Short Communication

Food safety, swine health, and productivity of a farrow-to-finish swine farm following implementation of a certified HACCP system in Japan

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Abstract

This study examined the safety and productivity of a farrow-to-finish swine farm from 2015 to 2019, in Japan. The farm implemented a farm Hazard Analysis and Critical Control Points (HACCP) system in July 2016. The critical control point was "the selection of shipping pigs" and the critical limit for preventing contamination with residual antibiotics in pigs was "the withholding period has passed," while that for preventing contamination with residual needle fragments was "the needle was not included." No deviations from critical limits were observed, indicating the pigs were safe. In addition, the numerical goal of pigs born alive per litter (PBA), pre-weaning mortality (PRWM) and post-weaning mortality (POWM) were not achieved during the study period. But PBA improved and POWM remained low, but PRWM was not improved. Although PRWM seems to have increased due to the birth of weaker piglets among the high number of PBA, overall productivity at the farm improved. These results suggest that the HACCP system had a positive effect on the health and productivity of the swine.

Keywords: hazard analysis and critical control point (HACCP) system, pigsborn alive, pig farm, post-weaning mortality, pre-weaning mortality

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Introduction

Food business operators are responsible for providing safe food. As defined by the General Principles of Food Hygiene in the Codex Alimentarius, the Hazard Analysis and Critical Control Point (HACCP) system is a science-based systematic approach that identifies specific hazards and potential control measures (Codex Alimentarius International Food Standards, 2020). Food business operators can ensure food safety by implementing good hygiene practices (GHPs) along with a HACCP system. In the agricultural sector, HACCP is referred to as "farm HACCP" or the "Good Agricultural Practice" system (Global G.A.P, 2020). In August 2009, the Japanese Ministry of Agriculture, Forestry and Fisheries published the farm HACCP certification standards (Ministry of Agriculture Forestry and Fisheries, Japan, 2009), which aim to improve the hygiene management of livestock farms, thereby ensuring the safety of livestock products in Japan. To this end, it is important not only to improve hygiene management within individual farms but also to reduce the risk of pathogenic contamination while raising healthy livestock.

We have previously published analyses of the food safety, livestock health, and productivity of a dairy farm over a 3-year period and a fatting farm for Japanese black cattle over a 4-year period following the implementation of a certified HACCP system (Akaike *et al*., 2022; Akaike *et al*., 2023). In these studies, the potential hazards were chemical (residual antibiotics) and physical (residual needle fragments). The critical control point (CCP) was "the selection of milking cows or shipping cattle. No deviation from the critical limit was observed in the observation period, indicating the milk and beef were safe. However, by implementing GHPs that included a number of sanitation standard operation procedures as well as providing education and training to farm workers, the somatic cell counts in the milk decreased while the milk yield per dairy cow increased at the dairy farm (Akaike *et al.*, 2022) and beef cattle treated for bovine respiratory disease less than 6 months after the introduction of cattle decreased at the Japanese black cattle farm (Akaike *et al*., 2023). As mentioned above, implementation of GHP led to healthier livestock, higher productivity, and fewer infectious diseases. There have been no peports on the effects of HACCP implementation in swine farms in Japan, and based on the fact that HACCP implementation has led to improved productivity in dairy farm and a fatting farm for Japanese black cattle through previous research and the experience of improved productivity in swine farms where HACCP was implemented in the past, it is hoped that results will also be achieved in the swine farms under study. We expected that the research would also produce results in the target swine farms.

The aim of this study was to investigate the effect of a HACCP-based food safety management system by analyzing CCP monitoring data and production data, including pigs born alive per litter (PBA), pre-weaning mortality (PRWM), and post-weaning mortality (POWM). Because, on swine farms, increasing PBA and reducing PRWM and POWM have a significant impact on farm management.

We compared food safety, livestock health, and productivity at a farrow-to-finish swine farm before and after implementation of a farm HACCP system.

