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African Swine Fever (ASF) in Manokwari Regency: Impact on pig population, recovery dynamics, and biosecurity and socio-cultural-based control strategies

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Abstract

The outbreak of African Swine Fever (ASF) has caused a multidimensional crisis in Manokwari Regency, West Papua. This study aims to analyze the impact of ASF on the pig population, assess post-outbreak recovery trends, and identify constraints and strategies implemented by the government and local communities. The research design used a mixed-methods convergent parallel approach, involving a quantitative survey of 45 pig farmers and semi-structured interviews with 5 extension workers, supported by secondary data from 2020–2024. The results show a drastic decline in the pig population from 24,530 (2020) to 7,125 (2021), with slow recovery reaching 11,350 by 2024 (46.2% of pre-outbreak levels). Compound growth projections indicate that at a rate of 10% per year, recovery to 2020 levels will only be achieved by 2033; 20% per year by 2028; and 30% per year by 2026. Socio-economic impacts include loss of income sources, reduced access to animal protein, and disruption of pig-based cultural rituals. Recovery strategies include biosecurity outreach, limited restocking, and strengthening farmer groups. However, limited access to healthy breeding stock, further education, and fear of re-outbreak remain major obstacles. This study emphasizes that accelerated recovery can only be achieved through collective biosecurity synergy, healthy group-based restocking, digital surveillance, and continuous financial and institutional support.

Keywords: African Swine Fever (ASF); West Papua; Pigs; Biosecurity; Population Recovery; Socio-Cultural Strategies

1. Introduction

Pig farming plays a role that is not only economic but also socio-cultural in West Papua, particularly in Manokwari Regency. In many Melanesian and Papuan communities, pigs serve as a medium for social exchange (e.g., for marriage/paca), a status symbol, and an important component in communal rituals—thus, disruptions in the pig subsector directly impact social cohesion and local cultural resilience (Kusumaryati, 2024; Kadir, 2020; Sorokowski et al., 2013; Jebadu et al., 2025).

Since the first confirmation of ASF in Indonesia on December 12, 2019, the disease has spread widely, affecting 33 out of 38 provinces as of October 2024. The spatial-temporal picture of incidents shows recurring waves of cases with peaks varying by region, indicating complex control challenges in smallholder farming systems and pig supply chains (WOAH RR-Asia, 2024; WOAH, 2025). At the Asia-Pacific level, the 2025 situation update confirms that ASF remains a persistent regional threat, requiring tiered biosecurity and integrated cross-sector responses (WOAH, 2025; FAO, 2025).

Biologically, ASF is a highly contagious viral disease in domestic and wild pigs, with high fatality and no cure. The development of vaccines has shown significant progress, particularly with live-attenuated vaccine (LAV) candidates that protect against specific strains; however, the heterogeneity of viral genotypes and potential safety/efficacy risks

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across regions remain obstacles, meaning that ready-to-use vaccines on a large scale are not yet universally available and widely licensed in the region (Van Diep et al., 2025; Ntakiyisumba et al., 2025; UK-Defra, 2025; Global Biodefense, 2025). In the context of Manokwari, the lack of access to operational vaccines makes biosecurity a primary pillar of control at the farmer level.

The socio-economic impacts of ASF in Manokwari have been indicated in studies on farmers' perceptions and knowledge: livestock loss reduces income, disrupts household liquidity, and severs the flow of value in social-cultural networks involving pigs (Mulyadi et al., 2024). At the same time, simple biosecurity practices—such as pen separation, control of livestock/human traffic, sanitation, and carcass management—become no-regret strategies with relatively low costs but high benefits for reducing the risk of reinfection (FAO, 2025). For West Papua, contextually relevant and easily adoptable biosecurity packages are prerequisites for population recovery, especially in decentralized small-scale systems.

