

Part 3. Biosafety

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ASSESSMENT OF BIOSECURITY POLICIES AND PRACTICES FOR THE CONTROL OF AFRICAN SWINE FEVER VIRUS ON UKRAINIAN PIG FARMS

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Summary. With monetary support from the United States Department of Agriculture Foreign Agricultural Service (USDA FAS), an investigative effort was undertaken to document the biosecurity practices employed by commercial pig producers in Ukraine to prevent the introduction of African swine fever virus (ASFV) on their farms. The cohort of farms selected and evaluated were owned by producers who were active members of the Association of Ukrainian Pig Breeders (AUPB). The assessment of biosecurity policies and practices consisted of an interview and in-person completion of a questionnaire that evaluated various aspects of biosecurity practices used on pig farms in Ukraine. The results of the interviews and completion of survey questionnaires support the conclusion that Ukrainian pig producers recognize the importance of farm biosecurity as it relates to preventing ASFV introduction on their farms and all the participating farms had biosecurity policies that were in force at the time of completion of the questionnaire. However, the results also support the conclusion that significant gaps in understanding about biosecurity exists and that there is a need for more education of Ukrainian pig producers about this critical aspect of health management and disease control. The broad impact of the project detailed that prospective, more comprehensive work on Ukrainian pig farms is required to adequately assist producers with ASFV control and effective applications of biosecurity

Keywords: African swine fever virus, Association of Ukrainian Pig Breeders, questionnaire, preventive measures

Introduction. African swine fever (ASF) is a longstanding disease that was first recognized as a viral disease of pigs on the continent of Africa in the early 1900s (Sánchez-Cordón et al., 2018). After introduction of African swine fever virus (ASFV) into the Caucasus region in 2007 via the Black Sea Port of Poti (Brown and Bevins, 2018), ASFV was later diagnosed in Ukraine in 2012 after circulating for several years in Eastern Europe and Russia (Arias et al., 2018). A diagnosis of ASF is disastrous for numerous reasons and not limited to the virulent and lethal nature of the virus or the lack of a vaccine to promote immunity among susceptible pigs (FAO, 2012). Due to its severity as a transboundary pathogen and its associated mandatory reporting requirements, an ASF diagnosis has devastating impacts on international trade and the national and agricultural economies of affected territories (Gallardo et al., 2015). ASF epidemiology in Eastern Europe has elevated the importance of comprehensive biosecurity as the primary means of controlling or mitigating virus introduction on commercial pig farms (Jurado et al., 2018). Like other infectious agents that cause disease in pigs, ASFV gains access to pig farms through various routes (Olesen et al.,

2018; Sánchez-Cordón et al., 2018). Therefore, if effective control of ASFV is to be achieved, it is necessary to attempt to identify deficiencies in farm biosecurity and subsequently develop effective protocols to counter the identified deficiencies.

The purpose of the effort described herein was to evaluate the biosecurity policies and practices used on commercial pig farms in Ukraine with a focus on preventing the introduction of ASFV. A questionnaire was developed and used to assess the biosecurity of farms participating in the investigative effort. In addition, the questionnaire was also developed with the specific purpose of making it available to pig producers in an electronic format so that they may perform periodic self-evaluations of their farms' biosecurity in the future and make adjustments to their biosecurity protocols as needed.

Materials and methods. In 2018, a competitive grant proposal was funded by the United States Department of Agriculture Foreign Agricultural Service (USDA FAS) for the purpose of assisting the Ukrainian Ministry of Agriculture and its nations' pig producers with their efforts to control the spread of ASFV. The diagnosis of ASF has curtailed Ukraine's ability to engage in significant

trade of pork and pork products internationally and inspired the Ukrainian Ministry of Agriculture to develop a working relationship with USDA FAS. In collaboration with the Association of Ukrainian Pig Breeders (AUPB), a cooperative of commercial pig operations throughout Ukraine, farms were identified for assessment of their biosecurity policies and practices to prevent the introduction of ASFV. Assessment of farm biosecurity consisted of interviews with farm owners or their managers and completion of a questionnaire to document farm policies and practices. The questionnaire was a comprehensive document that evaluated various aspects of the farm biosecurity plan and can be reviewed at www.pigua.info. The participating farms varied in size and scope and included farrow-to-finish and wean-to-finish operations. The time required to complete the interviews and questionnaire varied and typically exceeded 90 minutes in length from start to finish.