Materials and Methods

A farm surveyed: After deciding to implement a farm HACCP in September 2016, the farm began making the HACCP plan in June 2017, focusing on Good Agricultural Practices (GAP) and providing educational training. Implementation of the HACCP plan began in July 2017, and farm HACCP certification was obtained in August 2018. The study target was a farrow-to-finish swine farm with 300 head of mother pigs. The farm had eight employees, and the HACCP team consisted of three farm workers, one veterinarian (a professional farm HACCP advisor), and a representative from a veterinary drug supplier. The farm performed a hazard analysis and then created and implemented control measures (i.e., a HACCP plan and GMPs) in accordance with the farm HACCP certification standards published by the Japanese Ministry of Agriculture, Forestry and Fisheries.

***Hazard Controls of the farm*:** A potential chemical hazard was the presence of residual antibiotics in the pigs, while a potential physical hazard was the presence of residual needle fragments in the pigs. To ensure food safety, the farm decided on CCPs 1c and 3 c (chemical hazard) and CCP 2p and 4p (physical hazard) for its HACCP plan. CCPs 1c and 2p were "selection of shipping fattening pigs to slaughterhouse" and CCPs 3c and 4p were "selection of shipping mother pigs to slaughterhouse." The HACCP plan involved identifying pigs that had received antibiotics or were found to contain needle fragments prior to shipping in order to prevent contamination of the pig with residual antibiotics or needle fragments. As a control measure, the dosing and residual needle fragment records at the fattening barn or stall were checked against the management plate of the shipping pigs. The critical limit for preventing contamination with residual antibiotics in pigs was "the withholding period has passed," while that for preventing contamination with residual needle fragments was "the needle was not present." The monitoring method involved checking the dosing and residual needle fragment records against the management plate of shipping pigs, and then checking the antibiotics and residual needle fragment records and keeping a record of the check before shipment.

In Japan, meat inspections of all pigs are carried out by veterinary meat inspector, and antibiotic testing of pork is also testing according to a residue monitoring program. The fact that there are no notifications of drug residues positive from meat inspection laboratory also proves that CCP monitoring is being done without problems and that no pigs with drug residues are being shipped.

Management goals: The farm HACCP system sets management goals for livestock hygiene and productivity. In this case, the goals were increasing

pigs born alive per litter (PBA) to ≥12 head/belly, reducing pre-weaning mortality (PRWM) to ≤10%, and reducing post-weaning mortality (POWM) to ≤ 2%.

Activity of HACCP team: When the farm's HACCP team met to create the HACCP plan, the following facts were reported: a high rate of death in frail pigs during suckling, a high probability of death in these pigs even after weaning, delays in treatment due to missing sick pigs during rounds, a lack of sanitation control for worker's boots in sanitation-control areas as well as for workers, vehicles, and objects at the entrances and exits of sanitation-control areas. We held numerous meetings to discuss what measures to address these issues and we decided to implement GMPs, including the following sanitation standard operation procedures: observation of pigs in the pig barn, hygiene management of the pig barn, early detection of sick pigs by patrols, early treatment of sick pigs, proper feeding management, and feed additives. We created and implemented a program to provide education and training on the HACCP plan and GMPs for the farm's workers.

The training for the HACCP plan and GMPs : It was conducted by the HACCP team, and daily on-site guidance was provided by the manager. Training for feeding-sanitation management and disease control was provided by a medical representative of a veterinary drug manufacturer on a regular basis, and basic information about feed additives was provided by a sales representative of a veterinary drug supplier. Countermeasures against Aujeszky's disease (AD) were implemented through qualified vaccination by a contracted veterinarian. Porcine respiratory complex disease comprises multiple infections, including porcine reproductive and respiratory distress syndrome (PRRS) virus, swine influenza virus, porcine circovirus type 2, *Pasteurella multocida*, and *Mycoplasma hyopneumoniae*, and countermeasures included strict all-in-all-out procedures as well as enhanced biosecurity and vaccination based on relevant mycoplasma and circovirus vaccine programs. Antibody testing to monitor vaccine immune response and viral infection status was performed twice a year. The farm's HACCP team held monthly meetings in which they performed data analyses of the results. CCP monitoring was performed when pigs were selected for shipping since July 2017, when the HACCP plan was implemented, to 2019. During the study period, there were no deviations from the items set by the CCPs (no contamination of pigs with residual antibiotics or needle fragments), and the pork produced from the pigs was considered safe.

