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Strengthening classical swine fever surveillance and control measures in the Russian Federation

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ABSTRACT

Introduction. Classical swine fever (CSF) remains a critical challenge in global pig production. In the Russian Federation the last reported outbreak occurred in 2020 among wild boar populations, but the risk of re-emergence is sustained. To reduce the existing threats the targeted disease surveillance and control measures are needed to be improved.

Objective. To analyze the current classical swine fever situation and the outcomes of epizootic monitoring in the Russian Federation, and to develop evidence-based proposals for its improvement.

Materials and methods. This analysis draws upon laboratory test results from 2020 to 2024, as recorded in the “Vesta” electronic state information system (part of the FGIS “VetIS”); epidemiological data from the World Organization for Animal Health (WOAH); and the official “Guidelines for planning laboratory testing and sampling to improve classical swine fever surveillance in the Russian Federation”, developed and approved by the Federal Centre for Animal Health. Geospatial data were visualized using the MapChart platform, while statistical analyses were performed with Microsoft Excel.

Results. Drawing on international experience in disease eradication and control, this study outlines a phased approach for the eradication of classical swine fever in the Russian Federation, with a view toward achieving official recognition of disease-free status from the World Organization for Animal Health. The proposed disease surveillance strategy is comprehensive and multifaceted, comprising: early detection measures, including immediate notification of suspected cases, syndromic analysis, and clinical examinations with necropsies; routine monitoring at key control points, such as ante-mortem and post-mortem inspections; and confirmatory procedures, consisting of strategic sampling, laboratory diagnostics, and surveillance in sentinel units. The study further explores the prospects for a strategic transition, including the zoning of Russian territory, the phased discontinuation of immunization with live (attenuated) vaccines, and the potential introduction of marker vaccines.

Conclusion. The proposed approaches are fully aligned with international standards and are specifically designed to achieve classical swine fever freedom in the Russian Federation. The full implementation of the proposed measures will significantly strengthen classical swine fever control in Russia and, consequently, enhance the export potential of the domestic pork industry.

Keywords: classical swine fever, epizootological surveillance, monitoring, biosecurity, WOAH, freedom status, laboratory diagnostics, marker vaccines

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Совершенствование эпизоотологического наблюдения и контроля за классической чумой свиней в Российской Федерации

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РЕЗЮМЕ

Введение. Классическая чума свиней продолжает оставаться важной проблемой свиноводства. В Российской Федерации последняя вспышка была зарегистрирована в 2020 г. в популяции диких кабанов, однако риск возникновения новых случаев болезни сохраняется. Для снижения имеющейся угрозы необходимо совершенствование мер эпизоотологического наблюдения и контроля.

Цель исследования. Анализ текущей эпизоотической ситуации и результатов реализуемого на территории Российской Федерации эпизоотологического наблюдения за классической чумой свиней с разработкой предложений по его совершенствованию.

Материалы и методы. Для анализа использовались данные проведенных в 2020–2024 гг. лабораторных исследований, представленные в электронную государственную информационную систему «Веста» ФГИС «ВетИС», а также материалы Всемирной организации здравоохранения животных, «Методические

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рекомендации по планированию лабораторных исследований и отбору проб для совершенствования эпизоотологического надзора за классической чумой свиней на территории Российской Федерации», разработанные и утвержденные в ФГБУ «ВНИИЗЖ». Картографирование осуществлялось с помощью онлайн-платформы MapChart, статистическая обработка проводилась в программе Microsoft Excel.

Результаты. На основании анализа международного опыта по ликвидации и контролю болезни описаны аспекты поэтапного оздоровления территории Российской Федерации от классической чумы свиней с перспективами получения соответствующего статуса Всемирной организации здравоохранения животных. Предлагаемая в исследовании стратегия эпизоотологического наблюдения включает комплексный подход с немедленными уведомлениями о подозрении на классическую чуму свиней, проведением синдромного анализа, клиническими исследованиями животных и патолого-анатомическим вскрытием трупов, ветеринарным предубойным осмотром животных и экспертизой продуктов убоя, наблюдением в дозорных единицах, проведением эффективного пробоотбора и лабораторной диагностики. Обсуждены перспективы зонирования территории России, поэтапного отказа от иммунизации живыми (аттенуированными) вакцинами, применения маркированных вакцин.

Заключение. Изложенные подходы гармонизированы с международными рекомендациями и соответствуют цели оздоровления страны от классической чумы свиней. Реализация всех предложенных этапов будет способствовать усилению контроля за болезнью в России и увеличению экспортного потенциала отечественной свиноводческой отрасли.

Ключевые слова: классическая чума свиней, эпизоотологическое наблюдение, мониторинг, биозащита, ВОЗЖ, статус благополучия, лабораторная диагностика, маркированные вакцины

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INTRODUCTION

Classical swine fever (CSF) is one of the six priority diseases under the WOAH Terrestrial Animal Health Code (hereinafter referred to as the WOAH Terrestrial Code) for which countries or zones can apply for official recognition of disease-free status, along with foot-and-mouth disease, peste des petits ruminants, bovine spongiform encephalopathy, African horse sickness, and bovine contagious pleuropneumonia [1, 2].

According to Article 15.2.3 of the WOAH Terrestrial Code, a country or zone can achieve official recognition as free from CSF through complete cessation of vaccination against CSF in pigs, or use of validated DIVA (differentiating infected from vaccinated animals) vaccines as required by Chapter 3.9.2 of the WOAH Manual for Diagnostic Tests and Vaccines for Terrestrial Animals (hereinafter referred to as the WOAH Terrestrial Manual), followed by at least 12 months of continuous surveillance confirming no CSF cases in domestic pigs or wild boars during this period [2, 3].

In Russia's Primorsky Krai, the last CSF cases in domestic pigs were recorded in 2019, while wild boar infections extended into 2020. However, it is currently challenging to provide an objective assessment of the CSF situation in the country due to the absence of both an officially approved monitoring program and a state-led eradication strategy.

The persistent circulation of the virus in wild boar and domestic pig populations poses a significant threat for the re-emergence of CSF outbreaks. Individual CSF virus (CSFV) variants can persist in pigs, leading to asymptomatic carrier states that complicate disease detection, particularly in vaccinated animals [4].

Another threat is the contamination of pig products. The CSFV remains infectious for years in frozen or canned pork products under suitable conditions [5].

In addition to virus survival in abovementioned products, transboundary spread from infected neighboring countries poses a significant threat for CSF introduction, particularly in border regions [6].

Russia currently employs mass immunization of domestic pigs with live attenuated (non-marker) vaccines against CSF, which precludes DIVA strategy implementation and WOAH recognition of free status [7].

This work aims to analyze the CSF situation in the Russian Federation and propose improvements to surveillance, with the goal of strengthening the export potential of the pig industry, particularly following the official recognition of CSF-free status.

