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Designing smart pig farming development model in Indonesia (A Future-Oriented Framework For Sustainable Livestock Transformation In Papua)

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Abstract

Pig farming represents a strategic livestock subsector that contributes significantly to economic development, food security, and the preservation of indigenous cultural values in Papua, Indonesia. Despite its importance, pig production systems in Papua remain predominantly traditional and face numerous constraints, including low productivity, limited genetic quality, inadequate human resource capacity, high disease risks, and the underdevelopment of downstream livestock industries. This study aims to formulate a Smart Pig Farming Hub (SPFH) development model as a strategic framework for transforming traditional pig farming into a modern, technology-driven livestock production system in Sentani, Jayapura Regency, Papua. The proposed model integrates digital technologies, biosecurity measures, human resource development, and agribusiness downstreaming to enhance productivity and sustainability.

Keywords

Smart Pig Farming Hub;
Pig Farming;
Precision Livestock Farming;
Internet of Things;
Artificial Intelligence;
African Swine Fever;
Sustainable Agribusiness;
Papua; Sentani;
Rural Development.

Kata kunci:
Smart Pig Farming Hub,
Precision Livestock Farming,
Papua, Sentani,

The study employed a literature review and descriptive analytical approach using secondary data obtained from livestock statistics, government reports, Food and Agriculture Organization (FAO) publications, and relevant national and international studies published between 2020 and 2025. The findings indicate that Jayapura Regency possesses substantial potential for pig farming development, supported by a pig population of approximately 16,885 head in 2023, adequate land resources, strong socio-cultural acceptance of pig husbandry, strategic transportation access through Sentani, and expanding regional market opportunities within Papua.

The SPFH model is structured into four sequential development phases: Foundation (2026–2030), Transformation (2031–2035), Industrialization (2036–2040), and Global Competitiveness (2041–2045). The adoption of Precision Livestock Farming (PLF) technologies based on the Internet of Things (IoT), Artificial Intelligence (AI), and digital monitoring systems is projected to improve feed efficiency by 8–15%, reduce livestock mortality by 30–40%, strengthen African Swine Fever (ASF) prevention and control, and enhance overall productivity and farmer welfare. During the industrialization phase, the establishment of livestock processing industries is expected to increase farmers' income by 30–50% while generating higher economic value-added throughout the livestock value chain.

In the long term, implementation of the SPFH model is projected to increase the pig population of Jayapura Regency to more than 100,000 head by 2045 and transform Sentani into the "Papua Smart Pig Valley," a regional center for technology-based tropical pig production, research, and sustainable agribusiness in Eastern Indonesia and the Asia-Pacific region. The proposed model offers an integrated livestock development framework that combines technological innovation, environmental sustainability, economic competitiveness, and indigenous community empowerment as the foundation for inclusive and sustainable regional development.

A. Introduction

Pig farming represents one of the most strategically important livestock subsectors for economic development, food security, and the preservation of indigenous cultural heritage in Eastern Indonesia, particularly in Papua. For Papuan communities, pigs serve not only as a source of animal protein and household income but also as a valuable socio-cultural asset. Pigs play a central role in customary transactions, including traditional bride wealth payments, ceremonial exchanges, social status recognition, and various indigenous cultural rituals. Consequently, pig farming development extends beyond economic considerations and is closely associated with the sustainability of local social and cultural systems.

A study conducted by Atus et al. (2022) demonstrated that pig production systems in West Papua remain predominantly traditional, relying on husbandry practices that have been passed down through generations. These systems continue to contribute significantly to the livelihoods of rural households and local economic development. The findings highlight the strategic importance of pig farming as a key component of community-based regional development within indigenous Papuan societies.

Despite its considerable potential, pig production in Papua remains relatively less productive

compared with major pig-producing countries in Asia and Europe. Low productivity is attributed to several interrelated factors, including poor genetic quality, inadequate feeding management, limited adoption of modern production technologies, restricted access to information and extension services, and weak institutional support. Atus et al. (2022) identified feed quality, farming experience, and management intensity as the primary determinants of pig production performance in Papua. Similarly, Nugroho et al. (2022) reported that the sustainability of pig development programs in Southern Papua is strongly influenced by farmer participation, government support, market accessibility, and the availability of continuous technical assistance. These findings suggest that the transformation of traditional pig farming systems into modern and technology-based production systems is essential for improving productivity, competitiveness, and long-term sustainability.

Concurrently, the global livestock sector has entered the era of Precision Livestock Farming (PLF), a technology-driven production system that utilizes sensors, the Internet of Things (IoT), Artificial Intelligence (AI), computer vision, and advanced data analytics to monitor animal health, growth performance, feed consumption, reproductive status, and welfare conditions in real time. A systematic review by Trabachini et al. (2025) revealed that the implementation of PLF technologies in pig production systems can significantly improve production efficiency, enhance animal welfare, reduce operational costs, and support environmental sustainability through data-driven decision-making processes. Furthermore, digital monitoring technologies facilitate the early detection of health disorders and production inefficiencies, thereby minimizing potential economic losses.

The increasing integration of Artificial Intelligence and computer vision technologies has further accelerated innovation in modern livestock production systems. According to Bhujel et al. (2024), AI-powered imaging systems are capable of automatically identifying individual animals, monitoring behavioral patterns, detecting disease symptoms, and assessing animal welfare conditions with high levels of accuracy. These technological advancements create substantial opportunities for the development of more efficient, precise, and sustainable pig farming systems in Eastern Indonesia, particularly in regions with significant livestock development potential such as Papua.

In addition to production-related challenges, the pig industry is increasingly threatened by transboundary animal diseases, particularly African Swine Fever (ASF). ASF has caused substantial economic losses in many countries, including Indonesia, and remains one of the most serious threats to the sustainability of pig production systems. The Food and Agriculture Organization (FAO, 2024) identified community-based biosecurity interventions as one of the most effective approaches for controlling ASF outbreaks in smallholder farming systems. Furthermore, FAO (2025) emphasized that strengthening biosecurity measures, improving livestock movement control, enhancing farmer capacity, and adopting digital monitoring technologies are critical components for ensuring the long-term resilience and sustainability of the pig industry.

Within the context of regional development in Papua, Sentani possesses significant comparative advantages for becoming a center of innovation in modern pig farming. The region is supported by relatively abundant land resources, strategic transportation accessibility through Sentani International Airport, strong local market demand, the availability of locally sourced feed resources, and a socio-cultural environment in which pig husbandry has long been embedded in community life. Moreover, the presence of higher education institutions, research organizations, and local government agencies provides a favorable environment for the development and dissemination of science- and technology-based innovations.

Considering these opportunities and challenges, there is a need for an integrated livestock development model capable of combining digital

technologies, modern biosecurity systems, human resource development, circular economy principles based on local resources, and livestock product downstreaming within a unified framework. The Smart Pig Farming Hub (SPFH), or the Sentani Smart Pig Valley 2045 initiative, is proposed as an innovative development model with the potential to transform traditional pig farming into a modern, productive, sustainable, and globally competitive agribusiness ecosystem. Beyond improving livestock productivity and farmer welfare, this model is expected to serve as a strategic instrument for regional economic development based on Papua's comparative advantages while simultaneously contributing to the achievement of the Sustainable Development Goals (SDGs) in Eastern Indonesia.

