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Content

Summary

The surveillance programme for specific viral infections in swine herds in 2022 continued to show Norway to be free from Aujeszky's disease, transmissible gastroenteritis, porcine epidemic diarrhoea and porcine respiratory and reproductive syndrome.

Since 2009, influenza A (H1N1) pdm09 virus (H1N1pdm) has been endemic in the Norwegian swine population, showing a decline in seroprevalence to approx. 12% of herds testing positive during the last year. Other swine-associated influenza strains have never been diagnosed in Norway.

In 2018, porcine respiratory corona virus (PRCV) was detected for the first time in Norway, and the seroprevalence in the southwestern part of the country has since been high and also increasing in other parts of Norway.

Introduction

The Norwegian Food Safety Authority (NFSA) is responsible for implementing the surveillance programme for specific viral infections in swine. The national surveillance programme for specific viral infections in swine was launched in 1994 to document Norway's disease-free status for Aujeszky's disease (AD, national list 1, EU category C+D+E), and the status of transmissible gastroenteritis (TGE, national list 1), and porcine respiratory corona virus (PRCV, national list 3) in the Norwegian swine population. Porcine respiratory and reproductive syndrome (PRRS, national list 2, EU category D+E) and swine influenza (SI, national list 2) were added to the programme in 1995 and 1997, respectively. From 1997 to 1999, and again from 2015, porcine epidemic diarrhoea (PED, national list 2) was also included in the programme. The NFSA is responsible for collecting the samples. The Norwegian Veterinary Institute (NVI) is responsible for sampling plans, laboratory investigations and reporting components of the programme.

The EFTA Surveillance Authority (ESA) has recognized Norway's disease-free status for AD since 1st July 1994, and the current approval of disease-free status is described in ESA Decision No 032/21/COL. Specific criteria for documentation of maintenance of the disease free status is regulated in 2020/689 (EU), art 81. Additional measures for the trade of pigs have been laid down to protect Norway's disease free status for AD.

PRRS, TGE and PED have never been detected in Norway.

Norway recorded its first outbreak of influenza A (H1N1) pdm09 virus (H1N1pdm) in the swine population in 2009, and in the following years, a stable herd prevalence of between 40% and 50% indicated endemicity. In 2018, the national herd prevalence was reduced to 25%, and has further declined during the past four years to 12% in 2022. The region of Rogaland and Agder,

with the highest number and density of pig herds, has continued to have the highest herd prevalence at 35% (95% CI 29-43%).

In August 2018, antibodies against porcine respiratory corona virus (PRCV) were detected in seven swine herds in the county of Rogaland through the surveillance programme, and an outbreak investigation revealed PRCV specific antibodies in a high proportion (68%) of contact herds sampled. In 2022, the national herd seroprevalence for PRCV was estimated to 26.6%. In the counties of Rogaland and Agder the PRCV herd seroprevalence was 57.2%, while the corresponding herd seroprevalence was 13.4% outside Rogaland and Agder.

Aims

The aims of the serological surveillance programme are to document the disease free status of ADV, ascertain the continued absence of PRRS, TGE and PED and to contribute to the maintenance of this favourable situation. The programme also monitors the status of influenza A H1N1pdm, and from 2018 also PRCV, in the Norwegian swine population.

Materials and methods

Herds and sampling

All 92 nucleus and multiplying herds as well as the central-units of all 11 sow pools in Norway were included in the programme. Blood samples (target sample size of 10 pigs) from adult swine in each herd were collected, usually at the abattoirs, but occasionally also at the farms. In addition, a selection of the remaining Norwegian swine herds was included in the programme. At the 12 abattoirs where more than 99% of the pig slaughter takes place, blood samples proportional to the number of sows and boars slaughtered were collected. The samples were randomly collected from different herds and the sampling periods were evenly distributed throughout the year. Furthermore, at the seven largest abattoirs, blood samples (targeted sample size 10 pigs) was collected from 7 randomly selected large fattening herds at each abattoir, in total 49 herds.