MATERIALS AND METHODS

This analysis utilized laboratory test results retrieved from the "Vesta" electronic information system (part of the

FGIS “VetIS”) for the period 2020–2024, as well as data obtained from WOA. The data were assessed and analyzed in accordance with “The recommendations for planning laboratory studies and sampling to improve epizootological surveillance over CSF in the Russian Federation”, developed and approved by the Federal Center for Animal Health [8].

Geospatial analysis was conducted, with mapping performed using the online MapChart platform. Statistical analysis was performed using Microsoft Excel (Microsoft Office Professional Edition, 2003). This included correlation analysis with calculation of the Pearson correlation coefficient (R), the coefficient of determination (R^2), and the level of statistical significance (p); $R \geq 0.5$ was considered to indicate a strong positive correlation between the two variables; $R^2 \geq 0.5$ indicated a satisfactory level of explained variance.

RESULTS AND DISCUSSION

Analysis of CSF eradication strategies implemented in different countries. During the 91st WOA General Session in May 2024, 38 countries were officially recognized as free from CSF, among them North American countries, Oceania, most European nations and specific zones in Brazil, Colombia and Ecuador. From 2020 to 2024, 17 countries reported CSF outbreaks worldwide, including Russia. In 2024, CSF persisted in parts of Asia, South America, Oceania and Madagascar (Fig. 1) [2].

There are several different approaches to CSF eradication.

Countries like Australia, Canada, the United States, and the European Union achieved and maintain WOA-recognized CSF-free status through nationwide radical measures, throughout the country, including a strict no-vaccination policy, extensive serological and virological surveillance to detect carriers, and stamping-out (total culling of affected herds plus contacts), alongside enhanced farm biosecurity. All this imposed substantial economic costs [9].

To reduce costs, a less stringent approach is used – to adopt zoning and enhanced disease surveillance. The

vaccination is maintained in high-risk zones and phased out in low-risk compartments, gradually expanding free zones. This approach is typical for Latin American countries (Brazil, Colombia and Ecuador).

For example, Brazil has reported historical CSF outbreaks since 1888 [10]. The country's efforts in the disease surveillance and control [11] achieved WOA recognition for specific zones as free from CSF since 2001. The proportion of pigs raised in recognized areas was 95% by 2015 [10]. However, in 2018, the disease resurfaced in Brazil: 34 outbreaks were reported, followed by 15 outbreaks in 2023 and 2024 in backyards [2]. In response, the country developed and adopted a new Brazil CSF-Free Strategic Plan based on enhanced clinical observations, laboratory tests (using polymerase chain reaction, PCR), elimination of the infected animals and prophylactic vaccination (based on lapinized C-strain) in the zones at the highest risk. In Brazilian regions with the highest pig population density, CSF control measures included the cessation of vaccination, which enabled the use of serological diagnosis (i.e., the detection of specific

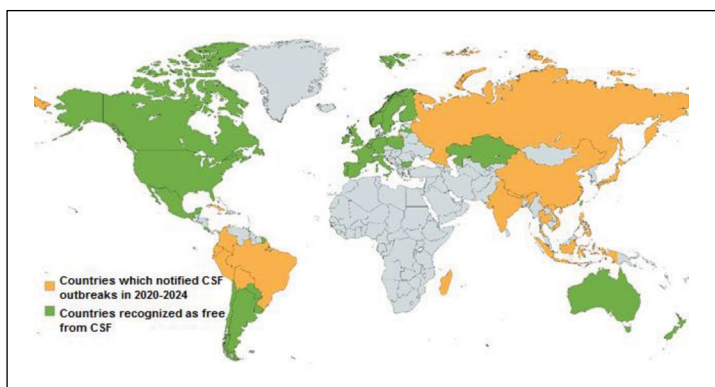


Fig. 1. CSF infected countries in 2020–2024

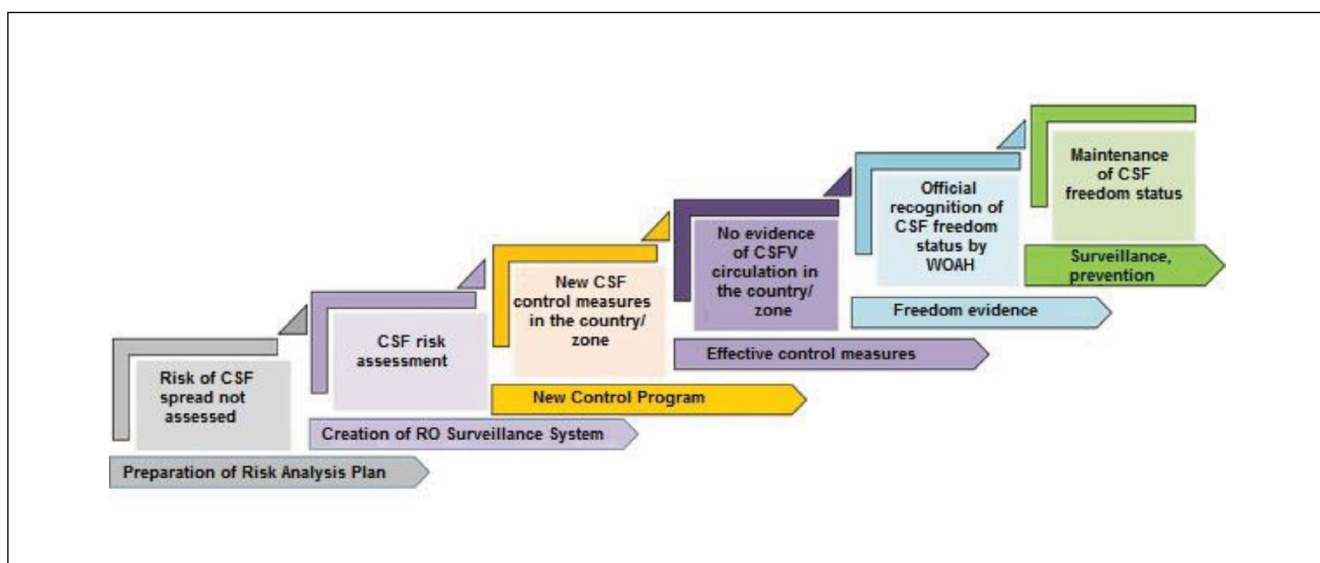


Fig. 2. Phased eradication plan for CSF in Russia [18]

antibodies). Serological surveillance was carried out by fauna managers (hunters) who collected blood samples [10]. Moreover, strict biosafety measures are applied to prevent the disease's spread [12].