B. Research Methodology

a) Smart Pig Farming Hub (SPFH) Development in Sentani, Jayapura Regency, Papua

The development of the Smart Pig Farming Hub (SPFH) in Sentani, Jayapura Regency, Papua, represents a strategic initiative aimed at transforming traditional smallholder pig farming into a modern, technology-driven agribusiness system capable of enhancing productivity, food security, and rural livelihoods. This development framework is particularly relevant in Papua, where pigs possess substantial economic, social, and cultural significance within indigenous communities. According to livestock statistics published by the Papua Provincial Plantation and Livestock Service, the pig population in Jayapura Regency reached approximately 16,885 head in 2023, positioning the regency as one of the major pig production centers in Papua Province. This demographic advantage indicates that Sentani possesses a sufficiently strong livestock resource base to support its transformation into a regional center for modern pig production in Eastern Indonesia.

Despite this considerable potential, pig farming systems in Papua remain predominantly traditional and are characterized by relatively low productivity levels. Atus et al. (2022) reported that production performance in Papuan pig farming systems is strongly influenced by feed quality, farmers' husbandry experience, and management intensity. As a result, reproductive performance, growth rates, and production efficiency remain significantly below the genetic potential of the animals. To address these limitations, the SPFH model proposes the establishment of the Sentani Pig Breeding Center, which would function as a regional center for genetic improvement, artificial insemination services, and digital reproductive recording systems. Through the implementation of systematic breeding programs and modern reproductive technologies, sow productivity is expected to increase from the current average of 8–10 piglets per sow annually to more than 15 piglets per sow annually, a performance level commonly achieved in advanced commercial pig production systems worldwide (Atus et al., 2022; Trabachini et al., 2025).

Beyond genetic improvement, the SPFH framework places Precision Livestock Farming (PLF) technologies at the core of livestock transformation efforts in Sentani. According to Trabachini et al. (2025), the integration of sensors, Internet of Things (IoT) devices, digital imaging systems, Artificial Intelligence (AI), and data analytics platforms can substantially improve production efficiency, animal welfare, and operational effectiveness while reducing production costs. Within the Sentani context, these technologies can be deployed to monitor housing temperature, humidity, air quality, feed consumption, body weight gain, and animal health status in real time. Such monitoring systems provide farmers with accurate and timely information, enabling data-driven management decisions that enhance production performance and farm profitability.

The adoption of PLF technologies is further strengthened by advances in AI-powered computer vision systems. Bhujel et al. (2024) demonstrated that computer vision technologies are capable of automatically identifying

individual animals, detecting abnormal behaviors, recognizing early signs of disease, and assessing animal welfare conditions with high accuracy. The implementation of these technologies in Sentani could significantly reduce production risks, improve disease surveillance, and facilitate more efficient livestock management practices. Consequently, the SPFH model aligns closely with global trends toward digital transformation and smart livestock production systems.

The implementation of SPFH is also particularly important in light of the growing threat posed by African Swine Fever (ASF), which has caused substantial economic losses in many pig-producing regions, including Papua. In recent years, ASF outbreaks have resulted in significant livestock mortality and economic disruption among smallholder farmers. During 2024, several pig farmers in East Sentani experienced severe losses due to ASF outbreaks, requiring government intervention through disease control measures and the culling of infected animals. As part of the recovery strategy, the Papua Provincial Government distributed 48 breeding pigs and approximately 650 kilograms of feed to farmer groups in Ayapo and Nolokla villages, East Sentani District, in 2025. These interventions demonstrate the government's commitment to rebuilding pig populations while strengthening biosecurity systems at the community level.

From a regional development perspective, the SPFH model extends beyond increasing livestock populations and focuses on strengthening local economic systems through an integrated agribusiness approach. Sentani possesses several comparative advantages, including strategic transportation connectivity through Sentani International Airport, proximity to Jayapura City as the primary consumption center, abundant land resources, and strong socio-cultural support for pig husbandry. These advantages create favorable conditions for the development of a comprehensive pig industry cluster. Furthermore, local feed resources such as sago, maize, cassava, market waste, and restaurant by-products provide significant opportunities for establishing a sustainable feed industry based on locally available raw materials. Such a circular economy approach can simultaneously reduce feed costs, improve resource-use efficiency, and mitigate environmental impacts associated with livestock production.

Human resource development constitutes another critical component of the SPFH framework. Nugroho et al. (2022) emphasized that the sustainability of pig farming enterprises in Papua is strongly influenced by farmer participation, institutional support, and the availability of continuous technical assistance. Consequently, the proposed establishment of the Papua Pig Farmer Academy in Sentani forms an integral element of the SPFH model. The academy would serve as a specialized training and capacity-building center focusing on digital livestock management, animal health, biosecurity, agribusiness management, and entrepreneurship. Through systematic training programs, the institution is expected to produce a new generation of technologically skilled and commercially oriented pig farmers capable of managing modern livestock enterprises.

If implemented consistently and supported by long-term policy commitments, the SPFH initiative has the potential to transform Sentani into the Sentani Smart Pig Valley, a comprehensive livestock innovation cluster integrating breeding, production, animal health services, feed manufacturing, processing industries, digital marketing, and human capital development within a single agribusiness ecosystem. Such a model would not only improve productivity and farmer incomes but also position Jayapura Regency as a leading center for sustainable pig farming development in Eastern Indonesia and the broader Pacific region. Supported by a substantial existing pig population, proactive government policies, and the increasing affordability of precision livestock technologies, the Smart Pig Farming Hub represents one of the most promising regional development innovations for achieving food security, economic growth, and community welfare in Papua over the coming decades.

b) Smart Pig Farming Hub (SPFH) Implementation Roadmap for Sentani, Papua (2026–2045)

The Smart Pig Farming Hub (SPFH) implementation roadmap was developed based on the current conditions of pig farming in Jayapura Regency, Papua, where production systems remain predominantly traditional, the pig population was estimated at approximately 16,885 head in 2023, African Swine Fever (ASF) continues to pose a significant threat, and global livestock production is increasingly transitioning toward Precision Livestock Farming (PLF) technologies supported by the Internet of Things (IoT), Artificial Intelligence (AI), and digital biosecurity systems. The roadmap adopts a phased development approach over a twenty-year period with the objective of transforming Sentani into a leading center for modern pig production, livestock innovation, and sustainable agribusiness within the Asia-Pacific region.

The proposed roadmap consists of four sequential development phases: (1) Foundation Phase (2026–2030), (2) Transformation Phase (2031–2035), (3) Industrialization Phase (2036–2040), and (4) Global Competitiveness Phase (2041–2045). Each phase is designed to address specific structural constraints while gradually strengthening the technological, institutional, economic, and human resource capacities required for sustainable livestock development.

During the Foundation Phase (2026–2030), priority will be placed on establishing the institutional and physical infrastructure necessary to support modern pig farming systems. Key interventions include the development of a comprehensive livestock database, the establishment of the Sentani Pig Breeding Center, the implementation of community-based biosecurity programs, and the creation of the Papua Pig Farmer Academy as a center for technical training and capacity building. This phase is expected to strengthen genetic resources, improve farm management practices, and enhance disease prevention capabilities among smallholder farmers.

The Transformation Phase (2031–2035) focuses on accelerating technological adoption through the integration of Precision Livestock Farming technologies. IoT-based sensors, AI-powered monitoring systems, automated feeding technologies, digital animal health surveillance, and smart farm management platforms will be introduced to improve productivity and decision-making processes. The widespread adoption of these technologies is expected to increase feed efficiency, improve animal welfare, reduce production costs, and strengthen resilience against disease outbreaks.

The Industrialization Phase (2036–2040) aims to expand the livestock value chain beyond primary production by promoting downstream agribusiness development. Strategic initiatives include the establishment of feed processing facilities utilizing local raw materials, livestock product processing industries, cold-chain logistics systems, digital marketing platforms, and integrated supply chain networks. Through these interventions, the pig farming sector is expected to generate greater value-added, create employment opportunities, and significantly increase farmers' incomes while supporting regional economic growth.

