

Nicola, Mirela Daniela; Mocuta, Dorina Nicoleta

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STRATEGIC MANAGEMENT OF THE AFRICAN SWINE FEVER

MIRELA DANIELA NICOLA¹,
PROF. DORINA NICOLETA MOCUTA ²

Abstract: *African swine fever (ASF) is a disease with a devastating impact on economy, affecting seriously the pig industry production and trade, discouraging farmers to restock their farms and continuing their business, overall changing policies and markets. In the last five years the ASF has badly affected the world: 50 countries affected on 4 continents, about quarter of pig world population died or was killed in order to control the disease, and millions of euro were paid to manage (eradicate) the disease. Despite the new policies, the overall management, the preventive and control measures taken, the disease is continuing to spread and leave behind huge losses into the global pork industry. In essence the paper aims to review experience on the management of ASF in affected countries and Romania and try to identify what went wrong in the management of the ASF and how countries can be better organized to react to an outbreak of African Swine Fever and to identify better ways to diminish the devastating impact of the disease upon societies, consumer, trade between the countries, economy.*

Key words: *animal health, crisis management, risk factors, economy, trade,*

JEL classifications: *H12, Q18*

INTRODUCTION

This article is looking to review management practices to control emergency crisis [11], in veterinary health. We would like to stress that despite a wide range of approaches and new and high-tech management achievements (modelling, risk management, genotyping and mapping technique followed by comparisons studies, etc) managers face huge problems in controlling critical situations as effectively and efficient as should be. From this standpoint, we selected African Swine Fever (ASF) as disease to analyse, because documented evidence show that it is a disease with a past (first described in 1921 in Kenya by Montgomery), endemic in several sub-Saharan countries (probably before 1921) and Sicily, was and is a challenging and devastating disease (Figure 1, 2 and 3, Table 1, 2) as regards the evolution and control, and after 99 years is still a problem with global impact which requires increased attention from all parties involved (government, scientists, industry, population). Studies performed by economists of Iowa State University estimated that if ASF enter in the North part of America (USA) the cost might be around 50 billion \$ over a period of 10 years. Therefore, the paper go over the chronology of the African swine fever (ASF) in the world, then focus on the most representative epidemiological part of 2018 year in Romania (devastating evolution, high speed of spreading, huge losses, the eradication programme faced hard choices), describing epidemiology and eradication policy chosen, trying to identify the reasons beyond the failures of the implementation of 2018 eradication programme.

MATERIAL AND METHODES

In order to review the management and epidemiology of PPA we used the retrospective method. The data used for the paper are only published data. For Romania data were collected, registered and notified to OIE and European Commission by the National Sanitary Veterinary and Food Safety Authority and for the other countries the data we refer in the paper are data collected,

¹ Doctoral student, University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, mireladanielanicola@gmail.com

² Ph.D in Economics, University of Agronomic Sciences and Veterinary Medicine Bucharest, Management & Marketing, 59 Marasti Boulevard, District 1, 011464, Bucharest, Romania, dorinamocuta@yahoo.com

recorded and notified to the OIE, by the competent authorities (CA) of the respective countries, or data published in various scientific articles, or official presentations (OIE, EC etc).

RESULTS AND DISCUSSIONS

Overall, virology studies characterise the virus as a very complex molecular structure which is not entirely known, high genotypic and serogroups variability, not entirely known[2], unpredictable and very complex pathogenity and pathogenesis [8] producing acute, sub- acute, chronic disease or nothing (non-infected strains) mechanisms of the immune response to ASFV remain still unclear [9], the detection of the virus is hampered by short viremia and the related high mortality[14], long distance jumps (Poland,18 Nov 2019) great resistance and long-term virus survival in the environment[5,6,7], (faeces, 60-100 days (Strauch - 1991 Haas et al, 1995), manure at 17 °C, 84 days - (Haas et al, 1995), blood on the buried bricks – 112 days , in soil – 81 days (Kovalenko et al. (1972) [4,5], up to 18, 60, and 83 days of curing in Italian salami, pork belly, and loin (Stefano Petrini et al, 2019), can persist indefinitely in frozen food etc), resistant to chemical and physical disinfectants[9].