It should be noted, that CSF remains endemic in several Asian countries including Japan, China, Indonesia, Thailand, and Nepal. A dramatic CSF situation has persisted in Japan in recent years. Outbreaks of CSF have been reported in the country since 1992 [13]. Vaccination with live GPE-strain was used historically for domestic pigs and wild boar but was banned for routine domestic use in 2006 [14]. Japan was officially recognized as a CSF-free country by the WOA in 2015 [13]. However, in 2018, the country again notified CSF outbreaks: the virus genome was detected in blood samples from asymptomatic wild boars [13, 14]. In the period from 2018 to 2024, 4,118 cases of CSF were reported in Japan among wild boars and 486 among domestic pigs. The country intensified surveillance in wild fauna, conducted depopulation of wild boar and environmental disinfection at carcass sites to eliminate fomites [15]. Oral vaccination of wild boars with Pestiporc Oral vaccine bait produced by Ceva Tiergesundheit (Reims, GmbH, Germany) was conducted followed by seroconversion monitoring [16]. Domestic pigs were immunized with live vaccines in high-risk areas. Based on 2025 data sporadic CSF cases persist in domestic pigs in Japan, but overall epizootic activity has significantly faded [6, 17].

Thus, cases of CSF continue to be registered in numerous territories worldwide (Japan, China, Southeast Asia and Latin America countries). To contain CSF spread and minimize economic losses, live attenuated vaccines are widely used in many affected countries. Final eradication of CSF requires implementing robust epizootological monitoring and control measures alongside complete cessation of vaccination. Experience from multiple countries demonstrates that drastic CSF eradication measures need not be applied nationwide immediately; gradual implementation by risk zones or compartments is both feasible and effective.

Development of CSF eradication approaches in the Russian Federation. In the 20th century, CSF outbreaks were reported in many Russian regions. However, a decrease in the number of reported outbreaks was already noted at the beginning of the 21st century. Between 2010 and 2020, the dynamics of the epizootic followed a downward trend. The most recent cases of CSF in Russia were recorded in the subjects bordering the People's Republic of China: Amur Oblast and Primorsky Krai [6, 18, 19, 20].

No CSF outbreaks have been reported in Russia since March 2020. The improvement of the situation in the country is attributed to the mass vaccination of pigs, along with the strengthening of biosecurity measures on pig farms and holdings [6, 18]. However, immunization against CSF has notable disadvantages, including failure to fully block virulent virus transmission and severe hindrance to detecting persistent infections in pigs [21]. Other disadvantages of CSF vaccination include post-vaccination reactions in some pigs, substantial financial and labor costs, export restrictions to free-status markets, and the inability to differentiate vaccinated from infected animals using conventional live vaccines [6, 7, 21].

The mentioned shortcomings fully justify the strict WOA Terrestrial Code recommendations to abandon vaccination for obtaining official CSF-free country/zone status. Given Russia's widespread use of vaccines against CSF, the

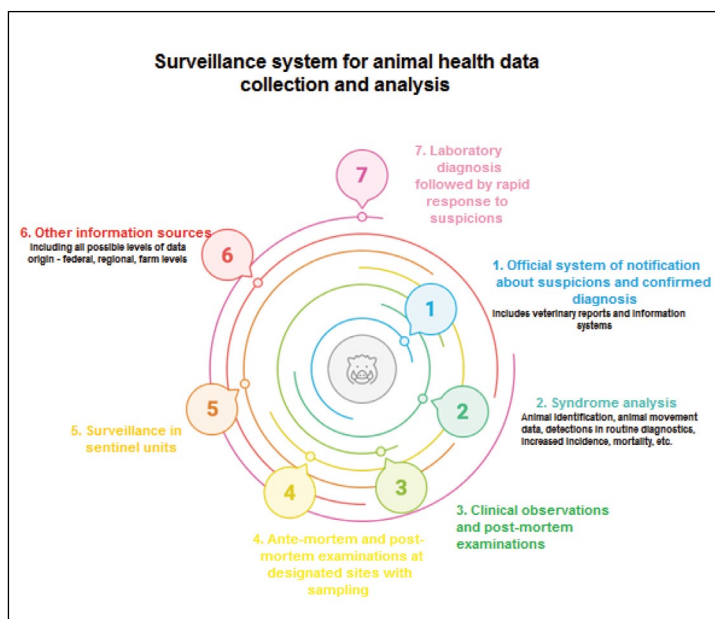


Fig. 3. Epizootological surveillance components

Russian Federation cannot currently apply for official CSF-free status. To eradicate CSF in Russia, developing and implementing a comprehensive federal program (roadmap) for epizootological monitoring and control would be preferable. Any regulatory document formalizing CSF control measures in Russia should account for diverse epizootic scenarios, tailored to disease manifestations across farm types: intensive industrial enterprises versus extensive backyard/collective systems [8].

If Russia's CSF eradication strategy includes abandoning conventional vaccines, phased implementation – coupled with rigorous biosecurity enforcement across all farm types – is essential to avoid epizootic deterioration and new outbreaks [18].

Previously proposed phased eradication plan for CSF in Russia [18] is shown in Figure 2.

This plan includes conducting a risk analysis, establishing a risk-oriented (RO) epizootological surveillance system, and developing a new CSF control program with enhanced measures designed for a potential vaccination withdrawal. The final stages involve collecting and analyzing information to confirm the territory (or country) is free from the disease. This is followed by submitting an application to the WOA to obtain official CSF-free status for the country or zone, and subsequently maintaining that status.

The implementation of the plan is feasible using "project management" approaches as a comprehensive process formalized by GOST R ISO 21500-2023, including risk analysis (regulated by the international standard ISO/IEC 31010:2009; GOST R ISO 58771-2019; GOST R ISO 31000-2019). In practice, simplified risk analysis approaches, including the use of only certain components, are often employed for applied purposes. For example, CSF eradication strategies can incorporate hazard identification and qualitative risk assessment to evaluate factors influencing outbreak likelihood or prevention, guiding targeted risk reduction measures.

Table 1
CSF diagnostic procedures recommended by the WOA Manual [24]

Method	Purpose					
	Population freedom from infection	Individual animal freedom from infection prior to movement	Contribute to eradication policies	Confirmation of clinical cases	Prevalence of infection – surveillance	Post-vaccination control
Detection of the agent						
Virus isolation	–	+	–	+++	–	–
RT-PCR	+	+++	++	+++	++	–
ELISA (antigen)	++	+	+	+	–	–
FAT	–	–	+	+	–	–
Detection of virus-specific antibodies*						
ELISA (antibody)	+++	+++	+++	–	+++	+++
VN (FAVN or NPLA)	+	+++	++	++	+++	+++

* the availability of diagnostic tools that can differentiate between antibodies specific to CSF and those induced by other pestiviruses is essential.

When identifying CSF outbreak scenarios in risk assessments, criteria for delineating high-risk zones and populations must be incorporated to define boundaries effectively (per WOA Terrestrial Code Articles 15.2.28–15.2.33) [3].