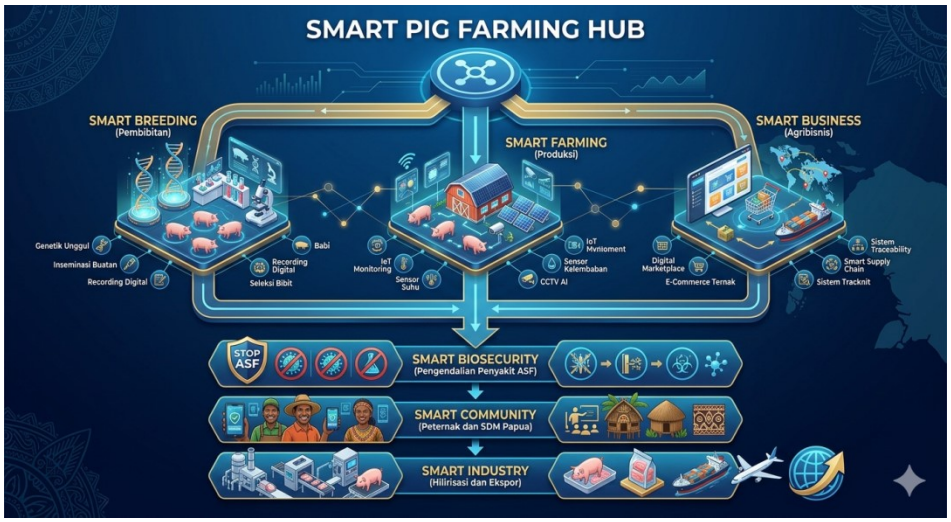

Figure 1. Smart Pig farming Hub

Finally, the Global Competitiveness Phase (2041–2045) seeks to position Sentani as the "Papua Smart Pig Valley," a regional hub for tropical pig production, livestock innovation, and research excellence. During this stage, the region is expected to function as a center for advanced breeding programs, livestock technology development, international research collaboration, and sustainable agribusiness investment. By 2045, the implementation of the SPFH model is projected to increase the pig population of Jayapura Regency to more than 100,000 head while establishing Papua as a leading center of technology-driven pig production in Eastern Indonesia and the Asia-Pacific region.

Overall, the SPFH roadmap provides a comprehensive and long-term development framework that integrates technological innovation, biosecurity enhancement, human capital development, circular economy principles, and agribusiness industrialization. This integrated approach is expected to contribute substantially to food security, economic diversification, environmental sustainability, and the socioeconomic empowerment of indigenous communities in Papua.

C. Discussion

1. Phase I (2026–2030):

1.1 Foundation Stage

a. Strategic Objectives

The Foundation Stage (2026–2030) serves as the initial phase of the Smart Pig Farming Hub (SPFH) development strategy and focuses on establishing the essential infrastructure required for a modern pig production system. The primary objectives include developing integrated livestock data systems, strengthening genetic improvement programs, and enhancing farmers' technical and managerial capacities.

Currently, most pig farming operations in Papua continue to rely on manual record-keeping practices. Consequently, local governments lack an integrated database containing comprehensive information on livestock populations, reproductive performance, animal health status, and production distribution. This limitation hinders evidence-based planning, disease surveillance, and the formulation of effective livestock development policies.

To address this challenge, the first phase prioritizes the establishment of the Papua Digital Pig Database, an integrated livestock identification and information management system based on RFID and QR Code technologies. Under this system, each animal will be assigned a unique digital identity containing information on origin, age, reproductive status, health history, ownership, and farm location. The availability of a centralized digital database is expected to improve traceability, facilitate disease control programs, and support data-driven decision-making in the livestock sector.

Simultaneously, the Sentani Pig Breeding Center will be established as the primary genetic improvement facility for pig production in Papua. The center will support systematic breeding programs, artificial insemination services, genetic evaluation, and reproductive performance recording. The introduction of superior breeding stock and structured genetic improvement programs is expected to substantially enhance reproductive performance and production efficiency.

Another critical component of this phase is the establishment of the Papua Pig Farmer Academy, a specialized training and capacity-building institution designed to strengthen farmers' competencies in housing management, animal health, feed formulation, biosecurity, digital farming technologies, and agribusiness entrepreneurship. The academy will serve as a catalyst for developing a new generation of skilled and technology-oriented livestock entrepreneurs in Papua.

Table 1. Development Targets for Phase I (Foundation Stage: 2026–2030)

Indicator	Baseline Condition (2025)	Target (2030)
Pig population in Jayapura Regency	16,885 head	25,000 head
Digitally registered farmers	<10%	80%
Trained farmers	Limited	1,500 farmers
Breeding centers	Not available	1 unit
Livestock database system	Manual	Fully integrated digital database

1.2 Expected Positive Impacts of SPFH Implementation During the Foundation Stage

The implementation of the Smart Pig Farming Hub during the Foundation Stage is expected to generate substantial structural improvements in pig production systems while enhancing productivity, production efficiency, and long-term sustainability. Recent international studies demonstrate that the integration of digital technologies, genetic improvement programs, farmer capacity building, and advanced animal health management systems constitutes the foundation of successful livestock transformation initiatives.

a. Availability of Real-Time Livestock Data

One of the major limitations of smallholder pig farming systems in Papua is the absence of an integrated database covering livestock populations, animal health status, reproductive performance, production outcomes, and farm-level economic indicators. As a result, decision-making processes at both farmer and government levels are frequently constrained by limited access to accurate and up-to-date information.

The implementation of the Papua Digital Pig Database will facilitate real-time data collection through RFID technology, QR-code identification systems, Internet of Things (IoT) devices, and digital livestock management applications. According to Trabachini et al. (2025), Precision Livestock Farming (PLF) systems enable continuous monitoring of animal conditions, feed consumption, housing environments, and health status, thereby improving management accuracy and resource-use efficiency. The availability of real-time data can significantly reduce production

losses, improve operational efficiency, and support more effective livestock development planning and disease control programs.

Furthermore, Bhujel et al. (2024) reported that the integration of Artificial Intelligence (AI) and computer vision technologies enables automated animal identification and monitoring, resulting in greater recording accuracy and more efficient management compared with conventional methods. Consequently, real-time livestock information systems represent a critical foundation for evidence-based livestock management and sustainable sector development.

b. Improvement in Genetic Quality

Genetic quality is one of the most important determinants of livestock productivity. In traditional production systems commonly found in Papua, natural mating practices are generally conducted without systematic genetic selection, resulting in inconsistent offspring quality and suboptimal production performance.

The establishment of the Sentani Pig Breeding Center will facilitate structured breeding programs, artificial insemination services, and digital reproductive recording systems. Zhang et al. (2023) demonstrated that data-driven genetic selection technologies can increase litter size by approximately 15–20%, improve growth performance, and enhance feed conversion efficiency in commercial pig production systems. Additionally, improved breeding stock is expected to produce animals that are better adapted to tropical environmental conditions and exhibit superior reproductive performance.

Within the Papuan context, genetic improvement programs are anticipated to directly increase livestock populations, improve farm productivity, and enhance household income. Assuming an increase in litter size from the current average of 8–10 piglets to approximately 12–15 piglets per sow annually, substantial population growth could be achieved over the long term.

c. Strengthening Human Resource Capacity

The successful transformation of traditional livestock systems depends not only on technological innovation but also on the quality of human resources responsible for managing production systems. Numerous studies have shown that low productivity in smallholder livestock enterprises is frequently associated with inadequate technical knowledge, limited managerial skills, and insufficient access to training opportunities.

Nugroho et al. (2022) found that the success of pig development programs in Papua is strongly influenced by farmer participation, access to training programs, and continuous technical support. Therefore, the establishment of the Papua Pig Farmer Academy constitutes a strategic component of the SPFH model. The academy will provide education and training in livestock management, animal health, feed formulation, biosecurity, digital farming technologies, and agribusiness entrepreneurship.

