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Albertas GAPŠYS, researcher, Head of Division of market research of agricultural products
Vida DABKIENĖ, products researcher
Lithuanian Institute of Agrarian Economics, Lithuania

African swine fever risk assessment and compensation calculation methodology: Lithuanian case

Scientific problem. African swine fever (ASF) is a devastating haemorrhagic fever of pigs with mortality rates approaching 100 per cent. It causes major economic losses, threatens food security and limits pig production in affected countries. ASF is caused by a large DNA virus, African swine fever virus. There is no vaccine against ASFV and this limits the options for disease control. ASF has been confined mainly to sub-Saharan Africa, where it is maintained in a sylvatic cycle and/or among domestic pigs. The relatively small numbers of incursions to other continents have proven to be very difficult to eradicate [3].

The introduction of ASF into Lithuania in 2014 and neighboring to Lithuania countries, such as Belarus, Latvia, Poland, Russian Federation increases further risk of ASF dissemination in Lithuania and other EU countries.

The objectives of the article is to represent the government's compensation calculation method for pig breeders in buffer zones, which should compensate for not breeding pigs temporarily and compel farmers to report about ASF cases. As well, to analyze the pig-–breeding situation and the main factors, which show that Lithuania is at high risk zone for ASF disease dissemination.

Analysis of recent researches and publications. Numerous economic studies have been carried out with respect to prevention and control of animal disease epidemics. N. Valeeva, G. Backus [23] focuses on incentives systems under ex post case of moral hazard problem of early disclosure, saying that there are possibilities of using incentives to influence farmers' decision on early disclosure. F. Kuchler, S. Hamm [19] analyzed the relationship between governments' indemnity payments and reported infected animal cases, and stated that higher government payments yielded more confirmed cases. C. A. Wolf [26] also noticed that paying market price or even more for diseased animals culled often intend to create incentives for reporting, but added the idea, that when someone else is paying for losses, there is less incentive to avoid risky behavior. T. L. Whiting [25] analyzed economic costs of eradication programs in Europe, compared costs for welfare slaughter and costs for disease control. This author recommended having funding, legislative authority, planning for comprehensive foreign animal disease response and emphasized the importance of veterinary leadership in the area of emergency management and farm animal welfare. S. Costard et al. [3] analyzed African swine fever history and distribution around the World. According to these authors global spread of ASF can be prevented developing effective vaccines, introducing surveillance and control measures at local, regional, transcontinental levels. However most studies are concentrated on farmers' decision for reporting ASF in relationship with government payments, but lack scientific practical approach how this compensation or government payment should be calculated, and farmers' loss evaluated.

Recently, several research projects (Khomonenko *et al.*[18], A. De la Torre *et al.* [4], D. Beltrain-Alcudo *et al.*[1], EFSA [12], S. Costard *et al.* [3] and etc.) have focused on the introduction of ASFV into the EU. Lithuania is not assessed as country with a highest risk for

ASFV in most studies. The analysis of ASF situation and risk profiles are presented at a national level (EVIRA [15], A. Viltrop, J. Jeremejeva [24], DEFRA [5, 6, 7].

Statement of the main results of the study. Pig breeding sector is the second livestock sector by its importance in Lithuania. In the scheme of livestock breeding in Lithuania the pigs made up the greatest part – 50 percent, and in the scheme of meat production the pork (live weight) made up 31 percent. Big pig breeding complexes realize approximately 800 thousands pigs per year. From the realization of pigs the government calculates around 24 million Lt income (paid as taxes). Created value added reaches around 120 million Lt per year from pig breeding. The main export destination of pork production till the first outbreak of ASF was the Russian Federation (the Russian Federation has stopped the pork products import from 7th of April, 2014). About 50 per cent of pork exported each year gave the income of around 160 million to the processing enterprises. Pig breeding sector also is important for its created workplaces. It creates around 10000 workplaces: 5 workplaces are used for breeding, slaughtering and realization of 1000 of pigs in pig breeding complexes.

Pork is the most popular meat for food consumption. In 2012 one Lithuanian consumed 44 kg of pork. Pork production supply doesn't meet the demand in Lithuania. The pork production supply balance sheet shows that self-sufficiency amounts to 59 per cent. To cover the needs of pork production this production should be doubled. Fodder production for pig breeding is sufficient in Lithuania. Grains are used as fodder for around 15 per cent for pig breeding and the self-sufficiency of grains was 237 per cent in 2012 [9].

