		
Gender:	Females or castrated males.		
Age range:	13 to 17 days of age on D0		
Weight range:	2.4 to 5.4 kg on D0		
Ownership of test animals:	Boehringer Ingelheim Vetmedica, Inc.		
Physiological status:	On D-2, pigs selected for assignment to the study were observed by the Study Investigator and determined to be in good health and nutritional status. Observations were recorded on the Animal Health Examination Record form.		
Group – Pig Assignments	Group 1 (n=22): 117, 118, 119, 121, 127, 128, 129, 131, 133, 136, 139, 141, 142, 144, 146, 147, 153, 154, 162, 163, 164 and 179	Group 2 (n=22): 123, 124, 125, 130, 134, 137, 138, 148, 149, 150, 156, 157, 158, 160, 161, 165, 167, 169, 170, 172, 177 and 178	Group 3 (n=12): 116, 120, 126, 132, 135, 145, 151, 152, 155, 159, 166 and 171

[0613] INCLUSION/EXCLUSION CRITERIA

[0614] All pigs enrolled in this study were PRRS ELISA negative (ELISA S/P ratio of <0.4) and were healthy at the time of vaccination (D0) as determined by observation.

[0615] POST-INCLUSION REMOVAL CRITERIA

[0616] No pigs were removed from the study. Three pigs were found dead before challenge administration. Further results on these three pigs are presented in Section 12.8.

[0617] ANIMAL MANAGEMENT AND HOUSING

[0618] Pigs were housed at Veterinary Resources, Inc. (VRI) in Cambridge, IA for the duration of the study. Pigs were housed in multiple pens (11 or 12 pigs/pen) within each room, with vaccinated (Group 1) and control animals (Groups 2 and 3) housed in uniform but separate rooms to ensure biosecurity. PRRS 94881 MLV pigs were housed in Room CB8 until D78, then in CC1 until D105, and then CC3 for the remainder of the study. Challenge control pigs were housed in Room CC2 throughout the study. Negative control pigs were housed in Room CB6 until D73 and then in CB7 for the remainder of the study. Animal pens were elevated with plastic slatted flooring, with age appropriate feeders and nipple cup drinkers. Each isolation room was constructed identical to the others and all were biohazard level 2 (BL2) compliant, hepafiltered, mechanically ventilated with thermostat regulated temperature control.

[0619] Treatment group isolation was necessary in this study as it is well known within the scientific community that PRRSv readily spreads from pig to pig via various mechanisms including aerosolization. This includes avirulent live PRRS vaccines as these biological products include attenuated virus particles that mimic the characteristics of virulent wild-type PRRS without the capability to cause disease. Proper methods were in place to ensure that biosecurity was maintained and that vaccinated animals did not accidentally cross-contaminate non-vaccinated, PRRSv naïve negative control animals.

[0620] Appropriate measures were taken by test facility staff to adequately clean and disinfect each room prior to its usage for this study.

[0621] Each room in the facility had fans and heaters to aid in sufficient air circulation and heating. The ventilation system was separate yet identical for each room, so air was not shared between rooms.

[0622] Feed was stored in bags, free from vermin. Feed and water were available *ad libitum*. Pigs were fed Lean Metrics Infant Medicated feed (Purina Mills LLC, St. Louis, MO) from arrival to D5, when they were switched to Lean

Metrics Senior Medicated feed (Purina Mills LLC, St. Louis, MO). On D64 the pigs were switched to Lean Metrics Complete 85 feed (Purina Mills LLC, St. Louis, MO), and on D82 they were switched to Lean Metrics Complete CE85, T40 (Purina Mills LLC, St. Louis, MO), which they were fed for the remainder of the study. Throughout the study, the feeds provided were appropriate for the size, age, and condition of the pigs according to acceptable animal husbandry practices for the region.

[0623] The pigs were in good health and nutritional status before initiation of the study as determined by the Study Investigator. During the study, select animals were observed with other conditions, including thinness, coughing, swellings, rough hair coat, depression, abscesses, and poor body condition. The Study Investigator considered all of these conditions to be typical of group housed growing/maturing pigs. These conditions were considered transient or inconsequential and were not treated.

[0624] ASSESSMENT OF EFFECTIVENESS

[0625] To assess the DOI of PRRS 94881 MLV at 26 weeks post-vaccination, the PRRS 94881 MLV and challenge control groups were challenged on D179 (DPC 0) and lung lesions post-challenge were evaluated 10 days later (DPC 10). A DOI of 26 weeks post-vaccination was achieved if PRRS 94881 MLV group had significantly decreased ($p \leq 0.05$) lung pathology (gross or histological) post-challenge compared with the challenge control group.

[0626] The secondary efficacy parameters analyzed between the vaccine group and the challenge control group included post-vaccination and post-challenge viremia, post-challenge clinical observations, post-challenge rectal temperatures, post-vaccination clinical assessments, average daily weight gain (ADWG) and PRRS serology. Viremia post-challenge was considered to be the most important secondary parameter since it is an objective and quantifiable parameter. Rectal temperature and clinical observations were then considered supportive in the DOI definition process. Lastly, growth performance, serology

and virus detection in lungs were used as supportive parameters towards the primary parameters in satisfying the study objective.

[0627] CRITERIA FOR A VALID TEST

[0628] All pigs were required to be PRRS ELISA negative (ELISA S/P ratio of <0.4) at pre-purchase screening and on D0. Challenge control pigs were required to be negative for PRRS antibodies up to challenge and the negative control group was required to be negative for PRRS antibodies throughout the study.

[0629] PRIMARY OUTCOME PARAMETER

[0630] The primary efficacy outcome variable was lung pathology (gross and histological lesions) at D189 (DPC 10) of the study.

[0631] Gross Lung Lesion Scores

[0632] On D189, after samples and data were collected and recorded, all remaining study pigs were euthanized following VRI SOP PRC1027 (Section 15.1). Each pig was necropsied in accordance with VRI SOP PRC 1028 (Section 15.1). The thoracic cavity of each pig was exposed by a designee and the heart and lungs were removed. The Study Investigator examined each set of lungs, described any gross pathology and determined the percentage of pathology for each lung lobe. Observations and data were recorded on the Necropsy Report Record form.

[0633] Histological Lung Lesion Scores

[0634] For each set of lungs, two samples from the Left and Right Apical lobes, the Left and Right Cardiac lobes, the Left and Right Diaphragmatic lobes and the Intermediate lobe were retained. Each lung sample was approximately 1 inch (2.54 cm) x 1 inch (2.54 cm). For one set of lung samples, all three samples from the left side were combined into one container; while all three samples from the right side and the Intermediate lung lobe sample were combined into another container. Each container was filled with a sufficient amount of 10% formalin solution. For the other set of lung samples, all three lung samples from the left

side were combined into one Whirlpak®; while all three samples from the right side and the Intermediate lung lobe sample were combined into another Whirlpak®. All containers and Whirlpaks® were appropriately labeled with animal number, study number, date of collection, study day, sample type and whether the samples were from the left or right side. Lung samples in formalin were stored at room temperature while lung samples in Whirlpaks® were stored on dry ice until transported to BIVI-Ames. Sample collections were recorded on the Necropsy Report Record form. Formalin fixed lung tissue samples and Whirlpak® lung samples were transferred to BIVI-Ames. A completed Specimen Delivery Record form was included with each shipment.

[0635] Formalin fixed lung tissue samples were held by BIVI-Ames at room temperature until submitted to Iowa State University Veterinary Diagnostic Laboratory (ISU VDL) by BIVI-Ames. Lung samples were handled and processed by ISU VDL personnel according to ISU VDL procedures within one week of necropsy. A single slide was generated for each pig containing seven sections (one each of all seven lung lobes). Each H & E slide was identified with a unique identifier code. ISU VDL provided a computer record containing the study number, identifier codes and associated pig tissues.

[0636] Once daily, on the days in which the study slides were read for histopathology, an ISU VDL pathologist (K. Schwartz) first read the EU PRRS positive and negative control slides. Afterwards, the pathologist read the H & E stained lung slides for pneumocytic hypertrophy and hyperplasia, septal infiltration with mononuclear cells, necrotic debris, intra-alveolar accumulation of inflammatory cells and perivascular accumulation of inflammatory cells. Results were recorded in an Excel spreadsheet. The lung histopathology scoring system is shown below in Table 8.8.

[0637] Table 8.8 Lung Histopathology Scoring System

Pneumocytic hypertrophy and hyperplasia	**Intra-alveolar accumulation of inflammatory cells**
0 = Not present 1 = Mild 2 = Moderate 3 = Severe	0 = Not present 1 = Mild 2 = Moderate 3 = Severe
Septal infiltration with mononuclear cells	**Perivascular accumulation of inflammatory cells**
0 = Not present 1 = Mild 2 = Moderate 3 = Severe	0 = Not present 1 = Mild 2 = Moderate 3 = Severe
Necrotic debris	**Definitions of scoring system applied to histological parameters (except necrotic debris):**
0 = Not present 3 = Yes present	**0 = not present:** no detectable lesions present within an area of view **1 = Mild lesions:** few positive cells (1-5 cells/area) present within an area of view **2 = Moderate lesions:** multiple positive cells (>5 cells/area) at single location or few cells (1-5 cells/area) at multiple locations within an area of view. **3 = Severe lesions:** multiple positive cells (>5 cells/area) at multiple locations within an aread of view.

[0638] Upon completion of the reading of all slides, slides were returned to the Sponsor Representative and will be archived at Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO upon completion of the final report.

[0639] Secondary PARAMETERs

[0640] Secondary variables included post-vaccination and post-challenge viremia, post-challenge clinical observations, post-challenge rectal temperatures, average daily weight gain (ADWG), lung PRRSv quantitation, post-vaccination clinical assessments, and PRRS serology.

[0641] Serum PRRS qPCR

[0642] Venous whole blood was collected at pre-purchase and on Days 0, 7, 14, 21, 28, 56, 84, 112, 140, 168, 179 (DPC 0), 182 (DPC 3), 186 (DPC 7), and 189 (DPC 10). Briefly, approximately 2-5 mL of blood was collected from each pig

into an appropriate sized serum separator tube (SST). Sample collections were recorded on the Sample Collection Record form. Blood in SSTs was allowed to clot at room temperature. Blood samples were delivered to BIVI-Ames on the day of collection and Specimen Delivery Record form was completed. Blood samples were spun down by BIVI-Ames and serum was harvested, split and transferred to appropriate tubes. Each tube was labeled with the pig's ID number, the study number, the date of collection, the study day and the sample type. At BIVI-Ames, one set of serum samples was held at 2-8 ºC and the other set of serum samples was held at -70 ± 10 °C.

[0643] Clinical Observations Post-Challenge

[0644] Pigs were observed for clinical signs of disease from D178 (DPC -1) to D189 (DPC 10). Observations were conducted by the Study Investigator or designees and were recorded on the Clinical Observation Record form. Pigs were observed each day for respiration, behavior and cough based on the clinical observation scoring system outlined below in Table 8.9.

[0645] Table 8.9 Clinical Observation Scoring System

Respiration	Behavior	Cough
0 = normal respiration 1 = panting/rapid respiration 2 = dyspnea 3 = dead	0 = normal 1 = mild to moderate lethargy 2 = severely lethargic or recumbent 3 = dead	0 = no coughing 1 = soft or intermittent cough 2 = harsh or severe, repetitive cough 3 = dead

[0646] Rectal Temperatures

[0647] Rectal temperatures were collected by the Study Investigator or designees from D178 (DPC -1) to D189 (DPC 10). Rectal temperatures were recorded in ºC units on the Clinical Observation Record form.

[0648] Body Weight and Average Daily Weight Gain

[0649] Individual body weights were collected on D0, D179 (DPC 0) and D188 (DPC 9). Each pig was weighed on a calibrated scale by the Study Investigator or designees. Results were recorded in kg units on the Body Weight

Record form. Average daily weight gain was determined from the D179 (DPC 0) to D188 (DPC 9).

[0650] Lung PRRS qPCR

[0651] Lung tissue samples in Whirlpaks® were held at -70 ± 10 °C at BIVI-Ames until shipped to address listed in Section 9.3.1. A completed Specimen Delivery Record form was included with the shipment. bioScreen tested lung samples for PRRSv RNA by qPCR (Section 15.1). Left lung tissues were homogenized and tested. Right lung tissues and intermediate lung lobe samples were homogenized and tested. Results were reported as genome equivalent (log_{10} GE/mL) for left and right lung samples. A geometric mean titer of right and left GE/mL values will be calculated for each pig by the statistician using SAS program.

[0652] Clinical Assessment Post-Vaccination

[0653] All pigs were observed for clinical assessments post-vaccination by the Study Investigator or designees. Observations were conducted daily from D-1 to D21 and then at least three times a week from D22 to D177. Observations were recorded on the Clinical Assessment Record form.

[0654] PRRS Serology

[0655] The serum samples collected at pre-purchase and on Days 0, 7, 14, 21, 28, 56, 84, 112, 140, 168, 179 (DPC 0), 182 (DPC 3), 186 (DPC 7), and 189 (DPC 10) and held at 2-8 ºC were tested by BIVI-Ames for PRRS antibodies (Section 15.1). Results were reported as negative (ELISA S/P ratio of < 0.4) or positive (ELISA S/P ratio of ≥ 0.4).

[0656] ADVERSE EVENTS

[0657] No adverse events attributed to PRRS 94881 MLV were noted in this study.

[0658] STATISTICAL METHODS

[0659] EXPERIMENTAL UNIT

[0660] Treatment groups were housed in separate rooms in this study to avoid transmission of PRRSv to non-vaccinated groups. Therefore, room was the experimental unit. However, for the purposes of analyses, possible bias due to confounding "room" and "treatment" effects were ignored, and pig was used as the statistical unit.

[0661] RANDOMIZATION

[0662] Fifty-six (56) pigs were randomly assigned to one of three groups. Randomization was performed by the BIVI. At the time of shipment Nos. 140 and 143 (challenge control group), as well as No. 168 (PRRS 94881 MLV group), were culled. Number 178 was randomly selected to replace No. 140, No. 177 was randomly selected to replace 143, and No. 179 was randomly selected to replace No. 168 from a pool of five extra pigs that met the inclusion criteria.

[0663] ANALYSIS

[0664] Statistical analyses and data summaries were conducted by Dr. rer. hort. Martin Vanselow, Biometrie & Statistik, Zum Siemenshop 21, 30539 Hannover, Germany, +49(0) 511 606 777 650, m.vanselow@t-online.de. Data were analyzed assuming a completely random design structure. The statistical analyses were performed using SAS software release 8.2 or higher (SAS, 2001, Cary, USA/North Carolina, SAS Institute Inc.). PRRS 94881 MLV pig 179 and challenge control pigs 124 and 161 died before challenge and were excluded from post-challenge analyses. All tests on differences were designed as two-sided tests at $\alpha = 5\%$. The statistician's report is presented in Section 15.9.

[0665] Gross Lung Lesion Scores

[0666] The gross lung lesion score for each pig was calculated using the factors shown below in Table 8.10 multiplied by the % pathology for a specific lung lobe. Calculations were conducted using SAS program.

[0667] Table 8.10 Factors for Calculating Gross Lung Lesion Scores

Lung lobe	Factor
Left apical	0.05
Left cardiac	0.06
Left diaphragmatic	0.29
Right apical	0.11
Cardiac	0.10
Right diaphragmatic	0.34
Right accessory/intermediate	0.05

[0668] Treatment groups were compared on differences using the Wilcoxon Mann-Whitney test.

[0669] Histological Lung Lesion Scores

[0670] Individual histological scores of the lung samples were accumulated per lobe and animal. This sum score was divided by the number of lobes examined per animal. The results were used as single values for the comparison between treatment groups. Treatment groups were tested on differences using the Wilcoxon Mann-Whitney test.

[0671] Lung PRRS qPCR

[0672] The quantitative PCR data (PRRS viral load [$\log_{10}$ GE/mL]) from lungs collected on D189 were used for comparisons between the treatment groups by the Wilcoxon Mann-Whitney test. The average ($\log_{10}$ GE/mL) of the left and right lung qPCR results were used for the evaluation. Prior to the calculations the analytical result 'not detected' was replaced by $\log_{10}$ GE/mL of 0.0 and 'positive' was replaced by 3.0.

[0673] Frequency tables of positive qPCR results were generated. Differences between treatment groups were tested by Fisher's exact test.

[0674] Serum PRRS qPCR

[0675] The viremia data were evaluated separately for each day of investigation. Additionally, for viral load the areas under the individual response

curves between D179 and D189 (AUC 0-10) and between D182 and D189 (AUC 3-10) were analyzed.

[0676] The quantitative PCR data (PRRS viral load [log_{10} GE/mL]) were used for comparisons between the treatment groups by the Wilcoxon Mann-Whitney test. Prior to the calculations the analytical result 'not detected' was replaced by a log_{10} GE/mL value of 0.0 and 'positive' was replaced by 3.0. The treatment groups were tested on differences using the Wilcoxon Mann-Whitney test.

[0677] Frequency tables of positive qPCR results were generated. Differences between treatment groups were tested by Fisher's exact test.