Results. For preservation of privacy, the identity and location of the farms participating in the investigative effort are not disclosed. The participating farms are identified by the sequence in which they were visited and the type of swine operation. Areas of concern with farm biosecurity were identified based on responses from interviews of farm representatives and completion of the questionnaires.

Farm 1, Farrow-to-Finish. The presence of wild boars has been documented in areas adjacent to the farm. The farm is located within 2 km of residences where backyard pigs may be maintained. Truck drivers are permitted to exit and re-enter their vehicles after entering the production area without consideration for biosecurity. Barn personnel participates in the loading of pigs for transport and the loading dock is located within the production area, which requires entry of transport vehicles into the production area for access. Personnel and vehicles that are used to retrieve and transport mortalities are permitted to enter the production area without consideration for biosecurity or hygiene status of the vehicle. Barn personnel moved freely between clean and dirty sides of the shower entry area without consideration for biosecurity. After entry into the production area, personnel that exited the main unit to enter the quarantine facility were not required to shower to re-enter the main unit. Shower facilities were not provided for this purpose. The farm management team did not appear to have sufficient knowledge of the disease status of their genetic supplier. Multiple-use cloth towels are used in common areas instead of single use paper towels. The number of towels provided to barn personnel for entry and exit of the shower area was considered inadequate. The farm lacked a water purification system. Post-disinfection assessments of facility hygiene are not performed. Building air intakes lacked coverings to restrict entry by unwanted pests. Vegetation was overgrown adjacent to the barrier fence.

Fruit trees were present and may act as an attractant for birds and other unwanted animals.

Farm 2, Wean-to-Finish. The presence of wild boars has been documented in areas adjacent to the farm. The farm was located within 2 km of residences where backyard pigs may be maintained. Weaned pigs are not obtained from a single source and some of the sow farms supplying weaned pigs do not have comprehensive biosecurity policies. A dedicated site for cleaning and disinfection of work vehicles does not exist and policies regulating vehicle movements within the production area have not been developed. Corridors used for moving pigs are not properly cleaned and disinfected after internal movements or load-outs for marketing. The farm lacked a water purification system. Barn personnel are permitted to take cellphones, cigarettes, and other personal items through the shower entry area and into production areas. The number of towels provided to barn personnel for entry and exit of the shower area was considered inadequate. Guard dogs are not confined to a specific area to prevent roaming off the premises. Fruit trees were present and may act as an attractant for birds and other unwanted animals.

Farm 3, Farrow-to-Finish. The presence of wild boars has been documented in areas adjacent to the farm. The farm is located within 2 km of residences where backyard pigs may be maintained and the farm is present in an area where there are other swine farms in close proximity with the nearest farm estimated to be within 500 m. Feed prepared on the farm is not subjected to heat treatment. Items are allowed to enter the farm without being subjected to decontamination. The farm does not have a current rendering agreement with the State, as required by law. Containers for storing mortalities under proper temperature conditions were not available. Shower facilities were poorly designed and would permit cross contamination of barn personnel entering and exiting the production area. Post-disinfection assessments of facility hygiene are not performed. Fruit trees were present and may act as an attractant for birds and other unwanted animals.

Farm 4, Farrow-to-Finish. The farm did not have a dedicated isolation facility for receiving pigs from outside sources. Vehicles are required to enter the production area for feed deliveries. Mortalities are placed in storage containers, but the containers are not temperature controlled. Barn personnel are permitted to take cellphones, cigarettes, and other personal items through the shower entry area and into production areas. Multiple-use cloth towels are used in common areas instead of single use paper towels. The farm lacked a water filtration system. The farm had a barrier fence in place but the rear area of the fence was cluttered and poorly maintained.

Farm 5, Farrow-to-Finish. Homes are within 2 km of the farm where backyard pigs may be maintained. The

farm does not have a current rendering agreement with the State, as required by law. Containers for storing mortalities under proper temperature conditions were not available. Heat treated feeds are not utilized. Feed delivery vehicles are required to enter the production area for unloading. A barrier fence was intact but appeared to be poorly maintained. A designated shower facility was not available for entry and exit from the quarantine area. A policy regulating movements of farm personnel around the premises has not been developed. Multiple-use cloth towels are used in common areas instead of single use paper towels. Guard dogs are not confined to a specific area to prevent roaming off the premises. Post-disinfection assessments of facility hygiene are not performed. Note: The farm management used formalin as one of its disinfectants, which while effective, raised safety concerns for the farm personnel and the environment. It was strongly recommended that commercial disinfectant products that are viewed as safe and approved be used for purposes of farm disinfection.