In recent years pig breeding complexes invested to improve their environment. New manure yards were built, modern slurry machines were bought. At the same time pig breeding companies monitor surface and ground water, schedule timetables for field fertilization, fertilize fields without exceeding the determined norms, and search for methods how to reduce the intensity of odours. So, pig breeding is profitable, pig breeding complexes create workplaces and invest in tools to be environmentally friendly.

Previous experience in coping with outbreaks of epidemic animal diseases has shown that such diseases pose a true threat for regional and national economies as well as for an individual farmer and for related industries in the chain [23]. ASF introduction to Lithuania has a severe socio-economic impact and serious implications for food security. In addition to high mortality rates, ASF introduction results in the loss of status at an international trade arena and the implementation of drastic and costly control strategies to eradicate the disease.

The first spread of ASF outside Africa was to Portugal in 1957 as a result of waste from airline flights being fed to pigs near Lisbon airport. Although this incursion of disease was eradicated, a further outbreak occurred in 1960 in Lisbon, and ASF then remained endemic in the Iberian Peninsula until the mid-1990s. The outbreaks of ASF were reported subsequently in a number of other European countries, including Malta (1978), Italy (1967, 1980), France (1964, 1967, 1977), Belgium (1985) and The Netherlands (in 1986). The disease was eradicated from each of these countries but in Sardinia it has remained endemic since its introduction in 1982. Increased global movements of people and products influenced further transcontinental transmission to Europe [3]. ASF was confirmed in Georgia in 2007 and then it spread to the Russian Federation where numerous outbreaks have been notified in domestic pigs and wild boar (Figure). Dudnikov et al. [10] predicts situation of ASF in the Russian Federation and reports that spread within the country and to the neighbors is at high risk. The authors indicated tools preventing from ASF infection to other areas. At the same time they report that there are no financial sources to support these measures, there no united coordination system within the country, and the society is not prepared for liquidation of ASF. All these problems influence the risk of ASF dissemination remaining in the region at very high level.

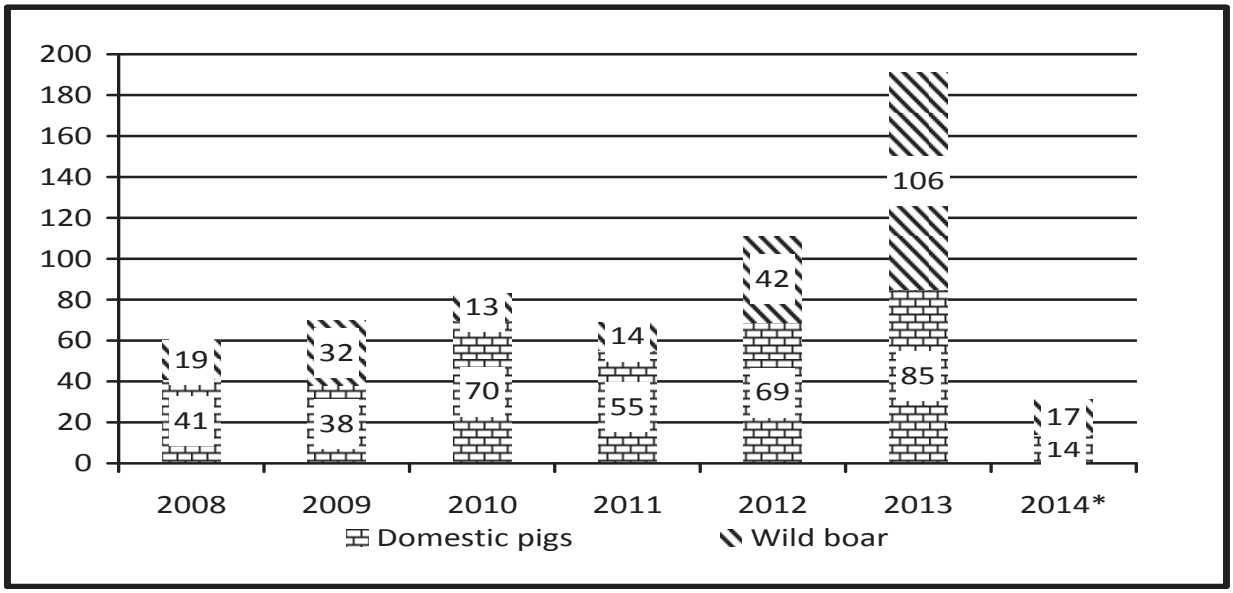

Figure. ASF outbreaks in Russian Federation in 2008-2014

Source: OIE 2008-2014*(data for 2014 last updated in 2014 07 14) [21].