The exposed population for ASF is a population represented by domestic and wild pigs from the Suidae family, order Artiodactylia. For this paper we considered that the domestic population as the entity that it is controllable (under control - the official surveillance and control of the CAs, the number of the pigs known, follow a known production technology, the population is easily traceable, bio-security measures are in place, etc), of course where is applicable, and the wild population (the main ASF reservoir host, where the real number only can be estimated, the itinerary – that it only can be predicted and however despite the studies – it can changed right away depending of many factors, different reaction (immunity) to the ASF pathogenity (genetic diversity not predictable, infection depending the dose, way of exposure etc), most of the exposed wild boars becoming the new sources of virus for the non exposed population).

So, there are a lot of unknown or not documented enough factors which imply many assumptions, and even if their evolution it is predicted by scientists through modern technology/different scenarios/modelling, we have to accept that these predictions can encompass sometimes big errors and the evolution of these factors or are out of the human control or are not controllable enough (Table1).

Table 1 Impact of ASF in the world, period 2016-2020 (source OIE)

Region	Swine				Wild boar				Total Outbreaks	Total Cases
	Outbreaks	Susceptible	Cases	Losses**	Outbreaks	Susceptible	Cases	Losses**		
Africa	128	213 795	61 459	85 539					128	61 459
Asia	9 928	8 107 951	115 309	6 733 791	631	NA	1 121		10 559	116 430
Europe	4 271	1 859 480	625 269	1 383 372	17 307	NA	29 513		21 578	654 809
Total	14 327	10 181 226	802 064	8 202 702	17 938	NA	30 634	0	32 265	832 698

Table 1. Impact of ASF by region based on the information submitted through the Early Warning System (2016-2020).

* NA: Not applicable. ** The impact of this disease is measured in terms of losses, which are calculated by the sum of dead and culled animals from the infected farm or backyard premises of the reported outbreak. ***Total of susceptible and losses do not appear in the table as for wildlife, it is often not possible to calculate the number of susceptible animals, and the losses are calculated only for swine.

Therefore, the unknown factor we can call it “X” and the characteristic of the “X” is that it can vary widely and it can change very quickly depending of many trigger factors. The “X” represents in the management of the ASF the uncontrollable/less controllable and the unpredictable fraction.

Epidemiology of the African Swine Fever (ASF) in the evolution of the ASF in the world, temporarily and spatially, literature differentiates several stages, described below.

A) Up to 1921, African continent the first outbreak, described in 1921 in Kenya, by Montgomery. However, probably before 1921, ASF was evolving endemic in several sub-Saharan countries. Then, the ASF remained confined until 1957, to the African continent where it continued to exist and spread, producing endlessly contaminated products. The results of ASFV genotyping/serogroups known [1,

3, 2] notes that in Africa the diversity of genotypes (I, V, VIII, X, untyped) and serotypes is the maximum recorded compared with other parts of the world where ASF evolved.

B) Between 1957-1995, Western Europe in 1957, the ASF virus went out Africa for first time and entered Europe through Lisbon, from Angola. This may have contributed to the most important epidemiological change in ASF at that time. From there was spread to Spain (1960-1995), France (1964, 67,77), Italy (1967,1980), Malta (1978), Belgian (1985), Netherlands (1986), coming back again in Lisbon in 1960.