According to FAO (2024), community-based training programs can increase the adoption rate of livestock technologies by more than 60% compared with farmer groups that do not receive formal training. Improved human resource capacity is therefore expected to accelerate the transition from traditional livestock systems toward modern, productive, and sustainable agribusiness enterprises.

d. Reduction in Piglet Mortality

Pre-weaning piglet mortality is a critical indicator of pig farming performance and profitability. Traditional production systems often experience relatively high mortality rates due to disease outbreaks, inadequate housing conditions, poor management practices, low genetic quality, and limited monitoring of animal health.

The implementation of SPFH through improved breeding programs, enhanced housing management, sensor-based health monitoring, and strengthened biosecurity measures is expected to substantially reduce piglet mortality rates. Muns et al. (2023) reported that digital monitoring systems and modern reproductive management practices can reduce piglet mortality by approximately 30–40% compared with conventional farming systems. Similarly, Trabachini et al. (2025) concluded that PLF technologies facilitate the early detection of health disorders, enabling rapid intervention and minimizing mortality risks.

Table 2. Expected Positive Impacts of SPFH Implementation During the Foundation Stage (2026–2030)

Component	Baseline Condition	Expected Outcome After SPFH Implementation	Supporting Literature
Livestock data management	Manual and fragmented	Integrated real-time digital database	Trabachini et al. (2025); Bhujel et al. (2024)
Genetic quality	Limited selection practices	Breeding center and structured genetic improvement program	Zhang et al. (2023)
Human resource capacity	Limited training opportunities	Papua Pig Farmer Academy	Nugroho et al. (2022); FAO (2024)
Piglet mortality	20–30%	<10–15%	Muns et al. (2023); Trabachini et al. (2025)

Moreover, biosecurity programs recommended by FAO (2024, 2025) have been proven effective in reducing the transmission risk of infectious diseases such as African Swine Fever (ASF), which remains one of the most significant threats to pig production in Eastern Indonesia. Lower mortality rates will increase sow productivity, accelerate population growth, and contribute significantly to achieving livestock development targets in Jayapura Regency.

2. Phase II (2031–2035)

2.1. Transformation Stage

a) Strategic Objectives

The Transformation Stage (2031–2035) represents the second phase of the Smart Pig Farming Hub (SPFH) development roadmap and focuses on the integration of digital technologies and advanced biosecurity systems into pig production. During this period, Sentani is expected to enter the era of Precision Livestock Farming (PLF), characterized by the adoption of data-driven management systems, real-time monitoring technologies, and smart production practices.

According to Trabachini et al. (2025), the integration of sensors, Internet of Things (IoT) devices, digital imaging systems, and Artificial Intelligence (AI) technologies can substantially improve production efficiency, animal welfare, and farm management performance. These technologies enable continuous monitoring of animal health, environmental conditions, and production indicators, thereby supporting more accurate and timely management decisions. Key technological innovations introduced during this phase include: Environmental sensors for monitoring housing temperature and humidity; Smart feeding systems for precision nutrition management; AI-powered camera systems for animal behavior and health monitoring; Digital livestock management applications for farm recording and decision support.

Table 3. Development Targets for Phase II (Transformation Stage: 2031–2035)

Indicator	Target (2030)	Target (2035)
Pig population	25,000 head	40,000 head
IoT-based farms	0%	40%
ASF incidence	Sporadic outbreaks	Reduced by 70%
Digital marketplace	Not available	Fully operational
Sow productivity	10 piglets/year	14 piglets/year

In addition to technological modernization, this phase prioritizes the implementation of a Smart Biosecurity System designed to strengthen resilience against African Swine Fever (ASF) and other infectious diseases. Community-based biosecurity interventions supported by the Food and Agriculture Organization (FAO) and the Indonesian Ministry of Agriculture have demonstrated significant effectiveness in improving disease preparedness and reducing ASF transmission risks. Consequently, the Community ASF Biosecurity Intervention (CABI) approach is proposed as a model for large-scale implementation throughout the Sentani pig production cluster.

To strengthen market integration, the development of the Papua Pig Digital Marketplace will connect producers directly with consumers, restaurants, hotels, meat processors, and regional buyers. This platform is expected to improve market transparency, reduce transaction costs, and increase producers' access to broader market opportunities.

2.2. Expected Impacts of the Transformation Stage (2031–2035)

The Transformation Stage represents a critical milestone in the development of the Smart Pig Farming Hub. During this phase, the implementation of Precision Livestock Farming technologies, Internet of Things infrastructure, Artificial Intelligence applications, digital biosecurity systems, and online livestock marketplaces is expected to significantly improve production efficiency, disease control, and market connectivity. Recent international studies consistently demonstrate that digital transformation in livestock systems can enhance productivity, reduce operational risks, and strengthen market participation among smallholder producers.

a. Improved Feed Efficiency

Feed constitutes the largest production cost component in pig farming systems, accounting for approximately 60–70% of total production expenses. Consequently, improving feed efficiency is essential for increasing farm profitability and economic sustainability.

In traditional pig farming systems commonly found in Papua, feeding practices are generally performed manually without considering age-specific nutritional requirements, growth stages, or physiological conditions. Such practices often result in feed wastage and suboptimal feed conversion ratios (FCR).

The introduction of Smart Feeding Systems will enable automated feed allocation based on animal age, body weight, production stage, and nutritional requirements. Digital sensors and IoT devices will facilitate real-time monitoring of feed consumption patterns, allowing farmers to identify abnormalities and health-related issues at an early stage.

Trabachini et al. (2025) reported that PLF technologies can improve feed-use efficiency by approximately 8–15% compared with conventional production systems. Similarly, Zhang et al. (2024) found that precision feeding technologies reduced feed costs by up to 12% without negatively affecting growth performance.

In Sentani, where feed costs remain a major constraint for smallholder producers, integrating precision feeding technologies with locally available feed resources such as sago, maize, cassava, and agricultural by-products could substantially improve the competitiveness of pig farming enterprises.

b. Reduced Livestock Mortality

Livestock mortality remains one of the most important indicators of production performance and farm profitability. Under traditional management systems, mortality is often associated with delayed disease detection, inadequate housing conditions, poor environmental management, and insufficient biosecurity practices.

The deployment of environmental sensors, AI-powered cameras, and digital health monitoring systems is expected to facilitate the early detection of behavioral changes, reduced feed intake, respiratory disorders, and other health-related abnormalities. Bhujel et al. (2024) demonstrated that computer vision technologies can identify abnormal behavioral patterns before clinical symptoms become visible, enabling earlier intervention and disease prevention.

Furthermore, Muns et al. (2023) reported that digital monitoring systems and modern management practices can reduce piglet mortality rates by approximately 30–40% compared with conventional production systems. If widely adopted in Sentani, these technologies could substantially lower mortality rates, improve productivity, and accelerate population growth within the regional pig industry.

c. More Effective African Swine Fever (ASF) Control

African Swine Fever (ASF) remains one of the most serious threats to pig production in Papua and throughout Southeast Asia. The disease is associated with extremely high mortality rates and significant economic losses. Given the absence of a fully effective commercial vaccine, biosecurity remains the primary strategy for ASF prevention and control.

During the Transformation Stage, SPFH will introduce a Smart Biosecurity System that integrates digital animal health records, livestock movement tracking, environmental monitoring, and early warning systems. According to FAO (2024), community-based biosecurity programs significantly reduce ASF transmission risks and strengthen the resilience of smallholder farming systems.