In 2012 an outbreak of ASF also was reported in Ukraine and in 2013 Belarus confirmed the disease in a backyard holding in the region of Grodno, some forty kilometers from the Lithuanian border. In July, a second outbreak was confirmed in a commercial holding in Belarus, close to the Russian border [12]. As noticed A. De la Torre et al. [4] countries bordering to Belarus as Latvia, Lithuania and Poland are at higher relative risk of ASF introduction via wild boars. At the same time outbreaks of ASF disease were reported in other Europe countries as well as in neighboring countries to Lithuania, such as Poland and Latvia. In EU ASF outbreaks were registered in Italy, Latvia, Lithuania, and Poland in 2014 (Table 1).

Table 1. ASF outbreaks in EU MS in 2004-2014 07 28 [11]

Outbreaks/ year	ASF in wild boar	ASF in farmed pigs
2004	-	Italy: 48
2005	-	Italy: 198
2006	-	-
2007	-	Italy: 31
2008	Italy: 2	Italy: 6
2009	Italy: 1	Italy: 3
2010	Italy: 1	Italy: 9
2011	Italy: 3	Italy: 31
2012	Italy: 17	Italy: 74
2013	Italy: 67	Italy: 109
2014	Italy: 27 Latvia:2 Lithuania: 2 Poland: 4	Italy: 35 Latvia: 1 Lithuania: 1

In 2014 2 cases of ASF registered in wild boar (2014 01 24) and in a big pig breeding complex (2014 07 28) in Lithuania. The main measures to control ASF are defined in Council Directive 2002/60/EC and Commission Decision 2003/422/EC. The measures include the notification, establishment of protection and surveillance zones, a ban on the movement and trade, stand-still, cleaning and disinfection, tracing backwards and forwards, carcass disposal, restocking, reference laboratories and contingency planning. The financial contribution by the EU within the framework of the eradication programmes is at the rate of 50per cent within a ceiling, per country and per year [14]. After the first outbreak of ASF detected in wild boar according to the Lithuanian state food and veterinary service statements No. B1-646, published in 10th October, 2013 and 17th of February, 2014 buffer zones for ASF were de-

termined. 16067 pigs were slaughtered in buffer zones which amounted to 2 per cent of all Lithuanian pig population. On19th of July, 2014 new cases of ASF were reported in Latvia both in wild boar and in domestic pigs. In this case the affected animals were raised close to the Estonia border, approximately 250 km from the previous outbreak place in Latvia. This fact shows that the ASF disease is not easily controlled, and it is hard to predict the next place of its outbreak. On 28th of July, 2014 a new outbreak in a big pig breeding complex in Lithuania was reported. Geographically outbreak is close to Belarus and Latvia borders. In this case more than 19 thousand pigs were culled and new buffer zones (within a radii of 3 (protection zone) and 10 (surveillance) kilometers) determined. In the buffer zones of 3 kilometers all breaded pigs were culled and in the zone of 10 kilometers all pigs are checked for ASF virus and the situation is under surveillance.

A. De la Torre et al. [4] assessed the risk of ASF introduction into the EU by following risk estimators: the susceptible population of (1) wild boars and (2) domestic pigs in the country of origin; the outbreak density in (3) wild boars and (4) domestic pigs in the countries of origin, the (5) suitable habitat for wild boars along the EU border; and the distance between the EU border and the nearest ASF outbreak in (6) wild boars or (7) domestic pigs. S Khomenko et al. [18] divided pig production systems into three main categories: a) specialized (industrial) production units with generally high biosecurity; b) small commercial farms; and c) backyard subsistence production. The last two categories have typically low to non-existent biosecurity and are referred to as the low biosecurity (LB) sector. In Lithuania according to the last available statistical data in 2007 there were 30 pig-breeding complexes, which raised around 60 percent of all pigs raised in the country. Farms raising approximately 20 pigs composed 99 percent of farms. These farms are considered as LB farms in Lithuania. Other countries have even higher LB level (Table 2).