Another step in the eradication strategy is the preparation of the disease monitoring program.

Epizootological surveillance. Article 15.2.28 of the WOA Terrestrial Code defines epizootological surveillance as a systematic, ongoing process of collecting, analyzing, and promptly reporting animal health data to enable timely intervention measures [3].

In the current context in Russia, the priority goal of epizootological surveillance is rationally considered to be the early detection of infection – including latent virus transmission in convalescent animals. An additional goal may be to demonstrate the absence of virus circulation within a herd, region, district, enterprise, or farm (information that is essential for regionalization purposes) [8].

Chapter 1.4 of the WOA Terrestrial Code “On animal health surveillance” outlines a framework where

the surveillance system comprises complementary components, which are shown in Figure 3 and discussed in detail in this paper below.

The components are the following:

1. The official notification system for suspicion and diagnosis, including the collection of information in accordance with Orders of the Ministry of Agriculture of the Russian Federation: No. 89 “On the Procedure for Information Submission to the State Information Agricultural System” of 21.02.2022¹; No. 318 “On Approval of the Procedure for Information Submission to the Federal State Veterinary Information System and Information Retrieving From It” of 30.06.2017².

2. Syndrome analysis involves systematically collecting and evaluating data on changes in animal incidence, mortality, productivity, sales, and slaughter patterns to enable timely identification of disease causes through

¹ <https://www.garant.ru/products/ipo/prime/doc/404424070> (in Russ.)

² <https://www.garant.ru/products/ipo/prime/doc/71700754> (in Russ.)

complementary methods like clinical exams, necropsies, and laboratory tests [3].

In large pig farms, permanent production losses (mortality) are routine and stem from injuries, poisoning, non-contagious diseases, and contagious pathogens. Syndrome analysis enables timely detection of subpopulations (specific herds or pig groups) showing deteriorated indicators, allowing rapid response measures to investigate incident causes [8].

3. Clinical observation and necropsy. Regular and thorough clinical examination of all susceptible livestock, including necropsy, must be organized.

Paragraph 3 of the “Veterinary Rules for the Implementation of Preventive, Diagnostic, Restrictive and Other Measures, for Imposing and Lifting Quarantine and Other Restrictions to Prevent Spread of Classical Swine Fever and Eradicate Its Outbreaks”³, approved by Order No. 580 of the Ministry of Agriculture on 29.09.2020 (hereinafter referred to as the Rules), Paragraph 3 provides an extensive list of clinical signs and post-mortem lesions which, as stipulated in Paragraph 9 of the Rules, constitute grounds for suspecting CSF.

However, practicing veterinarians often mistakenly believe that all or most of the symptoms listed in Paragraph 3 of the Rules must be present in order to suspect CSF. However, infection with the CSFV is not always accompanied by a pronounced or typical clinical and pathological picture. For example, at the beginning of an outbreak – when the acute course of the disease prevails – or in vaccinated pigs, where the disease may present atypically, animals may exhibit only isolated clinical signs. The situation may be further complicated by the presence of other diseases on farms that share some clinical signs with CSF.

Collectively, these factors underscore the necessity of laboratory testing with differential diagnosis to distinguish CSF from other infectious diseases, including African swine fever, circovirus infection, pasteurellosis, salmonellosis, Glässer’s disease, infection with *Actinobacillus pleuropneumoniae*, and others. It is important to note that CSF can be complicated by concurrent infections with the aforementioned or other pathogens [22]. To avoid errors, such tests should be regular.

4. Veterinary ante-mortem examination of animals and post-mortem inspection of slaughter products must be conducted in accordance with established veterinary and sanitary requirements⁴. Furthermore, in high-risk areas for CSFV introduction where pigs are kept, it is advisable to pay particular attention to the lymph nodes, spleen, and kidneys during inspection. Carcasses, half-carcasses, quarters (including heads), and organs from wild boars must be submitted for mandatory veterinary-sanitary examination, where signs of lymphadenitis and hemorrhagic syndrome should raise immediate suspicion for CSF. If suspicious signs are detected during veterinary-sanitary examination, available samples are sent for differential laboratory testing, followed by decisions on disposal or destruction of slaughter products per veterinary-sanitary requirements⁵.

5. Monitoring in sentinel units (for example farms in the settlement under high-risk of introduction or re-emergence; unvaccinated animals serve as most sensitive detectors)

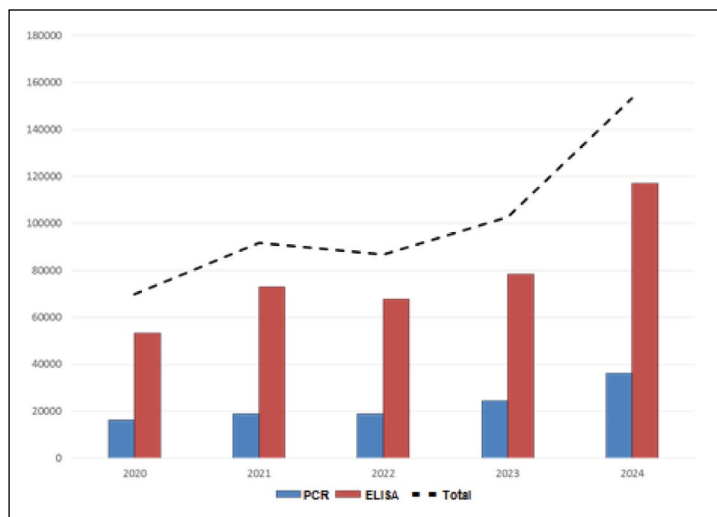


Fig. 4. Laboratory tests for CSF by PCR and ELISA conducted in Russia in 2020–2024 (retrieved from “Vesta” component, FGIS “VetIS”)

relies on regular clinical observation of pigs, with immediate sampling and testing if CSF signs appear to detect early cases [8]. Hunting farms within wild boar populations should be designated as sentinel units due to their heightened risk of CSFV introduction from adjacent infected territories.

6. Other sources of information. Data from diverse sources – such as owner/hunter reports of suspicious cases, animal/product exports, pig and pig product sales, commercial mortality, and wild boar carcass discoveries – play a crucial role in comprehensive epizootological surveillance for CSF.

7. Laboratory diagnostics.

7.1. Sampling. Paragraph 17 of the Rules lists the requirements for sampling only in case of CSF suspicion. For such cases, random sampling of the suspected group of susceptible animals is necessary, aiming for a detection level of around 10% prevalence. Routine sampling and testing in other circumstances is not required.