Figure 1 Entrance of ASF in Europe 1957 and Latin America in 1971 (source OIE)



According to literature the ASF was eradicated in all countries in Europe, except Sardinia where is still evolving endemic. It is interesting to highlight that the eradication of ASF in Spain lasted 10 years, and sources indicates that this was due primarily to the need to build up a new

infrastructure and the need for qualified staff. Literature [13] mentions that the last 5 years of the eradication programme in Spain were estimated to have cost US \$92 million (Arias & Sanchez-Vizcaino 2002). It should be noted that at that time the Spanish production system was open and ASF eradication was indeed difficult. The literature [1, 3, 2] register that in Europe the virus was mainly genotype I. The literature reviewed say that the entering of ASF virus in Europe/Lisbon was done via contaminated food waste originated from the African flights or vessels.

C) From 1971 to 1980, Latin American continent [14] from 1978 up to 1980, the ASF entered and spread in several American countries: Brazil, Cuba, the Dominican Republic, Haiti (table 2)

Table 2 – Evolution of ASF in Latin American continent

Country	YEARS	OUTBR.	POLICY ADOPTED	IMPACT		
				Duration	Cost USD	Pigs killed
Cuba	1971	33	Total eradication Radical change production system	1 year	No data	463,332
Brasilia	1978-1981	231	Targeted eradication	4 years	1.8 mill	66,966
Republic Dominican	1978-1980	374	Total eradication slaughtering of the pigs free of clinical signs	3 years	8,5 mill	192,473
Haiti	1978-1983	93	Total eradication	5 years	9.5 mill	384,391
Cuba	1980	56	Total eradication Radical change production system	1 year	9.4 mill	137,287

ASFV crossed the Atlantic Ocean and entered in Carrabin Islands. In 1971, Cuba was the first country of the Caribbean region who notified infection with ASF (Seifert 1996,), and the virus is believed to have been introduced from Spain thorough food waste from flights and vessels (Lyra 2006) or/and live pigs/pig products products (McDaniel, 1986), however again is not clear from the literature how has been transmitted.

In almost all cases described above (A, B, C) depopulation method (total/targeted), ban of animal moving and, in several cases, radical changes of the pork production system have been the control instruments for eradication of ASF in their countries.

D) Starting with June 2007- up today, Eastern Europe and Asia The ASFV left for the third time the African continent in 2007 and enter for the second time in Eastern Europe - Georgia (June 2007) and later on for the first time in China (August 2018).

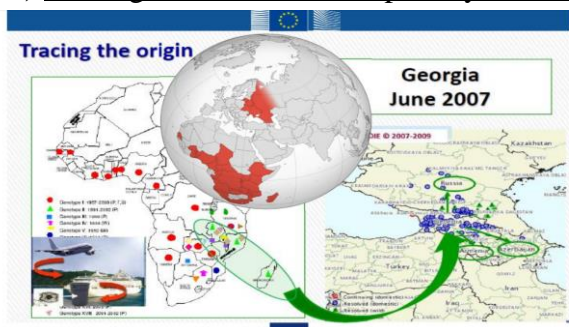


Figure 2 Tracing the origin from Africa to Georgia (source OIE)

Starting with June 2007, ASF had a devastating evolution and became a real threat to the global pork industry, because from Georgia it continued to spread very fast and affected 3 continents, more than 50 countries (Armenie, Azerbaijan and Russia in 2007, Ukraine in 2012, Belarus in 2013, Estonia, Latvia, Lithuania and Poland in 2014, Moldova in 2016, Romania and Czech Republic in 2017, Hungary, Bulgaria, Belgium in 2018 etc) and above 75% of world pig population. Genotype II was demonstrated that was/is present in Ukraine and Eastern Europe.

