# 国内生産農場における淘汰産次毎の母豚の生涯経済性の調査


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Original Article

# Assessment of Lifetime Economic Returns of Sows by Parity of Culled Sows in Commercial Breeding Herds

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## Summary

The objective of the present study were to determine the number of parities that a sow must remain in the herd for before lifetime net income becomes positive, in typical farrow-to-finish operations in Japan. A further objective was to evaluate the sensitivity of lifetime net income to feed price, price for marketed pigs, feed conversion ratio, and number of pigs weaned. The reproductive data were collected from records of 53,996 sows born between 2001 and 2004 in 101 commercial herds. The economic models for lifetime net income by parity were constructed using reproductive data and economic assumptions. The economic assumptions were based on data obtained from previous studies and multiple producer groups. Lifetime net income in each parity was calculated as the sum of net income in each litter, including salvaged values for sows, minus gilt costs. The net income in each litter was calculated as the revenue obtained by sales of marketed pigs from each litter minus production costs. The costs included feed costs for growing pigs and sows, depreciations for replacement gilts, and the other costs for facility, breeding, veterinary treatment and vaccines, transportation and slaughter fees, utility and labor. Sensitivity analysis was performed to investigate how changes in feed price, the price for marketed pigs, feed conversion ratio, or the number of pigs weaned would affect economic returns. Lifetime net income increased from $-272.8 to $1,944.9 as the parity increased from 1 to 8. A sow reached a positive value of lifetime net income at parity 3. The net income from each litter of a sow increased from $145.8 to $390.2 as the parity increased from 1 to 5. Sensitivity analysis showed that if the feed price increased from $0.40/kg to $0.45/kg, the lifetime net income became negative in parities 1 to 4. Furthermore, if the feed price increased from $0.40/ kg to $0.50/kg, lifetime net income was negative in all parity groups. If the price for marketed pigs declined to $4.25/kg kg or lower, the lifetime net income in all parity groups was negative. However, decreasing feed conversion ratio or increasing the number of pigs weaned increased lifetime net income. In conclusion, increased sow longevity results in increased lifetime net income of sows in commercial herds. Lower feed costs, decreased feed conversion ratio and increasing the number of pigs weaned also increased lifetime profitability of sows.

Keywords : culling, economic, longevity, management, swine

## Introduction

Sow longevity has a major effect on profitability in commercial breeding herds[15]. The longer a sow remains in a herd, the greater the opportunity to recuperate the initial cost of a replacement gilt and increase lifetime net income per sow[21]. Some studies in the U.S.A. have reported that net income per parity or over a sow's lifetime in farrow-to-wean operations increases as the number of parity increases[12, 17, 18, 22], but few studies have reported economic returns per parity or sow combined with reproductive and growth performance in farrow-to-finish herds. Additionally, large country-to-country variation in production values, market prices, feed cost, and other expenses means that each country, including Japan, needs to determine its own financial assumptions and standards in order to assess economic returns for commercial herds.

Sensitivity analysis can investigate the effect on net incomes of changes in value of one parameter while the rest of the variables in the analysis remain constant[4]. Feed price and the market price for growing pigs are major factors influencing the lifetime net income of sows. In the recent years, feed prices have increased due to escalating prices of corn[5]. The feed prices are directly related to the costs for marketed pigs. Furthermore, relatively small changes in market price can impact the profitability of any investment in replacement gilts[22]. Feed conversion ratio[7] and number

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of pigs weaned are performance factors controlled by producers and are considered to increase lifetime net income of sows.

The objective of the present study was to evaluate the number of parities that a sow must remain in the herd for economic returns over the lifetime of sows (lifetime net income) becomes positive in typical farrow-to-finish operations in Japan. A further objective was to use sensitivity analysis to determine how any changes in feed price, the price for marketed pigs, feed conversion ratio, or the number of pigs weaned would influence economic returns in Japanese commercial swine herds.