33,7 percent of Lithuanian pigs were held in family farms in 2013. Small family farms compared with pig breeding agricultural companies and enterprises have lower levels of awareness and biosecurity, poor compliance to livestock related regulations (reporting, movement control, certifications and inspection, vaccination, etc.). The probability of transmission of infectious diseases through direct or indirect wild boar population is quite high in Lithuania and Latvia in comparison with other neighbouring countries affected by ASF, which causes high risk to Lithuania to be affected.

Table 2. Total population and density of domestic pigs and wild boar in the countries already affected by ASF in the neighborhood to Lithuania [18]

Countries affected with ASF	Domestic pigs			Wild boar contact between susceptible	
	Population	%of LB	%of LB pig population (heads/km sq)	Population	Density (heads/km sq)
Lithuania	1010681	27,2	4,6	54608	0,840
Latvia	820286	54,5	6,9	67200	1,039
Belarus	3910900	25,2	5,0	56001	0,267
The Russian Federation	17640570	37,6	1,2	404570	0,082
Ukraine	8183842	56,1	8,8	48982	0,118
Poland*	12748728	42,1	1,5	173000	0,536

*Authors calculations based on K. Skrymowska [22], S. Deinet et al. [8].

In relation to bio-security, it is common to find compensation provided by the state. Ordinarily one might expect that such losses attaching to production will be borne by the producer. In the case of animal diseases, however, this is not the case. There are two main reasons. The first is that a strong public interest in maintaining food production dictates that the losses should be compensated to promote uninterrupted supply of food and regenerate the site of production in a manner which market mechanisms could not accomplish. A second reason is that the compensation encourages producers to behave in certain ways: reporting of disease and the rendering up of stock for slaughter [13].

Increasing early detection of ASF would improve the chances of disease control measures making them more effective. Implementing precaution measures to avoid outbreaks of affected animals, to reduce the risk of infection and to reduce the impact to the farm performance in the case of infection are stated in Lithuania. Compensation for pig breeders in buffer zones is calculated for covering losses to the pigs' owner for the compulsory culling of raised pigs, for transportation costs and for the loss of future income using the formula:

$$N = (g \times psp \times 100 - Rsk) + (kt \times d) + (gs \times 2{,}2 \times ksp \times 100 \times 0{,}2 \times n); \quad (1)$$

here:

N– the losses for the pig breeder related to the compulsory culling of raised pigs, transportation costs and the loss of future income, Lt;

g – the units of the delivered pigs to slaughterhouse, not exceeding registered amount.

psp – the average of live weight pigs (which weight differently) purchase price (this price is estimated according to the last months price in the market and it is announced in the webpage of Agricultural and Food market information system, access through the Internet: http://www.vic.lt, Lt/kg;

100 – the theoretical weight of bacon pig;

Rsk – the revenues of realized pigs in the slaughterhouse;

kt – the tariff of 1 km transit, Lt/km;

d – the distance from breeder to the slaughterhouse (not further than 50 km), km;

s – the amount of pigs (which weigh differently) at registration moment, units;

2,2 – the pig production cycle per year (coefficient);

0,2 – the share of pig breeder's income and remuneration in the pig breeder's future income, coefficient;

n – the number of years.

If the average weight of delivered pigs to the slaughterhouse is higher than 100 kg, then compensation is not calculated in the first formula part: (g x ksp x 100 – Psk). Pig breeder sells pigs to the slaughterhouse and gets revenues ((Psk) depending on purchase price. After that the sold animals becomes slaughterhouse's property.

Pigs can be transported to the slaughterhouses by the pigs' owner, by the slaughterhouse representative or it can be done by other subject who has been legally authorized for this activity. If pigs are transported to the slaughterhouse by the trader or the slaughterhouse representative, their transport costs are covered by the pig breeder.