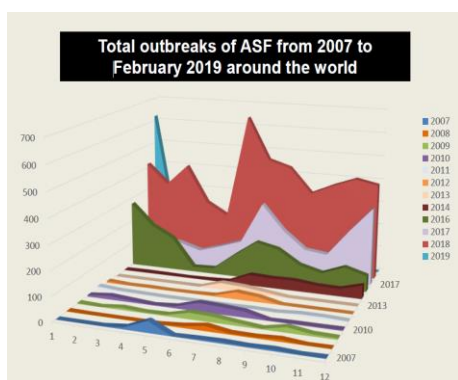
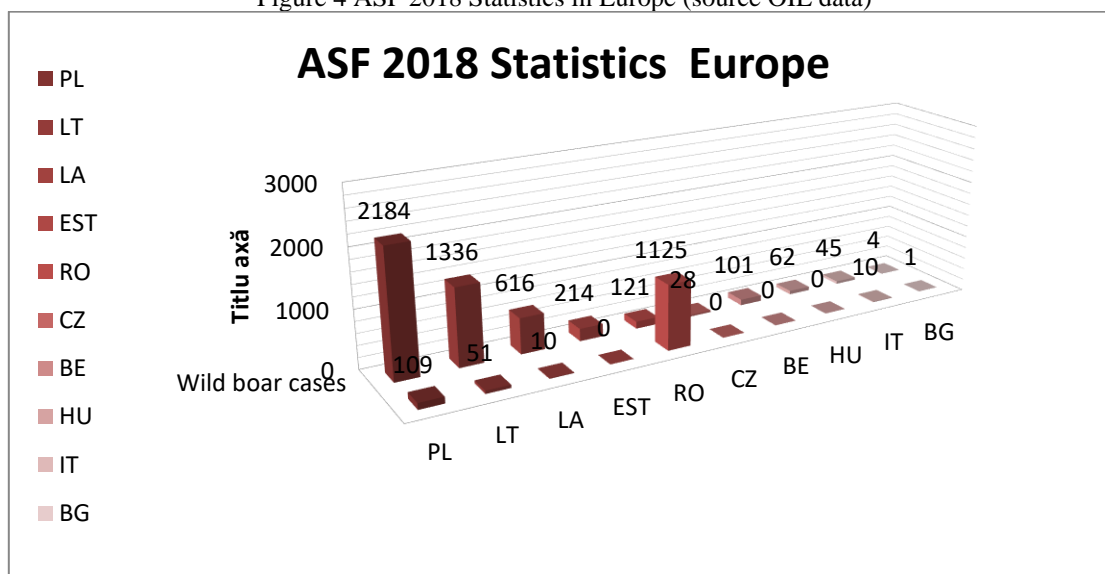


Figure 3 Total outbreaks in the world from 2007 to 2019 (source, Prof.JM Sanchez Viscaino, Beijing, 2019)

E) Romania

The first outbreak in Romania was in Satu Mare District (N-W, Romania), on 31 July 2017 (when two outbreaks were confirmed, source Ukraine). However, we focus primarily on the analyse of the Tulcea District (S-E, Romania), period 10 June- 17 October 2018 because that was the time of the 2018 year when the ASF had an explosive evolution in the Romanian pig domestic population. Furthermore, Tulcea was the point of entry of the virus in the S-E part of Romania (on 10 June 2018). Therefore, this was the moment when the management of the disease was hampered by different drivers. Compared with the other member states in Europe Romania had 1125 outbreaks in 2018, in the domestic pig (Figure 4). The data below shows that at the RO CAs had been really challenged and the ASF evolution escaped to some extent CAs control.

Figure 4 ASF 2018 Statistics in Europe (source OIE data)



The pork production system and the susceptible population in 2018 in Romania the susceptible pig population to ASF in Romania in 2018 was formed from 3.698.293 domestic pigs and X wild

boars. In line with Romanian legislation at that time the domestic pigs were raised in three types of farms: commercial farms (2.145.856 pigs), type A farms (109.289 pigs, also commercial farms) and backyards (1.443.148 pigs) (Table 3).