## Materials and methods

The economic models for lifetime net income by parity were constructed using reproductive data and economic assumptions. The production values, market prices, feed costs, and other expenses are shown in Tables 1, 2, and 3. All values and prices referred to in the present study are in U.S. dollars, with an assumed exchange rate of one U.S. dollar to 100 Japanese yen. The variables used for the economic analysis were obtained from various sources including PigCHAMP database, previous studies, and personal communications from multiple producer groups in Japan (Personal communications). The details of the calculation of each variable were as follows：

**Reproduction data**

Reproductive data, including number of pigs born alive, gestation length, lactation length, weaning-to-conception interval, and weaning-to-culling interval, were obtained from the records of 53,996 sows born between 2001 and 2004 in 101 Japanese com-

Table 1 By-parity production values and sow weight at culling used for the economic analysis

| | Parity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Number of pigs | | | | | | | | | |
| Pigs born alive, pigs | – | 9.7 | 10.3 | 10.8 | 10.9 | 10.8 | 10.6 | 10.2 | 9.8 |
| Weaned pigs[1], pigs | – | 8.7 | 9.2 | 9.6 | 9.7 | 9.6 | 9.5 | 9.1 | 8.8 |
| Marketed pigs[2], pigs | – | 8.2 | 8.7 | 9.2 | 9.2 | 9.2 | 9.0 | 8.7 | 8.3 |
| Number of days | | | | | | | | | |
| Gestation length, day | – | 115.3 | 115.3 | 115.3 | 115.3 | 115.3 | 115.3 | 115.4 | 115.3 |
| Lactation length, day | – | 21.0 | 21.1 | 21.1 | 21.1 | 21.2 | 21.1 | 21.3 | 21.6 |
| Weaning-to-conception interval, day | – | 14.1 | 10.7 | 9.7 | 9.3 | 8.6 | 7.9 | 7.7 | 7.8 |
| Weaning-to-removal interval, day | – | 62.9 | 64.2 | 60.4 | 57.3 | 49.4 | 32.2 | 19.1 | 14.9 |
| Sow weight at culling, kg | 140.0 | 155.0 | 175.0 | 190.0 | 205.0 | 215.0 | 215.0 | 215.0 | 215.0 |

[1] Weaned pigs were calculated as the number of pigs born alive multiplied by (1–preweaning mortality). The value of preweaning mortality (10.7%) was obtained from a previous report[10].

[2] Marketed pigs were calculated as the number of pigs weaned multiplied by (1–postweaning pig mortality). The value of postweaning mortality (5.0%) was obtained from a previous report[24].

Table 2 Feed costs for growing pigs during each stage of the lifecycle[1]

| Stage | Weight change, kg | Weight gain[2], kg | Feed price, $/kg | FCR[2] | Total cost[3], $ |
|---|---|---|---|---|---|
| Lactation | 0 to 6.5 | | 1.64 | | 1.64 |
| Weaner | 6.5 to 25.0 | 18.5 | 0.65 | 1.99 | 23.89 |
| Grower | 25.0 to 50.0 | 25.0 | 0.37 | 2.51 | 23.22 |
| Finisher | 50.0 to 116.6 | 66.6 | 0.35 | 3.55 | 82.75 |
| | | | Total feed cost for a growing pig: $131.50 | | |

[1] One U.S. dollar was assumed to be equivalent to 100 Japanese yen.

[2] Weight gain and feed conversion ratio (FCR) were obtained from a previous report[6]. Average FCR for growing pigs was 3.05.

[3] Total cost in the lactation stage was calculated as feed price multiplied by 1 kg feed intake during lactation. Feed price and feed intake in the lactation stage were obtained from producers' groups. Total costs in the weaner, grower, and finisher stages were calculated by multiplying the weight gain during each stage by feed price and FCR.

Table 3 Market prices, feed cost, and other expenses used for the economic analysis[1]

| Variable | Value |
|---|---|
| Market prices | |
| Marketed pigs | |
| Marketed weight[2] | 116.6 kg |
| Dressing percentage[3] | 64% |
| Price for a marketed pig[4] | $4.62/kg |
| Culled sows | |
| Dressing percentage[5] | 60% |
| Price for a salvaged sow[4] | $1.95/kg |
| Feed prices for sows[5] | |
| Gestating sows | $0.39/kg |
| Lactating sows | $0.44/kg |
| Weaned sows | $0.39/kg |
| Feed intake for sows[5] | |
| Gestating sows | 2.26 kg/day |
| Lactating sows | 6.0 kg/day |
| Weaned sows | 3.0 kg/day |
| Other expenses[5] | |
| Facility costs based on a typical Japanese herd of 100 sows | |
| Depreciation/litter | $378.7 |
| Interest payment/litter | $210.8 |
| Maintenance cost/litter | $113.6 |
| Breeding cost/litter | $50.0 |
| Veterinary treatment and vaccines per weaned piglet (WP) | $12.5/WP |
| Transportation and slaughter fees | $26.8/WP |
| Utility cost | $10.9/WP |
| Labor cost | $10.9/WP |
| Gilt costs | $600.0 |

[1] One U.S. dollar was assumed to be equivalent to 100 Japanese yen.

