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# Mortality And Economic Impact of African Swine Fever (ASF) Outbreak on Pigs in Luwu Timur Regency

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**Abstract.** Understanding the impact of ASF comprehensively is a crucial step in efforts to control and prevent future outbreaks. Therefore, an in-depth study is needed on the "Mortality and direct economic impact of African Swine Fever (ASF) outbreak" on pigs in East Tomoni District. This study was conducted in East Tomoni District, East Luwu Regency, South Sulawesi Province. Given the population of more than 1001 people, 5% of the population (1,085 farmers) were used as research samples. This study uses a comprehensive approach to evaluate economic losses due to ASF in the Tomoni Timur District. By considering three main aspects, namely pig mortality, direct losses to pig farms, and government losses. The analysis results show that the mortality rate of pigs due to ASF in the ASF outbreak in Tomoni Timur District caused pig mortality of up to 99.46%, having a major impact on the livestock population and the local economy. The economic loss per household reached IDR 55 million, reflecting a significant impact on farmers. The government also bears the cost of handling more than IDR 1 billion, but the main burden remains on farmers. The high number of losses shows the importance of appropriate interventions to prevent similar impacts in the future. More effective prevention strategies need to be designed to reduce the risk of recurrence. The mortality rate of pigs in East Tomoni District due to ASF is very high.

***Keywords:*** *Pigs, ASF, Mortality, Economic Loss.*

## A. INTRODUCTION

Pigs have many advantages compared to other livestock, namely high growth rate, easy to breed, diverse feed sources, high carcass value, and are an important provider of animal protein for humans. The method of raising pigs is relatively easy, but it is necessary to pay attention to several common diseases. Disease control is an important part of pig livestock management, and knowing common diseases is essential for taking effective preventive and control measures (Chojnacka et al., 2021).

One of the determining factors for the success of pig livestock development efforts is health and disease control. Pigs are very susceptible to various diseases, so disease control is a crucial aspect of their maintenance. Diseases can cause significant economic losses for farmers, including pig deaths (mortality), decreased production (morbidity), slowed growth rates, poor feed conversion, increased medical costs, and disruption of production continuity (Delsart et al., 2020.

Common diseases or those that often attack pigs can be prevented and controlled with the right knowledge and actions from farmers. Preventive measures that can be taken include biosecurity, vaccination, and adequate sanitation. Pigs are susceptible to various diseases, both those caused by infectious agents such as viruses, bacteria, or parasites, as well as non-infectious diseases (Alarcón et al., 2021).

Good husbandry management and knowledge of pig diseases are essential to maintain livestock health and prevent economic losses. The ASF outbreak in East Luwu is a clear example of how deadly diseases can threaten the pig farming industry. Comprehensive prevention and control efforts and cooperation between parties are needed to protect pig health and the sustainability of the pig farming industry (Gertzell et al., 2021).

The ASF outbreak in East Luwu has triggered an economic crisis for pig farmers in the East Tomoni sub-district. Mass deaths of pigs, huge financial losses, and disruption of pork supply pose serious threats to the survival of pig farming businesses and food security in East Luwu. Comprehensive and sustainable response efforts are urgently needed to overcome this crisis and protect the livelihoods of pig farmers and community food security (Kumareswaran & Jayasinghe, 2022).

Pig farming in East Luwu Regency has a long history and plays an important role in providing animal protein, increasing household income, and driving the local economy. Despite some challenges, this industry has the potential to develop sustainably with good management. Pig farming in East Luwu Regency presents an attractive opportunity for communities to increase income and contribute to the local economy. The diverse scale of the business, the potential for large profits, and the efficiency of cultivation make pig farming an attractive option for farmers in the East Tomoni sub-district. With good management and the implementation of sustainable farming practices, the pig farming industry in East Luwu can continue to grow and provide benefits to the community and the environment (Mason-D'Croz et al., 2020).