Table 3 pork production system in 2018 in Romania

	01/01/2018	%
PIG SECTOR DATA / DOMESTIC SECTOR		
Number of commercial farms	168	0.03
Number of "Type A" farms	13578	2.75
Number of non-commercial farms	479675	97.2
NO OF DOMESTIC PIGS		
Number of domestic pigs in Romania	3698293	58%
Number of pigs on commercial farms	2145856	2.95%
Number of pigs "Type A" farm	109289	39.05
Number of pigs on non-commercial farms	1443148	
WILDE SECTOR		
Number	Dont exist	
DATA CONCERNING THE WILD SECTOR		
Number hunting grounds in Romania	2154	2154

Furthermore, the legislation requirements concerning the biosecurity at that time were different for each type of farm. From proper biosecurity requirements applicable to commercial farm to insufficient biosecurity requirements for „Type A" farms and in the end to none biosecurity requirements applicable to non-commercial farms (population backyards). This means that 60.95% of the RO domestic pigs were more or less exposed to the virus (58% of domestic pigs raised in commercial farms plus 2.95% type A farms) and the other 39,05% were practically vulnerable and not protected in front of the ASFV. On the other hand, statistics shows that the pork production system in Romania at that time was obviously dominated by backyards (97,2%) making practically the pork population vulnerable to the ASFV.

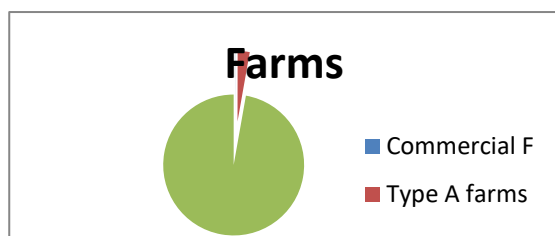


Figure 5 - System production pork in RO

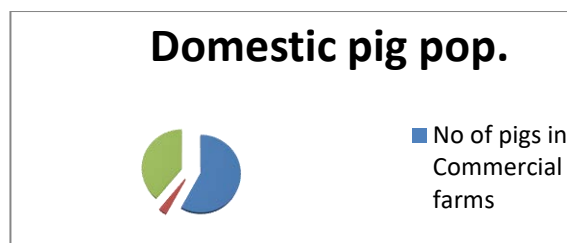
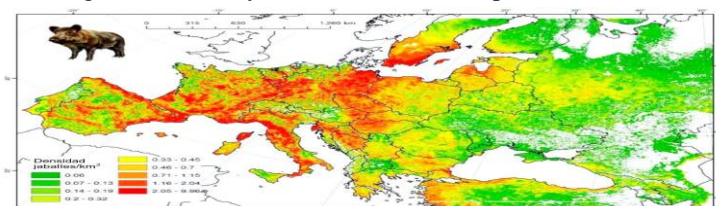


Figure 6 –Population of domestic pork in RO

Other weak link in the chain of the production of the pig in Romania was that a lot of people were traditionally raising their pigs grazing freely in the proximity of forests and water increasing the risk of infection with ASFV by oral, environmental and possible vector contamination. Moreover, the reproduction of the domestic pigs in the backyards was allowed at that time.

Figure 7 – Density of wild boars in Europe (source EFSA)



On the top of that at that time/also possible now the wild boar number/density/their itinerary were not known. That's why EFSA - Panel on Animal Health and Welfare, African Swine Fever on the request of the

European Commission - conducted a study concerning the comparisons on the reliability of wild boar density in Europe in order to improve the collection data system and to validate the data (guidance adopted in June 2018 [6]). At that time the only data available on wild boars were estimated based on

hunting data. Based on points described above we have to point out that the pork production system in Romania was unprotected in face of ASF virus and widely exposed to hazard.

Epidemiology of ASF in Romania on 10 of June 2018 in Delta area (Ceatalchioiu village), next to the Ukraine border the first outbreak was confirmed. Ceatalchioiu is a small fishermen village hardly accessible by people. One of the hypotheses would be that at that time the start of hunting in the Ukrainian delta would have caused the migration of wild boars on the Romanian bank of the Danube. Consequently, the wild boars carrying PPA virus would have come /not into contact with wild boars and/or domestic pigs, especially the domestics pigs supposedly raised free by the villagers.