[0678] Clinical Observations Post-Challenge

[0679] Frequency tables of animals with at least one positive finding between D180 and D189 were generated. Total scores were the summation of respiration score + behavior score + cough score. Calculations were conducted using SAS program. Differences between treatment groups were tested by Fisher's exact test.

[0680] The maximum scores and the mean scores per animal from D180 to D189 for respiration, behavior, coughing and for all three added together (total) were used for the statistical evaluation. Differences between treatment groups were tested by the Wilcoxon Mann-Whitney test.

[0681] Body Weight and Average Daily Weight Gain

[0682] Individual daily weight gains were calculated for the time period between D179 to D188. For each day of investigation and for the time period descriptive statistics were calculated. Differences between treatment groups were tested using analysis of variance and subsequent t-tests. Least squares means of the groups and differences between least squares means with 95% confidence intervals were calculated from the analysis of variance.

[0683] Rectal Temperatures

[0684] Differences between treatment groups with respect to the original temperature data were tested using analysis of variance and subsequent t-tests. Least squares means of the groups and differences between least squares means with 95% confidence intervals were calculated from the analysis of variance.

[0685] Clinical Assessment Post-vaccination

[0686] Frequency tables of animals with at least one positive finding between D1 and D21 were generated. Differences between treatment groups were tested by Fisher's exact test.

[0687] PRRS Serology

[0688] Frequency tables of positive ELISA results were generated for each time point. Differences between treatment groups were tested by Fisher's exact test.

[0689] RESULTS

[0690] gross Lung lesion Scores

[0691] Median gross lung lesion scores on D189 (DPC 10) were 0.1% and 13.8% for the PRRS 94881 MLV-vaccinated group and challenge controls, respectively. The median gross lung lesion score for PRRS-vaccinated pigs was significantly lower than the median gross lung lesion score for the challenge controls (**$p<0.0001$**). The median gross lung lesion score for the negative control group was 0.0%.

[0692] Number 123 (challenge control group) could not be scored for lung lesions on D189 due to diffuse pleuritis and adhesions. *Moraxella osloensis, Staphylococcus warneri, Staphyloccous hyicus* and *Pseudomonas* species were isolated from this pig's lung tissues post necropsy.

[0693] A summary of group gross lung lesion scores and the associated p-value is shown below in Table 8.11.

[0694] Table 8.11 Summary of Group Gross Lung Lesion Scores (%) on D189

Group[1]	N[3]	Min.	Max.	Median	95 % CI		Q Range	Mean	p value
1	21	0.00	12.40	0.060	0.050	0.550	0.400	1.099	<0.0001
2	19[2]	0.06	69.20	13.800	2.690	22.650	20.850	15.842	
3	12	0.00	0.59	0.000	0.000	0.110	0.085	0.093	NI

[0695] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]No. 123 was not scored due to diffuse pleuritis and adhesions due to bacterial infections. [3]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis

[0696] Histological Lung Lesion Scores

[0697] Median histological lung lesion scores were 6.0 and 19.5 for the PRRS 94881 MLV-vaccinated group and challenge controls, respectively. The median histological lung lesion score for the PRRS-vaccinated group was significantly lower than the median histological lung lesion score for challenge controls (**p<0.0001**). The median histological lung lesion score for the negative control group was 9.0.

[0698] A summary of the group histological lung lesion scores and the associated p-value is shown below in Table 8.12.

[0699] Table 8.12 Summary of Group Histological Lung Lesion Scores

Group[1]	N[2]	Min.	Max.	Median	95 % CI		Q Range	Mean	p value
1	21	2	20	6.0	3.0	8.0	5.0	6.6	<0.0001
2	20	8	47	19.5	15.0	23.0	10.0	20.2	
3	12	0	15	9.0	7.0	14.0	6.5	9.1	NI

[0700] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysisNI = Not included in statistical analysis

[0701] Lung PRRS qPCR

[0702] Median qPCR lung values from lung tissues were 3.69 and 6.25 log_{10} GE/mL for PRRS 94881 MLV-vaccinated pigs and challenge controls, respectively. The median qPCR value for PRRS 94881 MLV-vaccinated pigs was significantly lower than the median qPCR value for challenge controls (**p<0.0001**). No PRRSv RNA was detected in lung samples of any negative control pigs.

[0703] A summary of group lung qPCR values and test result (p value) is below in Table 8.13.

[0704] Table 8.13 Summary of Group Lung qPCR (mean log_{10} GE/mL) Values

Group[1]	N[2]	Min.	Max.	Median	95 % CI		Q Range	Mean	p value
1	21	0.00	6.83	3.69	1.50	5.21	3.18	3.36	<0.0001
2	20	4.80	7.40	6.25	5.62	6.68	1.26	6.22	
3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI

[0705] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis

[0706] PRRSv RNA was detected in lung tissues of 90% and 100% of PRRS 94881 MLV-vaccinated pigs and challenge control pigs, respectively. There was no statistical difference between the vaccinated group and challenge controls (p=0.4878).

[0707] A summary of group frequency of PRRS qPCR positive lung tissues from pigs at necropsy is shown below in Table 8.14.

[0708] Table 8.14 Group Frequency of PRRSv qPCR Positive Lung Tissues

Group[1]	N Positive	% Positive	95 % CI		Total Number[2]	p value
1	19	90	69.6	98.8	21	0.4878
2	20	100	83.2	100.0	20	
3	0	0	0.0	26.5	12	NI

[0709] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis

[0710] Serum PRRS qPCR

[0711] PRRSv RNA was not detected in the serum of any pigs on D0. Post-vaccination, PRRS 94881 MLV-vaccinated pigs had median values of 3.00, 0, 0, 3.00, 0, 0, 0, 0 and 0 $\log_{10}$ GE/mL on D7, D14, D21, D28, D56, D84, D112, D140 and D168 respectively. The values were significantly higher than challenge controls on D7, D14, D21 and D28 (**p≤0.0013)**, as challenge controls did not have any PRRSv RNA detected until D182 (DPC 3).

[0712] PRRSv RNA was not detected in the serum of any pigs on D179 (DPC 0). Post-challenge, PRRS 94881 MLV-vaccinated pigs had median values of 4.44, 0 and 0 $\log_{10}$ GE/mL on D182 (DPC 3), D186 (DPC 7), and D189 (DPC 10), respectively, compared with 5.88, 5.30 and 4.24 $\log_{10}$ GE/mL for challenge controls on the same days. Median values for the challenge controls were higher than the PRRS 94881 MLV group on all post-challenge days (**p≤0.0001**).

[0713] No PRRSv RNA was detected in serum from any negative control pig during this study.

[0714] The median AUC values for PRRS 94881 MLV-vaccinated pigs were 15.54 and 8.88 $\log_{10}$ GE/mL per day from DPC 0 to DPC 10 and from DPC 3 to DPC 10, respectively. In contrast, the median AUC values for challenge controls were 44.77 and 36.43 $\log_{10}$ GE/mL per day from DPC 0 to DPC 10 and from DPC 3 to DPC 10, respectively. Median values for the PRRS MLV group were

significantly lower than median values for the challenge controls for both periods (**p<0.0001**).

[0715] Summaries of serum PRRS qPCR data are shown below in Tables 8.15 and 8.16.

[0716] Table 8.15 Summary of Serum PRRS qPCR Results (log_{10} GE/mL) from D0 to D168

Day	Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
0	1	22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
	2	22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
7	1	21	3.00	4.63	3.00	3.00	3.00	0.00	3.23	**<0.0001**
	2	22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
14	1	21	0.00	3.00	0.00	0.00	3.00	3.00	1.43	**0.0005**
	2	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
21	1	21	0.00	3.00	0.00	0.00	3.00	3.00	1.29	**0.0013**
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
28	1	21	0.00	3.88	3.00	0.00	3.00	3.00	1.93	**<0.0001**
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
56	1	21	0.00	3.00	0.00	0.00	0.00	0.00	0.57	0.1069
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
84	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
112	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
140	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
168	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI

[0717] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. NI = Not included in statistical analysis

[0718] Table 8.16 Summary of Serum PRRS qPCR Results (log_{10} GE/mL) from D179 to D189

Day	Group[1]	N	Min.	Max.	Median	95 % CI		QRange	Mean	p value
179 (DPC 0)	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
182 (DPC 3)	1	21	3.00	5.58	4.44	3.93	5.28	1.51	4.42	**<0.0001**
	2	20	5.09	6.33	5.88	5.75	6.00	0.32	5.81	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
186 (DPC 7)	1	21	0.00	3.74	0.00	0.00	0.00	0.00	0.61	**<0.0001**
	2	20	3.66	6.57	5.30	4.86	5.69	1.08	5.30	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
189 (DPC 10)	1	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**<0.0001**
	2	20	0.00	5.88	4.24	3.71	4.42	1.18	3.97	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
AUC DPC 0-10	1	21	10.50	31.22	15.54	13.76	19.53	5.95	17.61	**<0.0001**
	2	20	36.86	52.16	44.77	43.23	48.03	6.24	44.84	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI
AUC DPC 3-DPC 10	1	21	6.00	23.45	8.88	7.86	11.16	3.40	10.97	**<0.0001**
	2	20	27.77	43.02	36.43	34.60	38.53	5.23	36.12	
	3	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NI

[0719] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. NI = Not included in statistical analysis. AUC = Area under the curve; $\log_{10}$ GE/mL per day

[0720] Post-vaccination, the PRRS 94881 MLV group had significantly higher proportions of qPCR positive pigs on D7, D14, D21 and D28 compared with the challenge control group. (**p≤0.0013)**. No significant difference was detected between groups on D56 for the proportion of qPCR positive pigs (p=0.1069).

[0721] On D182 (DPC 3), 100% of pigs in the PRRS 94881 MLV and challenge control groups were qPCR positive (no test conducted). On D186 (DPC 7) and D189 (DPC 10), the PRRS MLV group had significantly lower proportion of qPCR positive pigs compared with the challenge control group **(<0.0001**).

[0722] Summaries of group proportions of qPCR positive data are shown below in Tables 8.17 and 8.18.

[0723] Table 8.17 Summary of Group Proportion of Serum qPCR Positive Results Post-Vaccination

Day	Group [1]	N Positive	% Positive	95 % CI		Total Number	p value
0	1	0	0	0.0	15.4	22	n.a.
	2	0	0	0.0	15.4	22	
	3	0	0	0.0	26.5	12	NI
7	1	21	100	83.9	100.0	21	**<0.0001**
	2	0	0	0.0	15.4	22	
	3	0	0	0.0	26.5	12	NI
14	1	10	48	25.7	70.2	21	**0.0005**
	2	0	0	0.0	16.1	21	
	3	0	0	0.0	26.5	12	NI
21	1	9	43	21.8	66.0	21	**0.0013**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
28	1	13	62	38.4	81.9	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
56	1	4	19	5.4	41.9	21	0.1069
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
84	1	0	0	0.0	16.1	21	n.a.
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
112	1	0	0	0.0	16.1	21	n.a.
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
140	1	0	0	0.0	16.1	21	n.a.
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
168	1	0	0	0.0	16.1	21	n.a.
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI

[0724] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. n.a. = no test conducted; NI = Not included in statistical analysis

[0725]

[0726] Table 8.18 Summary of Group Proportion of Serum qPCR Positive Results Post-Challenge

Day	Group [1]	N Positive	% Positive	95 % CI		Total Number	p value
179 (DPC 0)	1	0	0	0.0	16.1	21	n.a.
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
182 (DPC 3)	1	21	100	83.9	100.0	21	n.a.
	2	20	100	83.2	100.0	20	
	3	0	0	0.0	26.5	12	NI
186 (DPC 7)	1	4	19	5.4	41.9	21	**<0.0001**
	2	20	100	83.2	100.0	20	
	3	0	0	0.0	26.5	12	NI
189 (DPC 10)	1	0	0	0.0	16.1	21	**<0.0001**
	2	19	95	75.1	99.9	20	
	3	0	0	0.0	26.5	12	NI

[0727] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. n.a. = no test conducted; NI = Not included in statistical analysis

[0728] Clinical Observations Post-challenge

[0729] Abnormal respiration was not observed in any PRRS 94881 MLV-vaccinated pigs after challenge, compared with one - challenge control pig (No. 149) which demonstrated a score of "1" on D185 (DPC 6). No difference was detected between groups for the percentage of pigs that demonstrated abnormal respiration for at least one day post-challenge (p=0.4878).

[0730] Abnormal behavior and coughing were not observed post-challenge in any PRRS 94881 MLV-vaccinated pigs or in challenge control pigs.

[0731] The percentages of pigs with total clinical scores > 0 for at least one day post-challenge were 0% and 5% for the PRRS 94881 MLV-vaccinated group

and the challenge control group, respectively. These values were not significantly different (p=0.4878).

[0732] No clinical signs were observed in the negative control group from D179 to D189.

[0733] A summary of group frequencies of pigs with at least one positive clinical observation score during the post-challenge period is shown below in Table 8.19.

[0734] Table 8.19 Summary of Group Frequencies of Pigs with at least One Positive Clinical Observation Score Post-challenge

Parameter	Group[1]	N Positive	% Positive	95 % CI		Total Number[2]	p value
Respiration	1	0	0	0.0	16.1	21	0.4878
	2	1	5	0.1	24.9	20	
	3	0	0	0.0	26.5	12	NI
Behaviour	1	0	0	0.0	16.1	21	NA
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
Coughing	1	0	0	0.0	16.1	21	NA
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
Total	1	0	0	0.0	16.1	21	0.4878
	2	1	5	0.1	24.9	20	
	3	0	0	0.0	26.5	12	NI

[0735] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis; NA=test not applicable due to lack of variability

[0736] There was no difference between groups for maximum respiration scores or maximum total scores post-challenge (p=0.4878).

[0737] A summary of the group maximum clinical observation scores for the post-challenge period (DPC 1 through DPC 10) is shown below in Table 8.20.

[0738] Table 8.20 Summary of Group Post-Challenge Maximum Clinical Scores

Parameter	Group[1]	N[2]	Min.	Max.	Median	95 % CI		QRange	Mean	p value
Respira-tion	1	21	0	0	0	0	0	0	0.0	0.4878
	2	20	0	1	0	0	0	0	0.1	
	3	12	0	0	0	0	0	0	0.0	NI
Behav-iour	1	21	0	0	0	0	0	0	0.0	1.0000
	2	20	0	0	0	0	0	0	0.0	
	3	12	0	0	0	0	0	0	0.0	NI
Cough-ing	1	21	0	0	0	0	0	0	0.0	1.0000
	2	20	0	0	0	0	0	0	0.0	
	3	12	0	0	0	0	0	0	0.0	NI
Total	1	21	0	0	0	0	0	0	0.0	0.4878
	2	20	0	1	0	0	0	0	0.1	
	3	12	0	0	0	0	0	0	0.0	NI

[0739] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis

[0740] Mean clinical observation scores followed a pattern similar to the percentage of pigs with positive clinical scores. There were no significant differences between the PRRS 94881 MLV-vaccinated group and the challenge control group ($p \geq 0.4878$).

[0741] A summary of the group mean clinical observation scores for the post-challenge period (DPC 1 through DPC 10) is shown below in Table 8.21.

[0742] Table 8.21 Summary of Group Post-Challenge Mean Clinical Scores

Parameter	Group[1]	N[2]	Min.	Max.	Median	95 % CI		QRange	Mean	p value
Respiration	1	21	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.4878
	2	20	0.0	0.1	0.00	0.00	0.00	0.00	0.01	
	3	12	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI
Behaviour	1	21	0.0	0.0	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.0	0.0	0.00	0.00	0.00	0.00	0.00	
	3	12	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI
Coughing	1	21	0.0	0.0	0.00	0.00	0.00	0.00	0.00	1.0000
	2	20	0.0	0.0	0.00	0.00	0.00	0.00	0.00	
	3	12	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI
Total	1	21	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.4878
	2	20	0.0	0.1	0.00	0.00	0.00	0.00	0.01	
	3	12	0.0	0.0	0.00	0.00	0.00	0.00	0.00	NI

[0743] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis

[0744] Body Weight and Average Daily Weight Gain

[0745] The difference between groups was not significant (p=0.2389). On D179 (DPC 0), mean and LS Mean body weights were 134.6 and 128.2 kg for the PRRS 94881 MLV group and the challenge control group, respectively. The difference was not significantly different (p=0.1090). On D188 (DPC 9), the mean and LS Mean body weights were 138.3 and 130.3 kg for the PRRS 94881 MLV group and the challenge control group, respectively. The body weight for the vaccinated group was significantly higher than the challenge control group on D188 (**p=0.0455**).

[0746] LS Mean ADWGs for the challenge period (DPC 0 through DPC 9) were 0.4 and 0.2 kg/d for the PRRS 94881 MLV group and the challenge control group, respectively. These values were not significantly different (p=0.1041).

[0747] Negative control pigs had mean body weights of 2.7, 117.2 and 120.0 kg on D0, D179 and D188, respectively. The ADWG for the negative control group from D179 to D188 was 0.5 kg/d.