However, pig farming in East Luwu is not just about economic profit. The industry has deep social, cultural, and traditional dimensions for the community. Despite the challenges of African Swine Fever (ASF), pig farmers in East Luwu have shown their tenacity and determination to rise and preserve their cultural heritage. Support and cooperation from various parties are essential to help the pig farming industry in East Luwu recover and thrive in the future (Sumiaty et al., 2023).

The challenges of ASF in East Luwu Regency require comprehensive and sustainable solutions. A deep understanding of the disease, cooperation between parties, and effective mitigation strategies are key to saving the pig farming industry, protecting the livelihoods of farmers, and advancing the local economy. With tenacity and shared commitment, a brighter future for pig farming in East Luwu can be realized.

The ASF outbreak in East Luwu Regency has had a wide and complex impact, going beyond the economic aspect alone. The outbreak has caused significant financial losses for farmers, disrupted livelihoods, and raised concerns in the community. Its social and cultural impacts cannot be ignored either, as pig farming is closely integrated with the traditions and identities of the people of East Luwu.

Understanding the impact of ASF comprehensively is a crucial step in efforts to control and prevent this outbreak in the future. Therefore, the purpose of this study was to determine the magnitude of the mortality rate caused by African Swine Fever (ASF) in East Tomoni District, identify the direct economic impacts caused by the outbreak, and evaluate the losses experienced by the government as a consequence of the spread of ASF in this region.

## B. LITERATURE REVIEW

### 1. Pig Farm

Pigs are classified as monogastric livestock, meaning they have a digestive system that has one stomach. This allows them to convert food materials effectively and make maximum use of nutrients. The combination of this ability with a good ration supports the rapid growth of pigs, allowing them to reach maturity in a short time. Pigs are also known for their high reproductive rate. A sow can give birth to between 8 and 14 pups in a single litter, allowing farmers to quickly increase the population and achieve greater profits (Seyedalmoosavi et al., 2022).

Wild pigs belong to the Suidae family and are categorized in the genus Sus, the same as domestic pigs. Domestic pigs are thought to have descended from several different species

of wild pigs, most notably the European wild boar (Sus scrofa) and the Asian wild boar (Sus scrofa cristatus). Domestication of pigs is thought to have begun around 10,000 years ago in the Middle East and Southeast Asia, intending to produce different breeds with different characteristics, such as size, coat color, and fertility levels (Xie et al., 2022).

For centuries, pigs have been an important source of animal protein and fat for humans. Pork is processed into various delicious dishes around the world. In addition to meat, pigs also produce other useful products, such as pig skin, pig bristles, and pig manure that can be used as fertilizer (Ribeiro et al., 2021).

Pig breeding techniques have developed rapidly, allowing farmers to better control reproduction and improve the quality of their offspring. Pigs are not only profitable pets in terms of growth but also have a good role and prospects for development in the future. Some of the potential benefits of pigs include:

a. Food Source: Pork is an important source of animal protein and fat, processed into various delicious dishes around the world.
b. Other Products: In addition to meat, pigs produce skin, bristles, and manure that can be used as fertilizer.
c. Biomedical Research: Pigs have physiological and anatomical similarities to humans, making them an ideal model for biomedical research (Bartolozzo et al., 2023).

The pig industry plays a significant role in the European Union (EU) livestock sector, with pork being the most consumed meat among land animals, followed by chicken and beef. Pork consumption in the EU averages 42 kg per capita per year, exceeding beef (22 kg per capita per year) and chicken. The pig industry in the EU makes a significant economic contribution, employing millions of people directly and indirectly, and generating billions of euros in revenue each year. Pig farming also plays a key role in maintaining food security in the EU (Bonardi et al., 2021).

As the global economy grows, demand for animal protein continues to increase. Pork is a popular and affordable source of animal protein, so pork consumption is expected to continue to increase in the future. Public awareness of healthy eating is also increasing, with consumers now preferring products that come from animals that are well-raised and free from disease. The increasing consumption of pork and the focus on healthy eating has raised concerns about the health and welfare of pigs. Consumers want to be sure that the pigs raised to produce the meat they consume are raised responsibly and humanely (Rauw et al., 2020).