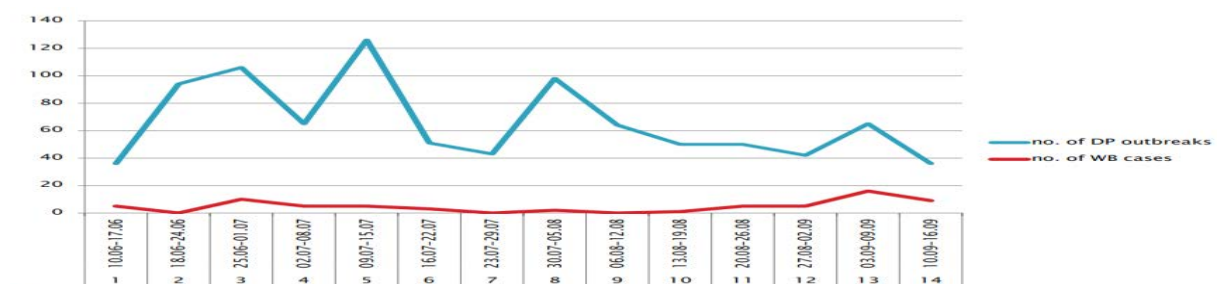
Figure 8 – First outbreak in the SE of Romania (source OIE)

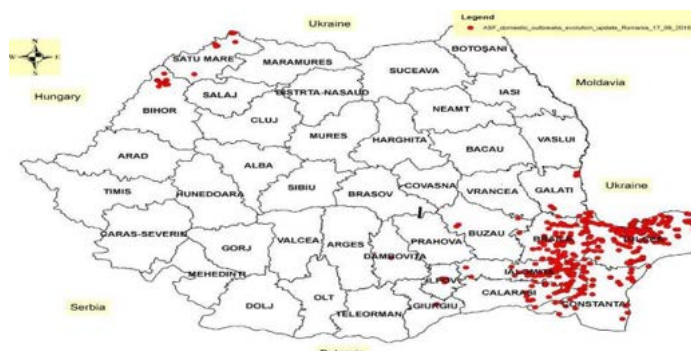
In short, Tulcea is located in northern part of Dobrogea and borders Ukraine in the north part. It is located on the right bank of the Danube and borders the communes of Ceatalchioiu (34 outbreaks/only backyards), Pardina (61 outbreaks/only backyards), Malcoci (20 outbreaks/only backyards), Nufăru (5 outbreaks /only backyards), Valea Nucarilor (2

outbreaks' /only backyards), Mihail Kogălniceanu (2 outbreaks/only backyards), Frecăței (5 outbreaks/only backyards) and Somova (37 outbreaks/only backyards). Located at 45o 10' north latitude and 28o 47' east longitude with a population of 194.421 inhabitants (2019, wikipedia source) with an area of about 19.9933 ha (199 km²), of which about 31% is included in the Danube Delta Biosphere Reserve. it is located on a continental promontory, its upstream extremity extends to the two forks of the Danube River (the arm Chilia and the arm St. George), in part it is submerged under the meadow and the Danube Delta. The relief includes regions with low altitudes (alluvial plains, deltaic and marshy lakes), but also regions with higher altitudes (maximum elevation in the Macin Mountains). In the Măcinului mountains there is a National Park (intersection - Mediterranean, Balkan and Caucasian area). Hydrographically, the territory is dominated by the Danube river, but there is also an important area covered with water, respectively two natural lakes Ciuperca and Zaghen. The Danube annually floods the territory, a phenomenon that begins in spring after the melting of snow and ice bridges, especially affecting the surface of the meadow on the left bank of the Danube. Few days later, during 3 days (13/15/16 06.2020) huge number of outbreaks were confirmed in the next villages. Then the ASFV spread extremely fast: on 03/07 the ASF was confirmed in Braila and in Constanta, on 27/07 was confirmed on Galati (Moldavia border), on 15/08/2018 was confirmed on Calarasi and on 18/08 was confirmed in Ilfov (next to Bucharest).