[2] Marketed weight was obtained from a previous report[24].

[3] Dressing percentage for marketed pig was obtained from a previous report[25].

[4] Marketed pig carcass price and salvaged sow carcass price was obtained from Japanese government statistics[14].

[5] These values were obtained from producers' groups.

mercial herds that used PigCHAMP recording software (PigCHAMP Inc., Ames, IA, U.S.A.). Females in the studied herds were mainly crossbreds between Landrace and Large White, which were reproduced within the herd, or gilt replacements purchased from international breeding companies.

The values of number of pigs and number of days at each stage of production, and sow weight (wt.) at culling are shown in Table 1. The numbers of pigs weaned and marketed pigs were calculated by the following equations：

Number of pigs weaned = Number of pigs born alive × (1− Preweaning mortality), and

Number of marketed pigs = Number of pigs weaned × (1− Postweaning pig mortality).

The preweaning mortality value of 10.7% and the postweaning pig mortality value of 5.0% were obtained from previous reports[10, 24]. Sow weight at culling in each parity was also obtained from a previous report[6].

**Prices for marketed pigs and culled sows**

The price for a marketed pig was calculated as follows：

Price for a marketed pig = Marketed Wt. × Dressing % × Price/Carcass Wt.

The average price of a marketed pig was calculated as $344.8 based on an average Marketed Wt. of 116.6 kg[24]; Dressing % of 64%[25]; and Price/Carcass Wt. of $4.62/kg[14].

The price for a culled sow was calculated separately for each parity as follows：

Price for a culled sow = Sow Wt. × Dressing % × Price/Carcass Wt.,

where Sow Wt. was the sow weight at culling in each parity (Table 1)[6]; Dressing % was 60% for salvaged sows (Personal communications); and Price/Carcass Wt. was $1.95/kg for a salvaged sow carcass[14].

**Feed costs for growing pigs and sows**

Feed prices for growing pigs and sows at each stage of production were obtained from multiple producer groups (Tables 2 and 3). The feed prices were calculated by assuming that the average feed price in a herd was $0.40/kg. Average feed intake for sows and nursing piglets was also obtained from multiple producer groups.

The feed cost for a growing pig was estimated by summing the feed costs at each stage of pig life such as lactation, weaner, grower, and finisher. The feed cost at each stage was determined by：

Feed costs at each stage = Feed price × Feed intake at each stage.

The feed price at each stage used in the calculation is shown in Table 2. The feed intake for a piglet during lactation (1 kg/piglet) was obtained from multiple producer groups, and the feed intake during weaner, grower, and finisher stages was calculated by the following formula：

Feed intake at each stage = Weight gain × Feed conversion ratio at each stage,

based on the weight gain and the feed conversion ratio at each stage shown in Table 2[6]. The total feed cost for a growing pig used in the present study was calculated as the sum of the feed costs for each growth stage, giving a total cost of $131.50.

The feed cost for a sow was estimated by summing the feed costs at three production stages, namely gestation, lactation, and postweaning stages. The feed cost at each stage was calculated by

the following equation：

Feed costs at each stage = Feed cost per day
× the number of days at each stage.

The daily feed cost ($/day) was calculated as feed price ($/kg) multiplied by daily feed intake (kg/day). The feed prices and daily feed intake during gestation, lactation, and postweaning are shown in Table 3, and gave respective daily feed costs of $0.88/day, $2.64/day, and $1.17/day. In addition, the number of days at each stage differs between parities (Table 1), so the total feed costs for sows vary with parity.