Farm 6, Farrow-to-Finish. Homes are within 2 km of the farm where backyard pigs may be maintained and the farm is present in an area where there are other swine farms in close proximity. The farm does not have a current rendering agreement with the State, as required by law. Containers for storing mortalities under proper temperature conditions were not available. Designated uniforms were not provided to farm personnel for handling mortalities. Truck drivers and vehicles were not monitored for compliance with biosecurity policies. There was a lack of knowledge about whether feed is heat treated by the feed supplier. The production area has to be accessed for feed deliveries. Birds are able to enter and occupy feed storage areas. The farm lacked a water filtration system. Supplies and materials entering the production area are not decontaminated. Biosecurity policies have not been developed for the different production areas on the farm or for movement of farm personnel around the premises. Barn personnel are permitted to take cellphones, cigarettes, and other personal items into production areas. Multiple-use cloth towels are used in common areas instead of single use paper towels. The number of towels provided to barn personnel to enter and exit the shower area was considered inadequate. A barrier fence was intact but did not restrict small rodents and there was no plan for rodent control. Post-disinfection assessments of facility hygiene are not performed.

Farm 7, Farrow-to-Finish. The farm was located within 2 km of residences where backyard pigs may be maintained. Farm personnel are permitted to own pigs. Another swine operation is located within 3 km of the farm. Vehicles entering the farm are required to pass through a wheel dip but effectiveness of the disinfection process is not assessed. A biosecurity policy has not been developed for truck drivers after arrival to the farm. There

was a lack of knowledge about whether feed is heat treated by the feed supplier. The production area has to be accessed for feed deliveries. Barn personnel are permitted to take cellphones, cigarettes, and other personal items into production areas and have avoided showering before entering the production area. Barn personnel wear the same footwear into and out of production areas. Barn personnel are permitted to bring food items onto the farm. Farm personnel are not required to wear different coveralls to identify their work assignments. Farm personnel share work equipment between buildings that is not disinfected and supplies are permitted to enter the production area without decontamination. Animal loading areas are not cleaned after pigs are handled at load out. Multiple use cloth towels are used in common areas instead of single use paper towels. A barrier fence is intact but not adequately monitored. Fruit trees were present on the site and may act as an attractant for birds and other unwanted animals.

Farm 7a, Wean-to-Finish. The farm was located within 2 km of residences where backyard pigs may be maintained. Farm personnel are permitted to own pigs. Another swine operation was located within 3 km of the farm. Farm management did not have sufficient knowledge of the biosecurity plan used by its weaned pig supplier. Vehicles entering the farm pass through a wheel dip but disinfectant is not applied to the undercarriage and vehicles are permitted into the production area. A biosecurity policy has not been developed for truck drivers after arrival to the farm. Truck drivers participate in load outs and are permitted to enter the production area without showering and changing clothes. The site lacks a dedicated loading ramp and does not have a designated area for cleaning and disinfection of vehicles. Vehicles are not properly cleaned and disinfected after transporting pigs and records of vehicle disinfection are not maintained. Policies regulating vehicle movements within the production area does not exist. The vehicle used to transport mortalities is permitted in the production area and is operated in open areas around the premises. Dedicated employees are not assigned to handle mortalities and do not change clothing after handling mortalities. Containers for properly storing mortalities on the farm are not available. The farm does not use heat-treated feeds and trucks have to enter the production area for feed deliveries. Materials entering the farm are not decontaminated. The farm entry shower area is not monitored and is used for reasons other than entering and exiting the farm. Barn personnel are allowed to move freely between clean and dirty areas. Barn personnel are allowed to use the same footwear throughout multiple locations in the production area. The number of towels provided to barn personnel to enter and exit the production area was considered inadequate. Barn personnel are permitted to take cellphones, cigarettes, and other personal items into production areas. Farm

personnel are permitted to bring food items onto the farm. A biosecurity plan regulating the movements of barn personnel within the production area has not been developed. The barrier fence is incomplete and areas around the fence are overgrown and cluttered.