When CSF is introduced into large vaccinated herds, initial infection prevalence can remain very low (around 0.1% or less, based on the observations of Federal Centre for Animal Health specialists during the disease outbreaks), especially in the herd where vaccination is practiced [8, 23]. Therefore, random sampling proves ineffective for early CSF detection in large herds. This is attributable to the fact that the representative sample size required for the aforementioned objective is virtually equivalent to the entire herd, effectively mandating comprehensive testing. Consequently, the financial burden of conducting such monitoring on a regular basis is substantial.

Methodological recommendations for planning laboratory testing and sampling to improve CSF surveillance in the Russian Federation advocate for a RO-approach. This strategy enhances testing effectiveness by combining passive and active surveillance components [8]. Passive surveillance must incorporate sampling and testing of live pigs and cadavers from suspected CSF cases, while active surveillance entails routine testing of samples from at-risk animals – including clinically healthy pigs. Active surveillance sampling should be rationalized by stratifying

³ <https://base.garant.ru/74901254> (in Russ.)

⁴ <https://legalacts.ru/doc/pravila-veterinarnogo-osmotra-uboinykh-zhivotnykh-i-veterinarno-sanitarnoi/> (in Russ.)

⁵ <https://docs.cntd.ru/document/350341002> (in Russ.)

Table 2
Number of tested samples from wild boar and domestic pigs

Year	PCR		FAT		ELISA	
	pos / No. of samples from boars	pos / No. of samples from pigs	pos / No. of samples from boars	pos / No. of samples from pigs	pos / No. of samples from boars	pos. in n / v / No. of samples from pigs
2020	7/2,893	13/13,286	0/17	0/279	0/142	0/53,187
2021	0/3,107	2/15,705	0/6	0/24	0/48	0/72,867
2022	0/2,251	3/16,518	0/0	0/0	0/12	0/67,860
2023	0/2,121	3/22,156	0/0	0/0	0/4	0/78,307
2024	0/3,040	3/33,090	0/0	0/160	0/25	0/116,977
Total	13,412	100,755	23	463	231	389,198

pos. – positive; n/v – non-vaccinated domestic pigs.

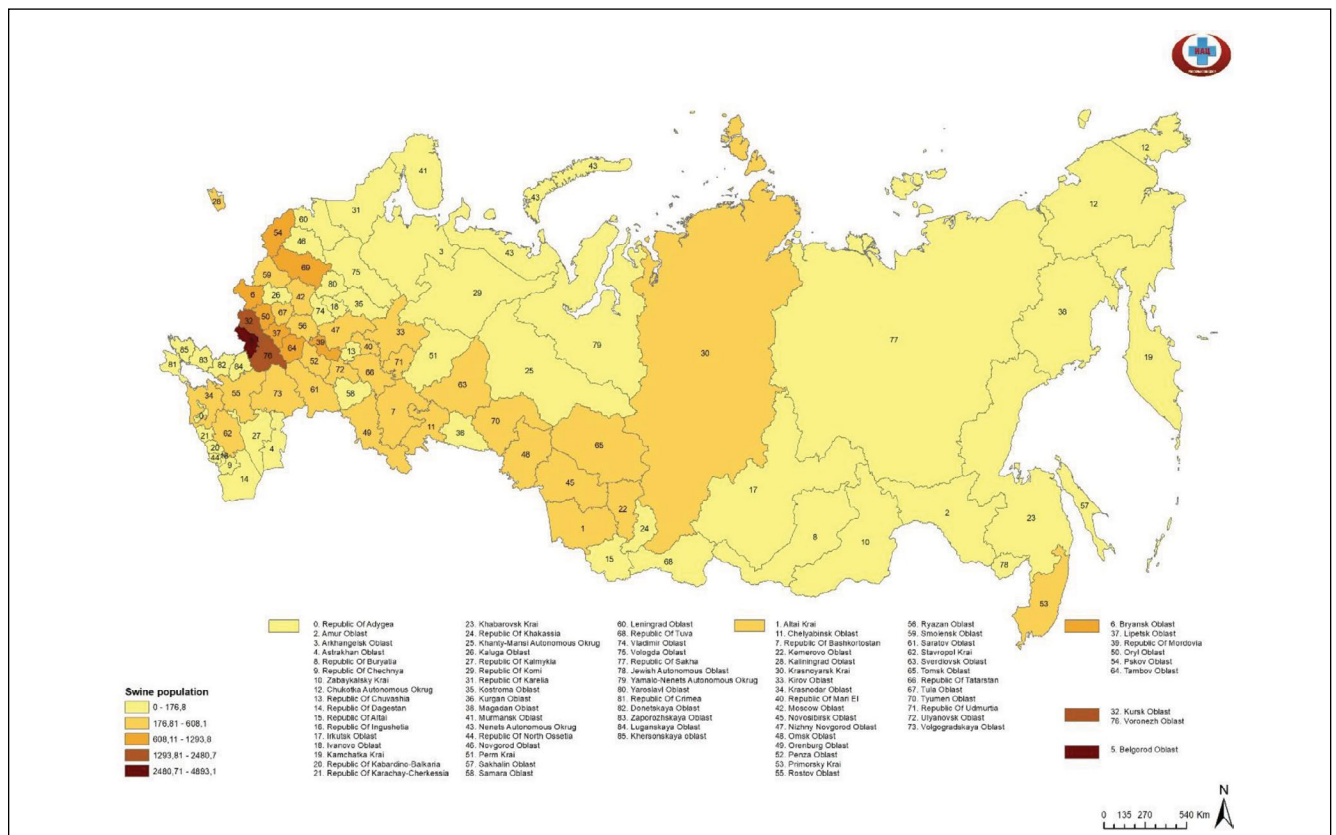


Fig. 5. Distribution of domestic pig population density and diagnostic testing across the Russian Federation in 2020–2024