Experiences from FAO-supported biosecurity initiatives implemented across Indonesia have demonstrated improved farmer compliance with animal health protocols and measurable reductions in disease incidence among participating communities. Through the integration of digital livestock databases and real-time monitoring systems, local authorities will be able to conduct disease surveillance, trace infection sources, implement quarantine measures, and manage outbreaks more effectively.

These interventions are expected to provide a robust foundation for maintaining population stability and protecting the long-term sustainability of the pig industry in Sentani and Papua as a whole.

d. Enhanced Market Connectivity Through Digital Platforms

Limited market access and inadequate price information remain major challenges for smallholder pig producers. Many farmers continue to rely on intermediaries, resulting in weak bargaining power and reduced profit margins.

The establishment of the Papua Pig Digital Marketplace is expected to transform marketing systems by connecting producers directly with consumers, restaurants, hotels, meat processors, retailers, and buyers from outside Papua. Digital marketplace platforms improve transaction

transparency, reduce marketing inefficiencies, and increase competitiveness throughout the value chain.

Additionally, real-time price information enables farmers to make more informed marketing decisions and optimize sales strategies. According to the World Bank (2023), digitalization of agricultural and livestock supply chains can increase smallholder producer incomes by approximately 15–30% through reduced transaction costs and improved market access.

For Sentani, digital market integration also creates opportunities to expand livestock product distribution to other regions of Papua, Maluku, and potentially neighboring Pacific Island countries, thereby strengthening regional economic integration and export potential.

Table 4. Expected Impacts of the Transformation Stage (2031–2035)

Expected Impact	Current Condition	SPFH Target (2035)	Supporting Literature
Feed efficiency	Manual feeding practices	8–15% efficiency improvement	Trabachini et al. (2025); Zhang et al. (2024)
Livestock mortality	Relatively high	Reduced by 30–40%	Muns et al. (2023); Bhujel et al. (2024)
ASF control	Reactive disease management	Digital biosecurity and early warning systems	FAO (2024, 2025)
Market access	Dependent on intermediaries	Fully operational digital marketplace	World Bank (2023)

The successful implementation of the Transformation Stage is expected to establish the technological and institutional foundations necessary for the subsequent Industrialization Phase (2036–2040). Through the integration of smart farming technologies, digital biosecurity systems, and market-oriented innovations, Sentani can progressively transition from a traditional livestock production area into a modern and competitive livestock innovation ecosystem.

3. Phase III (2036–2040)

3.1 Industrialization Stage

a) Strategic Objectives

The Industrialization Stage (2036–2040) aims to establish an integrated pig agribusiness value chain that extends beyond primary production and focuses on downstream industrial development. During this phase, the development strategy shifts from increasing livestock population and farm productivity toward creating a comprehensive livestock-based agro-industrial ecosystem capable of generating higher economic value and regional competitiveness.

The industrial development agenda includes: Modern slaughterhouse facilities; Local feed manufacturing industries; Meat processing plants; Regional cold storage and cold-chain logistics systems; Food safety certification and quality assurance programs.

As a result, production outputs will no longer be limited to live pigs but will expand to include value-added products such as: Premium fresh pork; Canned pork products; Sausages and processed meats; Smoked pork products; Traditional Papua-inspired pork specialties.

Sentani's strategic location, adjacent to Jayapura City and supported by Sentani International Airport, provides significant logistical advantages for developing a regional distribution hub serving Papua and neighboring South Pacific markets.

Table 5. Development Targets for Phase III (Industrialization Stage: 2036–2040)

Indicator	Target (2035)	Target (2040)
Pig population	40,000 head	70,000 head
Processing industries	1 unit	5 units
Processed product varieties	3 products	>15 products
Product value addition	Low	High
New employment opportunities	2,000 jobs	5,000 jobs

3.2 Expected Impacts of the Industrialization Stage (2036–2040)

The Industrialization Stage represents a pivotal milestone in the development of the Smart Pig Farming Hub (SPFH) in Sentani, Jayapura Regency. At this stage, development efforts move beyond livestock population growth and productivity enhancement toward establishing a fully integrated agribusiness system encompassing production, processing, distribution, marketing, and supporting industries. The development of processing industries, modern supply chains, cold-chain logistics systems, digital marketing platforms, and product diversification is expected to generate substantial economic value. International studies consistently demonstrate that livestock industrialization contributes significantly to farmer income growth, employment generation, and regional economic development (FAO, 2023; OECD, 2024).

a. Increased Farmer Income

One of the principal limitations of traditional livestock systems in Indonesia is the relatively low value captured by farmers due to the predominance of live-animal sales. Under such conditions, producers primarily benefit from production activities, while much of the economic value is captured by traders, distributors, and processing industries.

Through the implementation of SPFH, pig farmers in Sentani are expected to become active participants in a broader agribusiness value chain rather than merely suppliers of live animals. The establishment of farmer cooperatives, industrial partnerships, and equity-sharing schemes in processing enterprises will enable farmers to participate in downstream value creation.

According to OECD (2024), integrating farmers into modern agribusiness value chains can increase producer incomes by approximately 20–45% compared with conventional marketing systems. Similarly, FAO (2023) reported that livestock-based agro-industrial development can generate product value additions up to three times higher than those achieved through primary commodity sales.

In Sentani, where live pig prices are estimated at approximately IDR 45,000–55,000 per kilogram, converting raw materials into processed products such as sausages, smoked pork, shredded pork, canned pork, and Papua-inspired culinary products could increase market value by 150–300%.

Furthermore, digital marketing platforms and contractual partnerships with hotels, restaurants, supermarkets, and tourism-related businesses are expected to expand market opportunities and improve price stability. These developments will contribute significantly to the long-term welfare and economic resilience of livestock-producing households.

b. Development of Regionally Based Downstream Industries

The development of downstream industries is a key indicator of successful regional economic transformation. Within the SPFH framework, downstream industrialization encompasses not only meat processing but also the broader business ecosystem associated with pig production.

Planned downstream industries include: Modern slaughterhouse facilities; Meat processing plants; Feed manufacturing industries utilizing local resources; Packaging and cold-storage facilities; Organic fertilizer production from livestock waste; Biogas and renewable energy production; Livestock-based culinary and agro-tourism enterprises.

According to the World Bank (2023), every unit of investment in the livestock sector can generate an economic multiplier effect of up to 2.5 times across related sectors through employment creation, increased demand for raw materials, transportation services, and commercial activities. In Sentani, pig-based downstream industries have the potential to become an important new economic driver. The area's proximity to Sentani Airport, Jayapura City, and major regional distribution routes provides logistical advantages that are rarely available elsewhere in Papua.

Research by Porter and Kramer (2022) on shared-value agribusiness development suggests that industries based on local resources can strengthen regional economic resilience by reducing dependence on imported products while simultaneously generating employment opportunities for local communities.

Through SPFH, downstream pig industries are expected to absorb labor across multiple sectors, including production, processing, logistics, marketing, veterinary services, and supporting industries. Consequently, pig farming will evolve from a subsistence-oriented activity into a major engine of regional economic growth.

c. Increased Contribution of the Livestock Sector to Regional GDP

Gross Regional Domestic Product (GRDP) is a key indicator used to measure the economic contribution of a particular sector to regional development. Currently, the contribution of the livestock subsector to the GRDP of Jayapura Regency remains relatively modest compared with sectors such as trade, services, and public administration. One of the primary reasons is the limited value addition generated by livestock production activities.

The implementation of SPFH is projected to increase the livestock sector's contribution to regional GDP through three major mechanisms: Expansion of livestock populations; Improved productivity and production efficiency; Development of high-value downstream industries.