Farm 8, Farrow-to-Finish. The presence of wild boars has been documented in areas adjacent to the farm. The farm is located within 2 km of residences where backyard pigs may be maintained. The farm lacks an isolation facility for receiving pigs from outside sources. The load-out area is not cleaned and disinfected after use. Materials entering the farm are not decontaminated. Vehicles entering the farm are permitted into the production area without application of disinfectant to the undercarriage. A dedicated site for cleaning and disinfection of vehicles does not exist, records of vehicle disinfection are not maintained. Vehicles are not properly cleaned and disinfected after transporting live pigs. Vehicles used for transport of mortalities are not cleaned and disinfected after use. Feed is prepared on the farm but is not heat treated. Containers for mortalities are available but they are not temperature controlled. Farm personnel that handle mortalities are not required to change clothing after completing such tasks. The shower area is not monitored and barn personnel are permitted to take cellphones, cigarettes, and other personal items into production areas. Barn personnel are permitted to use their own undergarments and do not have access to a laundry service.

Farm 9, Farrow-to-Finish. The presence of wild boars has been documented in areas adjacent to the farm and have been documented to enter the farm premises and enter areas where farm vehicles routinely operate. The farm is located within 2 km of residences where backyard pigs may be maintained. Internal vehicles leave the production area to access other areas of the farm and a designated area for cleaning and disinfection of internal vehicles does not exist. The farm did not have an established policy for decontaminating supplies and materials entering the farm. The isolation facility lacked a designated shower for farm personnel working in the area. The farm has containers for mortalities but they are not temperature controlled. Moreover, the farm does have a contract with a renderer, but does not want the renderer entering the premises due to biosecurity concerns. The farm removed the incinerator that was used for disposing of mortalities. The health status of farm personnel is not assessed periodically. The shower area is not monitored and barn personnel are permitted to take cellphones, cigarettes, and other personal items into production areas. Biosecurity policies regulating the movement of farm personnel has not been developed. A barrier fence was intact but was overgrown with vegetation.

Discussion. In the absence of conducting extensive on-site assessments of farms, completion of the

questionnaire with representatives of the different swine operations permitted a comprehensive assessment of the biosecurity policies and practices used by the respective farms. A rigorous approach to farm biosecurity is necessary for Ukrainian swine producers to successfully control ASFV. The transmission of ASFV by ticks does not appear to be associated with a high probability in Ukraine, unlike other areas in Europe (Frant et al., 2017; Chenais et al., 2019). Therefore, biosecurity efforts can and should be focused on more relevant possibilities of ASFV introduction. While all the farms had established biosecurity policies and practices for purposes of preventing pathogen introduction, the responses to some questions raised concerns about the risk of ASFV introduction into all of the assessed farms.

Wild boars appear to be a reservoir for ASFV (Chenais et al., 2019; Brown and Bevins, 2018; Olševskis et al., 2016) and farms located in regions where wild boar habitats are in close proximity carries a heightened risk of ASFV introduction. When considered in the context of farms that lack barrier fencing or other physical means of preventing wild boars from accessing the premises, this finding should be viewed as a serious deficiency in farm biosecurity. Wild boars infected with ASFV shed copious amounts of virus in urine, feces, and oral secretions and this material is infectious to domestic pigs (Guinat et al., 2016). As such, pig production sites that are visited by wild boars are at risk because of the possibility of tracking infectious material left by wild boars into pig housing facilities. Studies have confirmed that ASFV can be detected in the blood of pigs for up to 90 days post-infection, but the risk of virus transmission by chronically infected pigs requires further research and clarification (Petrov et al., 2018). Conversely, statistical modeling suggests that ASFV movements by wild boars is often impacted by strain virulence, severity of the disease outbreak and the potential of infected pigs to transmit virus to naïve pigs in close proximity (Podgórski and Śmietanka, 2018). Therefore, the spread of more virulent strains of ASFV may be reduced because infected pigs often die soon after infection and do not have the opportunity-shed virus over wide geographic areas. However, decomposing carcasses will pose an infection risk for a period of time after the death of ASFV infected pigs (Petrov et al., 2018; Chenais et al., 2019). Although wild boars have resided in forested habitats for extended periods of time and would be difficult to impossible to evict completely, a proactive policy of killing and carefully removing these pigs where possible represents one approach in mitigating the threat posed by this population of pigs (Cwynar, Stojkov and Wlazlak, 2019). Recommendations for safely hunting and processing wild boar that recognizes the risks to regional biosecurity have been proposed (Chenais et al., 2019; Bellini, Rutili and Guberti, 2016).