In addition to being a food source, pigs play an important role in biomedical research. The physiological and anatomical similarities of pigs to humans make them ideal models for many types of medical research. For example, pig organs and body systems are often used in studies of cardiovascular disease, diabetes, and organ transplantation research. This research helps scientists better understand human diseases and develop more effective treatments (Käser, 2021).

Although the pig farming industry offers many benefits, it also faces several challenges. One of these is diseases that can cause great losses to farmers, such as African Swine Fever (ASF). This disease is highly contagious and can cause mass mortality of pigs, resulting in significant economic losses. To overcome these challenges, effective disease prevention and control efforts are needed, as well as collaboration between farmers, governments, and scientists (Nguyen-Thi et al., 2021).

However, the industry also has great growth potential. With the increasing global demand for animal protein, pig farming has the potential to continue to grow and contribute to global food security. The development of new technologies in animal husbandry and selective breeding can help improve production efficiency and animal welfare, making the industry more sustainable in the future (Oosting et al., 2022).

## 2. African Swine Fever (ASF)

African Swine Fever (ASF) is a highly contagious and deadly disease of pigs. The ASF virus can cause high fever, internal bleeding, and death within a short period. The mortality rate in infected pigs can be as high as 100%, making ASF a serious threat to the pig farming industry worldwide. An ASF outbreak can result in the loss of millions of pigs, significant economic losses, and impacts on food security and the livelihoods of farmers. In addition to its direct impact on livestock, ASF can also affect other sectors such as tourism (Li et al., 2022). Restrictions on the movement of pigs and pork products imposed to prevent the spread of the virus can disrupt the tourism industry associated with pig farming. As a result, many countries affected by ASF are facing extensive and complex economic challenges. ASF control efforts rely heavily on strict biosecurity, animal movement restrictions, and culling of infected pigs. The international community, including the World Organization for Animal Health (OIE) and FAO, are working together to provide guidance and technical support to affected countries. However, major challenges remain as there is no effective vaccine to prevent ASF (Hashem et al., 2020).

ASF is a highly contagious and deadly viral hemorrhagic disease of pigs. The virus attacks the immune system of pigs, causing severe internal bleeding and other complications. Transmission of the virus occurs through direct contact between pigs, contaminated pork products, and vectors such as ticks and mosquitoes. Since it was first identified in Kenya in 1921, ASF has spread to many regions of the world. It spread throughout Africa, then to Europe, and more recently to Asia and the Americas. ASF outbreaks have caused significant economic losses to the pig industry in many regions, resulting in the death of millions of pigs and impacting food security and public health (Salguero, 2020). Controlling ASF is a complex challenge because the virus is highly contagious and persistent. There is currently no effective vaccine to prevent it, so control efforts focus on implementing strict biosecurity, restricting the movement of pigs and pork products, and culling infected pigs. Research into the development of vaccines and treatments for ASF is also ongoing, with the hope of finding effective solutions in the future (Assavacheep & Thanawongnuwech, 2022).

ASF not only threatens domestic pigs but also the entire Suidae family, including wild boars and wild boars. The virus can infect all species of Suidae, both domestic and wild, causing a wide range of symptoms and is often fatal. Symptoms of ASF in Suidae include high fever, loss of appetite, weakness, depression, diarrhea, vomiting, and internal bleeding. In severe cases, ASF can cause death within 2 to 10 days of exposure to the virus, with mortality rates reaching 100% in some species (Oberin et al., 2022). The death of Suidae due to ASF can have a significant impact on the ecosystem, as wild boars and wild boars play a vital role in maintaining ecological balance. Their loss can disrupt the food chain and endanger other species. One of the main challenges in controlling ASF is the lack of an effective commercial vaccine. Although much research and development of a vaccine is underway, no vaccine has been approved and is available for widespread use (Bora et al., 2020).