Based on this context, this research focuses on: (1) analyzing the impact of ASF on the pig population in Manokwari Regency; (2) assessing post-outbreak recovery trends; and (3) identifying constraints and recovery strategies implemented by the government and local communities. By combining quantitative data (population statistics from 2020–2024) and qualitative data (interviews with extension workers/farmers), this study aims to provide location-based evidence to strengthen culturally sensitive and epidemiologically effective policies and interventions. Up-to-date regional and national literature references underpin the urgency of this integrated approach.

2. Methods

2.1. Study Design

This study employs a convergent mixed-methods design, where quantitative data (farmer surveys) and qualitative data (interviews with extension workers) are collected in parallel during the same period, analyzed separately, and then integrated at the interpretation stage to generate a complementary understanding of the impact of ASF and recovery dynamics in Manokwari. This approach was chosen as it is suitable for complex issues involving epidemiological, economic, and socio-cultural dimensions in smallholder farming systems.

2.2. Location, Time, and Context

The study was conducted in the West Manokwari, East Manokwari, and South Manokwari Districts from February to April 2025. The selection of districts considered the diversity of ASF impact intensity and the accessibility of extension support.

2.3. Population, Inclusion/Exclusion Criteria

2.3.1. Target Population: Pig farming households in the three study districts.

- Inclusion Criteria: (i) permanent residents in the study location; (ii) raised pigs during the period 2020–2025 or had raised them just before the outbreak; (iii) aged ≥18 years; (iv) willing to participate in the study.
- Exclusion Criteria: Unable to be contacted after ≥3 visits or refusing to provide consent. For the qualitative component, key informants are extension workers/technical staff with ≥12 months of experience in assisting pig farmers in Manokwari.

2.3.2. Sampling Technique and Sample Size

- Quantitative (45 farmers): Stratified purposive sampling based on districts, followed by the selection of villages with different ASF incident histories (hotspot vs. non-hotspot) in collaboration with relevant agencies; a sample was drawn from the village farmer list considering variations in farm scale (small: <10 pigs; medium: ≥10 pigs).
- Qualitative (5 extension workers): Purposive sampling based on roles (field extension workers, veterinarians/paramedics, district coordinators) to obtain diverse perspectives.

2.3.3. Instruments and Variables

- A structured questionnaire includes: household and business characteristics; pre-outbreak herd size (2020), outbreak peak (2021), and post-outbreak (2022–2024); deaths due to consistent ASF symptoms; biosecurity practices (control of human/livestock traffic, disinfection, quarantine, feed/water management, pen cleaning); assistance received; restocking plans; risk perceptions and obstacles.

- Semi-structured interviews for extension workers: topics on policy and implementation of control/mitigation, technical support, dynamics of farmer groups, and field constraints.
- Secondary data: recap of pig populations in the district from 2020–2024 from relevant agencies, ASF handling reports, and supporting technical documents.

2.3.4. Data Collection Procedures and Quality Control

Instrument trials on 5 farmers (outside the main sample) to check item clarity.

- Fieldwork biosecurity: following FAO/WOAH guidelines: no cross-farm visits in one day; use of specific footwear/clothing and disinfection; avoiding contact with pigs 48 hours before/after visits; implementation of foot wash stations/hand sanitizers; cleaning of equipment; safe observation procedures for carcasses if encountered.
- Data quality assurance: daily dashboard checks (completeness, range checks), double-entry for manual inputs, and call-back of 10% of samples for verification.

2.4. Ethical Considerations

The research adheres to the principles of informed written consent, confidentiality of identity, and the option to withdraw without consequences. Reporting follows the STROBE guidelines for observational studies and COREQ for qualitative components.

2.5. Data Analysis

2.5.1. Quantitative (descriptive)

- Descriptive statistics for numeric variables; frequency/percentage for categorical variables.
- Trends in population from 2020–2024 are presented as annual time series; relative decline in 2021, recovery index per year, and average annual increase (2021→2024) at the district level are calculated.
- At the household level, the recovery ratio (herd size in 2024 ÷ 2020) and proportion of biosecurity adoption (score ≥6/8 as high) are calculated.
- Uncertainty is presented as a 95% CI for the main proportions using normal/Wilson approaches as needed.