[0748] A summary of the group mean body weights on D0, D179 (DPC 0) and D188 (DPC 9) and ADWG from DPC 0 to DPC 9 are shown below in Table 8.22. A summary of LS Mean and statistical analysis of body weights and ADWG for the PRRS 94881 MLV group and the challenge control group is shown below in Table 8.23.

[0749] Table 8.22 Summary of Group Body Weight and Average Daily Weight Gain (kg and kg/d)

Day(s)	Group[1]	N	Min.	Max.	Median	Mean	SD
0 Body Weights	1	22	2.8	5.4	4.00	3.96	0.730
	2	22	2.4	4.8	3.75	3.72	0.547
	3	12	2.7	4.5	3.60	3.71	0.552
D179 Body Weights (DPC 0)	1	21	108.5	155.0	136.60	134.57	12.737
	2	20	103.3	152.6	130.10	128.15	12.288
	3	12	117.2	156.5	133.05	134.61	10.900
D188 Body Weights (DPC 9)	1	21	112.2	157.8	141.50	138.28	12.879
	2	20	109.4	150.9	131.90	130.27	11.896
	3	12	120.0	162.5	136.60	139.11	11.922
ADWG DPC 0 to DPC 9	1	21	-0.422	0.956	0.4111	0.4124	0.31653
	2	20	-0.589	0.844	0.2889	0.2350	0.36530
	3	12	-1.600	2.656	0.5111	0.5000	0.92391

[0750] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group

[0751] Table 8.23 Summary of Group LS Mean Body Weight and Daily Gain (kg and kg/d)

Day(s)	Group[1]	LS Mean	95% confidence interval		p value
0 Body Weights	1	3.96	3.674	4.241	0.2389
	2	3.72	3.446	4.000	
	Diff. 1-2	0.23	-0.162	0.631	
D179 Body Weights (DPC 0)	1	134.57	129.040	140.093	0.1090
	2	128.15	122.487	133.813	
	Diff. 1-2	6.42	-1.496	14.329	
D188 Body Weights (DPC 9)	1	138.28	132.800	143.756	**0.0455**
	2	130.27	124.652	135.878	
	Diff. 1-2	8.01	0.170	15.856	
ADWG DPC 0 to DPC 9	1	0.4124	0.26180	0.56297	0.1041
	2	0.2350	0.08070	0.38930	
	Diff. 1-2	0.1774	-0.03822	0.39299	

[0752] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group

[0753] Rectal Temperatures

[0754] Mean rectal temperature for the PRRS 94881 MLV group was 39.3 ºC on the day of challenge (D179), and means ranged from 39.1 ºC (D189, DPC 10) to 39.8 ºC (D181, DPC 2) after challenge. Mean rectal temperature for the challenge control group was 39.1 ºC on the day of challenge, and means ranged from 39.1 ºC (D183, DPC 4) to 39.9 ºC (D182, DPC 3) after challenge. Mean rectal temperatures for negative control group remained ≤ 39.3 ºC throughout the same time period.

[0755] A summary of group rectal temperatures is shown below in Table 8.24.

[0756] Table 8.24 Summary of Group Rectal Temperature (ºC) Days D179 (DPC 0) through D189 (DPC 10)

Day	Group[1]	N[2]	Min.	Max.	Median	Mean	SD
D179 (DPC 0)	1	21	38.5	40.0	39.40	39.33	0.360
	2	20	38.6	40.0	39.00	39.07	0.380
	3	12	38.8	39.7	39.30	39.27	0.257
D180 (DPC 1)	1	21	38.7	40.4	39.40	39.46	0.370
	2	20	38.9	40.9	39.60	39.61	0.527
	3	12	38.8	39.5	39.00	39.09	0.227
D181 (DPC 2)	1	21	39.0	41.0	39.80	39.82	0.473
	2	20	38.6	40.5	39.35	39.42	0.487
	3	12	38.8	39.2	38.80	38.90	0.141
D182 (DPC 3)	1	21	38.5	40.6	39.50	39.52	0.542
	2	20	39.0	41.1	40.05	39.86	0.588
	3	12	38.7	39.4	39.00	39.05	0.254
D183 (DPC 4)	1	21	38.9	40.8	39.50	39.52	0.411
	2	20	38.4	40.3	39.00	39.08	0.508
	3	11	38.8	39.4	39.10	39.08	0.209
D184 (DPC 5)	1	21	39.0	40.3	39.70	39.72	0.360
	2	20	38.7	39.7	39.10	39.15	0.302
	3	12	38.8	39.5	39.10	39.10	0.191
D185 (DPC 6)	1	21	39.1	40.5	39.60	39.66	0.376
	2	20	38.9	40.9	39.25	39.48	0.546
	3	12	38.4	39.4	38.85	38.88	0.313
D186 (DPC 7)	1	21	38.1	40.4	39.20	39.22	0.413
	2	20	38.6	40.4	39.35	39.39	0.479
	3	12	38.5	39.6	38.90	38.98	0.328
D187 (DPC 8)	1	21	38.8	39.9	39.20	39.23	0.290
	2	20	38.8	40.8	39.45	39.58	0.573
	3	12	38.5	39.5	38.85	38.93	0.296
D188 (DPC 9)	1	21	38.8	39.9	39.10	39.17	0.288
	2	20	38.3	40.5	39.00	39.20	0.598
	3	12	38.4	39.1	38.85	38.85	0.173
D189 (DPC 10)	1	21	38.7	39.7	39.00	39.06	0.256
	2	20	39.0	40.8	39.50	39.51	0.408
	3	12	38.6	39.3	39.05	39.00	0.226

[0757] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis

[0758] Least square Mean rectal temperatures were significantly higher for PRRS 94881 MLV-vaccinated pigs compared to challenge controls on DPC 0 (**p=0.0281**), DPC 2 (**p=0.0095**), DPC 4 (**p=0.0034**) and DPC 5 (**p<0.0001**). Least square Mean rectal temperatures were significantly lower for PRRS 94881 MLV-vaccinated pigs compared to challenge controls on DPC 8 (**p=0.0183**) and on DPC 10 (**p=0.0001**). No significant differences were detected between groups for the remaining days post-challenge (p≥0.0642). A summary of group LS Mean and statistical analysis of rectal temperature is shown below in Table 8.25.

[0759] Table 8.25 Summary of Group LS Mean Rectal Temperature (ºC) D179 (DPC 0) through D189 (DPC 10)

Day	Group[1]	LSMean	95 % confidence interval		p value
D179 (DPC 0)	1	39.33	39.170	39.496	**0.0281**
	2	39.07	38.903	39.237	
	Diff. 1-2	0.26	0.030	0.497	
D180 (DPC 1)	1	39.46	39.257	39.657	0.3025
	2	39.61	39.400	39.810	
	Diff. 1-2	-0.15	-0.434	0.138	
D181 (DPC 2)	1	39.82	39.612	40.036	**0.0095**
	2	39.42	39.198	39.632	
	Diff. 1-2	0.41	0.105	0.712	
D182 (DPC 3)	1	39.52	39.274	39.773	0.0642
	2	39.86	39.604	40.116	
	Diff. 1-2	-0.34	-0.693	0.021	
D183 (DPC 4)	1	39.52	39.320	39.727	**0.0034**
	2	39.08	38.867	39.283	
	Diff. 1-2	0.45	0.158	0.740	
D184 (DPC 5)	1	39.72	39.572	39.866	**<0.0001**
	2	39.15	38.999	39.301	
	Diff. 1-2	0.57	0.359	0.779	
D185 (DPC 6)	1	39.66	39.457	39.869	0.2164
	2	39.48	39.269	39.691	
	Diff. 1-2	0.18	-0.112	0.478	
D186 (DPC 7)	1	39.22	39.027	39.421	0.2408
	2	39.39	39.188	39.592	
	Diff. 1-2	-0.17	-0.448	0.116	
D187 (DPC 8)	1	39.23	39.034	39.432	**0.0183**
	2	39.58	39.376	39.784	
	Diff. 1-2	-0.35	-0.631	-0.062	
D188 (DPC 9)	1	39.17	38.966	39.377	0.8454
	2	39.20	38.989	39.411	
	Diff. 1-2	-0.03	-0.323	0.266	
D189 (DPC 10)	1	39.06	38.908	39.207	**0.0001**
	2	39.51	39.352	39.658	
	Diff. 1-2	-0.45	-0.662	-0.234	

[0760] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group

[0761]

[0762] Three of 21 (14%) PRRS 94881 MLV vaccinated pigs and 5 of 20 (25%) challenge controls had a rectal temperature ≥ 40.5 ºC for at least one day post-challenge. No difference was detected between groups for the proportion of pigs that exhibited a rectal temperature ≥ 40.5 ºC for at least one day post-challenge (p=0.4537). A summary of group proportion of pigs with pyrexia (≥ 40.5 ºC) for at least one day post-challenge is shown below in Table 8.26.

[0763] Table 8.26 Summary of Group Proportion of Pyrexia (≥ 40.5 ºC) for at Least One Day Post-Challenge

Day	Group[1]	N Positive	% Positive	95 % CI		Total Number[2]	p value
D180 (DPC 1) to D189 (DPC 10)	**1**	3	14	3.0	36.3	21	0.4537
	2	5	25	8.7	49.1	20	
	3	0	0	0.0	26.5	12	NI

[0764] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. [2]One PRRS 94881 MLV pig and two challenge control pigs died pre-challenge and were not included in analysis. NI = Not included in statistical analysis

[0765] Clinical Assessment Post-vaccination

[0766] Four of 22 (18%) PRRS 94881 MLV pigs, 8 of 22 (36%) challenge control pigs and 2 of 12 (17%) negative control pigs exhibited an abnormal clinical assessment for at least one day from D1 to D21. There was no significant difference between groups for this parameter (p=0.3102).

[0767] A summary of group percentage of pigs with at least one abnormal clinical assessment from D1 through D21 is shown below in Table 8.27.

[0768] Table 8.27 Summary of Group Percentage of Pigs with At Least One Abnormal Clinical Assessments from D1-D21

Group[1]	N Positive	% Positive	95 % CI		Total Number	p value
1	4	18	5.2	40.3	22	0.3102
2	8	36	17.2	59.3	22	
3	2	17	2.1	48.4	12	NI

[0769] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. NI = Not included in statistical analysis

[0770] Overall, 7 PRRS 94881 MLV pigs exhibited an abnormal clinical assessment for at least one day between D1 to D177:

[0771] Pig 121 exhibited belly swelling from D61 to D146, a swollen sheath from D147 to D167, belly swelling on D168, a swollen sheath from D169-172 and belly swelling from 173 to 177. Pig 141 was thin from D4-D10, was depressed from D4-D6 and rough hair coat on D5. Pig 144 exhibited coughing on D26. Pig 146 exhibited swelling on the sternum on D82. Pig 147 was weak on legs from D84-D86 and was shaking on D84. Pig 154 was thin from D4-D6. Pig 179 was thin from D2-D5, exhibited rough hair coat on D5 and was found dead on D6. Thirteen pigs in the challenge control group exhibited an abnormal clinical assessment for at least one day from D1 to D177: Pig 124 exhibited shaking and tremors on D20 and was found dead on D21. Pig 134 exhibited a swollen sheath from D46-D68, belly swelling from D69-D143, an umbilical hernia on D144, and belly swelling from D145 to D177. Pig 137 exhibited a swollen sheath from D108-D143. Pig 138 exhibited a swollen sheath from D115-D143. Pig 148 exhibited lameness or a swollen leg from D16-20 and coughing on D35. Pig 149 was thin from D5-D9 and on D12, and exhibited rough hair coat from D12-D15. Pig 150 was thin from D4-D9 and on D13, exhibited poor body condition from D10-D12, and was depressed on D11. Pig 161 was thin from D4-D9, exhibited rough hair coat and central nervous system signs on D9 and was found dead on D10. Pig 167 exhibited a swollen sheath from D117-D143. Pig 170 was thin from D4-D7 and exhibited depression on D7. Pig 172 exhibited a sore or a swollen dew claw from D120-D143. Pig 177 exhibited depression on D19 and swelling on the neck from D156-D159. Pig 178 exhibited depression on D5, from D17-20, and from D28-D36, was lame and/or

swollen leg from D15-D47, was thin from D16-D18, and was stiff on legs from D39-D47. Six pigs in the negative control exhibited an abnormal clinical assessment for at least one day from D1 to D177. Pig 120 exhibited coughing from D5-7 and on D12. Pig 126 was thin from D2-18, exhibited depression from D4-D5, on D10, and from D17-D19, rough hair coat on D5, and labored respiration from D18-D22. Pig 132 exhibited an abscess from D49-D56. Pig 145 exhibited a swollen sheath from D37-D43 and from D46 to D74, and a sore on the sheath from D75-D83 and from D85 to D87. Pig 151 exhibited lameness and/or a swollen leg from D78-D83 and on D85. Pig 155 exhibited an abscess on D69-D77.

[0772] Three mortalities occurred prior to challenge. Pig 179 (PRRS 94881 MLV, D6): Necropsy revealed minimal lesions (thin, poor body condition). Laboratory testing showed mild macrophagic interstitial pneumonia. Immunohistochemistry was negative for PRRS. Intestinal samples were autolysed but did not show evidence of severe necrosis or severe inflammation. Smooth *Escherichia coli* and *Enterococcus* spp were isolated (Section 15.9). Pig 124 (Challenge control, D21): No gross lesions were identified at necropsy. Laboratory testing revealed severe suppurative to pyogranulomatous meningoencephalitis with suppurative perivasculitis. Marked pulmonary and hepatic congestion were also evident. The diagnosis was *Streptococcus suis* associated meningoencephalitis. Pig 161 (Challenge control, D10): Necropsy revealed minimal lesions (thin, poor body condition). *Bordetella bronchiseptica, Streptococcus* alpha haemolytic and *Staphylococcus auricularis* were isolated from lung tissues.

[0773] PRRS Serology

[0774] All pigs were PRRS ELISA negative on D0 and D7. By D14, 90% of PRRS 94881 MLV-vaccinated pigs had positive PRRS ELISA titers. This number increased to 95% on D21 and was 100%, 100%, 100%, 90%, 100% and 95% on D28, D56, D84, D112, D140 and D168, respectively. None of the challenge control pigs developed PRRS antibody titers during the vaccination phase of this study, and from D14 through D168, a significantly higher percentage of PRRS

94881 MLV-vaccinated pigs had positive PRRS antibody titers compared to challenge controls (**p<0.0001**).

[0775] During the challenge phase of the study, the percentages of PRRS 94881 MLV-vaccinated pigs with positive PRRS ELISA titers were 95%, 95%, 100% and 100% on DPC 0, DPC 3, DPC 7 and DPC10, respectively. In contrast, challenge control pigs did not develop PRRS antibody titers until DPC 7, when 30% had titers. This increased to 80% on DPC 10. The PRRS 94881 MLV-vaccinated pigs had higher percentages of animals with positive PRRS antibody titers throughout the challenge phase of the study (**p≤0.0478**).

[0776] Pigs in the negative control group were PRRS ELISA seronegative throughout the study with the exception of two pigs on D112. Numbers 116 and 120 were PRRS ELISA seropositive on D112.

[0777] A summary of group percentages of pigs with positive PRRS-antibody titers before challenge is shown below in Table 8.28. Data from the challenge portion of the study are shown below in Table 8.29.

[0778] Table 8.27 Summary of Group Frequency of Pigs with Positive PRRS-Antibody Titer by Day, Days 0-168

Day	Group[1]	N Positive	% Positive	95 % CI		Total Number	p value
0	1	0	0	0.0	15.4	22	NA
	2	0	0	0.0	15.4	22	
	3	0	0	0.0	26.5	12	NI
7	1	0	0	0.0	16.1	21	NA
	2	0	0	0.0	15.4	22	
	3	0	0	0.0	26.5	12	NI
14	1	19	90	69.6	98.8	21	**<0.0001**
	2	0	0	0.0	16.1	21	
	3	0	0	0.0	26.5	12	NI
21	1	20	95	76.2	99.9	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
28	1	21	100	83.9	100.0	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
56	1	21	100	83.9	100.0	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
84	1	21	100	83.9	100.0	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
112	1	19	90	69.6	98.8	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	2	17	2.1	48.4	12	NI
140	1	21	100	83.9	100.0	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
168	1	20	95	76.2	99.9	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI

[0779] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. NI = Not included in statistical analysis. NA = Not applicable, no analysis conducted

[0780] Table 8.29 Summary of Group Frequency of Pigs with Positive PRRS-Antibody Titer by Day, DPC 0 through DPC 10

Day	Group[1]	N Positive	% Positive	95 % CI		Total Number	p value
D179 (DPC 0)	1	20	95	76.2	99.9	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
D182 (DPC 3)	1	20	95	76.2	99.9	21	**<0.0001**
	2	0	0	0.0	16.8	20	
	3	0	0	0.0	26.5	12	NI
D186 (DPC 7)	1	21	100	83.9	100.0	21	**<0.0001**
	2	6	30	11.9	54.3	20	
	3	0	0	0.0	26.5	12	NI
D189 (DPC 10)	1	21	100	83.9	100.0	21	**0.0478**
	2	16	80	56.3	94.3	20	
	3	0	0	0.0	26.5	12	NI

[0781] [1] Group 1 = PRRS 94881 MLV vaccine; Group 2 = Challenge control group; Group 3 = Negative control group. NI = Not included in statistical analysis.