Research and development efforts for an ASF vaccine are ongoing in many countries. Scientists are working to develop a safe, effective, and affordable vaccine to improve ASF control and protect the future of the pig industry. Although no commercial vaccine is available, these efforts are important to reduce the impact of ASF and ensure the sustainability of the swine farming industry (Urbano & Ferreira, 2022).

Prevention and control of African Swine Fever (ASF) requires a collective effort from various parties, including governments, farmers, and the general public. By implementing appropriate prevention and control strategies, we can minimize the impact of ASF and protect the health of pigs and humans. Preventive measures include implementing strict biosecurity on farms, restricting the movement of pigs and pork products, and educating farmers on the

importance of hygiene and sanitation (Tizzani et al., 2021). In addition, governments need to carry out strict monitoring and surveillance to detect and respond to ASF outbreaks quickly and effectively. The international community also has an important role to play in combating ASF. Organizations such as the World Organization for Animal Health (OIE) and FAO have provided guidance and technical support to affected countries. International cooperation is needed to develop effective control strategies and reduce the risk of ASF spreading to new areas (Gao et al., 2021).

## C. METHOD

This research was conducted in Tomoni Timur District, East Luwu Regency, South Sulawesi Province. The selection of this location was done intentionally (purposive) by considering several things, namely: Tomoni Timur District has the largest pig population in East Luwu Regency, with a total of 13,265 heads. This district consists of eight villages affected by African Swine Fever (ASF) in 2023 and is still ongoing. The research period lasted from January to April 2023. This study used a combination of primary and secondary data to obtain a comprehensive picture of the impact of African Swine Fever (ASF) on pig farming in Tomoni Timur District. The selected data collection method is expected to produce accurate, relevant, and useful data to formulate the right solution to overcome ASF in the Tomoni Timur District area. This study uses a comprehensive approach to evaluate economic losses due to ASF in the Tomoni Timur District. By considering three main aspects, namely pig mortality, direct losses to pig farms, and government losses, this study is expected to provide a more accurate picture of the significant economic impact of ASF in the East Tomoni sub-district area.

## D. RESULT AND DISCUSSION

African Swine Fever (ASF) is a highly contagious and deadly viral disease of pigs. This disease not only affects animal health and is not zoonotic but has a significant impact on mortality. In this study, we analyzed the mortality rate and found out the direct economic and government losses arising from this ASF outbreak.

### 1. High Mortality Rates Due to ASF Outbreak

To find out the mortality rate due to the ASF outbreak using data that includes the number of dead pigs and the total population of pigs in the East Tomoni sub-district in the same period. This data was obtained from Village data, sub-districts, and the Animal Husbandry and Food Security Service. The data obtained can be seen in Table 1.

**Table 1. Data on Livestock Farmer's Impact of Pig Deaths Due to ASF in Tomoni Timur District in 2024**

| No | Village | Number of Farmers/Livestock Farmers | Livestock Number | | Total Number of Livestock |
|---|---|---|---|---|---|
| | | | Dead | Alive | |
| 1 | Kertoraharjo | 279 | 4,957 | 0 | 4,870 |
| 2 | Alam Buana | 121 | 1,179 | 0 | 1,186 |
| 3 | Pattengko | 269 | 1,962 | 7 | 1,969 |
| 4 | Cendana Hitam | 179 | 2,683 | 11 | 2,694 |
| 5 | Manunggal | 98 | 278 | 0 | 238 |
| 6 | Margomulyo | 72 | 2,609 | 57 | 2,666 |
| 7 | Cendana Hitam Timur | 61 | 483 | 0 | 483 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Purwosari | 7 | 50 | 2 | 52 |
| | Total | 1,086 | 14,201 | 77 | 14,158 |

The data above can be seen as, a comprehensive picture of the condition of the livestock population in eight villages, namely Kertoraharjo, Alam Buana, Pattengko, Cendana Hitam, Manunggal, Margomulyo, Cendana Hitam Timur and Purwosari. The number of deaths recorded was very significant compared to the existing livestock population. A total of 14,201 pigs died in all these villages. Of that number, only 77 were still alive, Kertoraharjo Village recorded the highest number of deaths with 1,487, followed by Margomulyo with 1,011, and Cendana Hitam Village with 862.