Laboratory analyses

All serological analyses were performed at NVI. Positive or inconclusive results in the surveillance programme were retested in duplicate with the same test method. Samples were concluded as negative if the retest gave a negative result. If the result of the retest was positive or inconclusive, a specified confirmatory test was performed. In cases of positive or inconclusive test results for confirmatory tests (except for H1N1pdm virus and PRCV), at least 10 new pigs were resampled from the herd in question. If clinical signs of disease were absent in the herd, and all resampled animals were negative for antibodies against the pathogen in question, a single positive or inconclusive sample in the surveillance programme was considered false positive.

Aujeszky's disease/pseudorabies virus (ADV/PRV)
The diagnostic methods for granting and maintaining disease-free status are laid down in Art 6 of Regulation (EU) 2020/689. All serum samples were tested for antibodies against ADV using a commercial blocking ELISA from Svanova (SVANOVIR® PRV gB-Ab). The test detects antibodies against glycoprotein B (previously glycoprotein II) found on the surface of the virus in accordance with the requirements in Section 5 of Annex III of Regulation (EU) 2020/689. Positive or inconclusive samples were further analysed with ID Screen® Aujeszky gE and/or ID Screen® Aujeszky gB Competition ELISA at the NVI.

Transmissible gastroenteritis virus (TGEV) and porcine respiratory coronavirus (PRCV)
A commercial blocking ELISA from Biovet (Swinecheck®TGEV/PRCV Recombinant) was used to detect antibodies against TGEV/PRCV. The ELISA test enables discrimination between antibodies to TGEV and PRCV in serum samples. TGEV positive or inconclusive samples were tested with a confirmatory test (SVANOVIR® TGEV/PRCV-Ab, Svanova) at the NVI.

Porcine reproductive and respiratory syndrome virus (PRRSV)
All serum samples were tested for antibodies against PRRSV using a commercial indirect ELISA from IDEXX (IDEXX PRRS X3 Ab Test), which detects the most (pre)dominant type-1 and type-2 strains of PRRSV. PRRSV positive or inconclusive samples were tested with a confirmatory ELISA at the NVI (ID Screen® PRRS Indirect). If still positive, the samples were analysed with a real-time PCR for PRRSV (Applied Biosystems™, VetMAX™ PRRSV EU & NA 2.0 Kit).

Swine influenza virus
A commercial competitive ELISA from IDvet (ID Screen® Influenza A Antibody Competition, Multi-species) was used to screen serum samples from swine for antibodies against influenza A virus. In cases of positive or inconclusive results, the serum samples were retested using the haemagglutination inhibition (HI) test, for the detection of antibodies against the A/Swine/California/07/09 (A/H1N1/pdm09), A/Swine/Belgium/1/98 (H1N1), A/Swine/Gent/7623/99 (H1N2) and A/Swine/Flanders/1/98 (H3N2) subtypes as described in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals (1). The antigens for the tests were produced at NVI.

Porcine epidemic diarrhoea virus (PEDV)
All serum samples were tested for antibodies against PEDV using a commercial indirect ELISA from IDvet (ID Screen® PEDV Indirect). In cases of positive or inconclusive results, the samples were sent to SSI in Denmark for confirmatory testing.

Results and Discussion

The mean number of animals tested per farm aggregated for the year was seven (range 1 - 41). Less than 1% of the collected samples were rejected, resulting in 3,803 individual pig samples representing 531 herds being analysed (Table 1). Distribution of sampled herds in relation to production type is given in Table 2.The proportion of herds tested positive by region are presented in Table 3. Of the 531 tested herds, 66 (12.4%) were seropositive for H1N1pdm (Table 2, Figure 2) and 141 (30.5) were positive for PRCV (Table 2, Figure 1).