The presence of home-raised or backyard pigs injects a significant degree of risk for ASFV introduction to farms and is problematic for several reasons. In areas where ASFV is endemic and wild boars are active, it is possible for backyard pigs to have contact with wild boars because they are often housed with little to no consideration for biosecurity (Jurado et al., 2018). As a result, producers that permit their employees to own backyard pigs are at risk because farm personnel may become a source of ASFV originating from their home-raised pigs. Practices like swill feeding of backyard pigs further increases the risk of ASFV introduction because of contaminated table waste and is considered to be counterproductive to efforts to effectively control ASFV (Bellini, Rutili and Guberti, 2016). Backyard pigs are often unregulated by state regulatory officials and it is possible for them to become infected with ASFV and go undetected and unreported, thereby putting commercial farms in a given region at risk. Due to the inherent risk to commercial farms from backyard pigs, producers should discourage their employees from owning and maintaining such pigs (Bojkovski, 2015; Jurado et al., 2018). It is also reasonable to remove backyard pigs from locations in close proximity to commercial production sites whenever possible. The interviews revealed that several producers allowed their employees to own backyard pigs and this finding should be viewed as a serious deficiency in farm biosecurity. To address this concern, some producers have opted to provide pork to their employees free of charge or at a discount to discourage ownership of backyard pigs. This should be recognized as a worthwhile investment of resources to enhance farm biosecurity. In addition, several producers provided meals to their employees during the workday to prevent introduction of ASFV into their farms through contaminated meat products. This should also be recognized as a worthwhile biosecurity practice since ASFV can survive in cured and processed meat products for extended periods of time (Petrini et al., 2019; Bellini, Rutili and Guberti, 2016).

Vehicle movements represent a critical activity in the daily operation of swine farms. Transport of pigs, feed, supplies, and mortalities all require vehicle movements on and off pig production sites. It is in this context that the importance of a rigorous biosecurity policy for vehicles cannot be overlooked. Vehicles operating in and around pig production sites should be cleaned and disinfected on a regular basis, incorporating the necessary downtime to ensure that the process is done correctly (Jurado et al., 2018). A noteworthy example of failed vehicle biosecurity is the spread of Porcine Epidemic Diarrhea Virus (PEDV) in the United States after it was introduced in 2013 (Lowe, 2014). The spread of PEDV was exacerbated due to inadequate cleaning and disinfection of transport vehicles that delivered finishing pigs to slaughter facilities. Transport vehicles were contaminated at slaughter facilities during delivery of slaughter hogs and subjected

to inadequate cleaning and disinfection after departure from those facilities. Subsequent travel back to commercial pig farms with contaminated vehicles permitted transmission of PEDV, resulting in enteric disease outbreaks and an estimated 10 million neonatal pig deaths. Up to that time, it was assumed that existing practices for cleaning and disinfection of pig transport vehicles was adequate for effective pathogen control and in compliance with accepted biosecurity standards. Therefore, it is crucial that a heightened level of attention be placed on vehicles because of their potential role in pathogen introduction. Wheel baths or wheel dips are in use on many commercial pig farms in Ukraine for the purpose of sanitizing the tires of vehicles entering the farm. The premise for installation of such structures is fully appreciated since it is strongly recommended that vehicles entering production areas be subjected to proper cleaning and disinfection. However, there are concerns that wheel baths do not adequately sanitize the tires of vehicles entering and leaving production areas and should not be relied upon solely for acceptable vehicle biosecurity (Ford, 1995). A comprehensive approach to vehicle disinfection should include application of disinfectant to the tires and undercarriage of vehicles entering the production area, including animal transport vehicles. Maintenance of a record of cleaning and disinfection of transport vehicles is recommended to track compliance with this critical aspect of biosecurity (Bellini, Rutili and Guberti, 2016). Vehicles that regularly travel off production sites and those that are used to transport mortalities should receive added attention because of the potential for extensive contamination of such work vehicles (Ford, 1995). Contaminated footwear or clothing worn by transport personnel presents a serious risk of virus introduction into production sites (Štukelj and Plut, 2018) and farms should have policies and practices that acknowledge this reality. It is reasonable to insist that drivers carry disposable coveralls, boots, and gloves if they are to exit the cab of their vehicle after arrival to the farm. However, upon exiting their vehicle, they should not be permitted to assist with activities that require them to enter the production facility and have contact with pigs, such as unloading pigs after transport or loading pigs for transport (Bellini, Rutili and Guberti, 2016). Drivers should place their disposable items in garbage bags after use, making every attempt to avoid contaminating the cab of the truck or transport vehicle upon re-entry.

