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Economic impact of common health and fertility problems

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Objectives

From this chapter the reader should gain knowledge of:

- the financial losses in dairy cattle owing to reproductive failure, mastitis and clinical digital disease
- the way to calculate the economic impact of number of litters per sow per year, litter size, feed conversion efficiency, daily weight gain and mortality rate on swine farms

4.1 Introduction

The calculation of **financial losses** is especially of importance to help provide a better overall view of the impact of disease and to contribute to estimating the extent of the losses to be avoided. The latter is particularly the case if a difference in losses among farms is indicated, in addition to the losses in the average situation. Three questions should be answered for an economic characterization of the actual situation:

1. To what extent does the problem in its various forms occur?
2. What are the quantitative and qualitative effects on production, mortality, etc. expressed in physical terms?
3. How can these physical effects be expressed in financial terms?

The accuracy of the answers to these questions - and thus of the economic calculations - highly depends on the availability and usefulness of the underlying data. But even if enough data are available, it is not a simple task to quantify the losses from disease, because their effects:

- are not always obvious and pronounced;
- are influenced by other factors such as nutrition and housing;
- have a temporal dimension which adds to the complexity of determining their impacts at different stages in time; and
- often manifest themselves together with other diseases.

This may help explain why the outcome of calculations often differs so much, even for similar farm and price conditions.
From a methodological point of view, financial losses at farm level can be attributed to one or more of the following factors at animal level:
a. less efficient production and higher veterinary costs prior to disposal;
b. reduced slaughter value and idle production factors at disposal; and
c. lost future income owing to disposal.

Factor c only occurs when animals have to be replaced before reaching their economically optimal age. The loss is the difference between (1) the income that a particular animal could yield during her remaining expected life, had the reason for replacement not presented itself - given normal probabilities of disposal due to other reasons - and (2) the expected average income over the same period of time of replacement animals with normal productive qualities and normal probabilities of disposal. When calculating the total loss per farm, factors a, b and c must be added.
Quantifying the economic losses owing to disease is mainly performed by simple partial budgeting techniques. In the remainder part of this chapter this type of calculation is illustrated for dairy cattle (ie, reproductive failure, mastitis and lameness) and swine (sow and pig fattening performance) for typical Dutch conditions. The approach is general, however, and could also be used for other farm and price conditions.

4.2 Applications in dairy cattle

4.2.1 Reproductive failure

Underlying reasons for reduced reproductive performance in dairy herds may range from infertile cows to inadequate management practices. Economically speaking, such reasons eventually lead to either a **longer calving interval** or **premature disposal**. Hence, economic calculations should include both these factors.

Calving interval

The issues of optimal calving intervals and the effect of a change in calving interval (or days open) on the economic performance of cows have often been discussed. While some studies have found short intervals of 310 to 340 days to be optimal, others have indicated intermediate optima between 370 and 400 days. One reason for the different results in these studies may be the difference in criteria used (eg, milk production only versus a comparison on total net return) and the different price and production conditions under consideration. Also, in some field studies the average effect for all cows is presented, whereas others distinguish between cows that differ in age and calving season. Moreover, the losses because of extended calving intervals are sometimes wrongly combined with those from premature disposal, which also affects the results.
For a valid economic evaluation, insight is required into the relationship - on a per-cow basis - between the length of calving interval and the resulting **net return per unit of time** (day, year).

Taking a year as the most common basis in income calculations, total net return per calving interval (TNR_i) should be multiplied by $365/L_i$, where L_i refers to the length (in days) of the calving interval i concerned. The calving interval with the highest yearly net return ($Max[TNR_i \times 365/L_i]$) is defined as optimal, while the difference with every other calving interval indicates the loss in income per cow per year. These differences can only be influenced by those revenues and costs which are not proportional to the length of calving interval. Three categories are commonly considered (Jalvingh, 1993):

- net milk receipts;
- calf sales; and
- other components.

Each of these is discussed and illustrated for herd conditions as described in Appendix 4.1. Standard lactation curves of daily milk yields (kg) for individual cows have a downward slope following peak production. The increase in total lactation milk production with longer calving interval, therefore, is less than proportional. Total increase is further diminished by an increase in days dry with longer calving intervals. Moreover, pregnancy usually reduces milk yield beyond about four months after conception. As an example, results are presented in Table 4.1 for third lactation cows with average production level.

Table 4.1 Milk yield for third lactation cows

Calving interval (months)	12	14	Difference
Length of lactation (days)	305	345	+ 40
Length of dry period (days)	60	80	+ 20
Milk yield per lactation (kg)	7397	7979	+ 582
Milk yield per year (kg)	7397	6853	- 544

As indicated in Table 4.1, lactation length increases by 40 days and the dry period by 20 days with a calving interval that is two months longer. Total lactation milk yield increases by 582 kg, which equals 582/60 = 9.7 kg per additional day of calving interval. However, this increase is considerably less than the average production of 20.3 kg per day with a calving interval of 12 months. So, annual milk yield decreases by 544 kg (ie. 7.4%) or 544/60 = 9.1 kg per additional day of calving interval. At a milk price of US$0.42 per kg, therefore, the average loss amounts to US$3.82 per day. However, a considerable part of these losses is compensated for by three interrelated factors:

- higher percentage of fat and protein in the extra milk yield;
- lower total feed costs; and
- positive effect on milk yield in the subsequent lactation.