***Table 1**: Results from the surveillance for Aujeszky's disease (AD), transmissible gastroenteritis (TGE), porcine respiratory corona virus (PRCV), porcine epidemic diarrhoea (PED), porcine respiratory and reproductive syndrome (PRRS) and swine influenza (SI) from 1994 to 2022.*

Year	Total no. of herds	Herds tested	Animals tested	H1N1pdm		PRCV		Other viruses		Diseases included in other viruses
				Animals positive[3]	Herds positive	Animals positive	Herds positive	Animals positive	Herds positive	
1994	7 799	1 112	12 010	-	-	0	0	0	0	AD, TGE/PRCV
1995	7 471	956	11 197	-	-	0	0	0	0	AD, TGE/PRCV, PRRS
1996	7 045	468	4 968	-	-	0	0	0	0	AD, TGE/PRCV, PRRS
1997	6 661	512	4 925	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
1998	6 275	491	4 695	-	-	0	0	2[1]	1[1]	AD, TGE/PRCV, PRRS, SI, PED
1999	5 761	470	4 705	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2000	4 827	458	4 600	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2001	4 554	472	4 972	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2002	4 150	492	4 899	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2003	4 005	483	4 783	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2004	4 006	492	4 935	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2005	3 762	468	4 644	-	-	1[2]	1[2]	0	0	AD, TGE/PRCV, PRRS, SI
2006	3 339	457	4 569	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2007	3 010	456	4 641	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2008	2 682	487	4 845	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2009	2 546	452	4 724	131	20	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2010	2 441	459	4 250	940	189	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2011	2 346	730	4 713	2 216	353	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2012	2 213	764	4 961	2 412	378	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2013	2 178	737	5 038	1 417	338	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2014	2 117	622	4 083	1 138	296	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2015	2 141	568	3 764	993	280	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2016	2 180	564	3 824	952	271	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2017	1 955	548	3 804	695	225	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2018	2 038	533	3 598[3]	473	134	126[4]	30[4]	0	0	AD, TGE/PRCV, PRRS, SI, PED
2019	1 853	545	3 838[3]	526	153	532	118	0	0	AD, TGE/PRCV, PRRS, SI, PED
2020	1 724	527	3 851[3]	534	125	753	182	0	0	AD, TGE/PRCV, PRRS, SI, PED
2021	1 693	521	4 012[3]	394	102	904	201[5]	0	0	AD, TGE/PRCV, PRRS, SI, PED
2022	1 666	531	3 803[3]	131	66	554	141	0	0	AD, TGE/PRCV, PRRS, SI, PED
Total			**143 651**							

[1] Two samples from one herd were seropositive for SI H3N2 in 1998 (probably infection from humans)
[2] One sero-positive sample for PRCV in 2005 (probably unspecific reaction).
[3] Maximum 5 influenza A positive samples per submission were followed up with a HI-test to identify the influenza strain.
[4] In addition to routine surveillance for PRCV and not included in this table, NVI also detected 238 positive pigs in 30 positive herds (27 in Rogaland, 1 in Vest-Agder and 2 in Hedmark).
[5] In three herds, serological analyses were inconclusive for antibodies against TGEV, while antibodies against PRCV were detected. We consider it likely that this is due to serological cross-reactions between PRCV and TGEV. See discussion for details.

