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Quantitative risk assessment of African swine fever introduction into Spain by legal import of swine products

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ABSTRACT

African swine fever (ASF) is currently threatening the global swine industry. Its unstoppable global spread poses a serious risk to Spain, one of the world's leading producers. Over the past years, there has been an increased global burden of ASF not only in swine but also swine products. Unfortunately, many pigs are not diagnosed before slaughter and their products are used for human consumption. These ASF-contaminated products are only a source for new ASF outbreaks when they are consumed by domestic pigs or wild boar, which may happen either by swill feeding or landfill access. This study presents a quantitative stochastic risk assessment model for the introduction of ASF into Spain via the legal import of swine products, specifically pork and pork products. Entry assessment, exposure assessment, consequence assessment and risk estimation were carried out. The results suggest an annual probability of ASF introduction into Spain of 1.74×10^{-4}, the highest risk being represented by Hungary, Portugal, and Poland. Monthly risk distribution is homogeneously distributed throughout the year. Illegal trade and pork product movement for own consumption (e.g., air and ship passenger luggage) have not been taken into account due to the lack of available, accredited data sources. This limitation may have influenced the model's outcomes and, the risk of introduction might be higher than that estimated. Nevertheless, the results presented herein would contribute to allocating resources to areas at higher risk, improving prevention and control strategies and, ultimately, would help reduce the risk of ASF introduction into Spain.

1. Introduction

African swine fever (ASF) is one of the most serious diseases of swine due to its high mortality, the lack of an effective and safe treatment or vaccine, and the serious socio-economic impact on affected countries. ASF is on the list of notifiable diseases of the World Organisation for Animal Health (WOAH), (WOAH-WAHIS, 2023a). African swine fever virus (ASFV) is the only recognised member of the *Asfarviridae* family (Dixon et al., 2019). ASFV hosts are members of the *Suidae* family with different clinical presentations ranging from peracute to chronic forms. Soft ticks of the *Ornithodoros* genus are the natural reservoir and vector of ASFV (Sánchez-Vizcaíno et al., 2015).

ASF was first described in 1921 in Kenya (Montgomery, 1921). Since then, it has been reported in many sub-Saharan countries (Penrith et al., 2019). ASF was confined to Africa until 1957 when an outbreak in Portugal was reported. The outbreak was rapidly controlled and eradicated; however, the disease was notified again in 1960 and spread to the whole Iberian Peninsula, remaining endemic until 1995. Both introductions were suggested to be related to the inappropriate disposal of food waste containing infected pork products (Sánchez-Vizcaíno et al., 2015). In 2007, ASF re-entered the European continent and spread worldwide in the following years (WOAH-WAHIS, 2023b). This spread also appears to be related to infected pork products (FAO, 2008). Currently, ASF is present in Africa, America, Asia, Europe, and Oceania (WOAH-WAHIS, 2023b).

In view of the foregoing, the movement of pork and pork products

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plays a key role in ASF introduction and spread. The World Trade Organisation (WTO) and the World Organisation for Animal Health (WOAH) recommend preventive and control measures to reduce the risk of ASF spread, such as banning the trade of live swine and their products from ASF-affected countries or zones to ASF-free countries or zones (WOAH-WAHIS, 2023b). Considering these policies, the major risk for ASFV introduction by legal trade would be concentrated during the 'high-risk period' (HRP), the period from the initial infection of a new area or country until it is detected and reported, when trade is not restricted (De Vos et al., 2004).

The quantitative risk assessment of the present study quantifies the risk of ASF introduction into Spain by legal trade of pork and pork products. The main objective is to identify geographical zones and time periods that pose the highest risk, reinforce control and prevention strategies and, ultimately, try to mitigate the risk of ASF introduction into Spain.

2. Material and methods

2.1. Definition of the unit of analysis and data sources

The spatial and temporal unit of analysis was country and month, respectively. This level of aggregation was presumed to be the most adequate considering the available data. Data regarding kilograms of pork and pork products imported by Spain from origin countries per month from 2015 to 2021 were obtained from the Spanish official database of Foreign Trade (Spanish Chamber of Commerce, 2023). The assessment considered 36 origin countries for which data was available.

This study complements the results obtained from the risk estimation for the introduction of ASF into Spain by legal import of live pigs (Muñoz-Pérez et al., 2022). Tables 1 and 2 summarises all assumptions, input parameters, parameterisation, and information sources used in the quantitative model.

2.2. Model formulation

The present quantitative risk assessment follows WOAH guidelines using the system described by Covello and Merkhofer (1993). The model is divided into four steps: Entry assessment, exposure assessment, consequence assessment and risk estimation. Entry assessment describes the biological pathway(s) necessary for the importation activities of pork and pork products to introduce ASFV into Spain and estimates the probability of that introduction occurring. By the same token, exposure assessment describes the biological pathway(s) necessary for exposure of susceptible Spanish domestic pig and wild boar populations to ASF-contaminated products, also estimating the probability of this exposure occurring (WOAH, 2004). These risk pathways described are summarised by the event tree depicted in Fig. 1.