**Facility costs and other expenses**

Facility costs were determined based on facility costs assumed for running a typical Japanese herd model with a 100-sow farrow-to-finish operation. The investment required for a 100-sow farrow-to-finish operation was obtained from multiple producer groups. The annual facility costs included annual depreciation, annual interest payment, and annual maintenance cost. The annual depreciation was calculated by dividing the value of the facility ($871,000) by the expected life of the facility (10 years). The interest portions for a fixed payment were calculated using the PMT function in Microsoft Office Excel 2007 (Microsoft Corporation, U.S.A.). The analysis assumed that the producer had 50% equity in the swine facilities, debt was financed at a 2% annual interest rate, and was assumed to be paid off in 10 years. Annual maintenance costs were defined as 3% of the facility value. Thus, the annual depreciation, interest payment, and maintenance costs were $87,100, $48,482, and $26,130, respectively. In order to apply those costs to the calculation of lifetime net income, the annual costs for 100 sows were converted to the cost per litter by dividing by the average 230 litters that were produced by 100 sows per year. This gave depreciation, interest payment, and maintenance costs per litter were $378.7, $210.8, and $113.6, respectively.

The other expenses such as breeding costs, veterinary treatment and vaccines, transportation and slaughter fees, utility costs, labor costs, and gilt costs were obtained from multiple producer groups (Table 3). Veterinary treatment and vaccines, transportation and slaughter fees, utility costs, and labor costs were multiplied by the number of pigs weaned in each parity.

**Economic analysis**

On the basis of the reproductive data and economic assumptions, lifetime net income was calculated by parity using the following equation：

Lifetime net income = Accumulated net income
+Price for culled sows in parity.

The accumulated net income was calculated as follows：

Accumulated net income = $-\text{Gilt} + P_1 + P_2 + \cdots + P_N$,

where Gilt was the cost of replacement gilts; and $P_1$, $P_2$, $\cdots$ $P_N$ were the net income per litter for each parity. These equations for lifetime net income were built by modifying a formula for net present analysis used in a previous study[22].

The net income per litter for each parity was estimated as follows：

The net income per litter = Revenue for pigs−(Feed Pig
+Feed Sow+Depreciation for replacement gilts+Other Cost),

where Revenue for pigs = sales of marketed pigs; Feed Pig = feed cost for growing pigs; Feed Sow = feed cost for a sow; Depreciation for replacement gilts = depreciation cost for replacement gilts in each litter; and Other Cost = the other costs. The sales of marketed pigs were calculated by multiplying the number of marketed pigs by the price for a marketed pig. The feed cost for growing pigs was calculated by multiplying feed cost for a growing pig by the number of pigs weaned. The feed cost for a sow was calculated as the sum of feed costs in gestation, lactation, and postweaning. The asset value of the replacement gilt depreciates until parity 4. Depreciation cost for replacement gilts in each litter was calculated by subtracting residual value of the replacement gilts ($180.0; 30% of the replacement gilt cost) from the replacement gilts cost ($600.0), and dividing by the average parity at culling (4.0). The other costs included facilities, breeding, veterinary treatment and vaccines, transportation and slaughter fees, utility, and labor. Lifetime net income of sows was calculated by parity 8 because only a small proportion of herds had sows culled at parity 9 or greater. Feed cost per litter for each parity from weaning-to-culling is shown in Table 4.

**Sensitivity analysis**

Sensitivity analysis was performed to investigate how changes in the feed price, the price for marketed pigs, the feed conversion ratio, or the number of pigs weaned would influence economic returns if all other variables remained constant. In addition we analyzed how changes in feed price and any one of the other three variables affected economic returns. The sensitivity analysis was performed to obtain lifetime net income depending on parity. The ranges of feed and marketed pig prices used for the analyses were based on the ranges observed-over the three years from 2007 to 2009[14]. Similarly, the ranges of feed conversion ratios and the number of pigs weaned were determined based on the range of those variables in the data for the 101 herds used in this study.

## Results

Lifetime net income per sow, including revenue and costs in each litter, are shown in Table 4. Lifetime net income in female pigs culled at parity 0 was $-436.2. The lifetime net income increased from $-272.8 to $1,944.9 as the culling parity increased from 1 to 8, with positive lifetime net income values being reached at parity 2. Respective litter revenues and costs from parity 1 to 8 ranged between $2,838.1 and $3,189.2 and between $2,598.6 and $2,892.3, respectively. The net income per litter increased from $145.8 in parity 1 to a peak of $390.2 in parity 5, but then fell again $368.7 by parity 8. However, lifetime net income per parity was highest in parity 8 with a value of $243.1.