2.5.2. Qualitative (thematic analysis)

- Verbatim transcription of interviews; thematic analysis in 6 phases (familiarization → initial coding → theme searching → theme reviewing → naming/definition → reporting) with independent double coding, reconciliation through discussion, and documentation of the codebook.
- Reliability is strengthened through an audit trail, peer debriefing, and triangulation of sources (farmers vs. extension workers vs. documents).

2.6. Quantitative-Qualitative Integration

Integration occurs at the interpretation stage through joint displays (tables/figures aligning quantitative metrics e.g., IP_t, biosecurity adoption with thematic quotes) to assess convergence, complementarity, or discrepancies in findings

3. Results and Discussion

3.1. Decline in Pig Population

3.1.1. Population Dynamics and Initial Recovery Rate

Data from the Animal Husbandry Office (Table 1) shows that the population before ASF (2020) was 24,530 pigs, which dropped to 7,125 (2021) and partially recovered to 8,920 (2022). Quantitatively, the absolute decline from 2020 to 2021 was 17,405 pigs (-71.0%), while the growth from 2021 to 2022 was +25.2%. In 2022, the population reached only 36.4% of pre-outbreak levels (a deficit of 63.6%). This recovery rate is consistent with ASF literature that emphasizes that population recovery will be slow without interruption of infection sources and strengthened biosecurity in smallholder-based systems (Busch et al., 2021; EFSA, 2020; Li et al., 2022).

Table 1 Summary of Population Dynamics and Key Indicators (Manokwari, 2020–2022)

Indicator	2020	2021	2022
Population (heads)	24,530	7,125	8,920
Absolute Change (year-to-year)	–	−17,405	+1,795
Relative Change (year-to-year)	–	−71.0%	+25.2%
Recovery Rate vs 2020	100%	29.0%	36.4%
Deficit vs 2020	0%	71.0%	63.6%

The sharp decline followed by slow recovery indicates a continuous risk (the virus persists in the environment/movement chains), limited restocking capacity, and uneven adoption of biosecurity measures, as often found in small-scale farming in Asia and Africa (Penrith, 2022; Matsumoto et al., 2021).

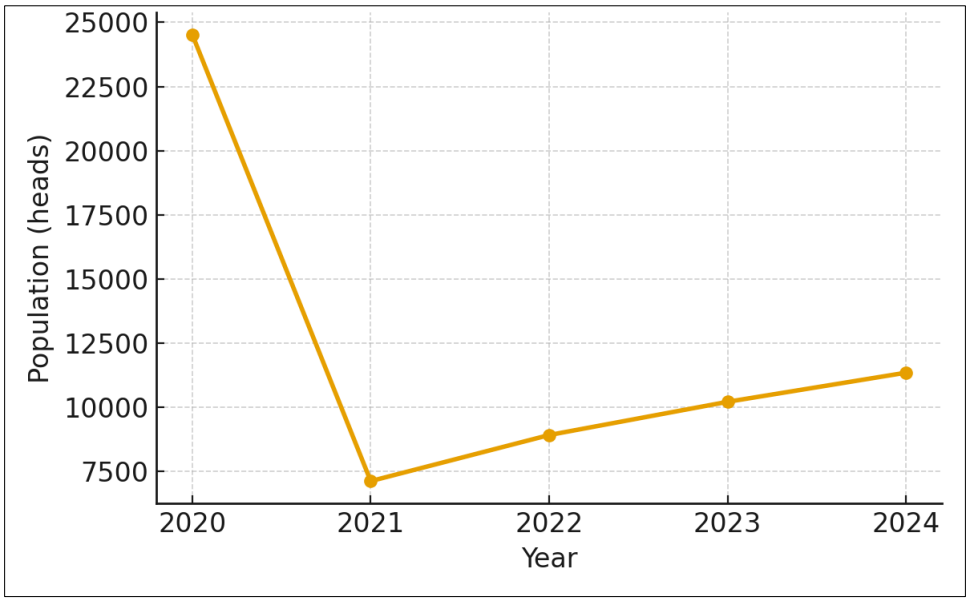

Figure 1 Trends in Pig Population 2020–2024

3.2. Recovery Time Scenario (What-If)

Using 2022 as the baseline (8,920 heads), the compound growth scenario shows the time horizon needed to reach the 2020 level (24,530 heads). Table 2 presents the projection of recovery to the pre-outbreak level.