Based on the above, this present risk assessment model evaluated the conditional probability of infected swine product entry into Spain during the HRP and the subsequent consumption by whole or part of those products by susceptible domestic pig or wild boar populations. This probability (PI) was estimated per month and per country of origin of imported pigs, assuming a binomial process of the form:

$$PI = \Sigma\, 1 - (1 - P_R \times P_E)^{ncm}$$

where P_R is the probability of entry, P_E is the probability of exposure and n_{cm} is the number of kilograms of pork and pork products imported from the country of origin (*c*) during the month (*m*).

The model was developed using @Risk version 8.2. (Palisade Corporation, Newfield, NY, USA) on Microsoft Excel 2013®and run for 10,000 iterations using the Monte-Carlo sampling method. A map to visualise the annual mean probabilities (sum of monthly probabilities) was generated in ArcGis 10.4.1 (ESRI, Redlands, CA, USA).

Table 1
Description of model inputs for the risk assessment of ASF introduction into Spain by legal imports of swine products.

Notation	Definition	Parameterisation	Source	Values
P_1	Probability of undetected infection in country of origin (*c*)	Beta (α_1, α_2) $\alpha_{1p} = X + 1$ $\alpha_{2p} = M - (X + 1)$	X: Number of months with at least one undetected ASF outbreak in *c* (WOAH-WAHIS, 2023b) M: Number of months considered in the analysis (WOAH-WAHIS, 2023b)	
P_2	Probability of selecting ASF-contaminated meat from the country of origin (*c*) in month (*m*) before detection of ASFV infection	Beta (α_1, α_2) $\alpha_{1q} = Q_{im} + 1$ $\alpha_{2q} = N_m - (Q_{im} + 1)$	$Q_{im} = NI \times P_m \times M_p$ $NI = O_u \times T_o \times H_p$	
N_m	Total meat production in country of origin (*c*)	Normal (μ,σ)	(FAOSTAT, 2023)	
P_m	Probability of an ASF-infected pig being transformed into meat		$P_m = P_3 \times P_4 \times P_{sm} \times P_{us}$	
P_3	Probability of an ASF-infected pig surviving the infection	Pert (min, most likely, max)	(Sánchez-Vizcaíno et al., 2015)	Pert (0.05, 0.2, 1)
P_4	Probability of an ASF-infected pig surviving transportation	Pert (min, most likely, max)	(Murray and Johnson, 1998)	Pert (0.0005, 0.0027, 0.092)
P_{sm}	Probability of an ASF-infected pig going to a slaughterhouse during a specific month	Normal (μ,σ)	(Herrera-Ibatá et al., 2017)	Normal (0.18, 0.02)
P_{us}	Probability of an undetected infected pig in a slaughterhouse	Beta (α_1, α_2)	(Martínez-López et al., 2009)	Beta (1.33, 34.16)
M_p	Average weight of the products (kg) obtained per slaughtered pig	Normal = K_p/N_p		
K_p	Kilograms of pig meat produced in country of origin (*c*)	Normal (μ,σ)	(FAOSTAT, 2023)	
N_p	Number of pigs slaughtered in country of origin (*c*)	Normal (μ,σ)	(FAOSTAT, 2023)	
O_u	Expected number of undetected outbreaks before official notification	Pert (min, most likely, max)	(Herrera-Ibatá et al., 2017)	Pert (1, 1.28, 6)
T_o	Average herd size in country *c*	Normal = N_o/S_o		

(*continued on next page*)

Table 1 (*continued*)

Notation	Definition	Parameterisation	Source	Values
N_o	Pig population size in country *c*	Normal (μ,σ)	(FAOSTAT, 2023)	
S_o	Number of pig farms in country *c*	Normal (μ,σ)	(FAOSTAT, 2023)	
H_p	Intra-herd prevalence	Pert (min, most likely, max)	(Herrera-Ibatá et al., 2017)	Pert (0.05, 0.15, 0.32)

Table 2
Description of model inputs to estimate the risk of exposure of Spanish swine populations to ASF-contaminated imported swine products.

Notation	Definition	Parameterisation	Source	Values
SF	Probability of a domestic pig having access to pork waste by swill feeding		W x SF|W	
W	Proportion of food waste in the food supply chain	Normal (μ,σ)	(AESAN, 2023)	Normal (0.11, 0.02)
SF|W	Proportion of food waste used in swill feeding	Pert (max, most likely, min)	Assumption based on (Horrillo et al., 2022; Simon-Grifé et al., 2013).	Pert (0.01, 0.03, 0.07)
P_{LF}	Probability of a wild boar having access to pork waste in landfills		W x LF|W x LF_{WB} x WB_A	
LF|W	Proportion of food waste discarded in landfills	Normal (μ,σ)	Assumption based on (CONAMA, 2023).	Normal (0.60, 0.1)
LF_{WB}	Probability of wild boar being present in landfills	Pert (max, most likely, min)	Assumption based on (Duarte et al., 2011)	Pert (0.01, 0.74, 0.97)
WB_A	Probability of wild boar having access to landfills	Pert (max, most likely, min)	(Herrera-Ibatá et al., 2017)	Pert (0.05, 0.1, 0.2)