Figure 9 - Temporal evolution of the ASFV by week, between 10.06-16.09.2018 (source EC, ADNS data).

Figure 10 - Spatial evolution of the ASFV, between 10.06-16.09.2018 (source CA presentation 2018, CE)





Pardina was the village with the biggest number of outbreaks. 61 outbreaks were registered from 16.06 to 11.07 (in less than 1 month), as it is exemplified below.

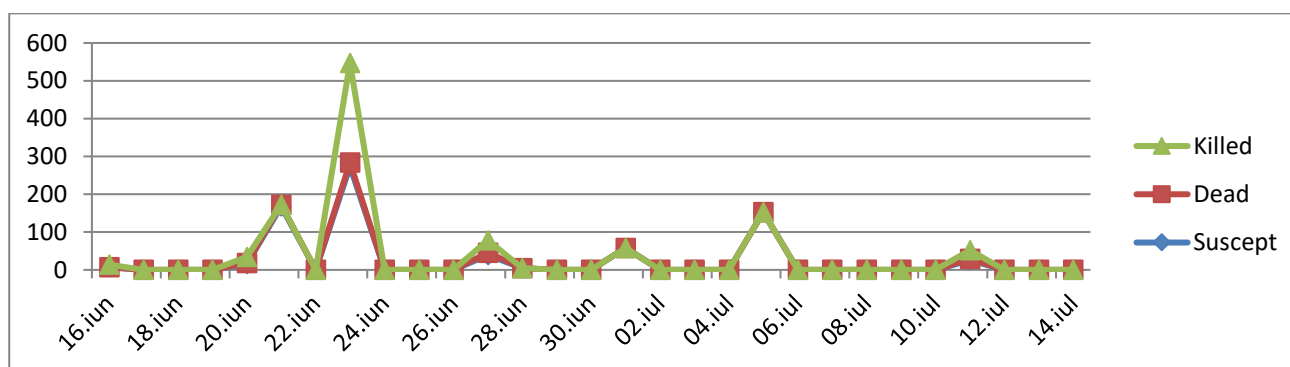


Figure 11 Outbreaks evolution in Pardina during period 16.06-11.07 2020 (source CA presentation 2018, CE)