The total number of pigs still alive in the eight villages was 77. This figure shows that most of the livestock died, even though efforts had been made to maintain livestock health. From the data obtained, as many as 14,201 pigs died due to ASF in Tomoni Timur District, with a total pig population in the same period of 14,278. So to calculate the death rate due to the ASF outbreak, use the following solution:

Death Rate = (14,201 heads / 14,278 heads) x 100% = 99.46%

The results of the analysis show that the death rate of pigs due to ASF in East Tomoni District reached 99.46%. This indicates a very high level of disease severity, where almost all pigs infected with ASF cannot be saved. This condition results in significant economic losses for pig farmers in the East Tomoni District area. Diseases that attack pigs and wild pigs, such as ASF, can cause significant economic losses due to morbidity rates that can reach 100% and very high mortality (60% -100%) and are highly contagious.

Based on data collected from Tomni Timur District, it was recorded that 14,201 pigs died due to the ASF outbreak in the same period, where the total pig population in the area reached 14,278. These figures show how serious the impact of the ASF outbreak was on the pig population in the area. To understand how big the impact of this outbreak was, a calculation of the livestock mortality rate was carried out by comparing the number of livestock that died with the total livestock population. The calculation results showed that the mortality rate reached 99.46%. This means that almost the entire pig population in Tomoni Timur District was counted as dead due to this outbreak, leaving only a few surviving.

This very high mortality rate illustrates a very concerning situation. The impact is certainly not only felt by farmers but also by the local economy that depends on the livestock sector. With almost the entire pig population wiped out, farmers have lost their main source of income, and the supply of pork in the area is likely to experience a drastic decline. In addition, the mortality rate approaching 100% also indicates that efforts to prevent and handle the outbreak may not have been effective enough or were implemented too late. This underscores the need for more rapid and coordinated action in dealing with emergencies like this in the future.

In the context of East Tomoni District, the results obtained showed a mortality rate of 99.46%, which is close to the maximum figure as described. This figure confirms how destructive an ASF outbreak is, in line with the finding that this disease can wipe out livestock populations in a short time, resulting in huge economic losses for farmers. Overall, this very high livestock mortality rate underscores the devastating nature of the ASF outbreak and the negative impact it has had on pig farming in East Tomoni District. This incident can be an important lesson in strengthening the response system to future outbreaks, to prevent greater losses.

## 2. Direct Economic Impacts of the ASF Outbreak

African Swine Fever (ASF) is a highly contagious and deadly viral disease of pigs, causing significant economic impacts on the pig farming industry. In this study, we analyzed

the direct economic impact of pig deaths due to ASF. The data used to calculate the direct economic impact were data obtained from respondent data to determine the number of livestock owned, average ownership, and average price per head of livestock, the data can be seen in the following table:

**Table 2. Recapitulation of Livestock Ownership Data and its Economic Value**

| No | Number of Respondents (People) | Number of Livestock Population | Average Ownership Per Person | Average Price Per Pig |
|---|---|---|---|---|
| 1 | 54 | 1,700 | 13 | 4,217,686 |

From the table above, it can be seen that the number of respondents involved in this study was 54 people from each village with varying livestock populations. The total number of livestock reported by all respondents reached 1,700. This figure reflects the diversity in the scale of livestock businesses among respondents.

The average number of livestock owned by each respondent was 35. This figure shows that each farmer, on average, manages around 13 livestock, providing an overview of the average size of livestock businesses in the area studied. The ownership of this livestock varies, from farmers with small numbers to those with quite large numbers. In terms of economic value, the average price per livestock head was recorded at IDR 4,217,686.