2.3. Definition of input parameters

2.3.1. Entry assessment

Entry assessment describes the biological pathway(s) necessary for the importation activities of pork and pork products to introduce ASFV into Spain, and estimates the probability of that introduction occurring. This conditional probability (P_R) was estimated as the product of two independent events: the probability of undetected outbreaks in the origin country (P_1) and the probability of selecting ASFV-infected meat (P_2).

$$P_R = P_1 \times P_2$$

2.3.1.1. Probability of undetected outbreaks (P_1). The probability of undetected outbreaks in origin country *c* in month *m* (P_1) was parameterised using a beta distribution with values α_{1p} and α_{2p}. These parameters were calculated as:

$$\alpha_{1p} = X + 1$$

$$\alpha_{2p} = M - (X + 1)$$

where X is the number of months with at least one undetected ASF outbreak in origin country *c* and M is the number of months considered in the analysis (i.e., the number of months with available information in the WOAH-WAHIS database).

2.3.1.2. Probability of selecting ASF-infected meat (P_2). The probability of selecting ASFV-infected pork meat from origin country *c* in month *m* (P_2) was modelled using a beta distribution with parameters α_{1q} and α_{2q}. These values were computed as:

$$\alpha_{1q} = Q_{im} + 1$$

$$\alpha_{2q} = N_m - (Q_{im} + 1)$$

where Q_{im} is the quantity (kg) of potentially infected swine products at origin country *c* during month *m* and N_m is the quantity (kg) of swine products imported from origin country *c* during month *m*. N_m is assumed to be normally distributed with parameters μ and σ, where μ is the average of kilograms of meat produced in country *c* during month *m* from 2018 to 2022, and σ is the standard deviation of the kilograms of meat produced in country *c* during month *m* from 2018 to 2022 (FAOSTAT, 2023). Q_{im} is estimated as the product of four independent parameters: the expected number of undetected outbreaks in country *c* before official notification (O_u), average herd size of domestic pigs (T_o), intra-herd prevalence (H_p), average weight of products obtained per slaughtered pig (M_p) and the probability of an ASF-infected pig being transformed into meat (P_m). Q_{im} is calculated as follows:

$$Q_{im} = O_u \times T_o \times H_p \times M_p \times P_m$$

The expected number of undetected outbreaks in country *c* before official notification (O_u) was modelled using a Pert distribution with minimum, most likely and maximum values of 1, 1.28 and 6, respectively. These values were assumed to be the same as those published in Herrera-Ibatá et al. (2017) based on ASF notifications in Europe.

The average herd size of domestic pigs in country *c* (T_o) was presumed normally distributed with parameters μ (mean) and σ (standard deviation), where μ is the average number of domestic pigs and pig farms in origin country *c* from 2018 to 2022, and σ is the standard deviation of the number of domestic pigs and pig farms in origin country *c* from 2018 to 2022 (FAOSTAT, 2023).

The intra-herd prevalence (H_p), representing the proportion of infected pigs in an infected (but undetected) herd (Mur et al., 2012) was assumed to be Pert distributed. The minimum, most likely and maximum values were assumed to be 0.05, 0.15, and 0.32, respectively. These values were accepted to be the same as those published in Herrera-Ibatá et al. (2017) based on WOAH data from ASF outbreaks in Europe.

The average weight of the products (kg) obtained per slaughtered pig (M_p) was assumed normally distributed with parameters μ and σ, where μ is the average of kilograms of pork meat produced in country *c* from 2018 to 2022, and σ is the standard deviation of the kilograms of pork meat produced in country *c* from 2018 to 2022 (FAOSTAT, 2023).

The probability of an ASF-infected pig being transformed into meat (P_m) is calculated as the product of four independent probabilities: the probability of an ASF-infected pig surviving the infection (P_3), probability of an ASF-infected pig surviving transportation (P_4), probability of an ASF-infected pig going to the slaughterhouse (P_{sm}) and the probability of an ASF-infected pig being undetected in the slaughterhouse (P_{us}). The parameterisation and sources of these probabilities are summarised below.

The probability of an ASF-infected pig surviving the infection (P_3) was modelled using a Pert distribution with a minimum, most likely, and maximum values of 0.05, 0.2, and 1. These values were based on the mortality rates of the different ASFV isolates which are responsible for the different clinical forms of the disease reported in the literature (Sánchez-Vizcaíno et al., 2015).