The first formula calculates compensation for pigs raised for slaughtering. Usually sows, boars, piglets are not slaughtered in slaughterhouse as their meat is not suitable for realization in the market. The compensation to pig breeder is calculated using formula:

$$Nr = \Sigma_{(j)} (grj \times pnj) + (gp \times 10 \times 2{,}2 \times pnp \times 0{,}2 \times n); \quad (2)$$

here:

Nr – the compensation to pig breeder for slaughtered or fallen sows, boars and piglets;

grj – the units of slaughtered or fallen sows, boars and piglets, units;

pnj – the reproduction pigs (except sows) and piglets (j type) minimum price (normative price is defined in the order of Lithuanian Minister of Agriculture, No. 3D-799, adopted on 27th of November, 2013). Maximum normative price is applied for sows until 1 year age, average normative price is applied to sows until 2 years age, and minimum normative price is applied to sows older than 2 years;

j – the sows, old sows condemned as defective, piglets until two months age, boars reproducers, boar condemned as defective;

gp – the amount of sows, units;

10 – the average number of piglets from one sow per brood;

2,2 – the pig production cycle per year (coefficient);

pnp – the minimum normative price of piglets;

0,2 – the share of pig breeder's income and remuneration in the pig breeder's future income, coefficient.

Future losses (Npen) for realized raised piglets in other farms are calculated using formula:

$$Npen = \sum_{n=1}^{n} \left(gnpen \times (pm - prel) \right); \quad (3)$$

here:

gnpen – the weight of piglets sold for further fattening, not exceeding 100 kg;

pm – the average purchase price of live weight of fattened pigs (this price is estimated according to the last months price in the market

and it is announced in the webpage of Agricultural and Food market information system, access through the Internet: http://www.vic.lt, Lt/kg;

prel – the price of live weight of fattened pigs sold to slaughterhouse (pigs fattened from piglets in buffer zone), Lt/kg;

n – the amount of realized piglets, which were born in buffer zone.

In the first and in the second formula the pig production cycle's coefficient (per year) that is used is 2,2. This pig production cycle approximate depends on the age when the piglets weaned from sow. Depending on the piglets weaning time, the sow is able to farrowing 2–2,9 times per year. Usually higher coefficient is reached in big pig breeding complexes [2, 16, 17, 20].

To estimate the share of pig breeder's income and remuneration in the pig breeder's future income the 0,2 coefficient is used. Pig breeders loss its income and remuneration, other stocks remain in the case of not breeding pigs. The income and the remuneration to pig breeder and salary for workers in pig breeding enterprise amount 20 per cent in the pork purchasing price according to pig breeders enterprises' production results in 2006-2013 years.

After the first outbreak of ASF in Lithuania in a determined buffer zone there were 419 subjects who raised pigs, and from that amount in a 414 of such farms the average count of pigs was 12 pigs per farm, and at the rest 5 farms the count of pigs ranged from 230 to 5459 pigs. Defined pig production cycle's coefficient is sufficient to compel farmers to report about ASF case in the farm.

The total compensation sum paid to farmers constitutes approximately 1 million euros after the first outbreak in Lithuania. The compensation to pig breeders after the second outbreak and the costs implementing control and monitoring programs will be much higher in comparison with the first one. The single country can face with difficulties to cover the costs from already planned budget. So the strategy for Lithuania and other EU Member States is needed how the ASF virus can be stopped and discussion with other neighbor countries, as Russia and Belarus, is very important.

Conclusions. Pig breeding sector is the second livestock sector by its importance in Lithuania. In the scheme of livestock breeding in Lithuania the pigs made up the greatest part – 50 percent, and in the scheme of meat production the pork (live weight) made up 31 percent. Pork is the most popular meat for food consumption. Pig breeding is profitable, as well pig breeding complexes create workplaces and invest in tools to be environmentally friendly. The introduction of ASF virus, into Lithuania in 2014 and neighboring to Lithuania countries, such as Belarus, Latvia, Poland, as well as to the Russian Federation increases further risk of ASF dissemination in Lithuania and other EU countries. If Lithuania till 2014 was not assessed as country with a highest risk for ASFV, so after the second outbreak in Lithuania the situation has changed dramatically. New outbreaks in 2014 shows that even all measures were taken to stop the spread after the first outbreak of ASF, this disease spread is difficult to control. The consequences of it can impact pigs breeding sector's situation, pork consumption, food security, pork trade balance and etc. The main risk estimators of ASF introduction into the Lithuania are density of outbreaks of ASF virus in a wild boar and in domestic pigs and low-biosecurity farms within the country and in neighboring countries, density of wild boar and pigs within the country.

The calculation of the compensation for pig breeders in the buffer zone is represented. The estimated coefficients of pig production cycle and pig breeder's income and remuneration in the pig breeder's future income should compensate for not breeding pigs temporarily and compel pig breeders to report about ASF outbreaks.

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