[0782] DISCUSSION/CONCLUSION

[0783] To achieve the study objective, twenty-two (22) healthy, PRRS susceptible and seronegative pigs were inoculated IM with 1 mL of PRRS 94881 MLV at approximately 14 days of age. Thirty-four (22 pigs – challenge control group and 12 pigs – negative control group) PRRS susceptible and seronegative pigs were inoculated IM with 1 mL of control product at approximately 14 days of age.

[0784] Validation of the study and challenge model

[0785] Pigs in the negative control group remained negative for PRRSv (viremia; qPCR) throughout the study. Two pigs (Nos. 116 and 120) in the negative control group had positive ELISA titers on D112, while all other ELISA results for this group were negative. Considering that no viremia was detected in these pigs or in the group as whole; likewise, all other serum samples were ELISA negative, the results for these two pigs on D112 were considered false positives possibly due to an unassignable lab error. Thus, this was a valid study.

Unrelated to the establishment of a valid study, the negative control group had a median histological lung lesion score of 9.0 on D189 in contrast to a median gross lesion score of 0.0%. These data highlight that pigs housed under normal swine husbandry conditions for an extended period of time develop minor lung lesions that are inconsequential and not related to specific pathogens.

[0786] Following inoculation with European PRRS isolate 205817 by the method described earlier, the challenge control group exhibited a mean ADWG from DPC 0 to DPC 9 of 0.2 kg/day (a mean ADWG of 0.5 kg/day for the negative control group), a median gross lung lesion score of 13.8% (0.0% for the negative control group), a median histological lung lesion score of 19.5 (9.0 for the negative control group) and a median value of 6.25 $\log_{10}$ GE/mL for the detection of PRRSv RNA in lung tissue (median of 0.0 $\log_{10}$ GE/mL for negative control group). These results highlight that PRRS-specific clinical disease was induced in the challenge control group, thus validating this challenge model as an adequate clinical laboratory tool to evaluate PRRS vaccine efficacy and more specifically, 26 week duration of immunity of PRRS 94881 MLV.

[0787] Determination of 26 week duration of immunity of PRRS 94881 MLV

[0788] Determination of DOI for PRRS 94881 MLV of 26 weeks post-vaccination was based upon the vaccine group exhibiting a significant reduction ($p \leq 0.05$) in post-challenge lung lesions (gross or histological) compared with the challenge control group.

[0789] Gross and histological lung lesions were selected as the primary parameter for determination of 26 week DOI because this parameter provides the most clinically relevant and convincing evidence of efficacy when evaluating a new vaccine within the PRRS respiratory challenge model in pigs. Lung lesion development is one of the hallmarks of PRRS respiratory disease in pigs and can be considered the source for all subsequent manifestations of secondary PRRSv disease characteristics such as clinical signs, pyrexia, decreased ADWG, etc.

[0790] The PRRS 94881 MLV group exhibited a significant reduction in gross lung pathology post-challenge, as evidenced by a median gross lung lesion score of 0.1% in comparison to the challenge control group, which exhibited a median gross lung lesion score of 13.8% (**p<0.0001**). In addition, the PRRS 94881 MLV group exhibited a significant reduction in histological lung lesion scores, as evidenced by a median histology lung lesion score of 6.0 for the PRRS 94881 MLV group compared with a median histology lung lesion score of 19.5 for the challenge control group (**p<0.0001**). Thus, DOI of 26 weeks for PRRS 94881 MLV at dosage of $1 \times 10^{4.27}$ $TCID_{50}$ was established based upon the primary parameter of a significant reduction for lung lesions post-challenge. This result was achieved with a vaccine dose slightly lower than the targeted minimum immunizing dose of $1 \times 10^{4.5}$ $TCID_{50}$/mL. One challenge control pig (No. 123) could not be scored for gross lung lesions because of pleuritis and adhesions due to bacterial infections, but was scored for histological lung lesions. The omission of this pig from the challenge control group's gross lung lesion score analysis did not affect the outcome of this study.

[0791] Viremia post-challenge was selected as the most important secondary parameter because it represents the level of viral replication and persistence occurring within the host animal upon exposure. A significant reduction ($p \leq 0.05$) in viremia would correspond with a PRRS vaccine that induces adequate immunity to limit PRRS pathogenesis within the host. At 3, 7 and 10 days post-challenge, the PRRS 94881 MLV-vaccinated group demonstrated a significant reduction in viremia (qPCR) compared with the challenge control group (**p<0.0001**). To further evaluate post-challenge viremia between groups, the quantity of the viral load over a specific duration of time post-challenge was calculated, as represented as "area under curve" or AUC. The PRRS 94881 MLV-vaccinated group had a median AUC value from DPC 0 to DPC 10 of 15.54 log_{10} GE/mL/day; while the challenge control group had a median AUC value of 44.77 log_{10} GE/mL/day (**p<0.0001**). In addition, the PRRS 94881 MLV-vaccinated group had a median AUC value from DPC 3 to DPC 10 of 8.88 log_{10} GE/mL/day; while the challenge control group had a median AUC value for this period of 36.43 log_{10}

GE/mL/day (**p<0.0001**). Whether viremia was examined at specific time points post-challenge or over the course of the post-challenge period, PRRS 94881 MLV administered 26 weeks prior to challenge with a virulent heterologous European strain of PRRS significantly ($p \leq 0.05$) reduced viremia after challenge inoculation.

[0792] In association with a reduction of PRRS viremia post-challenge, a significant ($p \leq 0.05$) reduction in the viral load in lung tissue would also be of great importance from the standpoint of PRRS vaccine immunity. A reduction of viral load in the lung tissue may be associated with reduced viral stability, replication and persistence within the host and may secondarily lead to reduced shedding of PRRSv to other pigs. In this study, lung tissues from the PRRS 94881 MLV group had a median lung qPCR result of 3.69 $\log_{10}$ GE/mL 10 days post challenge (DPC 10) while the challenge control group had a median lung qPCR result of 6.25 $\log_{10}$ GE/mL. The difference between the vaccine group and the challenge control group was significant (**p<0.0001**), thus further supporting duration of immunity of 26 weeks.

[0793] A marked reduction in severity and frequency of clinical signs post-challenge in pigs would also be supportive of PRRS vaccine efficacy and establishment of DOI of 26 weeks for PRRS 94881 MLV. Only one pig exhibited clinical signs following challenge: pig 149 (challenge control) had a respiratory score of "1" (panting/rapid respiration) on D185. No pigs in the PRRS 94881 MLV-vaccinated group exhibited clinical signs during the post-challenge phase of this study and there were no statistical differences between the vaccinated and challenge control groups ($p=0.4878$ or no test conducted). Clinical signs post-challenge were not strong enough in this study to assess the DOI.

[0794] Pyrexia between groups varied post-challenge. PRRS 94881 MLV-vaccinated pigs exhibited significantly lower LS Mean rectal temperatures on two days (DPC 8 and DPC 10; (**p≤0.0183**) and higher LS Mean rectal temperatures on four days (DPC 0, DPC 2, DPC 4 and DPC 5; **p≤0.0281**) compared with challenge control pigs. Otherwise, no significant differences were detected between groups post-challenge ($p \geq 0.0642$). Although statistical differences between groups were

detected post-challenge, these differences were not biologically meaningful, considering that mean rectal temperatures remained ≤ 39.9 ºC (challenge control group, D182) for all groups. No difference was detected between groups with respect to the proportion of pigs with pyrexia for at least one day post-challenge (p=0.4537).

[0795] The presence of significant viremia, lung pathology and viral load in lung tissues due to PRRS in the challenge control group resulted in a significant (p≤0.05) difference between groups for body weight on DPC 9. In this study, the vaccinated and challenge control groups had LS mean body weights on DPC 9 of 138.3 kg and 130.3 kg, respectively (**p=0.0455**). The LS mean ADWG from DPC 0 to DPC 9 were 0.4 kg/day and 0.2 kg/day, for vaccinated and challenge groups, respectively. This difference was not statistically significant (p=0.1041).

[0796] Post-Vaccination Parameters Examined In This Study

[0797] Three pigs were found dead during the vaccination phase of this study. Pig 179 (PRRS 94881 MLV-vaccinated) was found dead on D6 associated with smooth *Escherichia coli* and *Enterococcus* spp. infections. Pig 161 (challenge control group) was found dead on D10 associated with *Bordetella bronchiseptica, Streptococcus* alpha haemolytic and *Staphylococcus auricularis* infections. Pig 124 (challenge control group) was found dead on D21 associated with a *Streptococcus suis* infection that lead to meningoencephalitis. To control and prevent any more deaths, pigs were mass treated with injectable vitamins and antibiotics. Following treatments, no more deaths occurred. Since deaths occurred in both treatment groups it can be assumed that the IVP itself was not associated with infections. More likely, pigs arrived at the research facility harboring these infections. Data for these pigs were included when available. Gross and histological lung lesion scores from these pigs were omitted from lung lesion analyses since these pigs died before challenge administration. The loss of one – PRRS 94881 MLV pig and two – challenge control pig during the extended time period from vaccination to challenge did not affect the outcome of the study.

[0798] No abnormal clinical assessments related to PRRS 94881 MLV vaccination or control product were observed in pigs following inoculation on D0. Seven pigs in the PRRS 94881 MLV-vaccinated group had abnormal assessments post-vaccination; while thirteen challenge control pigs had abnormal assessments. Excluding the three pigs that died due to bacterial infections, these abnormal assessments included thinness, coughing, swellings, rough hair coat, depression, abscesses and poor body condition at various time points, none of which lasted an extended period of time. In the author's opinion, these findings were not related to the administration of either experimental product, but rather are typical findings in growing/maturing pigs, under group housing situations, over an extended period of time.

[0799] All pigs were PRRS ELISA serology negative on D0, thus confirming that all pigs met the inclusion criterion of being PRRS sero-negative upon entry into the study. The majority of pigs (90%) receiving PRRS 94881 MLV sero-converted to PRRS by D14 and all PRRS-vaccinated pigs were seropositive by D28. Conversely, the challenge control pigs remained seronegative until 7 days post-challenge, when this group began to demonstrate PRRS seroconversion. As covered earlier, two – negative control pigs were PRRS ELISA seropositive on D112, which was considered an incidental finding, possible due to an unassignable lab error.

[0800] At 7, 14, 21 and 28 days post-vaccination, the PRRS 94881 MLV-vaccinated group exhibited median qPCR results of 3.00, 0, 0 and 3.00 $\log_{10}$ GE/mL, respectively. These results highlight that within 4 weeks post-vaccination, a dosage of $1 \times 10^{4.27}$ $TCID_{50}$ of PRRS 94881 MLV induced sufficient replication of the MLV that is often required to build protective immunity already at 4 weeks after vaccination. Conversely, the challenge control group was negative for PRRS viremia until three days post-challenge.

[0801] Conclusion

[0802] A significant reduction ($p \leq 0.05$) of gross and histological lung lesions at necropsy, viral load in lung tissues at necropsy and viremia post-challenge for

the PRRS 94881 MLV group compared to challenge control group demonstrated vaccine efficacy against virulent PRRSv when vaccinated at 2 weeks of age and challenged 26 weeks post-vaccination. The results of this study therefore support the demonstration of duration of immunity of 26 weeks post-vaccination with PRRS 94881 MLV. These results were achieved with a vaccine dose of $1 \times 10^{4.27}$ $TCID_{50}$/mL, which was slightly lower than the minimum immunizing dose ($1 \times 10^{4.5}$ $TCID_{50}$/mL).

[0803]

[0804] The sequences of the PRRSV 94881 attenuated strain and the parental strain are as follow:

SEQ ID NO:1: FULL LENGTH NUCLEOTIDE SEQUENCE OF PRRS Master Seed Virus of 94881

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   1 TTTGTGTACC TTGGAGGCGT GGGTACAGCC CTGCCCCACC CTTTGGTCCC TGTTCTAGCC
  61 CGACAAGTAC CCTTCTCTCT CGGGGCGAGC GCGCCGCCTG CTGCTCCCTT GCGGCGGGAA
 121 GGACCTCCCG AGTATTTCCG GAGAGCACCT GCTTTACGGG ATCTCCGCCC TTTAACCATG
 181 TCTGGGATGT TCTCCCGGTG CATGTGCACC CCGGCTGCCC GGGTATTTTG GAACGCCGGC
 241 CAAGTCTATT GCACACGGTG TCTCAGTGCA CGGTCTCTTC TCTCTCCAGA ACTTCAGGAC
 301 ACGGACCTCG GTGCAGTTGG CTTGTTTCAC AAGCCTAAAG ACAAGCTCCA TTGGAAAGTT
 361 CCCATTGGTA TCCCCCAGGT GGAATGTTCT CCATCTGGGT GTTGCTGGCT GTCAACCATT
 421 TTTCCTTTAG CGCGCATGAC CTCCGGCAAT CACAACTTCC TTCAACGACT CGTGAAGGTT
 481 GCTGATGTAT TGTACCGTGA CGGTTGCTTA ACCCCTAGAC ACCTCCGTGA ACTCCAAGTT
 541 TACGAGCGTG GTTGCAATTG GTATCCGATT ACGGGGCCTG TGCCTGGGAT GGCTGTGTAC
 601 GCGAACTCCA TGCACGTGTC CGACCAACCG TTCCCTGGTG CCACTCATGT GTTAACAAAT
 661 TCCCCTTTGC CTCAACGGGC TTGTCGGCAG CCGTTCTGTC CGTTCGAAGA GGCCCATTCT
 721 AGCATATACA GGTGGGAAAA ATTTGTAATT TTTATGGATT CCTCCTCCGA CGGTCGATCT
 781 CGCATGATGT GGACTCCGGA ATCCGATGAC TCCACGGCTT TGGAAGTTCT GCCGCCCGAG
 841 CTAGAACACC AGGTCAAGGT CCTTGTTCGG AGCTTTCCCG CCCATCACCT TGTCGACCTT
 901 GCCGATTGGG AGCTCACTGA GTCCCCTGAT AACGGTTTTT CCTTCAGCAC GTCACATCCT
 961 TGCGGCTACC TTGTTCGGGA CCCGGCTGTA TCCGAAGGCA AGTGTTGGCT TTCCTGCTTT
1021 TTGAGCCAGT CAGCCGAAGT GCTCAGTCGC GAGGCGCATC TGGCTACCGC CTATGGTTAC
1081 CAAACCAAGT GGGGTGTGCC TGGCAAGTAC ATCCAGCGCA GACTTCAAGT TCACGGTCTC
1141 CGTGCTGTGG TCGACCCTGA TGGTCCCATT CACGTTGAAG CATTGTCTTG CCCCCAGTCT
1201 TGGATCAGGC ACTTGACCCT GAATGATGAT GTCACCCCGG GATTCGTTCG CCTAATGTCT
1261 CTTCGCATTG TGCCGAACAC AGAGCCTACC ACACACCGGA TCTTTCGTTT TGGAGTGCAC
1321 AAGTGGTATG GTGCCGCCGG CAAACGGGCC CGTGGCAAGC GTGCCGCCAA AAGTGAGAAA
1381 GACTCGGCTT CCACCCTCAA GGTTGCCCGA CCGACTTCCA CCAGTGGAAT CGTCACCTAC
1441 TCCCCACCTG CGGACGGGTC TTGTGGTTGG CATGCCCTTG CCGCCATACT GAACCGGATG
1501 ATTAATAATG ACTTCACGTC CCCTCTGCCT CGGTACAACA GGCCGGAGGA CGATTGGGCT
1561 TCTGATGGTG ACCTTGCTCA GGCCATTCAA TGTTTGCAAC TACCTGCCGC CATAGCTCGG
1621 AACCGCGCCT GCCCTAACGC CAAATACCTC ATAAAACTCA ACGGAGTTCA TTGGGAGGTA
1681 GAGGTGAGGC CTGGAATGGC TCCTCGCTCC CTCTCTCGTG AGTGCGTTGT TGGCGTCTGC
1741 TCTGAAGGCT GTGTCGCGTC GCCTTACCCG GAGGACGGGT TGCCTAAACG TGCACTTGAG
1801 GCCCTGGCGT CTGCTTATAG ACTGCCTTCA GACTGTGTTT GTGATGGTAT TATTGACTTC
1861 CTTGCCAATC CACCTCCCCA GGAGTTCTGG ACTCTTGACA AAATGTTGAC TTCCCCGTCA
1921 CCGGAGCAGT CCGGCTTCTC TAGTCTGTAT AAATTGTTGT TAGAGATCTT GCCGCAGAAA
1981 TGCGGATCCA CAGAAGGGGA ATTCATCTAT ACTGTTGAGA GGATGTTGAA GGATTGTCCG
2041 AGCTCCAAAC AGGCCATGGC CCTCCTTGCA AAAATTAAGG TCCCATCCTC AAAGGCCCCA
2101 TCCGTGACTC TGAACGAGTG CTTCCCCACG GATGTTCCAG TCAACTCTGA GTTAATATCT
2161 TGGGAAGAGC CCAAAGACCC TGGCGCTGCT GTTGTCCTAT GTCCATCGGA TGCAAAAGAA
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2701 TCCGAAGCCA GTTCTGTCGT CGATGACCGG ACAAAAGAAG CTCCGGTGGT TGACGCCCCC
2761 ATCGATTTGA CAACTTCGAA CGAGACGCTC TCTGGGTCTG ACCCCTTTGA ATTCGCCAAA
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2941 AGTCGTGCGA CCCCAGCCAC CAAGAAGTGG CTCGACAAAA TGTGGGACAG GGTGGACATG
3001 AAAACTTGGC GCTGCACCTC GCAGTTCCAA GCTGGTCACA TTCTTGAGTC CCTCAAATTC
3061 CTCCCTGACA TGATTCAAGA CACACCGCCT CCTGTTCCCA GGAAGAACCG AGCTGGTGAC
3121 AGTGCCGGCC TGAAGCAACT GGTGGCGCAG TGGGATAGGA AATCGAGTGT GACACCCCCC
3181 ACAAAACCGG TTGGACCGGT GCTTGACCAG GCCGTCCCTC TGCCTATGGA CATCCAGCAA
3241 GGAGATGCCA TCTCCGCTGA CAAGCCACCC CATTCGCAAA ACCCTTCTAG TCAAGTAGAT
3301 GTGGGTGGAG GTTGGAAAAG TTTTATGCTC TCCGGCACCC GTTTCGCGGG GTCCGTTAGT
3361 CAGCGCCTTA CGACATGGGT TTTTGAGGTT CTCTCCCATC TCCCAGCTTT TATGCTCACA
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3541 TTTTCTGGTT CTGTGCGGTG TGTTCGTTTG GGTGTTTTTG GTTCTTGGAT GGCTTTTGCT
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3661 GAGTGTCATG CTGAGCTTTT GGCTCTTGAG CAGCGCCAAC TTTGGGAACC TGTGCGCAGC
3721 CTTGTGGTCG GGCCATCGGG CCTCTTATGC GTCATTCTTG GCAAGTTACT CGGTGGGTCA
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4381 CAGACCCCCC TCAGGAACTC TGTCCCCACC AAAACAACTG GTGGGGCCTC ATACACCCTT
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4621 ACCCTGCCAT TGTTCTCAGC CGTTGCCCAT CTTTCCGGTA GAGAGGTGGG GATTTTTATT
4681 TTGGTGCTTG CCTCCTTGGG CGCTTTAGCC CACCGCTTGG CTCTTAAGGC AGACATGTCA
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5581 ACTAGGCTCT CTGACCTTTC TAGACATTTT GCAGGTCCAA GCGTCCCTCT TGGGGACATT
5641 AAGTTGAGCC CAGCCATCAT CCCTGATGTG ACAACTATTC CGAGTGACTT GGCATCGCTC
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6361 TTTGTGTCCG CTTCAAACAT GAAAAATGCA GCTGGCCAAT ACATCGAGGC GGCGTATGCT
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6961 CCCCAACAGG GATTCGATCC AAAGTCCGAA GCCCCTGTTG GCACTGTTGT AATCGGTGGC
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7561 AGGTAGAACT AGAGTTGTCC AAGCAAATAA TCCAAGCATG TGAAGTCAGG CGCGGGGACG
7621 CCCCTAACCT CCAACTCCCC TACAAGCTTT ATCCTGTCAG GGGGGACCCC GAGCGGCGTA
7681 AAGGTCGCCT TGTCAACACT AGGTTTGGAG ATTTACCTTA CAAAACTCCC CAAGACACCA
7741 AGTCCGCAAT TCATGCGGCT TGTTGCCTGC ATCCCAATGG GGTCCTCGTG TCTGATGGCA
7801 AATCCACGCT GGGTACCACT CTTCAACATG GTTTCGAGCT TTATGTCCCC ACTGTACCTT
7861 ATAGTGTCAT GGAATACCTT GATTCACGCC CTGACACCCC TTTTATGTGT ACTAAACATG
7921 GCACTTCCAA GGCTGCTGCA GAGGACCTCC AAAAATATGA CCTATCCACT CAAGGGTTTG
7981 TCTTGCCTGG GGTCCTACGC CTAGTGCGCA GGTTCATCTT TAGCCATGTT GGTAAGGCGC
8041 CACCACTGTT CCTTCCATCA ACCTACCCTG CCAAGAACTC CATGGCAGGG GTCAATGGCC
8101 AGAGGTTCCC AACAAAGGAT GTCCAGAGCA TACCTGAAAT TGATGAAATG TGCGCCCGTG
8161 CCGTCAAGGA AAATTGGCAG ACTGTGACAC CTTGCACCCT CAAAAAACAG TACTGTTCCA
8221 AACCTAAAAC TAGAACCATC CTAGGTACCA ACAACTTCAT AGCCTTGGCT CACAGGTCAG
8281 CACTCAGTGG TGTCACCCAG GCGTTCATGA AGAAGGCCTG GAAGTCCCCA ATTGCCTTGG
8341 GGAAAAACAA GTTTAAGGAA TTGCATTGCA CTGTCGCCGG CAGATGCCTT GAGGCTGACC
8401 TGGCTTCCTG CGATCGCAGC ACCCCCGCCA TTGTGAGGTG GTTTGTTGCC AACCTCCTGT
8461 ATGAACTTGC AGGATGTGAA GAGTACTTGC CTAGCTACGT GCTCAACTGT TGCCATGACC
8521 TTGTGGCAAC GCAGGATGGC GCTTTCACAA AACGCGGTGG CCTGTCGTCC GGGGACCCCG
8581 TCACCAGTGT GTCCAACACC GTCTACTCAC TGATAATTTA CGCCCAGCAC ATGGTGCTTT
8641 CGGCCTTGAA GATGGGTCAT GAAATTGGTC TCAAGTTCCT TGAGGAACAG CTCAAATTTG
8701 AGGACCTTCT TGAAATCCAG CCCATGTTAG TGTATTCTGA TGACCTCGTC TTGTATGCGG
8761 AAAGACCCAC TTTTCCCAAC TACCATTGGT GGGTCGAGCA TCTTGACCTG ATGTTGGGCT
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 8821 TTAAAACGGA CCCAAAGAAA ACTGTCATAA CTGATAAACC CAGTTTTCTC GGCTGCAGAA
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 9001 CGTGTGCTTG CATTGACCAT GACCCCGAGT GGTATGAGGA TCTTATCTGC GGCATCGCCC
 9061 GGTGTGCTCG CCAGGACGGT TACCGTTTTC CAGGCCCGGC ATTTTTCATG TCCATGTGGG
 9121 AGAAGCTGAA AAGTCATAAT GAAGGGAAGA AATGCCGTCA CTGCGGCATC TGCGACGCCA
 9181 AAGCCGACTA TGCGTCCGCC TGTGGACTTG ATTTGTGTTT GTTCCATTCA CACTTTCATC
 9241 AACACTGCCC AGTCACTCTG AGCTGTGGCC ACCATGCCGG TTCAAAGGAA TGTTCGCAGT
 9301 GTCAGTCACC TGTCGGGGCT GGCAAATCCC CCCTTGACGC TGTGCTGAAA CAAATCCCGT
 9361 ACAAACCTCC TCGTACCATT ATCATGAAGG TGGACAACAA AACAACGACC CTTGACCCGG
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11821 TCCTATGAGG GCTTGCTACC CAACTGCAGA CCGGATGTCC CACAATTCGC AGTTAAGCAC
11881 CCGTTGGGTA TACTTTGGCA TATGCGAGTC TCCCACCTAA TTGACGAAAT GGTCTCTCGC
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11941 CGCATTTACC GGACCATGGA ACATTCGGGT CAAGCGGCCT GGAAGCAGGT TGTTAGTGAA
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12121 GTTGGCAATG TGAGCCTGGA GTACAACACT ACTTTGGACC GCGTTGAGCT CATCTTTCCC
12181 ACACCAGGTA CGAGGCCCAA GTTGACCGAT TTTAGGCAAT GGCTTATCAG CGTGCACGCT
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14581 CCCCTAGCTG CTGAAGATGA CATTCGGCAC CATCTCACCC AGGCCGAACG TTCCCTCTGC
14641 TTGCAATCGA TCCAGACGGC TTTCAATCAA GGCGCAGGAA CTGCGTCGCT TTCATCCAGC
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14821 CGCGATTGAC GTGTGGCCTC TAA
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SEQ ID NO: 2: ORF 1a OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1 BETWEEN NUCLEOTIDES 178..7227

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SEQ ID NO:3 ORF 1B OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1
BETWEEN NUCLEOTIDES 7209...11600

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VGVSSPGRAAKAVCTLTDVYLPELRPYLQPETASKCWKLKLDFRDVRLMVWKGATA
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SEQ ID NO:4 ORF 2 OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1
BETWEEN NUCLEOTIDES 11611..12360

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RIYRTMEHSGQAAWKQVVSEATLTKLSRLDVVTHFQHLAAVEADSCRFLSSRLAML
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SEQ ID NO:5 ORF 3 OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1 BETWEEN NUCLEOTIDES 12219..13016

MAYQRARFHLLLCGFVCYLVHSALASNSSSTLCFWFPLAHGNTSFELTINYTICKPC
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SEQ ID NO:6 ORF 4 OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1 BETWEEN NUCLEOTIDES 12761..13312

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CLLAILLAV

SEQ ID NO:7 ORF 5 OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1 BETWEEN NUCLEOTIDES 13309..13914

MKCSCKLGHFLTPHSCFWWLFLLCTGLSWSFVDGNDDSSTSQYIYNLTICELNGTE
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GVCAFAAFVCFVIRAAKNCMACRYARTRFTNFIVDDRGRIHRWKSSIVVEKLGKAEV
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SEQ ID NO:8 ORF 6 OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1 BETWEEN NUCLEOTIDES 13902..14423

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SAAGLHSIPASGNRAYAVRKPGLTSVNGTLVPGLRSLVLGGKRAVKRGVVNLVKYG
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SEQ ID NO:9 ORF 7 OF 94881 MSV ENCODED BY SEQUENCE OF SEQ ID NO:1 BETWEEN NUCLEOTIDES 14413..14799

MAGKNQSQKKRRNAAPMGKGQPVNQLCQLLGTMIKSQRQQSRGGQAKKKKPEKP
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SEQ ID NO:10 FULL LENGTH NUCLEOTIDE SEQUENCE OF PARENT PRRS STRAIN 94881

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 241 CAAGTCTATT GCACACGGTG TCTCAGTGCA CGGTCTCTTC TCTCTCCAGA ACTTCAGGAC
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LQTPTPLFENGPRHRSEDDDLKVERMKKHCVSLGFHKINGKVYCKIWDKSNGDTFYTDDSRYTQDHAFQDRSTDY
RDRDYEGVQTAPQQGFDPKSEAPVGTVVIGGITYNRHLVKGKEVLVPKPDNCLEAARLSLEQALAGMGQTCDLTA
TEVEKLKRIISQLQGLTTEQALNC

SEQ ID NO:12 ORF 1B OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 7209..11600

TGFKLLAASGLTRCGRGGLVVTETAVKIVKYHSRTFTLGSLDLKVTSEVEVKKSTEQGHAVVANLCSGVVLMRPH
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ALGKNKFKELHCTVAGRCLEADLASCDRSTPAIVRWFVANLLYELAGCEEYLPSYVLNCCHDLVATQDGAFTKRG
GLSSGDPVTSVSNTVYSLIIYAQHMVLSALKMGHEIGLKFLEEQLKFEDLLEIQPMLVYSDDLVLYAERPTFPNY
HWWVEHLDLMLGFKTDPKKTVITDKPSFLGCRIEAGRQLVPNRDRILAALAYHMKAQNASEYYASAAAILMDSCA
CIDHDPEWYEDLICGIARCARQDGYRFPGPAFFMSMWEKLKSHNEGKKCRHCGICDAKADYASACGLDLCLFHSH
FHQHCPVTLSCGHHAGSKECSQCQSPVGAGKSPLDAVLKQIPYKPPRTIIMKVDNKTTTLDPGRYQSRRGLVAVK
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VSALKVCRYSIPGASGLPFPPPARSGPWVRLIASGHVPGRVSYLDEAGYCNHLDILRLLSKTPLVCLGDLQQLHP
VGFDSYCYVFDQMPQKQLTTIYRFGPNICAAIQPCYREKLESKARNTRVVFTTRPVAFGQVLTPYHKDRTGSAIT
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REYLDAAEEEAARELPHAFIGDVKGTTVGGCHHITSKYLPRSLPKDSVAVVGVSSPGRAAKAVCTLTDVYLPELR
PYLQPETASKCWKLKLDFRDVRLMVWKGATAYFQLEGLTWSALPDYARFIQLPKDAVVYIDPCIGPATANRKVVR
TTDWRADLAVTPYDYGAQVILTTAWFEDLGPQWKILGLQPFRRTFGFENTEDWAILARRMNDGKDYTDYNWHCVR
ERPHAIYGRARDHTYHFALGTELQVELGRPRLPPEQVP

SEQ ID NO:13 ORF 2 OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 11611..12360

MQWVHCGVKSVSCSWMPSLSSLLVWLTLSSFSPYCLGSLLQAGYWSSFSEWFAPRFSVRALPFTLPNYRRSYEGL
LPNCRPDVPQFAVKHPLGILWHMRVSHLIDEMVSRRIYRTMEHSGQAAWKQVVSEATLTKLSRLDVVTHFQHLAA
VEADSCRFLSSRLAMLKNLAVGNVSLEYNTTLDRVELIFPTPGTRPKLTDFRQWLISVHASIFSSVASSVTLFTV
LWLRIPALRYVFGFHWPTATHHSN

SEQ ID NO:14 ORF 3 OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 12219..13016

MAYQRARFHLLLCGFVCYLVHSALASNSSSTLCFWFPLAHGNTSFELTINYTICKPCPTSQAAQQRLEPGRNVWC
KIGHDRCEERDHDELSMSIPSGYDNLKLEGYYAWLAFLSFSYAAQFHPELFGIGNVSRVFVDKRHQFICAEHDGQ
NSTISARHNISASYAVYYHHQIDGGNWFHLEWLRPFFSSWLVLNISWFLRRSPASPASRRIYQILRPTRPRLPVS
WSFRTSIVSNLTGPQQRKVPLPSGGRPNVVKPSAFPSTSR

SEQ ID NO:15 ORF 4 OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 12761..13312

MAATILFLLAGAQHLMVSEAFACKPCFSTHLSDIKTNTTAAAGFMVLQNINCFQSHRASTAQGTTPLRRSSQCRE
AVGIPQYITITANVTDESYLYNADLLMLSACLFYASEMSEKGFKVIFGNISGVVSACVNFTDYVAHVTQHTQQHH
LVIDHIRLLHFLTPSTMRWATTIACLFAILLAV

SEQ ID NO:16 ORF 5 OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 13309..13914

MKCSCKLGHFLTPHSCFWWLFLLCTGLSWSFVDGNDNSSTSQYIYNLTICELNGTEWLSGHFDWAVETFVLYPVA
THIISLGFLTTSHFLDALGLGAVSATGFIGERYVLSSMYGVCAFAALVCFVIRAAKNCMACRYARTRFTNFIVDD
RGRIHRWKSSIVVEKLGKAEVGGDLVNIKHVVLEGVKAQPLTRTSAEQWEA

SEQ ID NO:17 ORF 6 OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 13902..14423

MGSLDDFCNDPTAAQKLVLAFSITYTPIMIYALKVSRGRLLGLLHILIFLNCSFTFGYMTYVHFQSTNRVALTLG
AVVALLWGVYSLTESWKFITSRCRLCCLGRRYILAPAHHVESAAGLHSIPASGNRAYAVRKPGLTSVNGTLVPGL
RSLVLGGKRAVKRGVVNLVKYGR

SEQ ID NO:18 ORF 7 OF PARENTAL PRRSV STRAIN 94881 ENCODED BY SEQUENCE OF SEQ ID NO:10 BETWEEN NUCLEOTIDES 14413..14799

MAGKNQSQKKRRNAAPMGKGQPVNQLCQLLGTMIKSQRQQSRGGQAKKKKPEKPHFPLAAEDDIRHHLTQAERSL
CLQSIQTAFNQGAGTASLSSSGKVSFQVEFMLPVAHTVRLIRVTSTSASQGAN

SEQ ID NO:19 Nucleotide encoding attenuated PRRSV 94881 ORF1A

178 ATG
181 TCTGGGATGT TCTCCCGGTG CATGTGCACC CCGGCTGCCC GGGTATTTTG GAACGCCGGC

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 421 TTTCCTTTAG CGCGCATGAC CTCCGGCAAT CACAACTTCC TTCAACGACT CGTGAAGGTT
 481 GCTGATGTAT TGTACCGTGA CGGTTGCTTA ACCCCTAGAC ACCTCCGTGA ACTCCAAGTT
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1441 TCCCCACCTG CGGACGGGTC TTGTGGTTGG CATGCCCTTG CCGCCATACT GAACCGGATG
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1561 TCTGATGGTG ACCTTGCTCA GGCCATTCAA TGTTTGCAAC TACCTGCCGC CATAGCTCGG
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6361 TTTGTGTCCG CTTCAAACAT GAAAAATGCA GCTGGCCAAT ACATCGAGGC GGCGTATGCT
6421 AGAGCTCTGC GTCAGGAGCT GGCCTCCTTG GTTCAGGTTG ACAAGATGAA AGGAGTATTG
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SEQ ID NO:20 Nucleotide encoding attenuated PRRSV 94881 ORF1B