Table 5 shows sensitivity analyses of changes in lifetime net

Table 4 Net income per sow by parity

| | Parity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Revenue | | | | | | | | | |
| Sales of marketed pigs[1] | 0 | 2,838.1 | 3,013.6 | 3,159.9 | 3,189.2 | 3,159.9 | 3,101.4 | 2,984.4 | 2,867.3 |
| Cost | | | | | | | | | |
| Feed for growing pigs[2] | 0 | 1,139.1 | 1,209.6 | 1,268.3 | 1,280.1 | 1,268.3 | 1,244.8 | 1,197.9 | 1,150.9 |
| Feed for sows[3] | 0 | 173.6 | 169.8 | 168.7 | 168.2 | 167.7 | 166.6 | 167.0 | 167.8 |
| Depreciation for replacement gilts | 0 | 105.0 | 105.0 | 105.0 | 105.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other costs[4] | 0 | 1,274.6 | 1,306.8 | 1,333.7 | 1,339.1 | 1,333.7 | 1,322.9 | 1,301.4 | 1,279.9 |
| Total cost | 0 | 2,692.3 | 2,791.3 | 2,875.7 | 2,892.3 | 2,769.7 | 2,734.4 | 2,666.3 | 2,598.6 |
| Net income in each litter[5] | 0 | 145.8 | 222.4 | 284.2 | 296.8 | 390.2 | 367.0 | 318.1 | 268.7 |
| Accumulated net income[6] | (600.0) | (454.2) | (231.8) | 52.4 | 349.2 | 739.5 | 1,106.5 | 1,424.6 | 1,693.4 |
| Replacement gilt cost | 600.0 | – | – | – | – | – | – | – | – |
| Salvaged sow price | 163.8 | 181.4 | 204.8 | 222.3 | 239.9 | 251.6 | 251.6 | 251.6 | 251.6 |
| Lifetime net income[7] | (436.2) | (272.8) | (27.1) | 274.7 | 589.1 | 991.0 | 1,358.1 | 1,676.2 | 1,944.9 |
| Net income per parity | (436.2) | (272.8) | (13.5) | 91.6 | 147.3 | 198.2 | 226.3 | 239.5 | 243.1 |
| Feed costs until culling[8] | – | 57.1 | 62.6 | 59.3 | 56.2 | 47.7 | 28.4 | 13.3 | 8.3 |

All values in the Table indicates U.S. dollar. One U.S. dollar was assumed to be equivalent to 100 Japanese yen. Values enclosed in parentheses represent negative net income.

[1] Price for marketed pigs ($344.8) x Number of growing pigs

[2] Feed price for marketed pigs ($131.5) x Number of pigs weaned

[3] Feed price for gestating sows ($0.88/day) x Gestation length + Feed price for lactating sows ($2.64/day) x Lactation length + Feed price for weaned sows ($1.17/day) x Weaning-to-conception interval

[4] Depreciation ($138.3) + Interest payment ($77.0) + Maintenance ($41.5) + Breeding costs ($50.0) + (Veterinary costs ($12.5/a weaned pig (PW)) + Transportation and slaughter fees ($26.8/PW) + Utility cost ($10.9/PW) + Labor cost ($10.9/PW)) x the number of PW

[5] Revenue/litter – Total cost in each parity

[6] –Replacement gilt cost + Net income in each litter

[7] Accumulated net income in each parity + sow salvaged price in culled parity

[8] Feed price for weaned sows ($1.17/day) x Weaning-to-removal interval (day) - Feed price for weaned sows ($1.17/day) x Weaning-to-conception interval (day)

income when feed price, price for marketed pigs, feed conversion ratio, or number of pigs weaned varies. When the feed price increased from the base price of $0.40/kg to $0.50/kg, the lifetime net income was negative in all parity groups. However, when the feed price only increased from $0.40/kg to $0.45/kg, the lifetime net income was negative up to parity 4. In addition, the lifetime net income in all parity groups was negative if the price for marketed pigs declined to $4.25/kg, but if the marketed price increased to $4.75/kg then lifetime net income was positive from parity 2. One extra weaned pigs per litter made lifetime net income positive in all parities, and a decrease in the feed conversion ratio also increased lifetime net income.