According to FAO (2024), regions that successfully establish integrated livestock value chains often experience increases in livestock-sector contributions to GDP ranging from 1.5 to three times over the long term. Experiences from countries such as Vietnam, Thailand, and the Philippines demonstrate that transforming smallholder livestock systems into modern agribusiness industries can significantly enhance regional economic performance.

Table 6. Projected Impacts of the Industrialization Stage (2036–2040)

Indicator	Baseline Condition (2025)	Target (2040)	Expected Impact
Pig population	Approximately 16,885 head	Approximately 70,000 head	Increased production capacity
Farmer income	Traditional production-based income	30–50% increase	Value addition and market expansion
Processing industries	Very limited	≥ 5 processing units	Downstream industrial development
Processed product varieties	Limited	>15 product types	Product diversification
Employment opportunities	Limited	>5,000 jobs	Local economic development
Livestock-sector contribution to GRDP	Relatively low	Significant increase	Regional economic growth

Under the SPFH development scenario, the pig population in Jayapura Regency is projected to increase from approximately 16,885 head in 2023 to more than 70,000 head by 2040. Combined with productivity gains and industrial expansion, the economic value generated by the pig sector is expected to increase by more than fivefold compared with current conditions.

In addition to its direct contribution to GRDP, livestock-sector growth is expected to stimulate the development of several related industries, including: Feed manufacturing; Transportation and logistics; Trade and commerce; Culinary tourism; Veterinary services; Agricultural and livestock digital technologies.

Consequently, the economic benefits generated by SPFH will extend well beyond the livestock sector itself, producing substantial multiplier effects throughout Jayapura Regency and Papua Province.

The Industrialization Stage is expected to transform Sentani into a leading livestock-based agro-industrial center in Eastern Indonesia. Through the integration of production systems, processing industries, logistics infrastructure, and digital marketing networks, SPFH will create a resilient and competitive pig agribusiness ecosystem capable of generating sustainable economic growth, employment opportunities, and enhanced regional prosperity.

4. Phase IV (2041–2045)

1.1 Global Competitiveness Stage

a) Strategic Objectives

The Global Competitiveness Stage (2041–2045) represents the culmination of the Smart Pig Farming Hub (SPFH) development roadmap. This phase aims to position Sentani as a world-class tropical pig farming center and a leading hub for innovation, research, education, and agribusiness development in the Asia-Pacific region.

During this stage, Sentani is envisioned to evolve into the Sentani Smart Pig Valley, an integrated livestock innovation ecosystem consisting of: A regional breeding and genetic improvement center; Smart farming production clusters; Livestock processing industries; Advanced veterinary laboratories; Agribusiness incubators and innovation centers; Livestock education and training facilities.

In addition, the establishment of the Asia-Pacific Tropical Pig Research Center (APTPRC) is proposed as a strategic initiative to strengthen Papua's position as a regional knowledge hub for tropical pig production systems.

The center will focus on research and innovation in the following areas: Tropical pig genetics and breeding; African Swine Fever (ASF) prevention and control; Precision Livestock Farming (PLF); Local resource-based nutrition systems; Climate change adaptation and resilience.

The research center is expected to collaborate with international organizations and academic institutions, including the Food and Agriculture Organization (FAO), CGIAR research networks, and leading universities across the Asia-Pacific region.

Table 7. Development Targets for Phase IV (Global Competitiveness Stage: 2041–2045)

Indicator	Target (2040)	Target (2045)
Pig population	70,000 head	>100,000 head
Digitally enabled farms	60%	>90%
Export-oriented products	Limited	Regular exports
Livestock researchers	50 persons	200 persons
Employment opportunities	5,000 jobs	>10,000 jobs
Contribution to regional economy	Moderate	Very high

4.2 Expected Impacts of the Global Competitiveness Stage (2041–2045): Toward the Papua Smart Pig Valley

The Global Competitiveness Stage represents the highest level of implementation within the Smart Pig Farming Hub framework. At this stage, Sentani is expected to emerge as a center for innovation, production, research, and education in tropical pig farming across Eastern Indonesia and the broader Asia-Pacific region.

Development efforts are no longer focused solely on increasing production capacity but on establishing a globally competitive livestock ecosystem that is technology-driven, environmentally sustainable, economically resilient, and culturally inclusive. International studies consistently indicate that livestock development models integrating technological innovation, institutional strengthening, and community participation are more likely to become sustainable engines of regional economic growth (FAO, 2024; OECD, 2024; World Bank, 2023).

a. Sentani Becomes the Leading Modern Pig Farming Center in Eastern Indonesia

One of the principal objectives of this phase is the establishment of Sentani Smart Pig Valley as the premier modern pig farming center in Eastern Indonesia.

The Smart Pig Valley concept integrates genetic improvement programs, technology-based production systems, processing industries, human resource development, and tropical livestock research within a single economic cluster. This model draws inspiration from successful livestock innovation clusters developed in countries such as Denmark, the Netherlands, and Vietnam, where production, research, education, and industry are closely interconnected.

Sentani possesses several comparative advantages, including: Availability of suitable land resources; Strong livestock-raising traditions among local communities; Strategic transportation access through Sentani Airport; Proximity to Jayapura as the administrative and commercial center of Papua.

With projected livestock populations exceeding 100,000 head by 2045, Sentani has the potential to become the largest pig production center in Eastern Indonesia. According to FAO (2024), livestock clusters supported by digital technologies, modern biosecurity systems, and efficient supply chains can achieve productivity levels up to twice those of conventional production systems.

Consequently, Sentani is expected to function not only as a production center but also as a regional hub for livestock genetics, technological innovation, training, and knowledge dissemination across Papua, Maluku, East Nusa Tenggara, and Pacific Island countries.

b. Establishment of a Technology-Based Pig Agribusiness Ecosystem

The successful implementation of SPFH will be characterized by the establishment of an integrated agribusiness ecosystem spanning the entire livestock value chain.

Within this ecosystem, digital technologies will serve as the backbone of production, management, logistics, and marketing activities. The integration of Internet of Things (IoT) devices, Artificial Intelligence (AI), computer vision systems, blockchain-based traceability, and digital marketing platforms will enable highly efficient and transparent operations.

Trabachini et al. (2025) demonstrated that Precision Livestock Farming technologies significantly improve feed efficiency, animal health, and production performance. Likewise, Bhujel et al. (2024) reported that AI and computer vision technologies enable automated livestock monitoring, reducing labor requirements while improving management accuracy.

The envisioned ecosystem includes: Advanced breeding centers; Local resource-based feed industries; IoT-enabled digital livestock farms; Modern slaughterhouse facilities; Livestock processing industries; Integrated cold-chain logistics systems; Digital livestock marketplaces; Innovation and agribusiness incubation centers.
The establishment of this ecosystem will strengthen linkages among farmers, industry actors, researchers, government institutions, and markets, thereby improving efficiency, innovation capacity, and overall competitiveness within the livestock sector.

c. Enhanced Competitiveness of Papua in the Asia-Pacific Market

The long-term vision of SPFH extends beyond satisfying domestic demand and aims to position Papua as an important supplier of livestock products, genetics, and technological innovations within the Asia-Pacific region.

Papua's strategic geographical location provides direct access to Pacific Island countries such as Papua New Guinea, Solomon Islands, Fiji, and Vanuatu, where demand for animal protein continues to increase due to population growth and urbanization.

According to OECD (2024), demand for livestock products across the Asia-Pacific region is projected to increase by more than 30% over the next two decades. Simultaneously, global consumers increasingly demand products that are safe, sustainable, traceable, and compliant with international animal welfare standards.

Consequently, the implementation of: Food safety certification systems; Animal welfare standards; Blockchain-based traceability systems; Sustainable production protocols; will become critical factors in improving the international competitiveness of Papua's livestock products.