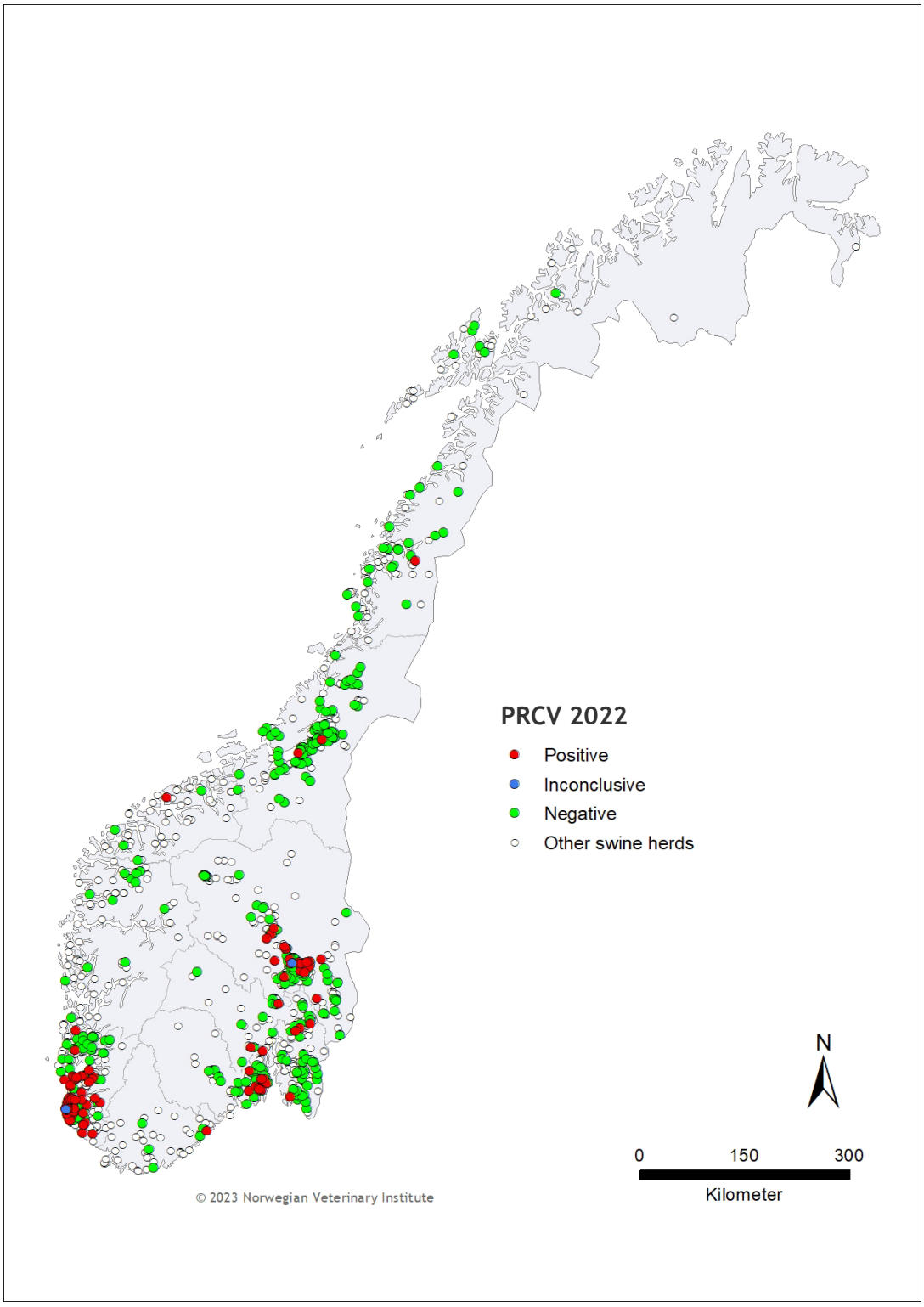

***Figure 1**: Serological results and geographical distribution of swine herds tested for antibodies against porcine respiratory coronavirus in the surveillance programme for specific viral infections in 2022.*

Table 2: *Distribution of swine herds in the surveillance programme 2022 according to type of production and the results for antibodies to H1N1pdm and PRCV.*

Category	No. of herds sampled	No. (%) of positive herds H1N1pdm	No. (%) of positive herds PRCV
Nucleus herds and multiplying herds	83	7 (8.4)	17 (20.5)
Sow pools	11	3 (27.3)	6 (54.5)
Integrated and piglet-producing herds	378	55 (14.6)	110 (29.1)
Fattening herds	59	1 (1.7)	8 (13.6)
Total herds (pigs)	**531**	**66 (12.4)**	**141 (26.6)**