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10201 ACAAATCCCG AGCACTTGTA GCCATCACTC GGGCAAGACA TGGGTTGTTC ATTTATGACC
10261 CTCATGACCA ACTCCAGGAG TTTTTCAACT TAACCCCCGA GCGCACTGAT TGTAACCTTG
10321 CGTTCAGCCG TGGGGATGAG CTGGTTGTTT TGAATGTGGA TAATGCGGTC ACAACTGTAG
10381 CGAAGGCCCT AGAGACAGGT TCACCCCGAT TTCGAGTATC GGACCCGAGG TGCAAGTCTC
10441 TCTTAGCCGC TTGTTCGGCC AGTCTAGAAG GGAGCTGCAT GCCACTACCA CAAGTAGCAC
10501 ATAACCTGGG GTTTTACTTT TCCCCGGACA GCCCAGCTTT TGCACCCCTG CCAAAAGAGC
10561 TGGCGCCACA TTGGCCAGTG GTCACCCACC AGAATAATCG AGCGTGGCCT GATCGACTTG
10621 TCGCTAGTAT GCGCCCAATT GATGCCCGCT ACAGCAAGCC AATGGTCGGT GCAGGGTATG
10681 TGGTCGGGCC ATCCATTTTT CTTGGCACTC CTGGTGTGGT GTCATACTAT CTCACATTAT
10741 ACATCGGGGG CGAGCCTCAG GCCCTGCCAG AAACACTCGT TTCAACAGGA CGTATAGCCA
10801 CAGATTGTCG GGAATATCTC GACGCGGCTG AGGAAGAGGC AGCGAGAGAA CTTCCCCACG
10861 CATTTATTGG CGATGTCAAA GGCACTACGA TCGGGGGGTG TCACCACATT ACATCGAAAT
10921 ACCTACCTAG GTCCCTGCCT AAAGACTCTG TTGCTGTGGT TGGGGTGAGT TCGCCCGGTA
10981 GGGCTGCTAA AGCCGTGTGC ACTCTCACCG ATGTGTACCT CCCCGAACTC CGACCATATT
11041 TGCAACCGGA GACGGCATCA AAATGCTGGA AACTTAAACT GGATTTCAGG GATGTTCGAC
11101 TGATGGTCTG GAAAGGCGCC ACAGCCTATT TCCAGTTGGA AGGGCTGACA TGGTCAGCGC
11161 TGCCCGATTA TGCTAGGTTC ATTCAGCTAC CCAAGGATGC CGTTGTGTAC ATCGATCCGT
11221 GTATAGGGCC GGCAACAGCC AATCGCAAGG TTGTGCGAAC CACAGACTGG CGGGCCGACC
11281 TGGCAGTGAC ACCGTATGAT TACGGTGCTC AGGTCATTTT GACAACAGCC TGGTTCGAGG
11341 ACCTTGGGCC GCAGTGGAAG ATTTTGGGGT TGCAGCCTTT CAGACGAACA TTTGGCTTTG
11401 AGAACACTGA AGATTGGGCA ATTCTCGCAC GCCGTATGAA TGACGGCAAA GATTACACTG
11461 ACTATAATTG GCATTGTGTA CGAGAACGCC CACACGCAAT TTACGGGCGC GCCCGTGACC
11521 ATACGTATCA TTTTGCCCTT GGCACTGAAC TGCAAGTAGA GCTGGGCAGA CCCCGGCTGC
11581 CTCCTGAGCA AGTGCCGTGA
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SEQ ID NO:21 Nucleotide encoding attenuated PRRSV 94881 ORF2

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11611 ATGCAATGGG TTTACTGTGG AGTAAAATCA
11641 GTCAGTTGTT CGTGGATGCC TTCACTGAGT TCCTTGTTAG TGTGGTTGAC ATTGTCATCT
11701 TTCTCGCCAT ATTGTTTGGG TTCACTGTTG CAGGCTGGTT ATTGGTCTTC CTTCTCAGAG
11761 TGGTTTGCTC CGCGTTTCTC CGTTCGCGCT CTGCCATTCA CTCTTCCGAA CTATCGAAGG
11821 TCCTATGAGG GCTTGCTACC CAACTGCAGA CCGGATGTCC CACAATTCGC AGTTAAGCAC
11881 CCGTTGGGTA TACTTTGGCA TATGCGAGTC TCCCACCTAA TTGACGAAAT GGTCTCTCGC
11941 CGCATTTACC GGACCATGGA ACATTCGGGT CAAGCGGCCT GGAAGCAGGT TGTTAGTGAA
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12001 GCCACTCTCA CAAAACTGTC AAGGCTTGAC GTAGTCACTC ATTTCCAACA CCTGGCCGCA
12061 GTGGAGGCTG ATTCTTGCCG CTTCCTTAGC TCACGACTCG CGATGCTGAA AAACCTTGCC
12121 GTTGGCAATG TGAGCCTGGA GTACAACACT ACTTTGGACC GCGTTGAGCT CATCTTTCCC
12181 ACACCAGGTA CGAGGCCCAA GTTGACCGAT TTTAGGCAAT GGCTTATCAG CGTGCACGCT
12241 TCCATCTTCT CCTCTGTGGC TTCGTCTGTT ACCTTGTTCA CAGTGCTTTG GCTTCGAATT
12301 CCAGCTCTAC GCTATGTTTT TGGTTTCCAT TGGCCCACGG CAACACATCA TTCGAACTAA
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SEQ ID NO:22 Nucleotide encoding attenuated PRRSV 94881 ORF3

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12219 AT GGCTTATCAG CGTGCACGCT
12241 TCCATCTTCT CCTCTGTGGC TTCGTCTGTT ACCTTGTTCA CAGTGCTTTG GCTTCGAATT
12301 CCAGCTCTAC GCTATGTTTT TGGTTTCCAT TGGCCCACGG CAACACATCA TTCGAACTAA
12361 CTATCAATTA CACTATATGT AAGCCATGCC CTACCAGTCA AGCTGCCCAA CAAAGACTCG
12421 AGCCTGGCCG TAACGTGTGG TGCAAAATAG GGCACGACAG GTGTGAGGAA CGTGACCATG
12481 ATGAGTTGTC AATGTCCATT CCGTCCGGGT ACGACAACCT CAAACTTGAG GGTTATTATG
12541 CTTGGCTGGC TTTTTTGTCC TTTTCCTACG CGGCCCAATT CCATCCGGAG CTGTTCGGAA
12601 TAGGAAACGT GTCGCGCGTC TTTGTGGATA AGCGACACCA GTTCATTTGC GCCGAGCATG
12661 ATGGACAAAA TTCAACCATA TCTGCCAGAC ACAACATCTC CGCGTCGTAT GCGGTGTATT
12721 ACCATCATCA AATAGACGGG GGCAATTGGT TTCATTTGGA ATGGCTGCGA CCATTCTTTT
12781 CCTCCTGGCT GGTGCTCAAC ATCTCATGGT TTCTGAGGCG TTCGCCTGCA AGCCCTGCTT
12841 CTCGACGCAT CTATCAGATA TTAAGACCAA CACGACCGCG GCTGCCGGTT TCATGGTCCT
12901 TCAGAACATC AATTGTTTCC AATCTCACAG GGCCTCAACA GCGCAAGGTA CCACTCCCCT
12961 CAGGAGGTCG TCCCAATGTC GTGAAGCCGT CGGCATTCCC CAGTACATCA CGATAA
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SEQ ID NO:23 Nucleotide encoding attenuated PRRSV 94881 ORF4

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12761 ATGGCTGCGA CCATTCTTTT
12781 CCTCCTGGCT GGTGCTCAAC ATCTCATGGT TTCTGAGGCG TTCGCCTGCA AGCCCTGCTT
12841 CTCGACGCAT CTATCAGATA TTAAGACCAA CACGACCGCG GCTGCCGGTT TCATGGTCCT
12901 TCAGAACATC AATTGTTTCC AATCTCACAG GGCCTCAACA GCGCAAGGTA CCACTCCCCT
12961 CAGGAGGTCG TCCCAATGTC GTGAAGCCGT CGGCATTCCC CAGTACATCA CGATAACGGC
13021 TAATGTGACC GATGAATCGT ATTTGTACAA CGCGGACTTG CTGATGCTTT CCGCGTGCCT
13081 TTTCTACGCC TCGGAAATGA GCGAGAAAGG CTTCAAAGTC ATCTTTGGGA ATATTTCTGG
13141 CGTTGTTTCC GCTTGTGTTA ATTTCACAGA TTATGTGGCC CATGTGACCC AACACACTCA
13201 GCAGCACCAT TTGGTAATTG ATCACATTCG GTTACTACAC TTCTTGACAC CGTCTACGAT
13261 GAGGTGGGCT ACAACCATTG CTTGTTTGCT TGCCATTCTT TTGGCGGTAT GA
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SEQ ID NO:24 Nucleotide encoding attenuated PRRSV 94881 ORF5

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13309 AT GAAATGTTCT
13321 TGCAAGTTGG GGCATTTCTT GACTCCTCAC TCTTGCTTCT GGTGGCTTTT TTTGCTGTGT
13381 ACCGGCTTGT CTTGGTCCTT TGTCGATGGC AACGACGACA GCTCGACATC CCAATACATA
13441 TATAATTTGA CGATATGCGA GCTGAATGGG ACCGAATGGT TGTCCGGTCA TTTTGATTGG
13501 GCAGTCGAAA CCTTTGTGCT TTACCCAGTT GCCACTCATA TCATTTCACT GGGTTTTCTC
13561 ACAACAAGCC ATTTCCTTGA TGCGCTCGGT CTCGGCGCTG TGTCCGCCAC AGGATTCATT
13621 GGCGAGCGGT ATGTACTTAG CAGCATGTAC GGCGTTTGCG CCTTCGCGGC GTTCGTATGT
13681 TTTGTCATCC GTGCTGCTAA AAATTGCATG GCTTGCCGCT ATGCCCGCAC CCGGTTTACC
13741 AACTTCATCG TGGACGACCG GGGAAGAATC CATCGATGGA AGTCTTCAAT AGTGGTGGAG
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13801 AAATTGGGCA AAGCTGAAGT CGGTGGTGAC CTTGTCAACA TTAAGCATGT TGTCCTCGAA
13861 GGGGTTAAAG CTCAACCTTT GACGAGGACT TCGGCTGAGC AATGGGAAGC CTAG
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SEQ ID NO:25 Nucleotide encoding attenuated PRRSV 94881 ORF6

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13902  ATGGGAAGC CTAGACGACT
13921 TTTGCAACGA TCCCACCGCC GCACAAAAAC TCGTGCTGGC CTTTAGCATC ACATATACAC
13981 CCATAATGAT ATACGCCCTT AAGGTGTCAC GCGGCCGACT CCTGGGGCTG TTGCACATCT
14041 TGATATTTCT GAATTGTTCC TTTACTTTTG GGTACATGAC ATATGTGCAT TTTCAATCCA
14101 CCAACCGTGT CGCATTCACT CTGGGGGCTG TAGTCGCCCT TTTGTGGGGT GTTTACAGCC
14161 TCACAGAGTC ATGGAAGTTC ATCACTTCCA GATGCAGATT GTGTTGCCTA GGCCGGCGAT
14221 ACATTCTGGC CCCTGCCCAT CACGTAGAAA GTGCTGCAGG CCTCCATTCA ATCCCAGCGT
14281 CTGGTAACCG AGCATACGCT GTGAGAAAGC CCGGACTAAC ATCAGTGAAC GGCACTCTAG
14341 TACCTGGGCT TCGGAGCCTC GTGCTGGGCG GCAAACGAGC TGTTAAACGA GGAGTGGTTA
14401 ACCTCGTCAA GTATGGCCGG TAA
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SEQ ID NO:26 Nucleotide encoding attenuated PRRSV 94881 ORF7

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14413   ATGGCCGG TAAGAACCAG AGCCAGAAGA AAAGAAGAAA TGCAGCTCCG
14461 ATGGGGAAAG GCCAGCCAGT CAATCAACTG TGCCAGTTGC TGGGTACAAT GATAAAGTCC
14521 CAGCGCCAGC AATCTAGGGG AGGACAGGCC AAAAAGAAGA AGCCTGAGAA GCCACATTTT
14581 CCCCTAGCTG CTGAAGATGA CATTCGGCAC CATCTCACCC AGGCCGAACG TTCCCTCTGC
14641 TTGCAATCGA TCCAGACGGC TTTCAATCAA GGCGCAGGAA CTGCGTCGCT TTCATCCAGC
14701 GGGAAGGTCA GTTTCCAGGT TGAGTTCATG CTGCCGGTTG CTCATACAGT GCGCCTGATT
14761 CGCGTGACTT CTACATCCGC CAGTCAGGGT GCAAATTAAT TTGACAGTCA GGTGAATGGC
14821 CGCGATTGAC GTGTGGCCTC TAA
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SEQ ID NO:27 Nucleotide encoding parental PRRSV 94881 ORF1a