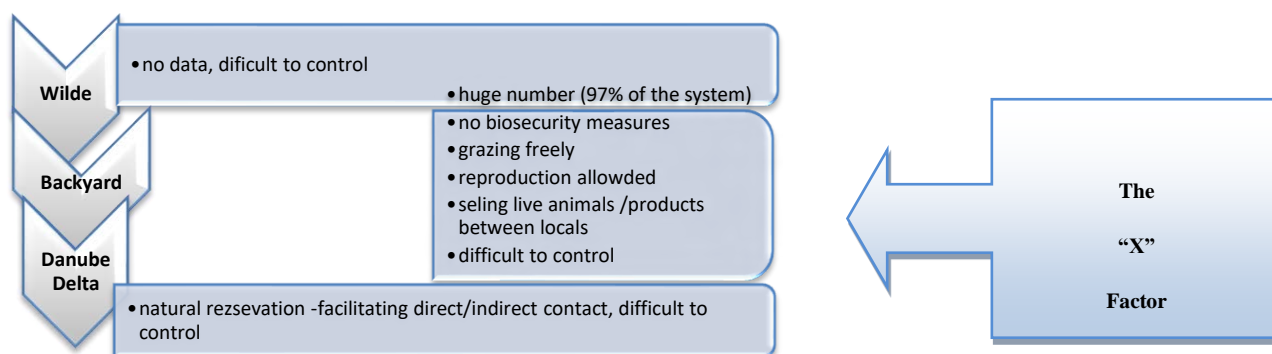
Based on the spatial – temporal analyses of the ASF statistics we observe that a big number of outbreaks were confirmed in a very short time, majority of the outbreaks were confirmed in backyards (the weak link of the chain, the vulnerable point of the production system), many outbreaks were confirmed in the same time in close points (cluster evolution), possible multifocal introduction. Therefore, we consider that the epidemiological evolution was very aggressive and spread all of the sudden. The fact that the first events occurred at once in close/distant points suggesting cluster evolution and spread unexpectedly in the following days it is obvious that the detection of the disease was missed at moment zero / the moment of entry of the ASFV into the pig population of Romania. So, the virus was already in the area and was circulating in the wild boar population, the disease becoming visible later on, for the first time in the backyards (no biosecurity measures, domestic pig – more vulnerable compared with wild boar). Furthermore, the surveillance system set up by the CAs of the wild boar population didn't work at all to diagnose the ASFV in the wild population before the first outbreak in the domestic pig to emerge. Might “the short viremia and high mortality associated with ASF make it virtually impossible to detect the disease through active surveillance.” was the cause. (African Swine Fever in the Russian Federation: Risk Factors for Europe and beyond study by Sergei and al (FAO), 2013 [12]). On the other hand, the spreading of ASF was frequently attributed to humans – people, hunters, farm keepers etc. In this kind of situation sometimes because of the impact of the crisis desperate people do desperate things. EFSA in 2019 did an Epidemiological analysis of African swine fever in the European Union (November 2018 to October 2019) based on extensive review of the updated data send by the member states concerning their experience with ASFV and concerning human contribution they conclude in their study that there is sufficient evidence in this direction (sufficient documented evidence provided- for Belgium, Czechia and western Poland/ for wild boar population) [7]).

CONCLUSIONS

Compared with the period described before 2007 things have definitely changed in the management of ASF after the first outbreaks/cases of ASFV. European Commission, FAO, OIE and

the other international entities involved cooperate together and use all the experience in the world to continuously improve the legislation, tools displaying regionalisation, launched research projects to identify and read the X mentioned at the start of the article and to find and develop a vaccine to eradicate the ASF, carry out audits to identify the problems in the country living behind recommendations in order to improve the control systems, share the experience with all the world even the ASFV management strategies still rely today only on early detection, strict biosecurity measures, strict quarantine and culling policies/depopulation. However, from the analyse in Romania we learned that the following drivers hampered the management of the ASF. Primarily we consider that failing the early detection of the disease was the crucial cause that did the management of the disease inefficient in Romania. During that time the infective animals but clinically healthy were continuing contributing exponentially to the spread of the disease in parallel with many other possible factors (humans, environmental contaminated staff etc), the traceability of the disease was lost and the eradication actions were implemented too late, leading to culling large number of animals. Due to the particular characteristics of the ASFV which produce short viremia associated with high mortality literature sais that the detection of disease is very difficult through active surveillance and recommends strongly the use of passive surveillance. In 2009 to 2011, an average of 4.6 days and up to 11 days (Dudnikov *et al.*, 2011) passed from the first sign of disease (usually indicated by death) before the ASF diagnosis was confirmed. Another factor that contributed to high vulnerability of the production system of the pork in Romania was the legislation. Applying gradual biosecurity measures depending of the size of the farm created breaches /vulnerable links in the pork production system (97% being backyards) and consequently increased the velocity of the transmission of the virus from one backyard to other with the help of the people/reproduction/contaminated food, habits to sell live pigs/products etc. Cooperation with the other authorities, mass media and trust of pig owners and consumers is a must, the responsibility of the eradication plan must be legislative shared with all the stakeholders involved, otherwise the implementation of the eradication plan is unsuccessful. Education and communication are crucial tools in the eradication of a disease. Supplementary we describe below the X factor the unknown factor, impossible/very hard to control and very costly.

Figure 12 Description of X factor in Romania



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