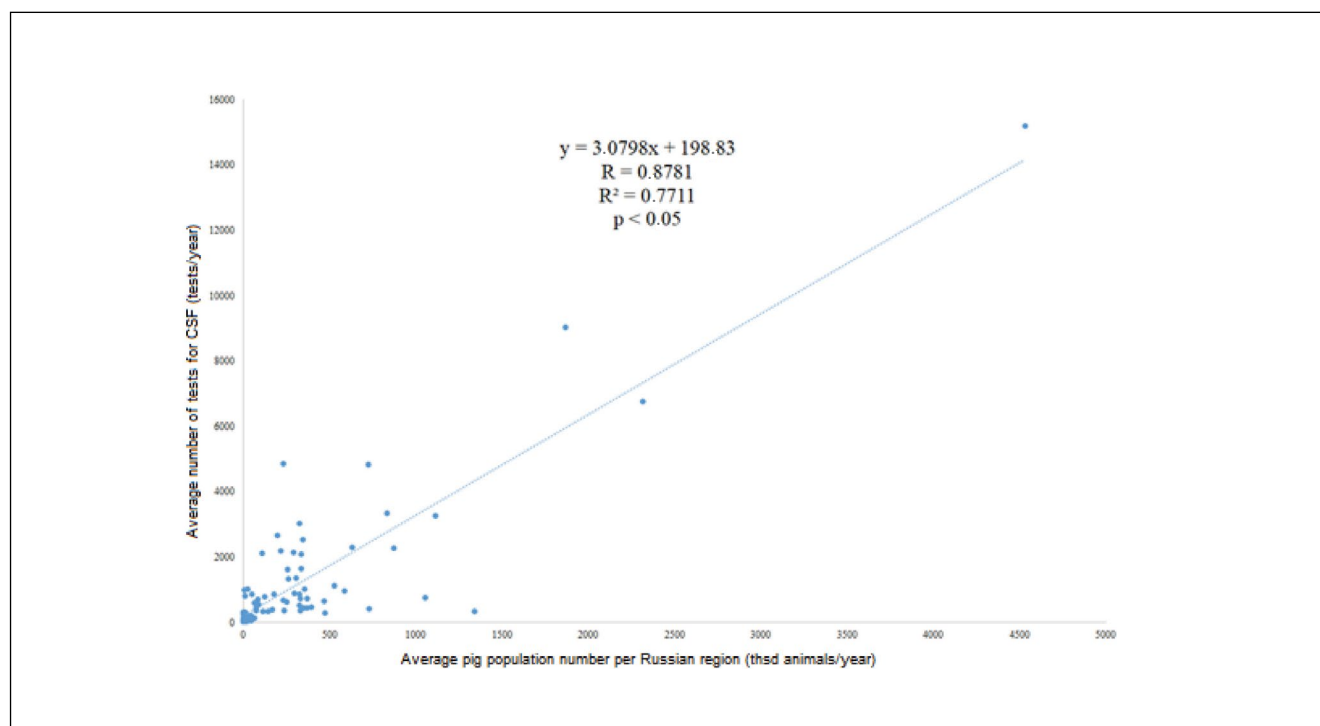


Fig. 6. Linear regression depicting the association between the average domestic pig population per region and the average number of CSF laboratory tests performed in that region (Russia, 2020–2024)

populations via syndrome analysis to target high-risk subgroups with rising morbidity/mortality. Syndrome data pinpoints deteriorating herds/sectors, prioritizing them over random sampling in large vaccinated systems. Within these groups, pigs exhibiting clinical or necropsy signs of infection are selected for testing⁶. In vaccinated pig herds, CSF introduction often leads to virus carriage in 1–3 month-old piglets, coinciding with waning colostral antibodies and immature post-vaccination immunity. It is recommended to consider such piglets as a high-risk group. Moreover, sampling vaccinated pigs should be delayed until 14–21 days post-vaccination to minimize detection of vaccine strain genomes, which could confound field virus identification.

7.2. Methods of laboratory diagnostics. According to Chapter 3.9.2 “On Classical Swine Fever” of the WOAHTerrestrial Manual, the methods of CSF laboratory diagnosis are divided into two groups:

a) direct – used to detect the virus (virus isolation in a sensitive cell culture), its antigen (fluorescence antibody test, FAT; enzyme-linked immunoassay, ELISA) and genome (reverse-transcription PCR, RT-PCR);

b) indirect – used to detect CSFV-specific antibodies: ELISA and virus neutralization (VN) tests (fluorescent antibody virus neutralization, FAVN, and neutralizing peroxidase-linked antibody, NPLA).

Recommendations for the use of direct and indirect techniques for CSFV diagnosis are given in the WOAHTerrestrial Manual (Table 1) [24].

The diagnostic techniques recommended by the WOAHT are primarily designed for countries that have ceased using live vaccines. Using non-marker vaccines necessitates ad-

justed serological strategies, prioritizing laboratory tests, especially serological ones.

7.3. Analysis of laboratory tests for CSF conducted in 2020–2024 in Russia, and improvement of the laboratory diagnostic scheme. According to the data from “Vesta” component of the FGIS “VetIS”, in 2020–2024, 504,140 tests for CSF were conducted, most of them tested by ELISA for specific antibodies (389,429 – 77.2%), and RT-PCR (114,167 – 22.6%), by FAT (486 – 0.1%) and virus isolation (58 – 0.01%) in 85 regions of the country (Fig. 4).

It was established that the number of ELISA tests for CSF (detection of CSFV antibodies) is significantly higher than by PCR (detection of the virus itself). At the same time, the feasibility of using indirect test methods for CSF is questionable, since in conditions of mass vaccination of pigs this fails the core goal of early virus detection in epizootological surveillance.

Details on the number of tests conducted on samples from wild and domestic pigs for CSF in 2020–2024 is presented in Table 2.

According to data from the “Vesta” component (FGIS “VetIS”), tests on wild boar samples account for only 2.7% of all tests conducted. In this context, direct testing methods (such as RT-PCR) are preferred, as serum sampling for ELISA is challenging.

The low number of tests conducted on wild boars is due to the absence of strict regulatory requirements. Thus, according to Paragraph 18 of the Rules, sampling from wild boars is regulated only in infected regions (status established in accordance with regionalization)⁷. We believe existing requirements should be adjusted to im-

⁶ <https://base.garant.ru/74901254> (in Russ.)

⁷ <https://base.garant.ru/74901254> (in Russ.)