The probability that an ASF-infected pig surviving transportation

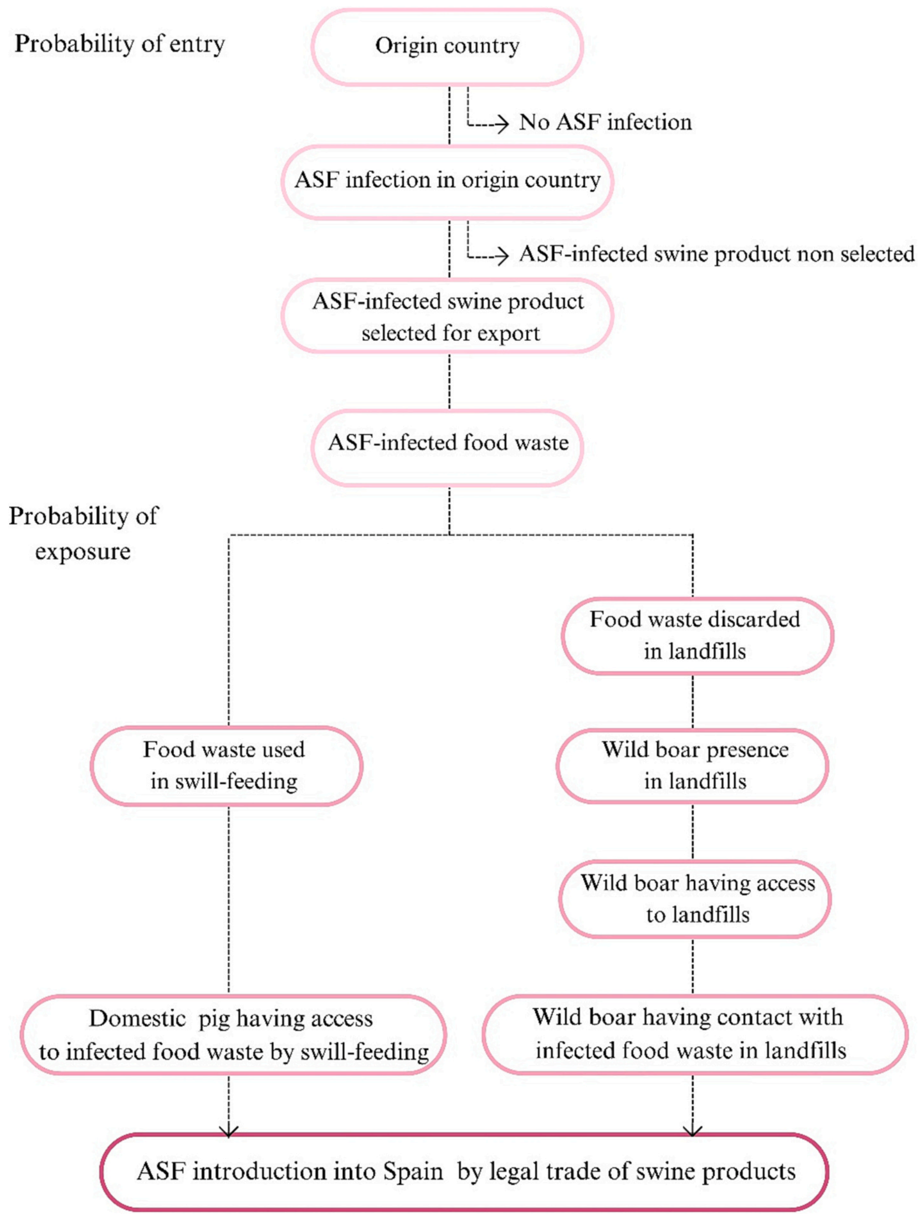

Fig. 1. Event tree of ASF introduction into Spain via legal import of swine products.

(P_4) was assumed to be Pert distributed with minimum, most likely, and maximum values of 0.0005, 0.0027, and 0.092 based on the mortality rates during transport described by Murray and Johnson (1998).

The probability of an ASF-infected pig going to the slaughterhouse (P_{sm}) was presumed normally distributed with parameters μ and σ. This probability was accepted to be the same as that published in Herrera-Ibatá et al. (2017) based on data from the pig farming sector.

The probability of an ASF-infected pig being undetected in the slaughterhouse (P_{us}) was modelled using a beta distribution with parameters α_1 and α_2. The probability was based on the estimations published by Martínez-López et al. (2009) for Spanish farms.

2.3.2. *Exposure assessment*

Exposure assessment describes the biological pathway(s) necessary for exposure of susceptible Spanish domestic pig and wild boar populations to ASF-contaminated products, and estimates the probability of this exposure occurring. This conditional probability (P_E) was estimated as the product of two independent events: the probability of a domestic pig having access to pork waste by swill feeding (SF_R) and the probability of a wild boar having access to pork waste in landfills (P_{LF}).

$$P_E = SF \times P_{LF}$$

Probabilities are estimated as follows:

$$SF = W \times SF|W$$

$$P_{LF} = W \times LF|W \times LF_{WB} \times WB_A$$

where W is the proportion of food waste in the food supply chain, SF|W is the proportion of food waste used in swill feeding, LF|W is the proportion of food waste discarded in landfills, LF_{WB} is the probability of wild boar being present in landfills and WB_A is the probability of wild boar having access to landfills. The parameterisation and sources of these probabilities are summarised in Table 2.