***Inspection items, measurements and statistical processing*:** Inspection items such as mean annual PBA, PRWM, and POWM were measured from 2015 to 2019. We obtained these data from the monthly farm records. Linear approximations were obtained from the inspection results, and statistically significant differences (t-test; $P < 0.01$) between annual means were calculated using spreadsheet software (Excel 365, Microsoft Corp., Redmond, WA, USA).

Results and Discussion

Figure 1 shows the mean PBA from 2015 to 2019. The mean ± standard deviation of PBA was 8.8 ± 0.4 in 2015, 9.0 ± 0.5 in 2016, 9.0 ± 0.5 in 2017, 9.6 ± 0.3 in 2018, and 10.0 ± 0.2 in 2019. The mean PBA in 2015 was statistically smaller compared with 2018 and 2019, according to the t-test ($P < 0.01$). The linear approximation was $Y = 0.3X + 8.4$ ($R^2 = 0.87$). Although mean PBA increased every year, the numerical goal of ≥ 12 head/belly per year was not achieved in either year. Ogura *et al*.(2020) reported that introducing sows capable of producing more litters per year is essential for improving productivity on swine farms. Sasaki *et al*.(2020) suggested the importance of eradicating PRRS and AD in improving the productivity of swine producers. PBA increased gradually every year in this study. The reason for this is thought to be that when we introduced GMPs and checked the number of births per sow, the number of births was found to be low, so we introduced high-producing pigs. In addition, this farm has good hygiene management and there were no outbreaks of AD or PRRS.

Figure 2 shows the mean annual PRWM. The mean ± standard deviation of PRWM was 10.4 ± 2.8 in 2015, 12.3 ± 3.8 in 2016, 10.3 ± 5.8 in 2017, 14.0 ± 3.9 in 2018, and 15.9 ± 5.0 in 2019. The mean PRWM in 2015 was statistically lower compared with 2018 and 2019, according to the t-test ($P < 0.01$). The linear approximation was $Y = 1.3X + 8.8$ ($R^2 = 0.70$). The numerical goal of ≤10 PRWM per year was not achieved in either year. In fact, PRWM has been increasing year by year. Muns *et al*.(2016) showed that piglets, sows, and the environment can all have an effect on PRWM (Ogura *et al*., 2022). There are various possible reasons for the observed increase in PRWM; for example, it is known that increased PRWM is associated with higher PBA (Kotetsu *et al*., 2021). Kotetsu *et al*.(2006) reported that the mean annual PRWM in Japan was 10.7%. According to the GMP-compliant breeding observation records, the causes of death during suckling at this farm were crushing of piglets by the mother sow and a higher PBA, resulting in an uneven distribution of piglets as well as weak pigs dying within a few days after birth. No deaths were observed throughout the study period, including those caused by infectious diseases.

Figure 3 shows the mean annual POWM. The mean ± standard deviation of POWM was 2.7 ± 0.9 in 2015, 2.4 ± 1.00 in 2016, 2.6 ± 0.8 in 2017, 2.8 ± 0.9 in 2018, and 2.2 ± 0.4 in 2019. No statistical differences were found in the means of POWM, according to the *t*-test. The linear approximation was $Y = -0.04X + 2.6$ ($R^2 = 0.10$). The numerical goal of ≤ 2% POWM was not achieved during the study period. The results in 2019 were the closest to the hygiene management target values. POWM has a complex causal matrix involving the pigs, their environment, and infectious etiologic factors (Kotetsu *et al*., 2021), with environmental management being a key contributor and integral aspect (Ramirez et al., 2022). In Japan, the POWM in 2007 was 6.38% (Koketsu *et al*., 2010), and Ogura et al. (2022) reported that POWM was controlled at the same level. The POWM range of this farm was low at 2.24%–2.75%, and it is estimated that the introduction of GMPs would not

have led to major improvements. There may be shortcomings in the process activities to achieve the POWM target values, and the skills of the employees in animal husbandry management techniques may not yet be sufficient.