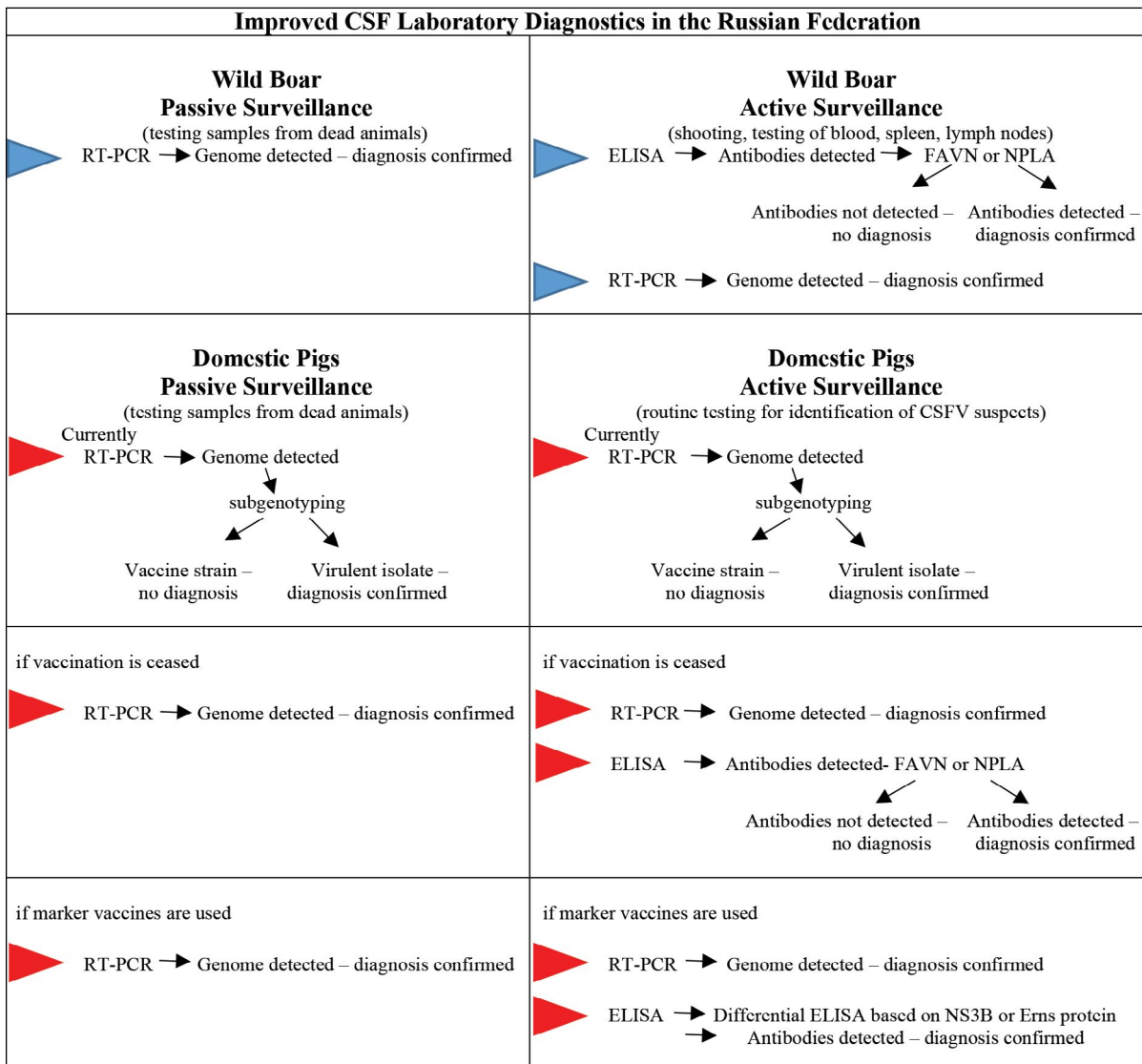


Fig. 7. A proposed strategy for CSF laboratory testing of samples from wild and domestic pigs in the Russian Federation (If the CSF virus genome is detected and confirmed to be unrelated to vaccine strains, virus isolation is recommended to obtain the strain for further scientific research. In the current context, serological diagnostics in domestic pig populations are considered impractical due to the widespread use of live vaccine immunization.)

prove the reliability of data on CSF in the wild boar population.

The Rules should also be amended regarding the diagnosis of CSF in domestic pigs. There has been a five-year upward trend in the number of laboratory tests for CSF in domestic pigs. Thus, in 2024 compared to 2020, the number of tests using molecular genetic methods increased 2.5-fold, while serological tests increased 2.2-fold. Analysis of the spatial distribution of CSF laboratory tests revealed a direct correlation between the percentage of tests conducted and the density of domestic pigs in specific regions of Russia. For example, most of the tests (31.13%) for CSF were carried out in Belgorod (15.265%), Voronezh (9.079%) and Kursk (6.786%) Oblasts, while in the territories at risk, namely Amur Oblast (1.016%), the Republic of Buryatia (0.334%), Khabarovsk (1.006%) and Primorsky (0.881%) Krai accounted only for 3.237% of the total number of tests conducted (Fig. 5). Correlation analysis of the average pig population per region (thousand animals/year) and the

average number of CSF laboratory tests conducted (tests/year) over 2020–2024 revealed a strong positive correlation ($R = 0.88$), with satisfactory variance explained ($R^2 = 0.77$) and statistical significance ($p < 0.05$), Fig. 6. The data indicate that, under current conditions, the primary criterion for sampling is the size of the livestock population in a given region of Russia. However, testing efforts should be redistributed in favor of regions at higher risk of CSFV introduction – particularly those bordering affected countries.

As shown in Figure 4 and Table 2, the majority of tests were performed using ELISA, which detects specific CSFV antibodies. In 2020–2024, no antibodies were detected in non-vaccinated pigs by ELISA. According to “Center of Veterinary Medicine”, more than 90 million doses of CSF vaccine are administered to pigs annually in the Russian Federation. The serological tests mentioned in Table 2 (389.2 thousand) were also conducted among immunized pigs, which were seropositive. Serological methods fail for CSF detection in non-marker vaccine contexts, as they

cannot distinguish vaccine-induced from infection-derived antibodies, rendering positives non-specific [14].

At the same time, despite the limitations, the ELISA method is fast and widespread, which can play a significant role in laboratory diagnostics when vaccinations are ceased or marker vaccines are used. However, at present, its application for early infection detection is only justifiable when testing domestic pigs and wild boars that are confirmed to be unvaccinated. In addition, ELISA tests used in veterinary laboratories must incorporate recombinant E2 protein as the antigen and undergo full validation for accuracy, repeatability, reproducibility, sensitivity (Se), and specificity (Sp). Special emphasis is placed on validating the absence of cross-reactions with antibodies against other pestiviruses, such as bovine viral diarrhea virus and border disease virus in swine serum to ensure diagnostic specificity.

The WOAHP Manual (Table 1) recommends using FAVN or NPLA to detect clinical cases rather than ELISA [24]. These methods offer the highest sensitivity for detecting CSFV antibodies but incur high costs for cell culture maintenance, virus propagation, specialized anti-specific conjugates, and monoclonal antibodies, rendering them unsuitable for routine diagnostics [25]. Although neutralization tests remain essential in reference laboratories to confirm and differentiate false-positive ELISA results. The integration of FAVN or NPLA into the workflows of accredited veterinary laboratories across Russia is a critical objective.

The next most frequently used method for CSF testing in Russia is RT-PCR, a technique specifically designed to rapidly and accurately detect fragments of the CSFV genome in test samples. Between 2020 and 2024, 31 positive results were obtained: 7 samples collected from wild boars in the Primorsky Krai – the site of Russia's last outbreak in 2020 – and 24 samples identified as vaccine strains.

Herewith, according to Paragraph 1.1.5 (“Molecular epidemiology and genetic typing”) of Chapter 3.9.2 in the WOAHP Terrestrial Manual, subgenotyping of CSFV upon a positive detection (virus isolation or genome confirmation) requires phylogenetic analysis targeting the 5'-non-translated region, E2 glycoprotein gene, and NS5B polymerase gene [24, 26, 27]. However, these genotyping methods face limitations including prolonged processing times, requirements for costly equipment and reagents, and the need for highly qualified personnel.