Sensitivity analyses on how changes in marketed pig prices, feed conversion ratio, or number of pigs weaned affected lifetime net income when average feed prices were $0.35/kg or $0.45/kg are shown in Figures 1, 2, and 3. Lifetime net incomes in parity 2 and 5 were chosen as representative values to show the relationships between feed price and respectively, marketed pig price (Figure 1), the feed conversion ratio (Figure 2), or the number of pigs weaned (Figure 3). If the feed price was $0.35/kg, the lifetime net income in parity 2 and 5 became positive when the market price was over $4.38/kg and $4.06/kg, respectively. If the feed price was $0.45/kg, a positive lifetime net income in parity 2 and 5 was obtained when the market price was over $4.91/kg and $4.59/kg, respectively. If the feed price was $0.35/kg then lifetime net income in parity 2 was positive regardless of feed conversion ratio. Similarly, when the feed price was $0.35/kg, the break even value in parity 2 for the number of pigs weaned was

Table 5 Changes in lifetime net income changing on feed price, price for marketed pigs, feed conversion ratio (FCR), and number of pigs weaned

| | Parity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Feed price, $/kg | Lifetime net income ($) when feed price varies | | | | | | | |
| 0.35 | (108.8) | 309.4 | 790.8 | 1,286.2 | 1,867.7 | 2,411.2 | 2,899.9 | 3,333.5 |
| 0.40 | (272.8) | (27.1) | 274.7 | 589.1 | 991.0 | 1,358.1 | 1,676.2 | 1,944.9 |
| 0.45 | (436.9) | (363.6) | (241.5) | (108.1) | 114.3 | 305.0 | 452.5 | 556.4 |
| 0.50 | (601.0) | (700.1) | (757.6) | (805.3) | (762.3) | (748.2) | (771.2) | (832.2) |
| 0.55 | (765.1) | (1,036.6) | (1,273.8) | (1,502.5) | (1,639.0) | (1,801.3) | (1,995.0) | (2,220.7) |
| Market price, $/kg | Lifetime net income ($) when price for marketed pigs varies | | | | | | | |
| 4.00 | (654.6) | (814.2) | (937.5) | (1,052.1) | (1,075.2) | (1,125.3) | (1,208.6) | (1,325.6) |
| 4.25 | (501.1) | (497.7) | (450.0) | (392.1) | (244.3) | (126.6) | (48.5) | (10.4) |
| 4.50 | (347.6) | (181.1) | 37.5 | 267.9 | 586.6 | 872.0 | 1,111.6 | 1,304.8 |
| 4.75 | (194.0) | 135.4 | 524.9 | 927.9 | 1,417.5 | 1,870.7 | 2,271.7 | 2,620.0 |
| 5.00 | (40.5) | 451.9 | 1,012.4 | 1,587.8 | 2,248.5 | 2,869.4 | 3,431.8 | 3,935.3 |
| FCR | Lifetime net income ($) when FCR varies | | | | | | | |
| 2.80 | (180.2) | 164.0 | 569.0 | 987.5 | 1,492.7 | 1,961.0 | 2,376.6 | 2,738.9 |
| 2.90 | (217.0) | 88.0 | 451.9 | 829.0 | 1,293.1 | 1,721.2 | 2,098.0 | 2,423.1 |
| 3.00 | (253.9) | 12.0 | 334.9 | 670.5 | 1,093.6 | 1,481.3 | 1,819.4 | 2,107.3 |
| 3.10 | (290.8) | (64.0) | 217.8 | 512.1 | 894.1 | 1,241.5 | 1,540.8 | 1,791.4 |
| 3.20 | (327.6) | (140.0) | 100.7 | 353.6 | 694.5 | 1,001.7 | 1,262.2 | 1,475.6 |
| Number of pigs weaned, pigs | Lifetime net income ($) when number of pigs weaned varies | | | | | | | |
| −2 pigs | (928.1) | (1,337.7) | (1,691.2) | (2,032.1) | (2,285.4) | (2,573.7) | (2,910.8) | (3,297.4) |
| −1 pigs | (600.5) | (682.4) | (708.2) | (721.5) | (647.2) | (607.8) | (617.3) | (676.2) |
| Average | (272.8) | (27.1) | 274.7 | 589.1 | 991.0 | 1,358.1 | 1,676.2 | 1,944.9 |
| +1 pigs | 54.8 | 628.2 | 1,257.6 | 1,899.6 | 2,629.2 | 3,323.9 | 3,969.7 | 4,566.1 |
| +2 pigs | 382.4 | 1,283.5 | 2,240.5 | 3,210.2 | 4,267.4 | 5,289.8 | 6,263.2 | 7,187.2 |

Values enclosed in parentheses represent negative net income.