2.4. *Sensitivity analysis*

A two-step sensitivity analysis was performed to estimate the influence of changes in input values on the model results. Regression coefficients (β_i) were calculated between each input and the monthly probability of ASFV introduction into Spain by legal trade of swine products. Subsequently, the inputs most likely to influence the results ($\beta_i \geq 0.1$) were further examined with the advanced sensitivity analysis tool of @RISK 8.2 by changing their base values in eight consecutive steps from a minimum of a 50% reduction to a maximum of a 50% increase.

3. Results

3.1. Probability of having at least one ASF outbreak in Spain due to the import of swine products

The probability of ASFV introduction into Spain by the legal trade of swine products from all countries in a given year was estimated as 1.74 $\times 10^{-4}$ with a 95% confidence interval (CI) = (5.97×10^{-5}, 4.07×10^{-4}).

The highest risk was originated in Hungary (3.80×10^{-5}), Portugal (2.76×10^{-5}) and Poland (2.25×10^{-5}), accounting for a total of 50% of the risk of ASFV introduction into Spain by legal trade of swine products. These countries are followed by The Netherlands (1.43×10^{-5}), Estonia (1.16×10^{-5}), France (1.13×10^{-5}), Latvia (1.01×10^{-5}), Italy (7.45×10^{-6}), Germany (6.05×10^{-6}), Belgium (4.60×10^{-6}), Denmark (4.24×10^{-6}) and Slovenia (4.07×10^{-6}), (see Figs. 2 and 3). The remaining countries included in the analysis concentrate around 5% of the risk. The risk map depicted in Fig. 4 shows the countries originating the highest risk. The Fig. 4 represents a map of Europe because most countries included in the study are located there. Due to this, it is important to highlight that seven non-European countries were also included in the analysis. However, the risk originated by these countries was extremely low: Chile (1.89×10^{-7}), Canada (1.91×10^{-8}), New Zealand (7.21×10^{-9}), Japan (4.46×10^{-9}), China (1.62×10^{-9}), Brazil (8.89×10^{-11}) and Colombia (7.76×10^{-11}).

3.2. Sensitivity analysis

The first step of the sensitivity analysis ($\beta_i \geq 0.1$) allowed the selection of the input parameters with higher influence on the model's outcomes: probability of undetected infection in Hungary (P_1 - Hungary), Netherlands (P_1 - Netherlands) and Portugal (P_1 - Portugal); probability of selecting contaminated meat from Estonia (P_2 - Estonia), France (P_2 - France), Hungary (P_2 - Hungary), Netherlands (P_2 - Netherlands), Poland (P_2 - Poland) and Portugal (P_2 - Portugal); proportion of food waste (W), the proportion of food waste used in swill feeding (SF|W), proportion of food waste discarded in landfills (LF|W), probability of wild boar being present in landfills (LF_{WB}) and probability of wild boar having access to landfills (WB_A). The advanced sensitivity analysis revealed that only five of the parameters have a considerable impact on analysis results: W, SF|W, LF|W, LF_{WB} and WB_A. The remaining parameters did not substantially influence the model's outcomes. Results are reported in Fig. 5.

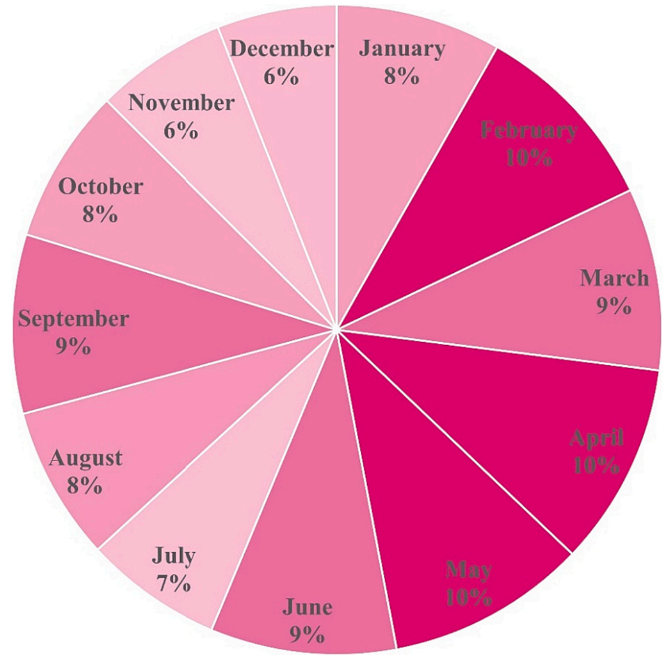

Fig. 3. Monthly disaggregation of the total probability of ASF introduction into Spain by legal trade of swine products. The graduated colour graphic represents the risk from highest (darker) to lowest (lighter) based on the quantile classification.