Magalhaes *et al*.(2022) suggested that higher sow farm productivity is associated with lower subsequent swine wean-to-finish mortality; conversely, lower sow farm productivity is associated with higher wean-to-finish mortality. Moreover, higher health status at a sow farm is also associated with lower subsequent swine wean-to-finish mortality (Magalhaes *et al*., 2022). At the farm in the present study, many piglets were born due to an increase in PBA. PRWM increased due to weak piglets being culled before weaning, and POWM was low because healthy piglets were raised in a good environment. During the study period, there were no major outbreaks of suspected infectious, and no mass deaths caused by infectious diseases. By introducing the farm HACCP system, we were able to ship healthy pigs without any hazards such as contamination with residual antibiotics or needle fragments. Furthermore, by implementing GMPs, we were able to obtain useful information for pig breeding programs on farms. The factors underlying the increase in PBA and the low POWM seem to be linked to countermeasures implemented after the implementation of the HACCP system.

The implementation of a farm HACCP system including regular meetings, education, and training was shown to be effective in maintaining farm hygiene management and is considered to have contributed to the maintenance of overall livestock health, resulting in improved productivity.

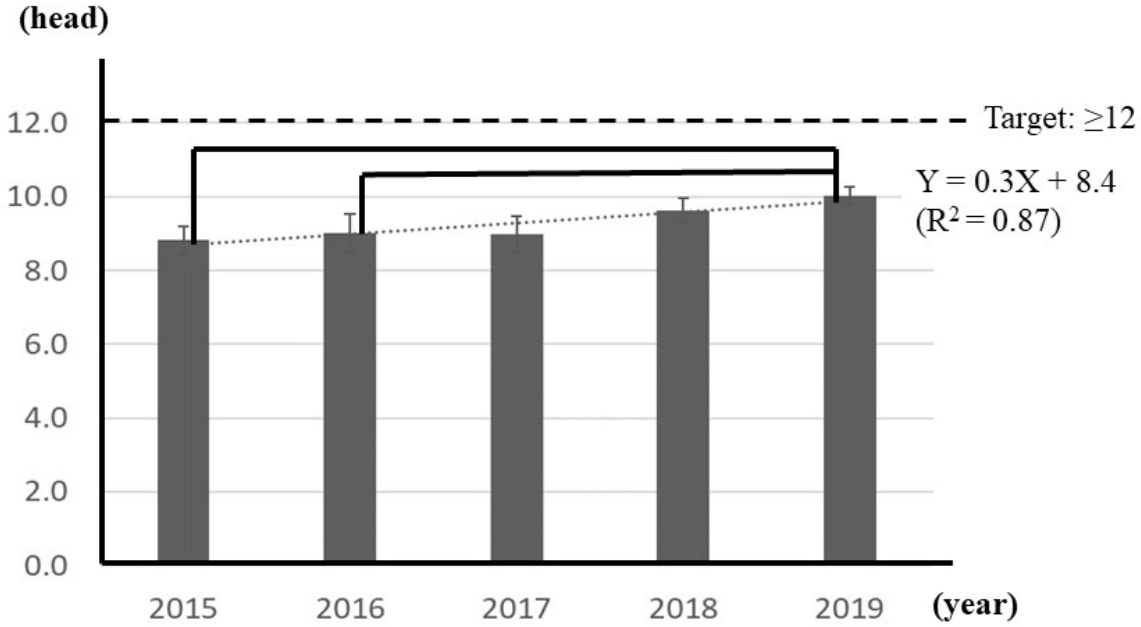


Figure 1 The mean pigs born alive per litter (PBA) from 2015 to 2019.