To calculate the direct economic losses experienced by farming households using data that includes the number of pigs that died due to ASF and the selling price of pigs per head, from the livestock ownership data of respondents, 1,700 pigs died due to ASF with an average selling price per head of IDR 4,217,686. To calculate the direct economic impact due to the ASF outbreak, it is substituted into the following equation:

$L0 = \Sigma (Ht \times Pt)$
$L0 = \Sigma (13 \times Rp\ 4,217,686)$
$L0 = Rp\ 55,336,040$

In this study, 54 respondents were involved from various villages with diverse livestock populations, reflecting variations in the scale of livestock farming among farmers. Overall, the number of livestock reported by all respondents reached 1,700, indicating the importance of livestock, especially pigs, in the economic life of their households. On average, each respondent owned around 35 livestock, with an average livestock management of 13 per household, providing a general picture of the size of livestock farming in this area. This shows that some farmers have fewer livestock, while others manage more, reflecting the diversity in livestock ownership and management.

In terms of economic value, the average price per pig recorded was IDR 4,217,686. Using this data, calculations were carried out to determine the direct economic losses experienced by farming households due to the ASF outbreak. Assuming that each farming household has an average of 13 pigs, the total economic loss experienced by each household is IDR 55,336,040.

The results of this calculation indicate that the financial losses experienced by farmers are quite large, especially since pigs are an important economic asset for farming households in the area. The ASF outbreak that caused a large number of livestock deaths had a direct impact on household income and economic stability. In addition, the variation in the scale of livestock ownership among respondents also illustrates that the impact of losses is uneven, with some farmers perhaps experiencing greater losses than others. Overall, these figures provide a deep understanding of how severely this outbreak has affected farmers' economic lives, as well as the importance of appropriate interventions to mitigate wider impacts in the future, the results of this study are in line. Saying that, Livestock diseases have significant economic and social impacts on farmers and the wider community, Measuring the economic impact of

livestock disease outbreaks is essential for decision-making on animal disease prevention and control. By implementing appropriate prevention and control strategies, the negative impacts of livestock diseases can be minimized, and the sustainability of livestock and community welfare can be maintained.

### 3. Direct Government Losses

African Swine Fever (ASF) is a highly contagious disease that is fatal to pigs and causes significant economic losses to farmers and the government. One of the main impacts of ASF is the mass death of pigs, which results in direct losses to the government in the form of costs incurred by the government during the ASF outbreak. Based on the Decree of the Regent of East Luwu No. 167/D-16/V/2013 concerning the Establishment of the Task Force for Monitoring and Controlling African Swine Fever in 2023. To calculate the direct losses to the government, data on the number of pigs that died and the average government expenditure per death were used, the calculation of the average government expenditure and the value of compensation issued by the government to reduce the burden on farmers due to the ASF outbreak, the data can be seen in the following table:

**Table 3. Data on livestock deaths and costs incurred by the government due to the ASF outbreak in East Tomoni District in 2024**

| Number of Farmers | Total Livestock Mortality (Pigs) | Government Expenditure | Average Government Expenditure (per Pig) | Compensation Value (Rp) |
|---|---|---|---|---|
| 1,086 | 14,021 | 1,014,300,000 | 72,341 | 0 |

From the table above, it can be seen that the data shows that there are 1,086 farmers in this area who experienced the death of 14,021 livestock. Government spending to deal with this outbreak reached a total of IDR 1,014,300,000. If we calculate the average government spending per livestock that died, the result is IDR 72,341. Unfortunately, the compensation value received by farmers in this situation is IDR 0, indicating no direct financial support to alleviate the losses they experienced. To calculate the government's losses, it is substituted into the following equation:

Lg = nd * (cg + cc)
Lg = 14,201 * (71,430 + 0)
Lg = 1,014,300,000

From the calculations made, it can be seen that the ASF outbreak has caused quite large direct losses for the government. The available data shows that as many as 14,201 pigs died as a result of this outbreak. For every pig death that occurs, the government has to spend an average of Rp 71,430. This cost covers various handling efforts, such as disinfecting the affected area, and other steps needed to prevent further spread of the outbreak.