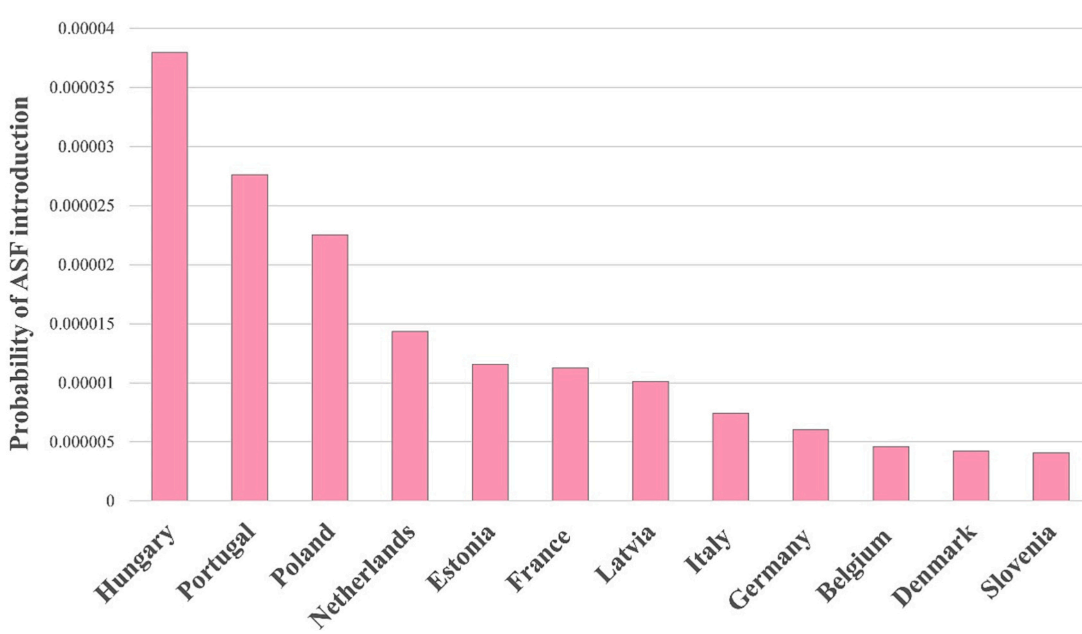

Fig. 2. Annual mean probability of ASF introduction into Spain by legal trade of swine products.

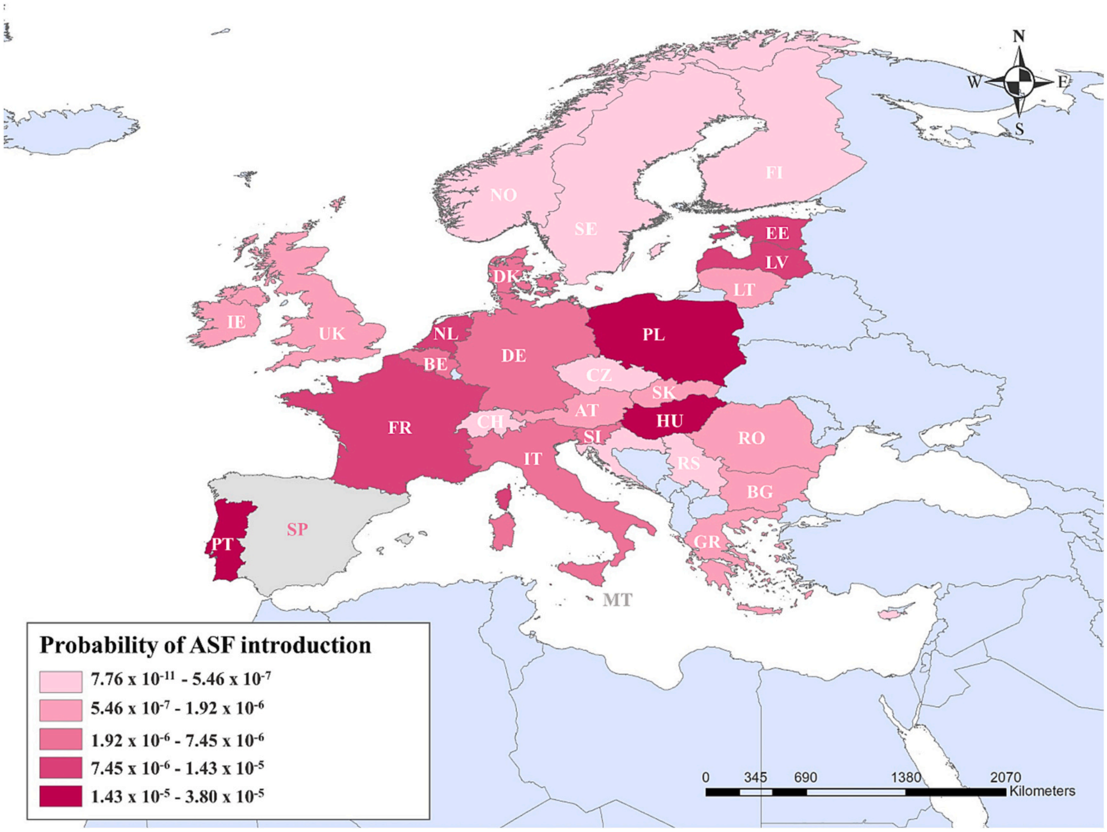

Fig. 4. Risk map of ASFV introduction into Spain by legal trade of swine products. The graduated colour map represents the final risk from the highest (darker) to the lowest (lighter) risk based on the quantile classification. Countries are named following the International Organisation for Standardisation (ISO) country code.