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  178        ATG
  181 TCTGGGATGT TCTCCCGGTG CATGTGCACC CCGGCTGCCC GGGTATTTTG GAACGCCGGC
  241 CAAGTCTATT GCACACGGTG TCTCAGTGCA CGGTCTCTTC TCTCTCCAGA ACTTCAGGAC
  301 ACGGACCTCG GTGCAGTTGG CTTGTTTCAC AAGCCTAAAG ACAAGCTCCA TTGGAAAGTT
  361 CCCATTGGTA TCCCCCAGGT GGAATGTTCT CCATCTGGGT GTTGCTGGCT GTCAACCATT
  421 TTTCCTTTAG CGCGCATGAC CTCCGGCAAT CACAACTTCC TTCAACGACT CGTGAAGGTT
  481 GCTGACGTAT TGTACCGTGA CGGTTGCTTA ACCCCTAGAC ACCTCCGTGA ACTCCAAGTT
  541 TACGAGCGTG GTTGCAATTG GTATCCGATT ACGGGGCCTG TGCCTGGGAT GGCTGTGTAC
  601 GCGAACTCCA TGCACGTGTC CGACCAACCG TTCCCTGGTG CCACTCATGT GTTAACAAAT
  661 TCCCCTTTGC CTCAACGGGC TTGTCGGCAG CCGTTCTGTC CGTTCGAAGA GGCCCATTCT
  721 AGCATATACA GGTGGGAAAA ATTTGTAATT TTTATGGATT CCTCCTCCGA CGGTCGATCT
  781 CGCATGATGT GGACTCCGGA ATCCGATGAC TCCACGGCTT TGGAAGTTCT GCCGCCCGAG
  841 CTAGAACACC AGGTCAAGGT CCTTGTTCGG AGCTTTCCCG CCCATCACCT TGTCGACCTT
  901 GCCGATTGGG AGCTCACTGA GTCCCCTGAG AACGGTTTTT CCTTCAGCAC GTCACATCCT
  961 TGCGGCTACC TTGTTCGGGA CCCGGCTGTA TCCGAAGGCA AGTGTTGGCT TTCCTGCTTT
 1021 TTGAGCCAGT CAGCCGAAGT GCTCAGTCGC GAGGCGCATC TGGCTACCGC CTATGGTTAC
 1081 CAAACCAAGT GGGGTGTGCC TGGCAAGTAC ATCCAGCGCA GACTTCAAGT TCACGGTCTC
 1141 CGTGCTGTGG TCGACCCTGA TGGTCCCATT CACGTTGAAG CATTGTCTTG CCCCCAGTCT
 1201 TGGATCAGGC ACTTGACCCT GAATGATGAT GTCACCCCGG GATTCGTTCG CCTAATGTCT
 1261 CTTCGCATTG TGCCGAACAC AGAGCCTACC ACACACCGGA TCTTTCGTTT TGGAGTGCAC
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1321 AAGTGGTATG GTGCCGCCGG CAAACGGGCC CGTGGCAAGC GTGCCGCCAA AAGTGAGAAA
1381 GACTCGGCTT CCACCCTCAA GGTTGCCCGA CCGACTTCCA CCAGTGGAAT CGTCACCTAC
1441 TCCCCACCTG CGGACGGGTC TTGTGGTTGG CATGCCCTTG CCGCCATACT GAACCGGATG
1501 ATTAATAATG ACTTCACGTC CCCTCTGCCT CGGTACAACA GGCCGGAGGA CGATTGGGCT
1561 TCTGATGGTG ACCTTGCTCA GGCCATTCAA TGTTTGCAAC TACCTGCCGC CATAGCTCGG
1621 AACCGCGCCT GCCCTAACGC CAAATACCTC GTAAAACTCA ACGGAGTTCA TTGGGAGGTA
1681 GAGGTGAGGC CTGGAATGGC TCCTCGCTCC CTCTCTCGTG AGTGCGTTGT TGGCGTCTGC
1741 TCTGAAGGCT GTGTCGCGTC GCCTTACCCG GAGGACGGGT TGCCTAAACG TGCACTTGAG
1801 GCCCTGGCGT CTGCTTATAG ACTGCCTTCA GACTGTGTTT GTGATGGTAT TATTGACTTC
1861 CTTGCCAATC CACCTCCCCA GGAGTTCTGG ACTCTTGACA AAATGTTGAC TTCCCCGTCA
1921 CCGGAGCAGT CCGGCTTCTC TAGTCTGTAT AAATTGTTGT TAGAGGTCTT GCCGCAGAAA
1981 TGCGGATCCA CAGAAGGGGA ATTCATCTAT ACTGTTGAGA GGATGTTGAA GGATTGTCCG
2041 AGCTCCAAAC AGGCCATGGC CCTCCTTGCA AAAATTAAGG TCCCATCCTC AAAGGCCCCA
2101 TCCGTGACTC TGAACGAGTG CTTCCCCACG GATGTTCCAG TCAACTCTGA GTTAATATCT
2161 TGGGAAGAGC CCAAAGACCC TGGCGCTGCT GTTGTCCTAT GTCCATCGGA TGCAAAAGAA
2221 TCTAAGGAAA CAGCCCCTGA AGAAGCTCAA GCGAGAAACC GTAAGGTCCT CCACCCTGTG
2281 GTCCTTACCG AGGAACTTAG CGAGCAACAG GTGCAGGTGG TTGAGGGTGA TCAGGATATG
2341 CCACTGGATT TGACTTGGCC AACCTTAACC GCTACGGCGA CCCCTGTTAG AGGGCCGGTA
2401 CCGGACAATT TGAGCTCTGG CATTGGTGCC CAGCCCGCTA CCGTTCAAGA ACTCATTCTG
2461 GCGAGGCCTG CACCCCGTCT TGTTGAGCGC TGTGGCACGG AGTCGAACGG CAGCAGTTCA
2521 TTTCTGGATT TGCCTGACGT GCAGACCTCG GACCAGCCTT TAGACCTGTC CCTGGCCGCG
2581 TGGCCTGTAA GGGCTACCGC GTCTGACCCC GGTTGGATCC ACGGTAGGCG TGAGCCTGTC
2641 TTTGTGAAGC CTCGAGGTGT TTTCTCTGAT GGCGAGTCGG CCCTTCAGTT CGGAGAGCTT
2701 TCCGAAGCCA GTTCTGTCGT CGATGACCGG ACAAAAGAAG CTCCGGTGGT TGACGCCCCC
2761 ATCGATTTGA CAACTTCGAA CGAGACGCTC TCTGGGTCTG ACCCCTTTGA ATTCGCCAAA
2821 TTCAGGCGCC CGCGTTTCTC CGCGCAAGCT TTAATCGACC GAGGTGGTCC GCTTGCCGAT
2881 GTTCATGCAA AGATAAAGAG TCGGGTATAT GAACAATGCC TTCAAGCTTG TGAACCTGGT
2941 AGTCGTGCGA CCCCAGCCAC CAAGAAGTGG CTCGACAAAA TGTGGGACAG GGTGGACATG
3001 AAAACTTGGC GCTGCACCTC GCAGTTCCAA GCTGGTCACA TTCTTGAGTC CCTCAAATTC
3061 CTCCCTGACA TGATTCAAGA CACACCGCCT CCTGTTCCCA GGAAGAACCG AGCTGGTGAC
3121 AGTGCCGGCC TGAAGCAACT GGTGGCGCAG TGGGATAGGA AATTGAGTGT GACACCCCCC
3181 ACAAAACCGG TTGGACCGGT GCTTGACCAG ACCGTCCCTC TGCCTATGGA CATCCAGCAA
3241 GAAGATGCCA TCTCCGCTGA CAAGCCACCC CATTCGCAAA ACCCTTCTAG TCAAGTAGAT
3301 GTGGGTGGAG GTTGGAAAAG TTTTATGCTC TCCGGCACCC GTTTCGCGGG GTCCGTTAGT
3361 CAGCGCCTTA CGACATGGGT TTTTGAGGTT CTCTCCCATC TCCCAGCTTT TATGCTCACA
3421 CTTTTCTCGC CACGGGGCTC TATGGCTCCA GGTGATTGGC TGTTTGCAGG TGCTGTTCTA
3481 CTTGCTCTCC TGCTCTGCCG TTCTTACCCA ATACTCGGAT GCCTTCCCTT ATTGGGTGTC
3541 TTTTCTGGTT CTGTGCGGTG TGTTCGTTTG GGTGTTTTTG GTTCTTGGAT GGCTTTTGCT
3601 GTATTTTTAT TCTCGACTCC ACCCGACCCA GTCGGTTCTT CTTGTGACCA CGATTCGCCG
3661 GAGTGTCATG CTGAGCTTTT GGCTCTTGAG CAGCGCCAAC TTTGGGAACC TGTGCGCAGC
3721 CTTGTGGTCG GGCCATCGGG CCTCTTATGC GTCATTCTTG GCAAGTTACT CGGTGGGTCA
3781 CGTTGTCTCT GGTTTGTTCT CCTACGTATA TGCATGCTCG CAGATTTGGC AATTTCTCTT
3841 ATTTATGTGG TGTCCCAAGG GCGTTGTCAC AAGTGTTGGG GAAAGTGTAT AAGGACGGCT
3901 CCTGCAGAAG TGACCCTTAA TGTGTTTCCT TTTTCGCGCG CCACCCGCTC ATCTCTTGTG
3961 TCCTTGTGTG ATCGGTTCCA AGCGCCAAAA GGAGTTGACC CCGTGCACTT GGCGACAGGC
4021 TGGCGCGGGT GCTGGTGTGG TGAGAGCCCT ATTCATCAAT CACACCAAAA ACCGATAGCT
4081 TATGCCAACT TGGATGAAAA GAAGATATCC GCCCAGACGG TGATTGCTGT CCCGTATGAT
4141 CCCAGTCAGG CCATTAAATG CCTGAAAGTT TTGCAGGCAG GAGGGGCTAT TGTGGACCAG
4201 CCTACGCCCG AGGTCGTCCG TGTGTCTGAG ATTCCCTTCT CGGCCCCATT TTTTCCGAAG
4261 GTCCCAGTCA ACCCAGATTG CAGGGTTGTG GTAGATTCGG ACACTTTTGT GGCTGCGGTC
4321 CGCTGCGGTT ATTCGACAGC ACAACTGGTC CTTGGTCGGG GCAACTTTGC CAAGCTAAAT
4381 CAGACCCCCC TCAGGAACTC TGTCCCCACC AAAACAACTG GTGGGGCCTC ATACACCCTT
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4441 GCCGTGGCCC AGGTATCTGT GTGGACTCTT GTTCATTTCA TCCTCGGCCT TTGGTTAACG
4501 TCACCTCAAG TGTGTGGTCG AGGGACCTCT GACCCGTGGT GTTCGAACCC TTTTTCGTAT
4561 CCTACTTATG GCCCCGGAGT TGTGTGTTCC TCTCGACTCT GCGTGTCTGC CGACGGAGTT
4621 ACCCTGCCAT TGTTCTCAGC CGTTGCCCAT CTTTCCGGTA GAGAGGTGGG GATTTTTATT
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4981 TATACCTCCG GACCACGTGG TGCAGCTGCT GTAGCAACGG CTCCAGAAGG TACTTACATG
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5281 ATGCACACGT TCAATACTAA TGGTGATTAT GCCTGGTCCC ATGCTGATGA CTGGCAAGGC
5341 GTTGCCCCTA TGGTTAAGAT CGCTAAGGGG TATCGCGGTC GTGCCTACTG GCAAACGTCA
5401 ACCGGAGTCG AACCTGGCAT CATGGGGGAA GGATTCGCCT TCTGTTTCAC TAACTGTGGC
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5521 AACAAACTCG GTTCTGGTCT TGTGACAACC CCTGAAGGGG AGACCTGCTC CATCAAGGAA
5581 ACTAGGCTCT CTGACCTTTC TAGACATTTT GCAGGTCCAA GCGTCCCTCT TGGGGACATT
5641 AAGTTGAGCC CAGCCATCAT CCCTGATGTG ACAACTATTC CGAGTGACTT GGCATCGCTC
5701 CTTGCTTCTG TCCCCGTGAT GGAAGGTGGC CTCTCAACTG TCCAGCTTTT GTGCGTCTTT
5761 TTCCTTCTCT GGCGCATGAT GGGCCATGCC TGGACACCCA TTGTTGCCGT AGGCTTCTTT
5821 TTGCTGAATG AAATTCTCCC AGCAGTCTTG GTCCGAGCTG TGTTCTCTTT TGCACTCTTT
5881 GTACTTGCAT GGGCCACCCC CTGGTCGGCA CAAGTGTTGA TGATTAGACT CCTCACGGCG
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6001 GCCACAGAAA TCGGGACTTT TGCTGGTGGA TGGCCTGAAC TGTCCCAAGC CCTCTCGACA
6061 TACTGCTTCC TGCCCAGGTT CCTTGCTGTG ACTAGTTATG TCCCCACCAT CATCATCGGT
6121 GGGCTCCATG CCCTCGGCGT AATTTTGTGG TTATTCAAAT ACCGATGCCT CCACAACATG
6181 CTGGTTGGTG ATGGGAGTTT CTCAAGCGCT TTCTTCCTAC GGTATTTTGC TGAGGGTAAT
6241 CTTAGGAAAG GCGTGTCGCA GTCCTGTGGC ATGAATAACG AATCCCTGAC AGCTGCTTTG
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6361 TTTGTGTCCG CTTCAAACAT GAAAAATGCA GCTGGCCAAT ACATCGAGGC GGCGTATGCT
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6481 GCCAAGCTCG AGGCTTTCGC TGAGACGGCC ACTCCGTCAC TTGACACAGG TGACGTGATT
6541 GTTCTGCTTG GGCAACACCC CCATGGATCC ATCCTCGACA TTAATGTGGG GGGTGAAAGG
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6661 GTCGTGTCCA ACACGCCCGT GGATACCTTG ACCGGCATCC CACTTCAGAC GCCAACCCCA
6721 CTTTTTGAAA ATGGCCCGCG CCATCGCAGC GAGGACGACG ACCTTAAAGT TGAGAGAATG
6781 AAAAAACACT GTGTATCCCT CGGCTTCCAC AAAATCAATG GTAAAGTTTA CTGCAAAATT
6841 TGGGACAAGT CTAACGGCGA CACCTTTTAC ACGGATGATT CCCGATACAC TCAAGACCAT
6901 GCTTTTCAGG ACAGGTCAAC CGACTATAGA GACAGGGATT ATGAAGGTGT ACAGACCGCC
6961 CCCCAACAGG GATTCGATCC AAAGTCCGAA GCCCCTGTTG GCACTGTTGT AATCGGTGGC
7021 ATTACGTATA ACAGGCATCT GGTCAAAGGT AAGGAGGTCC TAGTTCCCAA ACCTGACAAC
7081 TGCCTTGAAG CTGCCAGACT GTCCCTTGAG CAAGCTCTTG CTGGGATGGG CCAAACTTGT
7141 GACCTTACAG CTACCGAAGT GGAGAAACTA AAGCGCATCA TTAGTCAACT CCAAGGTCTG
7201 ACCACTGAAC AGGCTTTAAA CTGCTAGCCG CCAGCGGCTT GACCCGCTGT GGCCGCGGCG
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SEQ ID NO:28 Nucleotide encoding parental PRRSV 94881 ORF1b

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 7261 GCCTAGTTGT AACTGAAACG GCGGTAAAAA TCGTAAAATA CCACAGCAGA ACTTTCACCT
 7321 TAGGCTCTTT AGACCTAAAA GTCACCTCCG AGGTGGAGGT GAAGAAATCA ACTGAGCAGG
 7381 GGCACGCTGT CGTGGCGAAC TTATGTTCCG GTGTCGTCTT GATGAGGCCT CACCCACCGT
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 7501 ATGGGGCCGG GAATATGGGC GTGAACGGTT CTATTTGGGA TTTTGAAACT GCACCCACAA
 7561 AGGTAGAACT AGAGTTGTCC AAGCAAATAA TCCAAGCATG TGAAGTCAGG CGCGGGGACG
 7621 CCCCTAACCT CCAACTCCCC TACAAGCTTT ATCCTGTCAG GGGGGACCCC GAGCGGCGTA
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 9181 AAGCCGACTA TGCGTCCGCC TGTGGACTTG ATTTGTGTTT GTTCCATTCA CACTTTCATC
 9241 AACACTGCCC AGTCACTCTG AGCTGTGGCC ACCATGCCGG TTCAAAGGAA TGTTCGCAGT
 9301 GTCAGTCACC TGTCGGGGCT GGCAAATCCC CCCTTGACGC TGTGCTGAAA CAAATCCCGT
 9361 ACAAACCTCC TCGTACCATT ATCATGAAGG TGGACAACAA AACAACGACC CTTGACCCGG
 9421 GAAGATATCA GTCCCGTCGA GGTCTTGTTG CAGTCAAAAG AGGTATTGCA GGTAATGAGG
 9481 TTGATCTTTC TGATGGAGAC TACCAAGTGG TGCCTCTTTT GCCGACTTGC AAAGACATAA
 9541 ACATGGTGAA GGTGGCTTGC AACGTACTAC TCAGCAAGTT TATAGTAGGG CCGCCAGGTT
 9601 CCGGAAAAAC CACCTGGCTA CTGAACCAAG TCCAGGACGA TGATGTCATT TACACACCTA
 9661 CTCATCAGAC AATGTTTGAC ATAGTCAGTG CTCTTAAAGT TTGCAGGTAT TCCATCCCAG
 9721 GAGCCTCAGG ACTCCCTTTT CCACCACCTG CCAGGTCCGG GCCGTGGGTT AGGCTCATCG
 9781 CCAGCGGACA TGTCCCTGGC CGAGTGTCAT ATCTCGATGA GGCAGGATAT TGCAATCATC
 9841 TAGACATTCT AAGGCTGCTT TCCAAAACAC CCCTTGTGTG TTTGGGTGAC CTTCAGCAAC
 9901 TTCACCCGGT CGGCTTTGAT TCCTATTGTT ATGTGTTCGA TCAGATGCCT CAGAAGCAGC
 9961 TGACCACCAT TTATAGATTT GGCCCTAACA TCTGTGCAGC CATCCAGCCT TGTTACAGGG
10021 AGAAACTTGA ATCCAAGGCC AGGAACACCA GAGTGGTTTT CACCACCCGG CCTGTGGCCT
10081 TTGGTCAGGT CCTGACACCG TACCACAAAG ATCGTACCGG CTCTGCAATA ACTATAGATT
10141 CATCCCAGGG GGCGACCTTC GACATTGTGA CATTGCATCT ACCATCGCCA AAGTCCCTAA
10201 ACAAATCCCG AGCACTTGTA GCCATCACTC GGGCAAGACA TGGGTTGTTC ATTTATGACC
10261 CTCATGACCA ACTCCAGGAG TTTTTCAACT TAACCCCCGA GCGCACTGAT TGTAACCTTG
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10321 CGTTCAGCCG TGGGGATGAG CTGGTTGTTT TGAATGTGGA TAATGCGGTC ACAACTGTAG
10381 CGAAGGCCCT AGAGACAGGT TCACCCCGAT TTCGAGTATC GGACCCGAGG TGCAAGTCTC
10441 TCTTAGCCGC TTGTTCGGCC AGTCTAGAAG GGAGCTGCAT GCCACTACCA CAAGTAGCAC
10501 ATAACCTGGG GTTTTACTTT TCCCCGGACA GCCCAGCTTT TGCACCCCTG CCAAAAGAGC
10561 TGGCGCCACA TTGGCCAGTG GTCACCCACC AGAATAATCG AGCGTGGCCT GATCGACTTG
10621 TCGCTAGTAT GCGCCCAATT GATGCCCGCT ACAGCAAGCC AATGGTCGGT GCAGGGTATG
10681 TGGTCGGGCC ATCCATTTTT CTTGGCACTC CTGGTGTGGT GTCATACTAT CTCACATTAT
10741 ACATCGGGGG CGAGCCTCAG GCCCTGCCAG AAACACTCGT TTCAACAGGA CGTATAGCCA
10801 CAGATTGTCG GGAATATCTC GACGCGGCTG AGGAAGAGGC AGCGAGAGAA CTTCCCCACG
10861 CATTTATTGG CGATGTCAAA GGCACTACGG TCGGGGGGTG TCACCACATT ACATCGAAAT
10921 ACCTACCTAG GTCCCTGCCT AAAGACTCTG TTGCTGTGGT TGGGGTGAGT TCGCCCGGTA
10981 GGGCTGCTAA AGCCGTGTGC ACTCTCACCG ATGTGTACCT CCCCGAACTC CGACCATATT
11041 TGCAACCGGA GACGGCATCA AAATGCTGGA AACTTAAACT GGATTTCAGG GATGTTCGAC
11101 TGATGGTCTG GAAAGGCGCC ACAGCCTATT TCCAGTTGGA AGGGCTGACA TGGTCAGCGC
11161 TGCCCGATTA TGCTAGGTTC ATTCAGCTAC CCAAGGATGC CGTTGTGTAC ATCGATCCGT
11221 GTATAGGGCC GGCAACAGCC AATCGCAAGG TTGTGCGAAC CACAGACTGG CGGGCCGACC
11281 TGGCAGTGAC ACCGTATGAT TACGGTGCTC AGGTCATTTT GACAACAGCC TGGTTCGAGG
11341 ACCTTGGGCC GCAGTGGAAG ATTTTGGGGT TGCAGCCTTT CAGACGAACA TTTGGCTTTG
11401 AGAACACTGA AGATTGGGCA ATTCTCGCAC GCCGTATGAA TGACGGCAAA GATTACACTG
11461 ACTATAATTG GCATTGTGTA CGAGAACGCC CACACGCAAT TTACGGGCGC GCCCGTGACC
11521 ATACGTATCA TTTTGCCCTT GGCACTGAAC TGCAAGTAGA GCTGGGCAGA CCCCGGCTGC
11581 CTCCTGAGCA AGTGCCGTGA
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SEQ ID NO:29 Nucleotide encoding parental PRRSV 94881 ORF2