Table 2 Simple projection of recovery to the pre-outbreak level (target: 24,530 heads)

Constant annual growth rate	Estimated duration	Estimated year achieved
10%/year	11 years	2033
20%/year	6 years	2028
30%/year	4 years	2026

Table 2 illustrates the sensitivity of recovery time—the process can be accelerated if biosecurity, surveillance, and healthy restocking are implemented simultaneously (FAO, 2021; Busch et al., 2021). Recovery projections up to 2030 with various constant growth rates are presented in Figure 2.

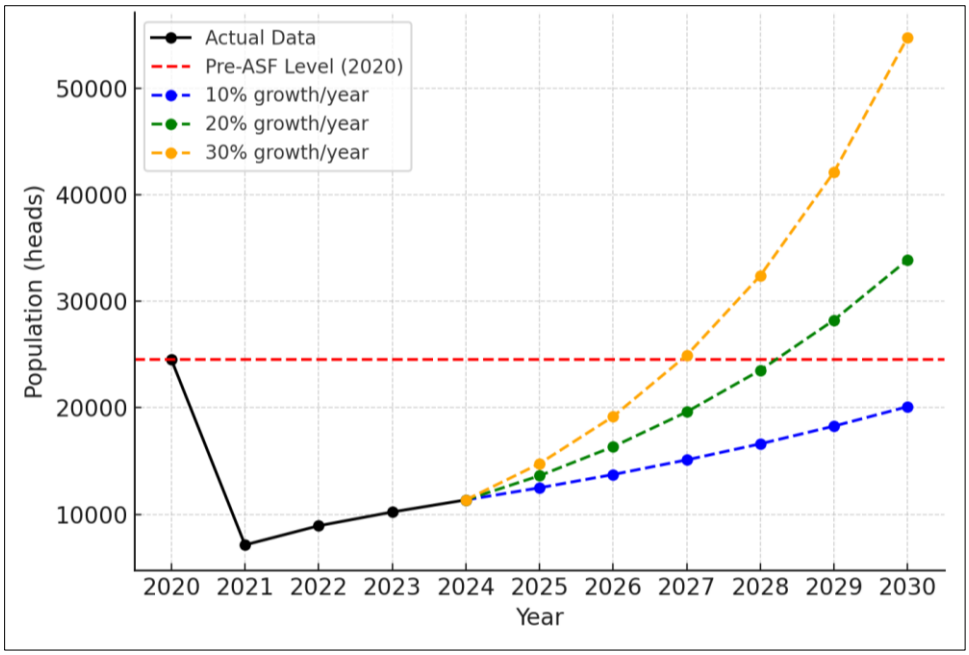

Figure 2 Population Recovery Trend and Projection 2020–2030

Figure 2 illustrates two main aspects: the actual trend of pig populations in Manokwari District during 2020–2024, and the recovery projection until 2030 under different growth scenarios. Actual data show a sharp decline in 2021 due to ASF, followed by a slow recovery during 2022–2024. The projection lines depict three possibilities: if growth remains only at 10% per year, the pre-ASF population target (24,530 heads) will only be reached around 2033; with 20% per year the target can be achieved by 2028; while with 30% per year recovery could occur earlier, by 2026. This figure underscores that the acceleration of recovery is highly dependent on the success of biosecurity implementation, healthy restocking, and effective surveillance systems.