Using this data, the total loss was calculated by multiplying the number of pigs that died by the average cost per head. The calculation results show that the government must bear a loss of IDR 1,014,300,000. This figure is quite large and reflects the financial impact borne by the government in its efforts to overcome the ASF outbreak. What makes this situation more difficult is the fact that no compensation was given to farmers or other affected parties, so the entire burden of the loss was borne by the farmers. The government only covered the costs of handling this outbreak. This loss not only has an impact on the state budget but also shows how big the challenge is in overcoming a highly contagious disease outbreak such as ASF.

In a broader context, this calculation underscores the importance of having better prevention strategies and more effective response measures to reduce the economic impact of future disease outbreaks.

## E. CONCLUSION

The ASF outbreak in East Tomoni District has caused a very high pig mortality rate, reaching 99.46%, indicating a serious impact on the livestock population and the local economy. In addition, the economic losses experienced by farmers are very large, with an average of 13 pigs per household and losses reaching IDR 55,336,040 per household. This outbreak not only threatens the economic stability of households but also shows the importance of appropriate interventions to avoid more severe impacts in the future. On the other hand, the government also bears the loss of IDR 1,014,300,000 due to the death of 14,201 pigs, which includes the costs of handling and preventing the spread of the outbreak. However, the full burden of the losses remains borne by the farmers without compensation, thus emphasizing the need for better prevention and response strategies to reduce the economic impact in the future.

## REFERENCES

Alarcón, L. V., Allepuz, A., & Mateu, E. (2021). Biosecurity in pig farms: a review. *Porcine health management*, *7*(1), 5.

Assavacheep, P., & Thanawongnuwech, R. (2022). Porcine respiratory disease complex: Dynamics of polymicrobial infections and management strategies after the introduction of the African swine fever. *Frontiers in Veterinary Science*, *9*, 1048861.

Bonardi, S., Blagojevic, B., Belluco, S., Roasto, M., Gomes-Neves, E., & Vågsholm, I. (2021). Food chain information in the European pork industry: Where are we?. *Trends in Food Science & Technology*, *118*, 833-839.

Bora, M., Bora, D. P., Manu, M., Barman, N. N., Dutta, L. J., Kumar, P. P., ... & Nimmanapalli, R. (2020). Assessment of risk factors of African swine fever in India: perspectives on future outbreaks and control strategies. *Pathogens*, *9*(12), 1044.

Bortolozzo, F. P., Zanin, G. P., Ulguim, R. D. R., & Mellagi, A. P. G. (2023). Managing reproduction in hyperprolific sow herds. *Animals*, *13*(11), 1842.

Chojnacka, K., Mikula, K., Izydorczyk, G., Skrzypczak, D., Witek-Krowiak, A., Gersz, A., ... & Korczyński, M. (2021). Innovative high digestibility protein feed materials reducing environmental impact through improved nitrogen-use efficiency in sustainable agriculture. *Journal of Environmental Management*, *291*, 112693.

Delsart, M., Pol, F., Dufour, B., Rose, N., & Fablet, C. (2020). Pig farming in alternative systems: strengths and challenges in terms of animal welfare, biosecurity, animal health and pork safety. *Agriculture*, *10*(7), 261.

Gao, L., Sun, X., Yang, H., Xu, Q., Li, J., Kang, J., ... & Huang, B. (2021). Epidemic situation and control measures of African swine fever outbreaks in China 2018–2020. *Transboundary and emerging diseases*, *68*(5), 2676-2686.

Gertzell, E., Magnusson, U., Ikwap, K., Dione, M., Lindström, L., Eliasson-Selling, L., & Jacobson, M. (2021). Animal health beyond the single disease approach–A role for veterinary herd health management in low-income countries?. *Research in Veterinary Science*, *136*, 453-463.

Hashem, N. M., González-Bulnes, A., & Rodriguez-Morales, A. J. (2020). Animal welfare and livestock supply chain sustainability under the COVID-19 outbreak: An overview. *Frontiers in veterinary science*, *7*, 582528.