To overcome these limitations, upgraded PCR assays have been developed for rapid and accurate differentiation of vaccine from field CSFV strains [28]. One advanced method is PCR with subsequent DNA melting analysis or PCR (PCR-DMA) high-resolution melt curve analysis (PCR-HRM) [29]. However, during new CSF outbreaks, Sanger sequencing followed by subgenotyping of isolates remains essential to trace virus origin, spread, and localization [2].

Furthermore, Paragraph 20 of the Rules stipulates the use of the FAT for detecting CSFV antigen in biological smears⁸. However, FAT usage for CSF diagnosis confirmation has declined in recent years due to high conjugate costs and domestic market shortages, risks of non-specific reactions, and subjective result interpretation errors.

Virus isolation serves as a direct diagnostic method for CSF confirmation, yet its application remains extremely limited nationally compared to total testing volume. Virus isolation for CSF diagnosis involves detecting viral replication in permissive porcine cell cultures such as the PK-15

kidney cell line or primary trypsinized testicular cells (TC), requiring confirmatory identification due to the absence of cytopathic effects. These are immunoperoxidase testing, FAT and RT-PCR [30].

According to WOAHP recommendations, virus replication confirmation in cell cultures can be performed via FAT after 24–72 hours or immunoperoxidase testing 3–4 days post-inoculation. Virus isolation protocols recommend planning for 3–5 serial passages [24]. However, these methods face significant limitations, including costly cell culture bank maintenance, high prices and domestic shortages of specific conjugates, risks of non-specific staining, and subjective visualization errors.

RT-PCR simplifies and lowers the cost of confirming virus isolation results for CSF while minimizing false results compared to immunofluorescence or immunoperoxidase methods [31]. Virus isolation remains valuable for obtaining current CSFV isolates and strains to evaluate their biological properties – such as contagiousness, virulence, seroconversion, immunogenicity, and protectivity – in naturally susceptible animals. While these activities are integral to CSF surveillance, they are not directly involved in disease detection.

Virus isolation is preferably reserved for research within CSF surveillance frameworks, whereas RT-PCR has become the standard for routine diagnostics [31, 32].

Based on the discussion, a laboratory diagnostic scheme for CSF in domestic pig and wild boar populations is proposed for the current situation without routine vaccination but using marker vaccines (Fig. 7).

Together, the surveillance components provide reliable information, confirmed by several data sources. The integrated application of these methods will allow for the timely identification of and response to suspicious cases, as well as the formulation of an effective emergency control strategy.

CSF control. The next stage in Russia's CSF eradication strategy is to formulate an emergency response plan and incorporate the requisite amendments into the regulatory documentation. This necessitates the consistent refinement of the nation's current regulatory framework governing pig husbandry, as well as the prevention, diagnosis, and control of CSF.

For instance, it is already evident that to ensure the early detection of all infection cases and viral transmission among susceptible animals, the Rules must be amended to strengthen the epizootological surveillance measures they contain. To achieve this, one must account for the possibility of a prolonged latent period of the disease spread and the variability of clinical symptoms. We deem it advisable to approve the requirements based on the aforementioned methodological recommendations [8], mandating regular, rather than episodic, laboratory testing using direct methods. It should be noted that the transition to serological diagnostics as the primary method is contingent upon two prerequisites: the cessation of vaccine use (either regionally or nationally) and the removal of seropositive animals from the susceptible herd. This is necessitated by several factors:

- the duration of antibody persistence in previously immunized pig populations (post-vaccination antibodies to the vaccines used in Russia can be detected for at least two years, irrespective of the animal's age) [33];
- colostrum antibody persistence (on average 5–7 weeks or more) [34];

⁸ <https://base.garant.ru/74901254> (in Russ.)

– inability to differentiate post-vaccination antibodies from post-infectious ones.

As part of the ongoing improvement of regulatory documentation, it is paramount to immediately introduce requirements mandating a comprehensive set of biosecurity measures for pig farms and enterprises, designed to reliably prevent the introduction and spread of infectious diseases.

Implementing the vaccination withdrawal phase will increase the risk of disease outbreaks on low-biosecurity farms throughout the country, and particularly in compartment III and IV pig farms situated on the border with countries that are currently or have historically been infected. Therefore, when adopting a non-vaccination policy, a phased approach is recommended, initiating the measure in a single region or even within a select group of farms (compartments) in the Central Federal District of Russia. Upon achieving positive results with the strategy outlined above, the list of such farms or regions can be expanded incrementally [18].

Upon successful cessation of vaccination, followed by 12 months of compliant surveillance and fulfillment of other requirements in Chapter 1.9 “Application for official recognition by WOAHP of free status for classical swine fever” the official CSF-free status recognition becomes feasible.

In cases of high CSFV incursion risk precluding vaccination cessation, marker vaccine use is acceptable. For example, in 2024, a marker vaccine based on the recombinant E2 protein of the CSFV (“VERRES-CSF-E2”, Vetbiokhim) was registered in the Russian Federation [35, 36]. In this case, post-vaccination antibodies can be differentiated from those resulting from infection using an ELISA based on recombinant E^{2ms} and/or NS3B proteins (antibodies against these viral proteins are detectable only in infected pigs, not in vaccinated ones). For the implementation of a DIVA strategy in the country, it is feasible to utilize either the aforementioned marker vaccine or another registered alternative that has been validated in accordance with WOAHP recommendations. For these purposes, the use of differentiating ELISA test kits will also be required.

In the future, our country will be required to substantiate its CSF-free status by submitting evidentiary documentation to the Scientific Committee.

CONCLUSION

Although no cases of CSF have been recorded in the Russian Federation in recent years, the absence of a legislatively mandated eradication policy and the continued practice of mass immunization with live vaccines render it impossible to apply for CSF-free status under current conditions.

Based on international experience and the current CSF situation in Russia, the article suggests approaches to improve the disease surveillance and control. These approaches are aligned with international recommendations and support the national disease eradication goal, which mandates amendments to the current veterinary regulations on CSF.

The methods for timely CSF laboratory diagnosis have been developed in Russia. However, the application of certain methods (e.g., ELISA) has only partial justification and does not consistently align with the national CSF eradication strategy. However, future development and implementation of the FAVN and/or NPLA tests will be necessary for differentiating false-positive sera in ELISA. These

methods will be especially relevant following vaccination cessation. The proposed order and priority for using CSF diagnostic methods will enable more efficient allocation of available resources.

The framework proposed in this article for improving CSF surveillance and control in the Russian Federation will bring the country closer to attaining disease-free status recognized by WOAHP. Success in this endeavor would, in turn, enhance the profitability of the pig industry and strengthen Russia’s export potential.

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