Table 3: *Number of herds tested and percentage of herds positive for PRCV per region in 2022. The total number of herds is based on Register of Production Subsidies as of 1st March 2022.*

Region	Total no. of herds	No. of herds tested	No. of herds tested positive	No. of herds tested inconclusive	Percentage of herds tested positive (95% CI)
Troms og Finnmark, Nordland	104	29	1	0	3.4 (0.1 - 17.8)
Trøndelag, Møre og Romsdal	308	117	3	0	2.6 (0.5 - 7.3)
Vestland	103	19	1	0	5.3 (0.1 - 26)
Rogaland, Agder	516	159	91	1	57.2 (49.2 - 65)
Vestfold og Telemark	121	46	11	0	23.9 (12.6 - 38.8)
Oslo, Viken	200	57	6	0	10.5 (4 - 21.5)
Innlandet	314	104	28	1	26.9 (18.7 - 36.5)
Total	**1 666**	**531**	**141**	**2**	**26.6 (22.8 - 30.5)**

The results from the surveillance programme in 2022 showed that Norway has maintained its freedom of disease status for AD, TGE and PRRS virus infections in the national swine population since the surveillance started in 1994.

Porcine respiratory coronavirus (PRCV) is a variant of transmissible gastroenteritis virus (TGEV). PRCV likely emerged naturally and subsequently spread rapidly in the European swine populations during the early 1980s, causing mostly unapparent infections and ameliorating TGE through immunological cross-protection (2).

Based on surveillance data from this and previous years, it is likely that the introduction of PRCV to the Norwegian pig population occurred during 2018. The outbreak investigation conducted by the NFSA further showed that the virus spread rapidly to a high proportion of herds connected by trade of live pigs, but also to herds located less than 3 km from PRCV seropositive herds. The route of introduction to Norway was not identified. Based on the epidemiological features of PRCV and data from other countries, it appears likely that PRCV will become endemic in the Norwegian pig population. In 2022, the national herd seroprevalence for PRCV was estimated to 26.6%. In the counties of Rogaland and Agder the PRCV herd seroprevalence was 57.2%, while the corresponding herd seroprevalence was 13.4% outside Rogaland and Agder.

***Table 4**: Number of herds tested and percentage of herds positive for H1N1pdm per region in 2022. The total number of herds is based on Register of Production Subsidies as of 1st March 2022.*

Region	Total herds	No. of herds tested	No. of herds tested positive	Percentage of herds tested positive (95% CI)
Troms og Finnmark, Nordland	104	29	0	0 (0 - 11.9)
Trøndelag, Møre og Romsdal	308	117	1	0.9 (0 - 4.7)
Vestland	103	19	1	5.3 (0.1 - 26)
Rogaland, Agder	516	159	56	35.2 (27.8 - 43.2)
Vestfold og Telemark	121	46	0	0 (0 - 7.7)
Oslo, Viken	200	57	5	8.8 (2.9 - 19.3)
Innlandet	314	104	3	2.9 (0.6 - 8.2)
Total	**1 666**	**531**	**66**	**12.4 (9.7 - 15.5)**

With regards to influenza A, studies have shown that the H1N1pdm virus was most likely introduced to pigs by humans infected with the same virus (4, 5). The herd seroprevalence for H1N1pdm has decreased from 41% in 2017 to approximately 12% in 2022, however the reasons for this decline are not known. The decline from 2017 in herd prevalence was across all four production types and across all counties (Tables 2 and 4). The herd prevalence in Rogaland/Agder region, the densest pig farming area in Norway, remains the highest at 35.2% indicating a continued endemic situation. Except for H1N1pdm, the Norwegian swine population tested negative against other strains of influenza A virus that are endemic in most pig producing countries.