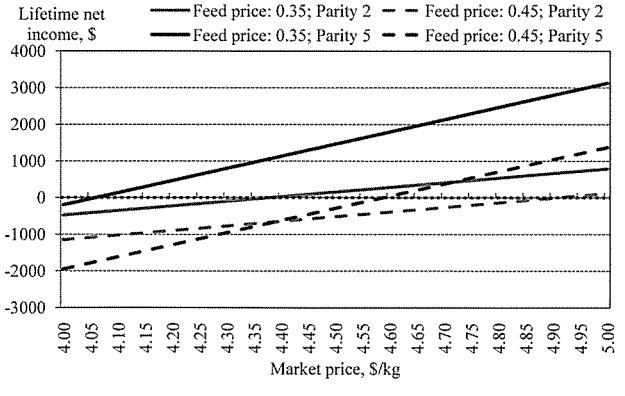


Fig. 1 Changes in lifetime net income in parity 2 or 5 due to changes in price for marketed pigs when the feed price is $0.35 or $0.45/kg.

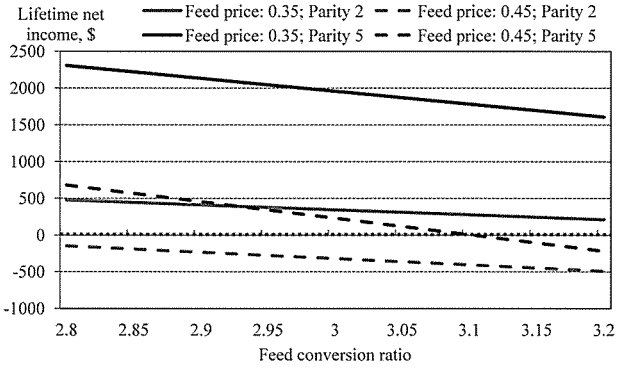


Fig. 2 Changes in lifetime net income in parity 2 or 5 due to changes in feed conversion ratio when the feed price is $0.35 or $0.45/kg.

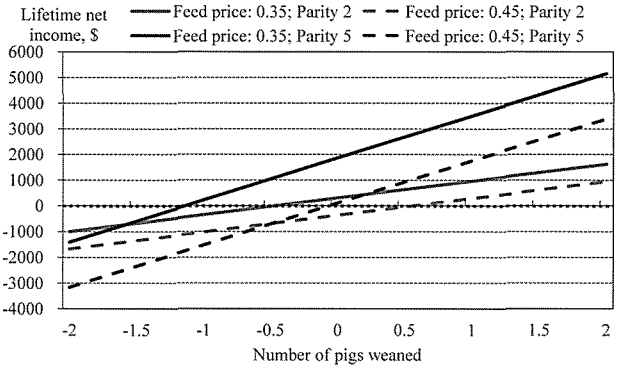


Fig. 3 Changes in lifetime net income in parity 2 or 5 due to changes in number of pigs weaned when the feed price is \$0.35 or \$0.45/kg.

-0.4 additional pigs. However, when the feed price was \$0.45/kg, lifetime net income in parity 2 only became positive with an additional 0.6 pigs weaned, and remained negative regardless of feed conversion ratio. In parity 5 the break even value for feed conversion ratio and the number of pigs weaned was 3.10 and 0.1 additional pigs, respectively.

## Discussion

This is the first report to assess the lifetime economic returns of sows using financial assumptions and standards in Japanese commercial herds. The present study showed that increased net income can be obtained if sows remain in the herd for an extended number of parity. Increased gilt costs due to a high replacement rate incur a burden of debt on the herd, and also requires an additional parity to obtain a positive net income[22]. Producers should focus their herd management on extending the productive herd life of their female pigs, whilst maintaining other breeding parameters[21]. However, it is noteworthy that the decision on how long to remain a sow in the herd is affected by other important factors, such as the present reproductive status of the sow, current parity, previous performance of the sow, producers' desired within-herd age structure[9], or the market value for culled sows. For example, an open sow exhibiting no estrus or failing pregnancy is more likely to be culled. Furthermore, a high proportion of high-parity sows in the herd results in unstable age structure, which is related to low herd productivity[9]. Additionally, high-parity sows are at high risk of dying, or producing piglets with uneven weights[16, 19]. The present study provides a management tool to evaluate lifetime net income per parity when producers make a decision to cull in breeding herds.