Through the development of Sentani Smart Pig Valley, Papua has the potential to become a supplier of superior genetics, processed pork products, and tropical livestock technologies for Pacific markets. Furthermore, the Asia-Pacific Tropical Pig Research Center will strengthen Papua's role as a regional knowledge hub in tropical pig production systems.

Thus, Papua's competitiveness will be measured not only by production volume but also by its capacity to generate innovation, knowledge, and high-quality livestock products that meet international standards.

d. Establishment of a Sustainable Indigenous Community-Based Livestock Development Model

A distinctive feature of the Smart Pig Farming Hub compared with many conventional livestock development programs is its integration of indigenous cultural values within the modernization process.

In Papua, pigs possess profound social and cultural significance, serving as symbols of social status, customary payment instruments, bridewealth assets, and essential components of traditional ceremonies. Consequently, livestock development cannot rely solely on economic considerations but must also recognize the social and cultural dimensions of indigenous communities.

Nugroho et al. (2022) found that the success of livestock development programs in Papua is strongly influenced by community participation and alignment with local socio-cultural conditions. Similarly, the World Bank (2023) emphasized that sustainable rural development requires participatory approaches that empower local communities as principal development actors.

Under the SPFH model, indigenous communities are positioned not merely as beneficiaries but as key stakeholders and decision-makers within the livestock development ecosystem. Strengthening customary institutions, farmer cooperatives, and community-based education programs will ensure that economic benefits remain within local communities.

Additionally, circular economy principles will be implemented through: Conversion of livestock waste into organic fertilizers; Biogas and renewable energy production; Resource recycling and environmental management systems.

These initiatives will contribute to environmental sustainability while minimizing the ecological footprint of livestock production activities.

Through this approach, Sentani can become a model of sustainable livestock development that successfully harmonizes technological modernization with the preservation of indigenous cultural heritage. Such a model possesses strategic relevance not only for Papua but also for indigenous regions throughout Indonesia and the Pacific.

Table 8. Strategic Impacts of the Global Competitiveness Stage (2041–2045)

Strategic Impact	Success Indicator by 2045	Primary Benefit
Sentani as the leading modern pig farming center in Eastern Indonesia	>100,000 head population; regional breeding and training hub	Livestock production and innovation center
Technology-based agribusiness ecosystem	>90% adoption of digital farming technologies	Enhanced efficiency, productivity, and traceability
Increased competitiveness in Asia-Pacific markets	Export-compliant livestock products and regular export activities	Higher income and international market access
Indigenous community-based sustainable development	Integration of customary institutions within the agribusiness system	Community welfare and cultural preservation

The successful implementation of the Global Competitiveness Stage will position Sentani as a globally recognized center for tropical pig production, innovation, education, and agribusiness development. By integrating advanced technologies, sustainable resource management, regional economic development, and indigenous community empowerment, the Smart Pig Farming Hub offers a comprehensive model for inclusive and sustainable livestock transformation in Papua and the broader Asia-Pacific region.

D. ROADMAP SUMMARY (2026–2045)

Assuming an average annual population growth rate of 8–10%, supported by strengthened biosecurity measures and the adoption of Precision Livestock Farming (PLF) technologies, the pig population in Jayapura Regency is projected to increase from approximately 16,885 head to more than 100,000 head by 2045. This growth trajectory is expected to transform Sentani into a leading center for tropical pig farming innovation in Eastern Indonesia. Such projections are consistent with global trends emphasizing enhanced biosecurity, livestock digitalization, and the development of more resilient pig production systems capable of mitigating the impacts of African Swine Fever (ASF).

The development of the Smart Pig Farming Hub (SPFH) in Sentani, Jayapura Regency, Papua, represents an innovative livestock development model that integrates digital technologies, modern

biosecurity systems, human resource capacity building, genetic improvement programs, circular economy principles, and agribusiness downstream development to establish a productive, sustainable, and globally competitive pig production system. This concept is founded upon the substantial potential of the Sentani region, which currently supports a pig population of approximately 16,885 head, benefits from the strong socio-cultural significance of pigs within Papuan communities, and occupies a strategic position as one of Papua's emerging economic growth centers.

Table 9. Summary of the Smart Pig Farming Hub (SPFH) Roadmap, 2026–2045

Phase	Strategic Focus	Key Outcomes
2026–2030	Foundation	Digital livestock database, breeding center, and human resource development
2031–2035	Transformation	Adoption of IoT, Artificial Intelligence (AI), biosecurity systems, and digital marketplace platforms
2036–2040	Industrialization	Development of downstream livestock industries and establishment of a regional production hub
2041–2045	Global Competitiveness	Development of the Sentani Smart Pig Valley and the Asia-Pacific Tropical Pig Research Center

The SPFH development roadmap is structured into four sequential phases: the Foundation Phase (2026–2030), the Transformation Phase (2031–2035), the Industrialization Phase (2036–2040), and the Global Competitiveness Phase (2041–2045). During the Foundation Phase, the establishment of a digital livestock database, a genetic improvement and breeding center, and farmer training programs will provide the institutional and technological foundation for transforming traditional pig farming systems. Subsequently, the Transformation Phase focuses on implementing Precision Livestock Farming (PLF) technologies through the integration of Internet of Things (IoT) devices, Artificial Intelligence (AI), digital biosecurity systems, and livestock e-marketplace platforms. These innovations are projected to improve feed efficiency by 8–15%, reduce livestock mortality by 30–40%, and strengthen the control of major animal diseases, particularly African Swine Fever (ASF).

During the Industrialization Phase, investments in meat processing industries, modern slaughter facilities, locally based feed manufacturing enterprises, and cold-chain logistics systems are expected to increase farmers' incomes by 30–50%, generate thousands of new employment opportunities, and enhance the contribution of the livestock subsector to regional economic development. In the subsequent Global Competitiveness Phase, Sentani is envisioned to evolve into the Sentani Smart Pig Valley, a modern livestock innovation cluster integrating production, processing industries, research, education, and technological innovation within a single regional ecosystem.

Supported by the adoption of precision livestock technologies, continuous genetic improvement, enhanced farmer capacities, and integrated downstream agribusiness development, the pig population in Jayapura Regency is projected to increase from approximately 16,885 head in 2023 to more than 100,000 head by 2045. This expansion is expected to strengthen regional food security, improve community welfare, create employment opportunities, and reinforce Papua's strategic position as a center for tropical pig farming development in the Asia-Pacific region.

Overall, the Smart Pig Farming Hub (SPFH) should not be viewed merely as a livestock production enhancement initiative. Rather, it represents a comprehensive regional development framework that integrates technological advancement, environmental sustainability, economic value creation, and the indigenous knowledge and cultural heritage of Papuan

communities. If implemented consistently and supported through effective collaboration among government agencies, universities, private-sector stakeholders, research institutions, and local communities, SPFH has the potential to become a replicable model of sustainable livestock development across Eastern Indonesia and Pacific Island countries.

E. Conclusion

The development of the Smart Pig Farming Hub (SPFH) in Sentani, Jayapura Regency, Papua, represents an innovative livestock development model that integrates digital technologies, modern biosecurity systems, human resource capacity building, genetic improvement programs, circular economy principles, and agribusiness downstream development to establish a productive, sustainable, and globally competitive pig production system. This concept is founded on the substantial potential of the Sentani region, which supports a pig population of approximately 16,885 head, benefits from the strong socio-cultural significance of pigs within Papuan communities as both economic and cultural assets, and occupies a strategic position as one of Papua's key economic growth centers.