4. Discussion

The main objective of import risk analysis is to provide importing countries with an objective and defensible method of assessing the disease risks related to the importation of live animals and other animal products (Welte, 2016). The quantitative risk assessment presented herein is based on WOAH guidelines to assess the risk of ASF introduction into Spain by legal trade of swine products (WOAH, 2004). This assessment must be performed with complete transparency, which means documentation and communication of all data, information, assumptions, methods, results, discussion, and conclusions (Welte, 2016). This allows us to provide clear reasons that can be used to impose conditions to regulate international trade. Based on the above, only high-quality, accredited databases and fully referenced information were used in the analysis. Nevertheless, certain limitations and assumptions were included in the model, which lead to uncertainties in estimated risks. All assumptions have been fully described in the article ensuring the transparency of the model. Furthermore, parameters used in the risk analysis are continuously evolving so the results presented here should be periodically evaluated and updated.

The risk of ASF introduction into Spain by legal trade of swine products was estimated as 1.74×10^{-4}. Similar quantitative risk assessments have been performed to estimate the risk of ASF introduction through the legal importation of swine products in the United States (Herrera-Ibatá et al., 2017) and Korea (Cho et al., 2021). The probabilities were estimated as 8.90×10^{-4} for the United States and 1.59×10^{-10} for Korea. The estimated risk for the United States is similar to that estimated for Spain, while the risk for Korea was considered negligible. In addition, it is important to emphasise that other entry pathways should have been analysed, such as the importation of other biological products (semen, ova, and embryos), illegal trade and pork product movement for own consumption (e.g., air and ship passenger luggage). By the same token, feed and feed ingredients are showed to be able to serve as vehicles for viruses spread, being another relevant route of pathogen entry that require further consideration (Stoian et al., 2019; Dee et al., 2020; Dee and Spronk, 2022). However, the aforementioned entry pathways have not been included in these analyses. The inclusion of such entry pathways would result in an improvement in future risk assessment models of the introduction of ASF.

Hungary, Portugal, and Poland are the countries with the highest contribution to the risk of ASF introduction into Spain, accounting for 50% of the total risk. Hungary and Poland pose a major risk of introduction, and are countries with a relevant trade relationship with Spain. Moreover, Hungary and Poland officially reported ASF in April 2018, and February 2014, respectively (WOAH-WAHIS, 2023b). Here, it is important to emphasise that prevention measures in the EU include geographical demarcation of zones depending on their epidemiological ASF situation with control and restrictions of swine and swine product movements in affected zones (European Commission, 2022). Nevertheless, the analysis points to Portugal as a country with a major risk of introduction, despite not being currently affected. This might be caused by the relevant trade relationship between Spain and Portugal, given that the risk is directly related to the kilograms of imported pig meat. The risk of ASF introduction was also high in the Netherlands, France, Italy, and Germany. These countries have a powerful pig industry and are the main exporters of swine products to Spain together with Portugal. Therefore, if any of these countries become infected, the risk for Spain will increase substantially. Major probabilities are also located in Estonia and Latvia, ASF-affected countries since September and June 2014, respectively (WOAH-WAHIS, 2023b). In relation to the temporal analysis, monthly risk disaggregation revealed that it is widely distributed throughout the year.

Sensitivity analysis outcomes identified that the probability of food waste used for swill feeding had a stronger influence on the model's