Käser, T. (2021). Swine as biomedical animal model for T-cell research—Success and potential for transmittable and non-transmittable human diseases. *Molecular immunology*, *135*, 95-115.

Kumareswaran, K., & Jayasinghe, G. Y. (2022). Systematic review on ensuring the global food security and covid-19 pandemic resilient food systems: towards accomplishing sustainable development goals targets. *Discover Sustainability*, *3*(1), 29.

Li, Z., Chen, W., Qiu, Z., Li, Y., Fan, J., Wu, K., ... & Chen, J. (2022). African swine fever virus: a review. *Life*, *12*(8), 1255.

Mason-D'Croz, D., Bogard, J. R., Herrero, M., Robinson, S., Sulser, T. B., Wiebe, K., ... & Godfray, H. C. J. (2020). Modelling the global economic consequences of a major African swine fever outbreak in China. *Nature Food*, *1*(4), 221-228.

Nguyen-Thi, T., Pham-Thi-Ngoc, L., Nguyen-Ngoc, Q., Dang-Xuan, S., Lee, H. S., Nguyen-Viet, H., ... & Rich, K. M. (2021). An assessment of the economic impacts of the 2019 African swine fever outbreaks in Vietnam. *Frontiers in veterinary science*, *8*, 686038.

Oberin, M., Hillman, A., Ward, M. P., Holley, C., Firestone, S., & Cowled, B. (2022). The potential role of wild suids in African swine fever spread in Asia and the Pacific region. *Viruses*, *15*(1), 61.

Oosting, S., van der Lee, J., Verdegem, M., de Vries, M., Vernooij, A., Bonilla-Cedrez, C., & Kabir, K. (2022). Farmed animal production in tropical circular food systems. *Food Security*, *14*(1), 273-292.

Rauw, W. M., Rydhmer, L., Kyriazakis, I., Øverland, M., Gilbert, H., Dekkers, J. C., ... & Gomez-Raya, L. (2020). Prospects for sustainability of pig production in relation to climate change and novel feed resources. *Journal of the Science of Food and Agriculture*, *100*(9), 3575-3586.

Ribeiro, D. M., Martins, C. F., Costa, M., Coelho, D., Pestana, J., Alfaia, C., ... & Prates, J. A. M. (2021). Quality traits and nutritional value of pork and poultry meat from animals fed with seaweeds. *Foods*, *10*(12), 2961.

Salguero, F. J. (2020). Comparative pathology and pathogenesis of African swine fever infection in swine. *Frontiers in veterinary science*, *7*, 282.

Seyedalmoosavi, M. M., Mielenz, M., Veldkamp, T., Daş, G., & Metges, C. C. (2022). Growth efficiency, intestinal biology, and nutrient utilization and requirements of black soldier fly (Hermetia illucens) larvae compared to monogastric livestock species: a review. *Journal of Animal Science and Biotechnology*, *13*(1), 31.

Sumiaty, M. H., Randalele, C. E., Iye, R., & Nur Abida, F. I. (2023). The value of Tallu Lolona and its influence to the life of Toraja people. *Cogent Social Sciences*, *9*(2), 2262775.

Tizzani, M., Muñoz-Gómez, V., De Nardi, M., Paolotti, D., Muñoz, O., Ceschi, P., ... & Capua, I. (2021). Integrating digital and field surveillance as complementary efforts to manage epidemic diseases of livestock: African swine fever as a case study. *Plos one*, *16*(12), e0252972.

Urbano, A. C., & Ferreira, F. (2022). African swine fever control and prevention: an update on vaccine development. *Emerging microbes & infections*, *11*(1), 2021-2033.

Xie, H. B., Yan, C., Adeola, A. C., Wang, K., Huang, C. P., Xu, M. M., ... & Zhang, Y. P. (2022). African suid genomes provide insights into the local adaptation to diverse African environments. *Molecular Biology and Evolution*, *39*(12), msac256.