The wholesomeness and safety of feed is a major consideration for swine producers since the pigs that they market enter the food chain for human consumption. The introduction and circulation of ASFV in Europe has elevated the importance of feed and water quality on swine farms. Research conducted utilizing transboundary shipping models has demonstrated that contaminated feed ingredients can harbor infectious titers of ASFV and put farms at risk if feed ingredients are sourced from

territories that are endemic for ASFV (Dee et al., 2018). In addition to contaminated complete feed, it has been demonstrated that contaminated water sources can transmit ASFV, with transmission via the water requiring lower viral titers than those required for feed transmission (Neiderwerder et al., 2019). The potential for feed ingredients to introduce ASFV into swine farms is raising concerns around the world due to global sourcing of feed ingredients and sourcing of many critical feed additives from China, who is experiencing a major swine health crisis due to ASFV (Zhou et al., 2018). As such, the use of heat-treated feeds as an adjunct to other biosecurity practices would have considerable value in reducing the risk of ASFV introduction. Temperatures approaching 85°C are achieved during the feed pelleting process, which is in excess of temperatures that will inactivate ASFV (Thomas, Van Zuilichem and Van der Poel, 1997). A temperature of 60°C for a minimum of 20 minutes is considered necessary for effective inactivation of ASFV (Penrith and Vosloo, 2009). Most of the assessed farms did not have the necessary feed mill infrastructure to produce pelleted feeds. This reality is not restricted to Ukrainian farms and is best viewed as a significant global challenge as it relates to addressing the risk of ASFV introduction into ASFV-free and endemic territories. Moreover, the preparation of pelleted diets may have limitations with regards to ASFV inactivation and the potential for failure of this process should be recognized. As a result of investigations into Seneca Valley Virus (SVV) outbreaks in Brazil, Leme et al. (2019) demonstrated that SVV can be recovered from pelleted swine diets. Two conclusions are possible, this may be indicative of post-pelleting contamination or an indication that the pelleting process failed to completely inactivate infectious agents. Relative to farm water sources, most of the assessed farms did not utilize water purification systems. The risk of ASFV transmission via the water has been demonstrated under laboratory conditions by Niederwerder et al. (2019), so there is reason for concern about this potential route of virus introduction. An example of this risk is the assumption that contaminated water from the Danube River may have resulted in ASFV infection of a large swine farm in Romania (Mazur-Panasiuk, Żmudzki and Woźniakowski, 2019). Therefore, biosecurity of water sources represents another factor that must be considered in the formulation of comprehensive farm biosecurity plans.

A recognized principle of a viable biosecurity program for swine farms is controlled access to production areas. Pigs entering farms should be sourced from ASFV-free territories with approved movement permits to reduce the risk of virus introduction (Jurado et al., 2018). The potential for pathogen transmission from human-to-pig has been established in the literature (Amass and Clark, 1999) and farm biosecurity policies should be reflective of this major risk. Visitors should be restricted and farm entry for employees and veterinary staff should consist of

an orderly process where street clothing and footwear that is worn to the farm is changed at a designated location and not allowed to enter areas where pigs are housed (Jurado et al., 2018; Bellini, Rutili and Guberti, 2016). All the farms were consistent in their requirements for farm personnel and visitors to shower upon arrival and enter the production area only after dressing in clothing maintained at the farm. However, the shower area was not adequately supervised on some farms and farm personnel were permitted to carry personal items through the shower and into the production area, thereby putting the farm at risk for pathogen introduction. A properly supervised shower area utilizing Danish entry protocols would help in reducing the likelihood of pathogen introduction into the farm (Reicks, 2019; Jurado et al., 2018). Transport of personal items from the dirty side of the entry area to the clean side should not be permitted because of the inherent risk with such practices. In addition, equipment that is used by farm personnel inside buildings where pigs are housed should not be shared between different units (Jurado et al., 2018; Bellini, Rutili and Guberti, 2016). If equipment sharing becomes necessary, all equipment should be cleaned and disinfected as best as possible. Farm personnel responsible for removal and disposal of mortalities should utilize an orderly process for exiting and re-entering production areas that is consistent with acceptable farm entry practices.