Nevertheless, the 2020–2030 projection indicates that the speed of pig population recovery in Manokwari District is strongly determined by the annual growth rate. With the current trend of only around 11–15% per year, the target of returning to the pre-ASF level (24,530 heads) could be delayed until after 2030. This highlights that government intervention and multi-stakeholder collaboration are crucial to accelerate recovery. Acceleration can be achieved if the growth rate reaches ≥20% per year, with the following recommendations:

- Collective cross-village biosecurity with simple SOPs (pen and equipment hygiene, leftover feed control, entry/exit quarantine) and periodic light audits (FAO, 2021).
- Group-based healthy restocking, with certified breeding stock + quarantine + sentinel pigs, implemented gradually but continuously (e.g., net target 8–12% of stock per year).
- Digital surveillance (WhatsApp/SMS reporting + district-level dashboard), combined with reporting incentives (Busch et al., 2021).
- Microfinance and subsidized piglets, conditional on biosecurity compliance, to accelerate adoption and maintain discipline.
- Reproduction and feed management packages to increase net births (improved sow management, feeding during gestation/lactation, piglet handling).

FAO (2021) reported that in Vietnam, recovery of pig populations after ASF took about five years, through a combination of restocking subsidies, farmer compensation, and trial vaccines. Meanwhile, in China, massive interventions (multi-billion USD subsidies, transport bans, and strict biosecurity measures) were required to restore production to 2018 levels by 2021 (Li et al., 2022).

Implications for Manokwari: without systematic financial support schemes, recovery in West Papua may take far longer than in Vietnam or China.

4. Socio-economic impacts

4.1. Loss of Income and Livelihood Security

The ASF outbreak caused the loss of productive assets (sows, boars, piglets), cash flow (animal sales), and social capital (mutual lending/gifting of pigs). Cross-country studies show that ASF depresses household income, disrupts liquidity, and increases food insecurity among smallholder farmers (Matsumoto et al., 2021; Kivumbi et al., 2021). Findings in Manokwari are consistent—farmers stated that the business stopped, feed expenses were wasted during high mortality, and access to capital for restocking was limited.

4.2. Cultural Disruption and Social Cohesion

The scarcity of pigs disrupted traditional ceremonies (bride price, peace agreements, and communal rituals), weakening social cohesion and delaying the resolution of disputes through customary mechanisms. As a result of ASF, 78% of farmers reported being unable to attend customary feasts due to the lack of pigs to contribute, while 65% of respondents reported household income dropping by more than 50% after losing their stock. Some communities substituted pigs with consumer goods (rice, sugar, instant noodles) as symbolic replacements, but these were considered less meaningful in cultural contexts (consistent with Penrith, 2022).

This implies that ASF is not only an economic crisis but also a socio-cultural crisis, requiring cross-sectoral responses (livestock, cultural, and social agencies). Literature on the role of pigs in traditional socio-economic systems affirms that the loss of animals equates to the loss of social function in traditional pig-keeping communities (Penrith, 2022; Busch et al., 2021).

Table 3 Observed socio-economic impacts and supporting literature

Domain	Main observed impact	Policy implication	Supporting references
Income	Loss of the main livelihood source	Restocking schemes and microfinance access	Matsumoto et al., 2021; Kivumbi et al., 2021
Food	Reduced access to animal protein	Integration of temporary protein substitution	Li et al., 2022
Culture	Postponed traditional ceremonies	Customary mechanisms using non-animal compensation	Penrith, 2022; Busch et al., 2021
Local market	Supply and price volatility	Facilitation of safe and biosecure markets	EFSA, 2020; Costard et al., 2013

5. Recovery Strategies and Efforts

5.1. Farmer-Based Biosecurity

Biosecurity promotion is the foundation of ASF control (movement restrictions, pen/equipment hygiene, control of swill feeding, entry/exit quarantine). Global evidence stresses that eliminating contact with the virus is the key to success; eradication may not be realistic in areas with wild hosts/vectors, but effective control is possible in domestic systems if biosecurity is consistent (Busch et al., 2021; EFSA, 2020; FAO, 2021).