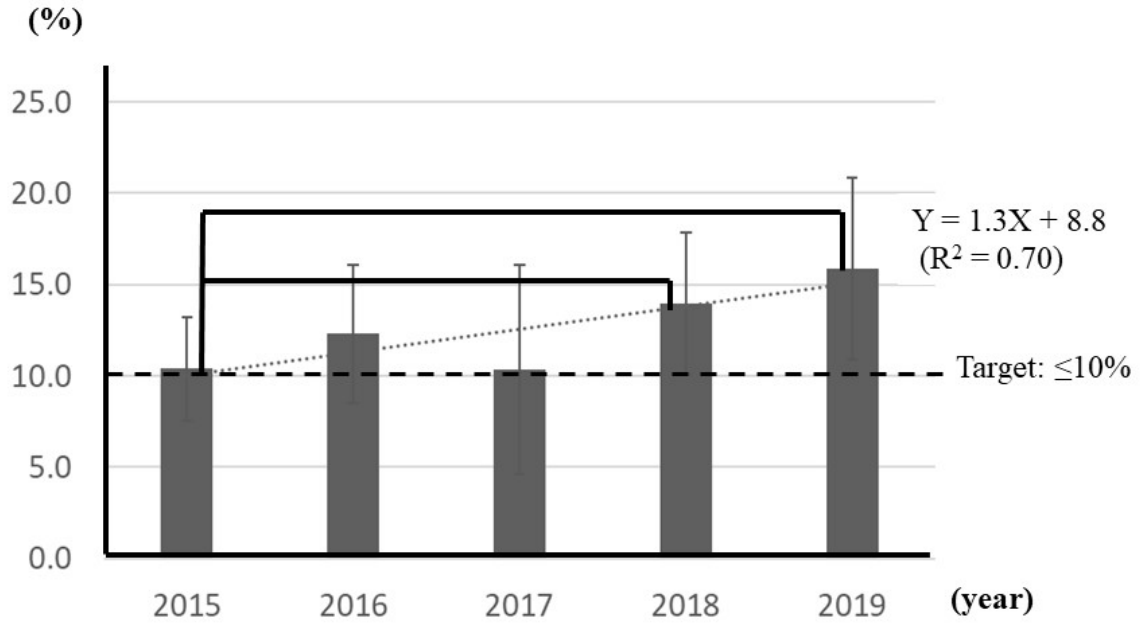


Figure 2 The mean annual pre-weaning mortality (PRWM) from 2015 to 2019.

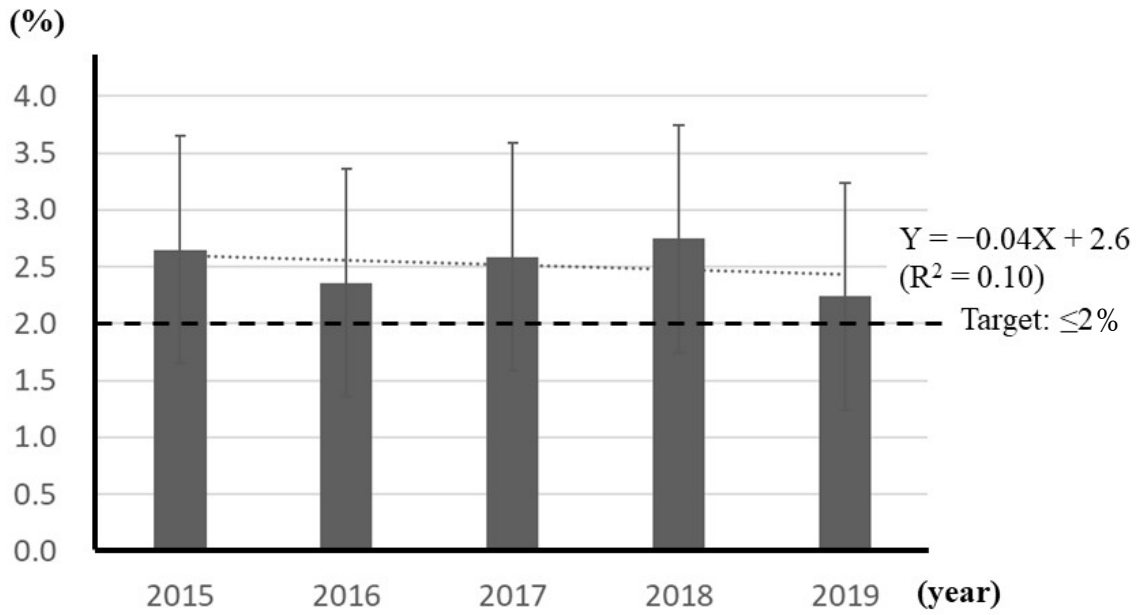


Figure 3 The mean annual post-weaning mortality (POWM) from 2015 to 2019.

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