Swine influenza A H1N1pdm infection in Norwegian pig herds have mainly been subclinical or with mild clinical signs in a small proportion of the herds (4, 7, 8). A longitudinal study from a Norwegian boar testing station published in 2014 showed that infected growing pigs had reduced feed efficiency due to poorer feed conversion ratio and as such increased the time before being sent to slaughter (9).

In the recent years, the number of herds in the Norwegian swine production has stabilized while the average herd size has increased. The pork production by tonnage has remained relatively stable. In 2011, the sampling procedure for conventional herds with sows, changed from 10 samples collected in randomly selected herds to individual animals being collected at the abattoir. Therefore, the mean number of samples per herd decreased, while the fraction of the total pig herd population sampled increased from 19% in 2010 to 31% in 2011. Since 2014, this proportion has been between 26% and 32%, while the mean number of samples per herd has further decreased.

Farmed wild boars and pigs kept as pets were not included in the programme. These populations are small and are presumed have little to no contact with the commercial pig population. There is a small wild boar population mainly in an area along the Swedish border in the southeast of Norway. A wild boar health surveillance was conducted during 2022 and is reported separately.

Apart from AD, the EU has not approved additional guarantees against other porcine viral infections for trading pigs into Norway. To protect the swine population against disease-related risks, Norway has its own national guidelines for the trade of live pigs (10).

In conclusion, the surveillance programme for specific viral infections in 2022 documents Norwegian pig herd's favourable health status by demonstrating that Norwegian pig herds remained free from the serious infectious diseases: AD, TGE, PRRS and PED. It also documents that SI other than H1N1pdm was not detected in the pig population.