5.2. Gradual Restocking and Sentinel Pigs

Distribution of piglets must be gradual, prioritizing healthy sources (laboratory-tested), initial quarantine, and the use of sentinel pigs (small numbers, monitored) before scaling up—a practice recommended for smallholder/communal systems in Asia (FAO, 2021). Restocking too quickly risks triggering new waves of cases.

5.3. Strengthening Farmer Groups

The formation/activation of farmer groups facilitates technical assistance, collective purchase of feed/stock, and dissemination of biosecurity SOPs. Group institutions are also important for disease reporting and enforcement of livestock/product movement restrictions (Busch et al., 2021; EFSA, 2020).

5.4. Note on Vaccines

Globally, safe, effective, and stable commercial vaccines for wide use remain limited. Some countries (e.g., Vietnam) have trialed live-attenuated vaccines, but concerns remain regarding efficacy and safety (reversion to virulence, shedding). Thus, biosecurity remains the main pillar (WOAH, 2025; CFSPh, 2025).

6. Recovery challenges

6.1. Access to Healthy Stock and Supply Chains

Limited access to high-quality piglets stems from the scarcity of certified breeding units, high logistics costs, and irregular health verification. Literature recommends certified breeding sources, pre-shipment testing, and quarantine at destination units (EFSA, 2020; FAO, 2021).

6.2. Continued Education and Farmer Behavior

Adoption of biosecurity practices often declines after the crisis phase. Thus, continuous education, light audit feedback, and collective incentives (e.g., conditional access to piglets/feed based on compliance) are required (Busch et al., 2021).

6.3. Fear of Recurrence

Farmer reluctance to restart farming is rational given that ASF can persist in the environment/products, while mobility of products/swill remains a risk pathway (Costard et al., 2013; EFSA, 2020). Risk communication, one-stop information, and support during outbreaks (limited compensation, rapid veterinary services) are important to restore trust.

Table 4 Mapping of recovery strategies and implementation requirements

Strategy	Key steps	Requirements and risks	References
Farm biosecurity	Sanitation, movement control, and safe feed	Sustained compliance; monitoring	FAO, 2021; Busch et al., 2021
Gradual restocking	Healthy sources, quarantine, sentinel pigs	Risk of reintroduction if testing is weak	FAO, 2021
Farmer groups	SOPs, case reporting	Need facilitation and monitoring	EFSA, 2020
Continuous training	Periodic training, demo-plots	Local materials and languages required	Penrith, 2022; Matsumoto et al., 2021
Digital surveillance	Rapid reporting, case dashboards	Infrastructure and digital literacy are needed	FAO, 2021

7. Conclusion

- ASF has caused a drastic decline in the pig population in Manokwari, from 24,530 heads (2020) to 7,125 heads (2021), a reduction of 71%.
- Post-outbreak recovery has been slow; by 2024, the population had only reached 46.2% of the pre-outbreak level.
- Projections indicate that without acceleration, the recovery target will only be achieved after 2030; an annual growth rate of ≥20% is required to reach the target by 2026–2028.
- The impact of ASF is not only economic but also socio-cultural: loss of livelihoods, reduced consumption of animal protein, and disruption of traditional rituals.
- Current recovery strategies (biosecurity, restocking, farmer groups) need to be strengthened through:
  - Collective cross-village biosecurity,
  - Group-based healthy restocking with certified breeding stock,
  - Digital surveillance for early detection,
  - Piglet subsidies and microfinance conditional on biosecurity compliance,
  - Improved reproduction and feeding capacity to accelerate natural population growth.
- Without integrated cross-sectoral interventions (livestock, social, cultural), the recovery of the pig population may be delayed, with significant economic and social consequences for the people of West Papua.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the conduct of this study, the collection and interpretation of data, or the preparation of this manuscript. All institutional and community contributions—including those from the West Papua Provincial Livestock and Animal Health Service, the Manokwari District Agriculture and Food Security Office, pig farmers in Manokwari, the enumerator team, colleagues, and families—were purely in the form of technical assistance, facilitation, and moral support. None of these contributions influenced the research outcomes or the conclusions presented in this paper.

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