Our economic evaluation suggests that positive lifetime net income of sows can be obtained from the third parity. Our evaluation is consistent with the studies showing positive income was obtained from parity 2[17] or parity 3[12, 21, 22], although there are large differences in reproductive performance and financial assumptions between countries[23]. In fact, Japanese commercial herds incur higher costs, but realize a higher market price for pigs than herds in U.S.A.[14,18].

Our sensitivity analysis indicates that it is impossible to obtain positive lifetime net income even in high parity if feed prices are greater than \$0.50/kg, unless the price for marketed pigs increases to over \$4.62/kg. The negative effect of increased feed cost can be reduced by improving the feed conversion ratio, which can increase lifetime net income to a certain degree. Improving the feed conversion ratio can be achieved by avoidance of overcrowding of pigs[2], providing easily accessible drinking water fixtures, unlimited water supply, and feeder maintenance[3].

The present study reveals that an additional weaned pig can increase lifetime net income by about 2.1 times in each parity. Therefore, it is crucial for producers to increase the number of weaned pigs and marketed pigs by improving preweaning and postweaning mortality. In order to decrease postweaning pig mortality, it is important to prevent or control infectious diseases such as porcine reproductive and respiratory syndrome or porcine circovirus[1, 13]. In addition, assisted farrowing by administrating $PGF_{2\alpha}$ can reduce preweaning mortality[8], although it incurs increased labor costs due to time requirements. Further, increased numbers of marketed pigs can be achieved by increasing litter weight at weaning through intermittent suckling, milk replacer, and creep feed for piglets[11, 24].

It is important to interpret the maximum net income in parity 8 in the present study with some caution, because our economic assumptions do not include the opportunity cost of postponed replacement, which would reflect the profit sacrificed by keeping a sow[20]. Therefore, the maximum lifetime net income in parity 8 does not represent optimal parity of sow replacement for the long-term profitability of a farm.

In conclusion, increased sow longevity results in increased lifetime net income of sows in commercial herds. High feed prices for growing pigs and sows are strongly related to a decline in lifetime net income of sows. However, increasing the number of pigs weaned or decreasing the feed conversion ratio, both of which producers can achieve with improved management, would offset this effect of increased feed price on lifetime net income of sows.

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原　著

# 国内生産農場における淘汰産次毎の母豚の生涯経済性の調査

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## 要旨

本研究の目的は，国内生産農場における淘汰産次毎の母豚の生涯経済性の調査と，生涯純利益と飼料費，市場価格，飼料要求率，離乳子豚数の感受性分析を行うこととした。本研究では，101 農場における 53,996 頭の母豚の繁殖記録を繁殖データとして用いた。産次毎の生涯純利益の経済モデルは繁殖データと経済的な仮定値から作られた。生涯純利益は，各産次の純利益の総和と母豚出荷代の合計から更新豚の費用を引いて算出した。各産次の純利益は，肉豚出荷代から飼料費，更新豚の減価償却費，施設費，交配費，治療・ワクチン費，出荷・と畜手数料，光熱費，人件費を引いて算出した。淘汰産次が 1 産から 8 産に増加するにつれて，生涯純利益は－272.8 ドルから 1,944.9 ドルまで増加した。生涯純利益は 3 産において黒字となった。1 産から 5 産までにおいて，各産次の純利益は 145.8 ドルから 390.2 ドルに増加した。感受性分析の結果，飼料費が 0.40/kg ドルから 0.45/kg ドルに増加すると，4 産次までの生涯純利益は赤字となった。さらに，飼料費が 0.50/kg ドルに増加すると，全産次の生涯純利益が赤字となった。市場価格が 4.25/kg ドル以下となった場合，全産次の生涯純利益は赤字となった。しかし，飼料要求率の低下および離乳子豚数の増加は生涯純利益を増加させた。結論として，長期生存性を高めることは生涯純利益の増加につながる。母豚の生涯純利益を高めるためには，飼料費および飼料要求率の低下，離乳子豚数の増加が重要である。

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