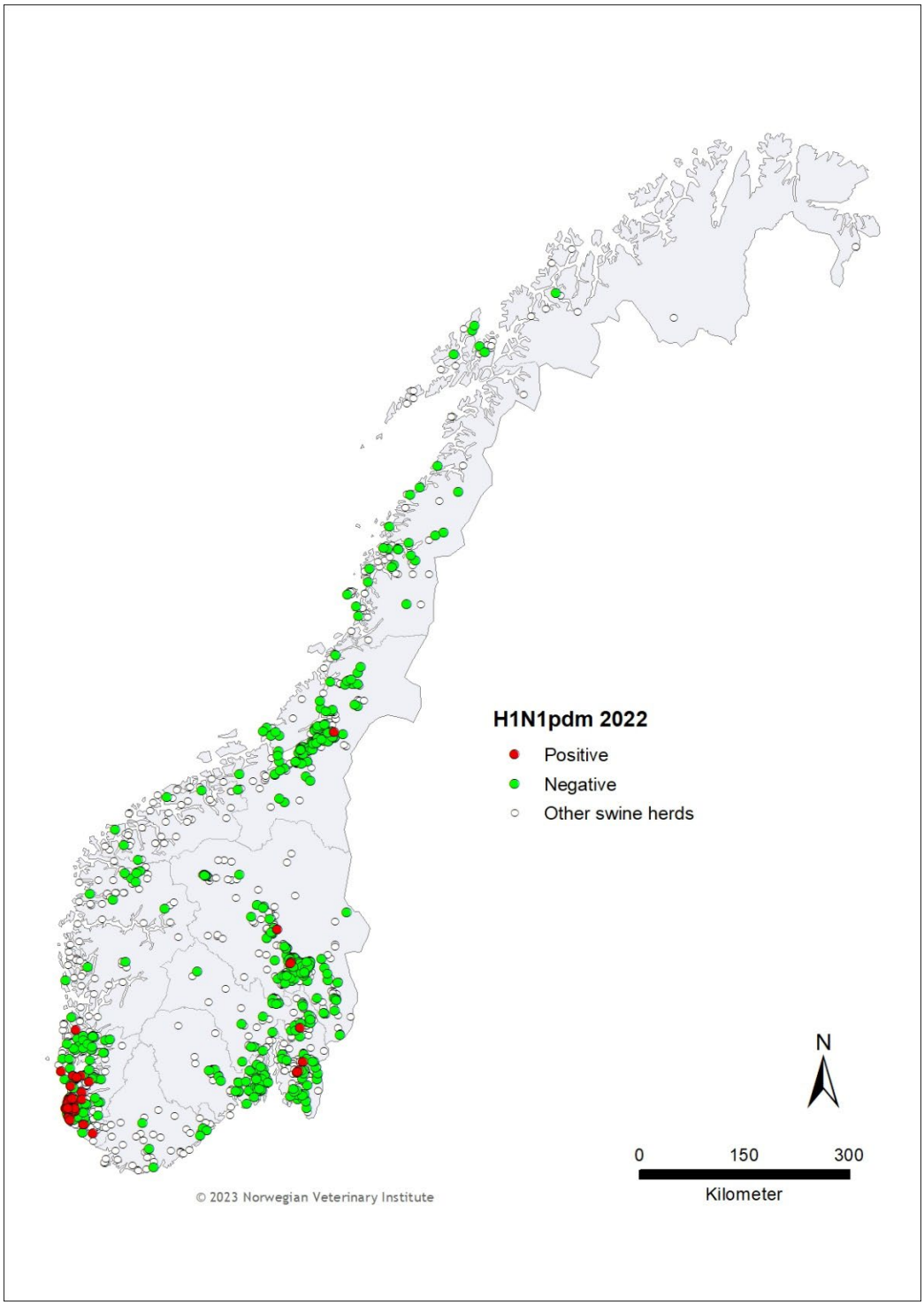

***Figure 2**: Serological results and geographical distribution of swine herds tested for antibodies against influenza A virus in the surveillance programme for specific viral infections in 2022.*

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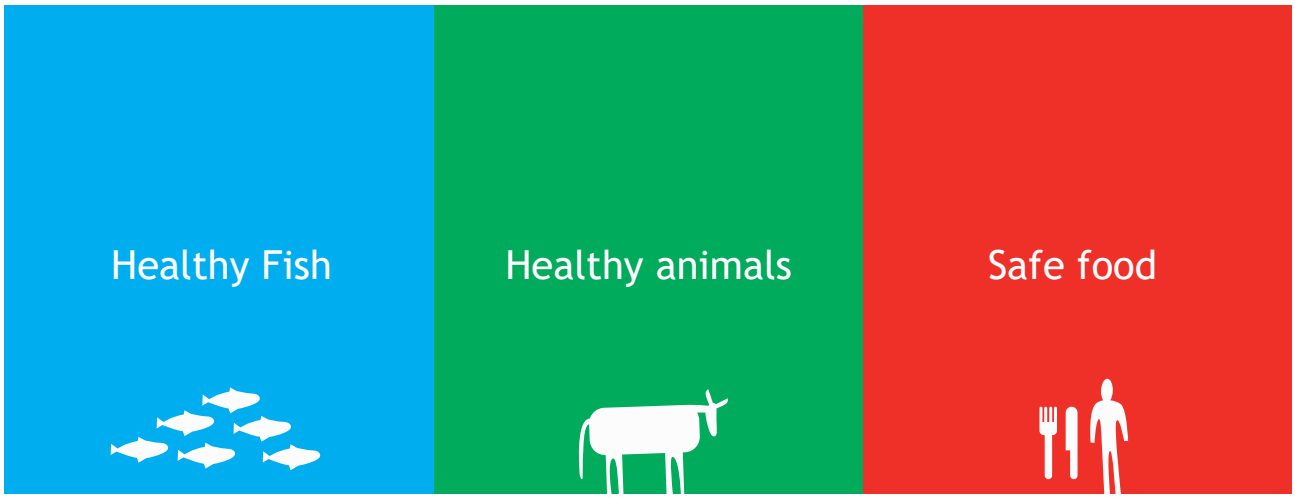

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