The SPFH development roadmap is structured into four sequential phases: the Foundation Phase (2026–2030), the Transformation Phase (2031–2035), the Industrialization Phase (2036–2040), and the Global Competitiveness Phase (2041–2045). During the Foundation Phase, the establishment of a digital livestock database, a superior breeding center, and farmer training programs will provide the institutional and technological basis for transforming traditional smallholder pig farming systems. Subsequently, the Transformation Phase focuses on the adoption of Precision Livestock Farming (PLF) technologies through the integration of the Internet of Things (IoT), Artificial Intelligence (AI), digital biosecurity systems, and livestock e-marketplace platforms. These innovations are projected to improve feed efficiency by 8–15%, reduce livestock mortality by 30–40%, and strengthen the control of major transboundary animal diseases, particularly African Swine Fever (ASF).

During the Industrialization Phase, investments in meat processing industries, modern slaughter facilities, local feed manufacturing enterprises, and cold-chain logistics systems are expected to increase farmers' incomes by 30–50%, generate thousands of new employment opportunities, and enhance the contribution of the livestock subsector to regional economic development. In the subsequent Global Competitiveness Phase, Sentani is envisioned to evolve into the Sentani Smart Pig Valley, a modern livestock innovation cluster that integrates production, processing industries, research, education, and technological innovation within a single technology-driven ecosystem.

Supported by the adoption of precision livestock technologies, continuous genetic improvement, enhanced farmer capacities, and integrated downstream agribusiness development, the pig population in Jayapura Regency is projected to increase from approximately 16,885 head in 2023 to more than 100,000 head by 2045. This expansion is expected to strengthen regional food security, improve community welfare, create employment opportunities, and reinforce Papua's strategic position as a leading center for tropical pig farming development in the Asia-Pacific region.

Overall, the Smart Pig Farming Hub (SPFH) should not be viewed merely as a livestock production enhancement initiative. Rather, it represents a comprehensive regional development framework that integrates technological advancement, environmental sustainability, economic value creation, and the indigenous knowledge and cultural heritage of Papuan communities. If implemented consistently and supported through effective collaboration among government agencies, universities, research institutions, private-sector stakeholders, and local communities, SPFH has the potential to become a replicable model of sustainable livestock development across Eastern Indonesia and the Pacific region.

References

1. Atus, S., Widayati, T. W., Supriyantono, A., Randa, Y. S., & Iyai, D. A. (2022). *Pig Farming System in West Papua: A Case Study of Three Districts*.
2. Bhujel, A., Wang, Y., Lu, Y., Morris, D., & Dangol, M. (2024). *Public Computer Vision Datasets for Precision Livestock Farming: A Systematic Survey*.
3. FAO. (2024). *Community Biosecurity Intervention Programme Against African Swine Fever in Indonesia*.
4. FAO. (2025). *Expansion of African Swine Fever Biosecurity Programme in Eastern Indonesia*.
5. Nugroho, W., Klemen, M., Reichel, M. P., & Efendi, A. (2022). *Factors Affecting Enduring Participation in a Pig Farming Program in Southern Papua, Indonesia*. *Tropical Animal Health and Production*, 54(1), 46.
6. Trabachini, A., Moreira, M. R., Harada, É. S., Amorim, M. N., & Silva-Miranda, K. O. (2025). *Precision Livestock Farming Applied to Swine Farms: A Systematic Literature Review*. *Animals*, 15(14), 2138.
7. Dinas Perkebunan dan Peternakan Provinsi Papua. (2025). Peta Klasifikasi Babi Provinsi Papua. (Dinas Perkebunan dan Peternakan)
8. ANTARA Papua. (2025). Program Pemulihan Peternakan Babi Pasca ASF di Sentani Timur. (Antara Papua)
9. Atus, S., Widayati, T. W., Supriyantono, A., Randa, Y. S., & Iyai, D. A. (2022). *Pig Farming System in West Papua: A Case Study of Three Districts*.
10. Bhujel, A., Wang, Y., Lu, Y., Morris, D., & Dangol, M. (2024). *Public Computer Vision Datasets for Precision Livestock Farming: A Systematic Survey*. arXiv Preprint.
11. Food and Agriculture Organization (FAO). (2024). *Community Biosecurity Intervention Programme Against African Swine Fever in Indonesia*. Rome: FAO.
12. Food and Agriculture Organization (FAO). (2025). *Expansion of African Swine Fever Biosecurity Programme in Eastern Indonesia*. Rome: FAO.
13. Nugroho, W., Klemen, M., Reichel, M. P., & Efendi, A. (2022). Factors Affecting Enduring Participation in a Pig Farming Program in Southern Papua, Indonesia. *Tropical Animal Health and Production, 54*(1), 46.
14. Trabachini, A., Moreira, M. R., Harada, É. S., Amorim, M. N., & Silva-Miranda, K. O. (2025). Precision Livestock Farming Applied to Swine Farms: A Systematic Literature Review. *Animals, 15*(14), 2138.
15. Bhujel, A., Wang, Y., Lu, Y., Morris, D., & Dangol, M. (2024). *Public Computer Vision Datasets for Precision Livestock Farming: A Systematic Survey*.
16. FAO. (2024). *Community Biosecurity Intervention Programme Against African Swine Fever in Indonesia*.
17. FAO. (2025). *Expansion of African Swine Fever Biosecurity Programme in Eastern Indonesia*.
18. Muns, R., et al. (2023). *Precision Pig Farming and Piglet Survival Management*. *Animals*.
19. Nugroho, W., Klemen, M., Reichel, M. P., & Efendi, A. (2022). *Factors Affecting Enduring Participation in a Pig Farming Program in Southern Papua, Indonesia*. *Tropical Animal Health and Production*.
20. Trabachini, A., Moreira, M. R., Harada, É. S., Amorim, M. N., & Silva-Miranda, K. O. (2025). *Precision Livestock Farming Applied to Swine Farms: A Systematic Literature Review*. *Animals*.
21. Zhang, X., et al. (2023). *Genomic Selection and Breeding Strategies in Modern Swine Production Systems*. *Livestock Science*.
22. Trabachini, A., Moreira, M. R., Harada, É. S., Amorim, M. N., & Silva-Miranda, K. O. (2025). *Precision Livestock Farming Applied to Swine Farms: A Systematic Literature Review*. *Animals, 15*(14), 2138.
23. World Bank. (2023). *Digital Agriculture Transformation and Smallholder Market Access in Developing Countries*.
24. Zhang, X., et al. (2024). *Precision Feeding Technologies for Sustainable Swine Production*. *Livestock Science*.

25. Food and Agriculture Organization (FAO). (2023). *Livestock Value Chain Development and Rural Economic Growth*.
26. Food and Agriculture Organization (FAO). (2024). *Sustainable Livestock Development and Regional Economic Transformation*.
27. Organisation for Economic Co-operation and Development (OECD). (2024). *Agricultural Value Chains and Rural Prosperity*.
28. Porter, M. E., & Kramer, M. R. (2022). *Creating Shared Value in Agribusiness Development*. *Harvard Business Review*.
29. World Bank. (2023). *Agricultural Transformation and Rural Economic Development in Emerging Economies*.
30. FAO. (2024). *Sustainable Livestock Development and Regional Economic Transformation*.
31. Nugroho, W., Klemen, M., Reichel, M. P., & Efendi, A. (2022). *Factors Affecting Enduring Participation in a Pig Farming Program in Southern Papua, Indonesia*. *Tropical Animal Health and Production*, 54(1), 46.
32. OECD. (2024). *Agricultural Value Chains and Rural Prosperity*.
33. Trabachini, A., Moreira, M. R., Harada, É. S., Amorim, M. N., & Silva-Miranda, K. O. (2025). *Precision Livestock Farming Applied to Swine Farms: A Systematic Literature Review*. *Animals, 15*(14), 2138.
34. World Bank. (2023). *Agricultural Transformation and Rural Economic Development in Emerging Economies*.

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