Management of mortalities is a critical aspect of biosecurity on swine farms. Mortalities present a particular challenge to swine farms in Ukraine because producers are required to have a relationship with a rendering service to handle pigs that die on their premises. In ASFV endemic areas, this raises concerns with farm biosecurity because it requires that vehicles with unknown hygiene status have contact with farms (Bellini, Rutili and Guberti, 2016). In addition, holding and storing carcasses in ASFV endemic areas raises biosecurity concerns as well. Utilizing video recordings, Probst et al. (2019) documented the activity of scavengers on wild boar carcasses in Germany and determined that birds (raven, common buzzard) and small mammals (red fox, raccoon dog) will consume wild boar carcasses when located. They also documented that the observed scavengers will remove pieces of tissue from carcasses and transport it away from the original location of the carcass. This raises the importance of securely storing mortalities on farms to prevent visits by birds and small mammals that may have contact with ASFV infected material in endemic areas. Containers for storing mortalities were lacking on some farms or the containers were not temperature controlled, thereby limiting the ability to influence the rate of decomposition of carcasses. Proper storage of mortalities is also critical because stable flies infected with ASFV from a blood meal and later ingested by pigs resulted in infections and demonstrated that biting flies can acquire

an infectious viral titer sufficient to cause disease (Olesen et al., 2018). Therefore, actions that reduce attraction of flies to production areas would have value to the overall biosecurity of the farm.

Cleaning and disinfection of housing areas, vehicles, and equipment are major considerations when formulating biosecurity plans for pig farms. The goal of cleaning and disinfection is to decontaminate surfaces or objects, such that contact with those surfaces or objects does not result in pathogen transmission and disease. Effective cleaning involves mechanical removal of organic matter from surfaces with the aid of detergents, followed by application of disinfectants (Juszkiewicz, Walczak and Woźniakowski, 2019). An equally important part of cleaning and disinfection is drying (Amass and Clark, 1999). Drying promotes desiccation of microorganisms and creates a hostile environment that limits the survival of viruses and bacteria. Ideally, facilities should be allowed to dry completely before and after application of disinfectants. Numerous disinfectant classes are effective at inactivating ASFV and compared to viruses like PCV2, ASFV is very susceptible to disinfection because it is an enveloped virus (Juszkiewicz, Walczak and Woźniakowski, 2019). Caustic soda (sodium hydroxide), aldehydes (formalin), phenolics, hypochlorites, and iodine compounds are considered to be effective at inactivating ASFV (Jurado et al., 2018). The most effective ASFV disinfectants, formalin and caustic soda, present safety concerns with their use so disinfectant selection should be based on overall effectiveness of ASFV inactivation and safety for employees handling the chemicals. Proper cleaning and disinfection of housing spaces is critical to maintaining acceptable standards of health on swine farms. Therefore, this critical aspect of biosecurity should be assessed frequently to insure the quality of the cleaning and disinfection process. The farm veterinarian should serve as a resource for the development and implementation of protocols to assess the quality of hygiene on the farm due to their knowledge of laboratory

methods used to accomplish this important task. Research completed by Luyckx et al. (2015) on poultry farms provides some insight into considerations related to sampling procedures and microbiological and non-microbiological criteria that can be utilized to evaluate the quality of cleaning and disinfection on swine farms.

Conclusions. African swine fever virus has captured the attention of government officials, regulatory agencies, veterinarians, researchers, and swine producers worldwide. Implementation of biosecurity practices that reduce the likelihood of introduction of ASFV should be the overarching goal for territories that are currently free of this devastating pathogen. For ASFV endemic territories, the ultimate goal should be eradication of the virus with subsequent recognition by the World Organisation for Animal Health (OIE) for such an accomplishment. Eradication of ASFV from endemic areas has proven to be very difficult and when eradication in a timely manner is not a realistic option, establishment of compartments, or ASFV-free zones within endemic areas, as recognized by OIE, is the most viable alternative. Implementation of stringent biosecurity standards and establishment of compartments in Ukraine will permit engagement in regional and international trade of pork and pork products. The described assessment of biosecurity practices on Ukrainian pig farms revealed that producers are aware of the importance of this aspect of health and farm management. As intended, the assessments uncovered numerous deficiencies in farm biosecurity that if adequately addressed, would improve the overall health status on Ukrainian pig farms, permit establishment of regional compartments and stimulate more lucrative trade in pork and pork products for the nation.

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