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11611 ATGCAATGGG TTCACTGTGG AGTAAAATCA
11641 GTCAGTTGTT CGTGGATGCC TTCACTGAGT TCCTTGTTAG TGTGGTTGAC ATTGTCATCT
11701 TTCTCGCCAT ATTGTTTGGG TTCACTGTTG CAGGCTGGTT ATTGGTCTTC CTTCTCAGAG
11761 TGGTTTGCTC CGCGTTTCTC CGTTCGCGCT CTGCCATTCA CTCTCCCGAA CTATCGAAGG
11821 TCCTATGAGG GCTTGCTACC CAACTGCAGA CCGGATGTCC CACAATTCGC AGTTAAGCAC
11881 CCGTTGGGTA TACTTTGGCA TATGCGAGTC TCCCACCTAA TTGACGAAAT GGTCTCTCGC
11941 CGCATTTACC GGACCATGGA ACATTCGGGT CAAGCGGCCT GGAAGCAGGT TGTTAGTGAA
12001 GCCACTCTCA CAAAACTGTC AAGGCTTGAC GTAGTCACTC ATTTCCAACA CCTGGCCGCA
12061 GTGGAGGCTG ATTCTTGCCG CTTCCTTAGC TCACGACTCG CGATGCTGAA AAACCTTGCC
12121 GTTGGCAATG TGAGCCTGGA GTACAACACT ACTTTGGACC GCGTTGAGCT CATCTTTCCC
12181 ACACCAGGTA CGAGGCCCAA GTTGACCGAT TTTAGGCAAT GGCTTATCAG CGTGCACGCT
12241 TCCATCTTCT CCTCTGTGGC TTCGTCTGTT ACCTTGTTCA CAGTGCTTTG GCTTCGAATT
12301 CCAGCTCTAC GCTATGTTTT TGGTTTCCAT TGGCCCACGG CAACACATCA TTCGAACTAA
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SEQ ID NO:30 Nucleotide encoding parental PRRSV 94881 ORF3

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12219         AT GGCTTATCAG CGTGCACGCT
12241 TCCATCTTCT CCTCTGTGGC TTCGTCTGTT ACCTTGTTCA CAGTGCTTTG GCTTCGAATT
12301 CCAGCTCTAC GCTATGTTTT TGGTTTCCAT TGGCCCACGG CAACACATCA TTCGAACTAA
12361 CTATCAATTA CACTATATGT AAGCCATGCC CTACCAGTCA AGCTGCCCAA CAAAGACTCG
12421 AGCCTGGCCG TAACGTGTGG TGCAAAATAG GGCACGACAG GTGTGAGGAA CGTGACCATG
12481 ATGAGTTGTC AATGTCCATT CCGTCCGGGT ACGACAACCT CAAACTTGAG GGTTATTATG
12541 CTTGGCTGGC TTTTTTGTCC TTTTCCTACG CGGCCCAATT CCATCCGGAG CTGTTCGGAA
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12601 TAGGAAACGT GTCGCGCGTC TTTGTGGATA AGCGACACCA GTTCATTTGC GCCGAGCATG
12661 ATGGACAAAA TTCAACCATA TCTGCCAGAC ACAACATCTC CGCGTCGTAT GCGGTGTATT
12721 ACCATCATCA AATAGACGGG GGCAATTGGT TTCATTTGGA ATGGCTGCGA CCATTCTTTT
12781 CCTCCTGGCT GGTGCTCAAC ATCTCATGGT TTCTGAGGCG TTCGCCTGCA AGCCCTGCTT
12841 CTCGACGCAT CTATCAGATA TTAAGACCAA CACGACCGCG GCTGCCGGTT TCATGGTCCT
12901 TCAGAACATC AATTGTTTCC AATCTCACAG GGCCTCAACA GCGCAAGGTA CCACTCCCCT
12961 CAGGAGGTCG TCCCAATGTC GTGAAGCCGT CGGCATTCCC CAGTACATCA CGATAA

SEQ ID NO:31 Nucleotide encoding parental PRRSV 94881 ORF4

12761 ATGGCTGCGA CCATTCTTTT
12781 CCTCCTGGCT GGTGCTCAAC ATCTCATGGT TTCTGAGGCG TTCGCCTGCA AGCCCTGCTT
12841 CTCGACGCAT CTATCAGATA TTAAGACCAA CACGACCGCG GCTGCCGGTT TCATGGTCCT
12901 TCAGAACATC AATTGTTTCC AATCTCACAG GGCCTCAACA GCGCAAGGTA CCACTCCCCT
12961 CAGGAGGTCG TCCCAATGTC GTGAAGCCGT CGGCATTCCC CAGTACATCA CGATAACGGC
13021 TAATGTGACC GATGAATCGT ATTTGTACAA CGCGGACTTG CTGATGCTTT CCGCGTGCCT
13081 TTTCTACGCC TCGGAAATGA GCGAGAAAGG CTTCAAAGTC ATCTTTGGGA ATATTTCTGG
13141 CGTTGTTTCC GCTTGTGTTA ATTTCACAGA TTATGTGGCC CATGTGACCC AACACACTCA
13201 GCAGCACCAT TTGGTAATTG ATCACATTCG GTTACTACAC TTCTTGACAC CGTCTACGAT
13261 GAGGTGGGCT ACAACCATTG CTTGTTTGTT TGCCATTCTT TTGGCGGTAT GA

SEQ ID NO:32 Nucleotide encoding parental PRRSV 94881 ORF5

13309 AT GAAATGTTCT
13321 TGCAAGTTGG GGCATTTCTT GACTCCTCAC TCTTGCTTCT GGTGGCTTTT TTTGCTGTGT
13381 ACCGGCTTGT CTTGGTCCTT TGTCGATGGC AACGACAACA GCTCGACATC CCAATACATA
13441 TATAATTTGA CGATATGCGA GCTGAATGGG ACCGAATGGT TGTCCGGTCA TTTTGATTGG
13501 GCAGTCGAAA CCTTTGTGCT TTACCCAGTT GCCACTCATA TCATTTCACT GGGTTTTCTC
13561 ACAACAAGCC ATTTCCTTGA TGCGCTCGGT CTCGGCGCTG TGTCCGCCAC AGGATTCATT
13621 GGCGAGCGGT ATGTACTTAG CAGCATGTAC GGCGTTTGCG CCTTCGCGGC GCTCGTATGT
13681 TTTGTCATCC GTGCTGCTAA AAATTGCATG GCTTGCCGCT ATGCCCGCAC CCGGTTTACC
13741 AACTTCATCG TGGACGACCG GGGAAGAATC CATCGATGGA AGTCTTCAAT AGTGGTGGAG
13801 AAATTGGGCA AAGCTGAAGT CGGTGGTGAC CTTGTCAACA TTAAGCATGT TGTCCTCGAA
13861 GGGGTTAAAG CTCAACCCTT GACGAGGACT TCGGCTGAGC AATGGGAAGC CTAG

SEQ ID NO:33 Nucleotide encoding parental PRRSV 94881 ORF6

13902 ATGGGAAGC CTAGACGACT
13921 TTTGCAACGA TCCCACCGCC GCACAAAAAC TCGTGCTGGC CTTTAGCATC ACATATACAC
13981 CCATAATGAT ATACGCCCTT AAGGTGTCAC GCGGCCGACT CCTGGGGCTG TTGCACATCT
14041 TGATATTTCT GAATTGTTCC TTTACTTTTG GGTACATGAC ATATGTGCAT TTTCAATCCA
14101 CCAACCGTGT CGCACTCACT CTGGGGGCTG TAGTCGCCCT TTTGTGGGGT GTTTACAGCC
14161 TCACAGAGTC ATGGAAGTTC ATCACTTCCA GATGCAGATT GTGTTGCCTA GGCCGGCGAT
14221 ACATTCTGGC CCCTGCCCAT CACGTAGAAA GTGCTGCAGG CCTCCATTCA ATCCCAGCGT
14281 CTGGTAACCG AGCATACGCT GTGAGAAAGC CCGGACTAAC ATCAGTGAAC GGCACTCTAG
14341 TACCTGGGCT TCGGAGCCTC GTGCTGGGCG GCAAACGAGC TGTTAAACGA GGAGTGGTTA
14401 ACCTCGTCAA GTATGGCCGG TAA

SEQ ID NO:34 Nucleotide encoding parental PRRSV 94881 ORF7

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14413   ATGGCCGG TAAGAACCAG AGCCAGAAGA AAAGAAGAAA TGCAGCTCCG
14461 ATGGGGAAAG GCCAGCCAGT CAATCAACTG TGCCAGTTGC TGGGTACAAT GATAAAGTCC
14521 CAGCGCCAGC AATCTAGGGG AGGACAGGCC AAAAAGAAGA AGCCTGAGAA GCCACATTTT
14581 CCCCTAGCTG CTGAAGATGA CATTCGGCAC CATCTCACCC AGGCCGAACG TTCCCTCTGC
14641 TTGCAATCGA TCCAGACGGC TTTCAATCAA GGCGCAGGAA CTGCGTCGCT TTCATCCAGC
14701 GGGAAGGTCA GTTTCCAGGT TGAGTTCATG CTGCCGGTTG CTCATACAGT GCGCCTGATT
14761 CGCGTGACTT CTACATCCGC CAGTCAGGGT GCAAATTAA
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CLAIMS

1. A Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) of a European type, which is of the strain deposited with European Collection of Cell Cultures (ECACC) under the Accession Numbers ECACC 11012501 or Accession Numbers ECACC 11012502.

2. The PRRSV of claim 1, wherein said virus is attenuated by passaging at least 36 times in cell culture such that when the modified virus is administered to a swine or other mammal prone to PRRSV, it fails to cause clinical signs of PRRSV disease but is capable of inducing an immune response that immunizes the mammal against pathogenic forms of PRRSV.

3. A method for the preparation of the live attenuated PRRSV according to claim 1, comprising adapting an MA 104-grown PRRSV of a European type to non-MA 104 mammalian cells.

4. A vaccine for the protection of pigs against PRRSV infection, comprising the live attenuated PRRSV according to claim 1 and a pharmaceutically acceptable carrier.

5. The vaccine according to claim 4, which further comprises one or more non-PRRSV attenuated or inactivated pathogens or antigenic material thereof.

6. The vaccine according to claim 5, wherein said non-PRRSV pathogens are selected from Pseudorabies virus, Porcine influenza virus, Porcine parvovirus, Transmissible gastroenteritis virus, Escherichia coli, Erysipelo rhusiopathiae, Bordetella bronchiseptica, Salmonella cholerasuis, Haemophilus parasuis, Pasteurella multocida, Streptococcus suis, Mycoplasma hyopneumoniae and Actinobacillus pleuropneumoniae.

7. The vaccine according to claim 4 which further comprises one or more additional European PRRSV strains selected from the group consisting of a PRRSV strain deposited under the Accession Numbers Lelystad virus strain (Lelystad Agent (CDI-NL-2.91), or other strains such as those deposited under the Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, CNCM Accession No I-1388, ATCC VR 2332, VR 2385, VR 2386, VR 2429, VR 2474, and VR 2402; CNCM I-1102, CNCM I-1140, CNCM I-1387, CNCM I-1388, or ECACC V93070108 or a U.S. strain such as North American PRRS virus, pT7P129A; ATCC deposit VR-2332, ATCC deposit VR-2368; ATCC VR-2495; ATCC VR 2385, ATCC VR 2386, ATCC VR 2429, ATCC VR 2474, and ATCC VR 2402.

8. The vaccine according to claim 4, which comprises a carrier that is suitable for intradermal or intramuscular application.

9. The vaccine according to claim 4, which is in freeze-dried form.

10. The vaccine of claim 4 wherein said vaccine comprises at least about 107 virus particles.

11. A method for the preparation of a live attenuated vaccine for combating PRRS, comprising admixing a live attenuated PRRSV according to claim 1 with a pharmaceutically acceptable carrier.

12. The method according to claim 11, wherein the live attenuated PRRSV further comprises one or more additional European PRRSV strains selected from the group consisting of a PRRSV strain deposited under the Accession Numbers ECACC 04102703, ECACC 04102702, ECACC 04102704, CNCM Accession No. I-1140, CNCM Accession No I-1387, and CNCM Accession No I-1388.

13. The method according to claim 11, wherein the live attenuated PRRSV further comprises an adjuvant.

14. A method of immunizing swine against porcine reproductive and respiratory syndrome (PRRS), said method comprising the step of administering to swine a vaccine composition including a live porcine reproductive and respiratory syndrome virus mixed with a pharmacologically compatible carrier agent, said virus comprising PRRS 94881 virus passaged at least 36 times in cell culture to modify the virus such that when the modified virus is administered to a swine or other mammal prone to PRRS, it fails to cause clinical signs of PRRS disease but is capable of inducing an immune response that immunizes the mammal against pathogenic forms of PRRS.

15. The method of claim 14, wherein said swine presents no lung lesions after vaccination.

16. The method of claim 14, wherein said swine presents fewer lung lesions after vaccination as compared to vaccination with Porcilis vaccine.

17. A PRRS virus having a nucleotide sequence that is at least 95% homologous with the sequence set forth in either SEQ ID NO:1 or SEQ ID NO:10.

18. A PRRS virus that comprises at least one ORF that encodes a protein that is at least 98% identical to any of the sequences set forth in SEQ ID NO: 2 to 9 or SEQ ID NO:11 to SEQ ID NO:18.

19. A PRRS virus that has a nucleotide sequence of SEQ ID NO:1 or SEQ ID NO:10 or a fragment of either SEQ ID NO:1 or SEQ ID NO:2 wherein said fragment encodes an ORF selected from the group consisting of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8,

SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18.

20. A subunit vaccine for vaccination of a porcine animal wherein said vaccine comprises one or more nucleotides selected from the group consisting of a nucleotide that encodes an ORF selected from the group consisting of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18.

21. A subunit vaccine for vaccination of a porcine animal wherein said vaccine comprises one or more nucleotides selected from the group consisting of SEQ ID NO:19; SEQ ID NO:20; SEQ ID NO:21; SEQ ID NO:22; SEQ ID NO:23; SEQ ID NO:24; SEQ ID NO:25; SEQ ID NO:26; SEQ ID NO:27; SEQ ID NO:28; SEQ ID NO:29; SEQ ID NO:30; SEQ ID NO:31; SEQ ID NO:32; SEQ ID NO:33; and SEQ ID NO:34.

22. A composition comprising one or more proteins selected from the group consisting of a protein having the sequence of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18.

23. An isolated nucleic acid comprising a sequence selected from the group consisting of SEQ ID NO:19; SEQ ID NO:20; SEQ ID NO:21; SEQ ID NO:22; SEQ ID NO:23; SEQ ID NO:24; SEQ ID NO:25; SEQ ID NO:26; SEQ ID NO:27; SEQ ID NO:28; SEQ ID NO:29; SEQ ID NO:30; SEQ ID NO:31; SEQ ID NO:32; SEQ ID NO:33; and SEQ ID NO:34.

24. A recombinant expression vector comprising a nucleic acid sequence that encodes one or more PRRSV ORFs selected from the group consisting of SEQ

ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:15, SEQ ID NO:16, SEQ ID NO:17, and SEQ ID NO:18 operably linked to a promoter.

25. The recombinant expression vector of claim 24 wherein said nucleic acid encoding said ORFs is selected from the group consisting of SEQ ID NO:19; SEQ ID NO:20; SEQ ID NO:21; SEQ ID NO:22; SEQ ID NO:23; SEQ ID NO:24; SEQ ID NO:25; SEQ ID NO:26; SEQ ID NO:27; SEQ ID NO:28; SEQ ID NO:29; SEQ ID NO:30; SEQ ID NO:31; SEQ ID NO:32; SEQ ID NO:33; and SEQ ID NO:34.

26. A vaccine comprising a recombinant expression vector of any of claims 24 or 25.