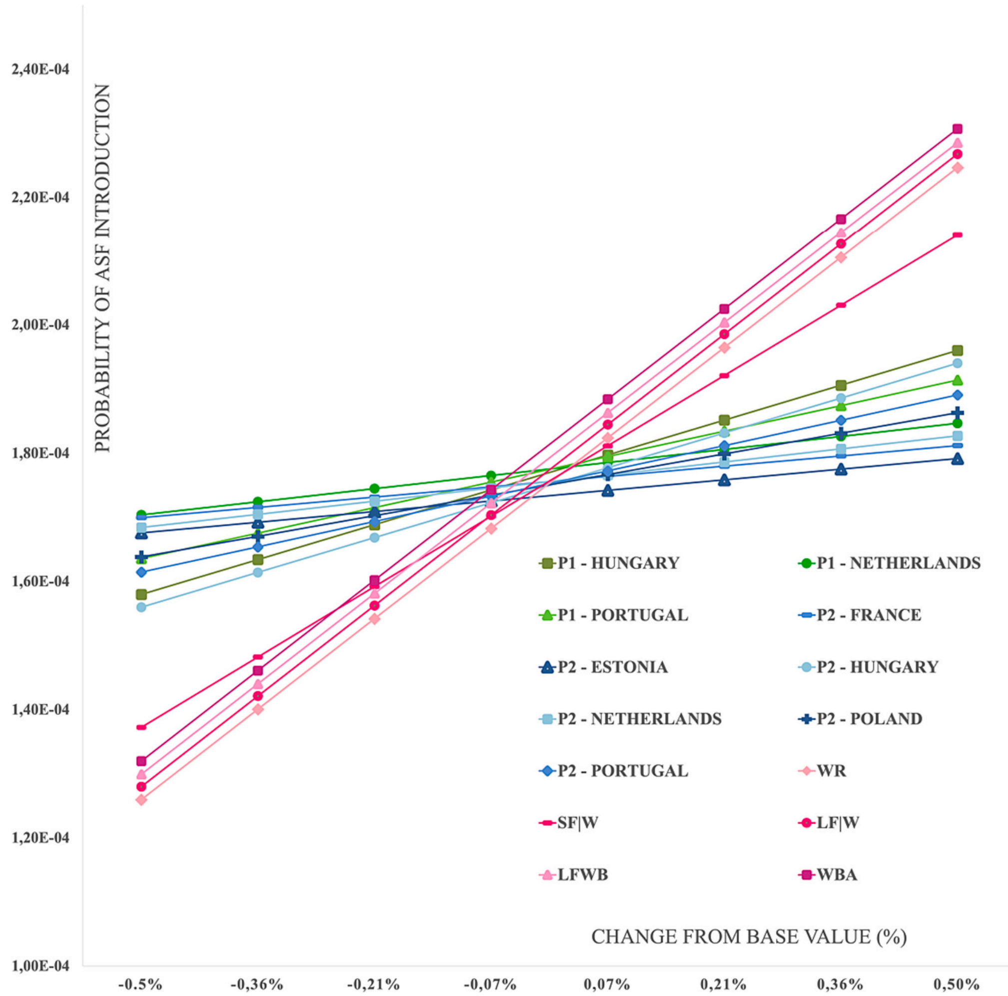

Fig. 5. Advanced sensitivity analysis. Graphical representation of variations in the annual mean probability of ASF introduction into Spain by legal trade of swine products as a consequence of changes in the parameters with the strongest influence on the model.

results, reinforcing the importance of avoiding swill feeding practices. This traditional practice was banned across the European Union, although it still seems to occur sporadically (de la Torre et al., 2022). In the absence of specific legislation or in countries where swill feeding is still permitted, heat treatment of swill before feeding the animals must be ensured. Additionally, the probabilities of food waste discarded in landfills together with the probabilities of wild boar presence or access to landfills have the strongest influence on the analysis. This result supports the importance of avoiding wild boar or feral pigs getting in contact with food waste disposed of in landfills, bins, or containers. However, the potential access to food waste disposed in bins and containers before arriving at the landfills has not been included in the analysis due to the lack of available, high-quality databases.

To the best of our knowledge, this is the first analysis quantifying the risk of ASF introduction and exposure by legal importation of swine products especially focused on Spain, which is currently one of the world's leading pig and pork producers. The study presented here supplements the results obtained by Muñoz-Pérez et al. (2022) which quantified the annual risk of ASF introduction by legal importation of live pigs in Spain. The epidemiological information reported in both studies identifies geographical areas with the highest risk of disease introduction. These results represent a powerful tool for improving the effectiveness of control and prevention strategies, and, ultimately, contributes to reducing the risk of ASF introduction into Spain.

5. Conclusions

The present quantitative risk model assesses the probability of ASF introduction into Spain by the legal trade of swine products. The risk is not negligible, and greatly depends on swill feeding practices or potential access to landfills of wild boar, both highly uncertain parameters. Results highlight the risk of introduction in Spain and other ASF-free countries associated with the legal trade of swine products given the huge burden of ASF globally and the urgent need to increase the awareness of pig producers regarding swill feeding practices.

Ethical statement

Not applicable.

CRediT authorship contribution statement

Carolina Muñoz-Pérez: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft. **Beatriz Martínez-López:** Writing – review & editing, Supervision. **José Pablo Gómez-Vázquez:** Software, Validation, Writing – review & editing. **Cecilia Aguilar-Vega:** Software, Formal analysis, Writing – review & editing. **Jaime Bosch:** Conceptualization, Writing – review & editing. **Satoshi Ito:** Software, Writing – review & editing. **Marta Martínez-Avilés:** Conceptualization, Writing – review & editing. **José Manuel Sánchez-Vizcaíno:** Writing – review &

editing, Supervision, Project administration.

Declaration of Competing Interest

The authors declare no conflict of interest.

Acknowledgments

Not applicable.

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