In contrast to the downward slope of the milk yield curve (kg), the percentages of fat and protein increase towards the end of lactation. Thus, the fat and protein percentages in the extra milk yield with lengthened calving interval are relatively high. This is an important consideration if the milk price is dependent on fat and protein contents (as is the case in many countries). Feed requirements per cow depend, among other things, on age, level of milk yield, percentages of fat and protein in the milk and live body weight. Consequently, total feed costs decrease with diminishing annual milk yield. On the other hand, feed costs increase with calving interval because of the increase in live body weight. Finally, the increased dry period and associated higher live body weight with longer calving interval is assumed to have a slightly positive effect on milk yield in the subsequent lactation. This leads to a difference in net milk receipts (calculated as the margin between gross milk receipts and feed costs), as is presented in Table 4.2.

Table 4.2 Losses in net milk receipts per cow per year (US$)[a]

Calving interval (months)	11	12	13	14	15	16	17
Lactation 1	21	0	13	42	81	123	169
Lactation 2	1	0	36	91	152	219	288
Lactation 3	0	17	72	144	223	307	393
Lactation 4-5	0	19	76	152	234	321	409
Lactation 6-8	0	20	77	152	233	319	408
Lactation ≥9	0	18	73	145	223	306	392
Average cow	0	3	43	101	167	237	309

[a] The calving interval with highest net milk receipts is set at zero

Taking into account net milk receipts only, the optimal calving interval for first lactation cows is one year. For older cows the optimal interval is shorter than one year, while the loss due to a longer calving interval is much higher than for first lactation cows.

It is obvious that the number of calves born per year will decrease with longer calving intervals. With a calving interval of 11 months, for instance, theoretically 12/11 = 1.09 calves are born per year versus 12/17 = 0.71 with a calving interval of 17 months. These differences are slightly reduced when taking into account a - fixed - percentage for calf mortality. Nevertheless, considering calf sales only, the shortest calving interval is optimal for both first lactation and older cows.

Labour costs per year will slightly decrease with longer calving intervals because of, for instance, fewer milking days and number of calves born. Other components to be included involve costs of insemination and veterinary treatment. Their relationship with the length of calving interval, however, highly depends on the underlying causes of the problems (eg, poor oestrus detection versus retained placenta and/or metritis). It is considered more appropriate, therefore, to exclude the costs of insemination and veterinary treatment from the more general type of calculations with respect to calving intervals as such and add them separately per farm as additional costs due to reproductive failure.

The final economic comparison of calving intervals should be based on the combined outcome of the three categories considered (net milk receipts, calf sales and other components). The results are summarized in Table 4.3.

Table 4.3. Optimal length of calving interval and calculated losses per cow per year (US$)

Calving interval (months)	11	12	13	14	15	16	17
Lactation 1	7	0	26	66	113	163	217
Lactation 2	0	17	68	136	208	284	362
Lactation 3	0	36	106	297	282	376	471
Lactation 4-5	0	38	111	199	293	390	487
Lactation 6-8	0	38	111	199	292	389	486
Lactation ≥9	0	36	106	192	282	375	470
Average cow	0	20	75	146	222	301	382
Per day longer calving interval for an average cow:							
Per average day	-	0.67	1.25	1.62	1.85	2.01	2.12
Per marginal day	-	0.67	1.83	2.37	2.53	2.63	2.70

If all relevant factors are considered, the optimal calving interval for first lactation cows is still exactly one year. For older cows the optimal interval is shorter than one year, while the loss due to a longer calving interval is much higher than for first lactation cows. For an average cow it is also apparent that the **average loss per day** increases from US$0.67 (20/30) with a calving interval of one year to US$2.12 (382/180) with a calving interval of 17 months. Thus, the costs of each day of increased calving interval are not uniform, which is also shown by the **marginal loss per day**. Lengthening the optimal calving interval by one month causes a loss of US$0.67 ((20-0)/30) per day, which increases to US$1.83 ((75-20)/30) per day when lengthening from 12 to 13 months, while the loss due to a further lengthening amounts to US$2.37 to 2.70 per extra day.

The outcome of the calculations on the economics of calving interval is found to be not very sensitive to changes in major input factors such as milk price, value of calves, production level and production effect in subsequent lactations. In contrast, a change in shape of the lactation curve has a very strong influence. A 10% higher **persistency** (ie, a reduced downward slope after peak production) leads to a decrease of 25 to 50% in loss, with the optimal interval increasing from 11 to 12 months. A 10% lower persistency increases the loss by 25 to 50%: then the marginal loss beyond 400 days amounts to almost US$3.50 per day. **Month of calving** is another factor with a significant impact on the economics of calving interval, at least if prices for milk and calves show seasonality. For Dutch conditions these prices are highest in autumn and winter. Losses because of extended calving intervals, therefore, are higher for cows calving in these seasons than for cows calving in spring and summer, as is shown in Table 4.4. In the latter cases the time of calving(s) is shifting towards a more profitable season.

Table 4.4 Optimal length of calving interval and calculated losses per cow per year (US$) for an average cow with different months of calving[a]

Calving interval (months)	11	12	13	14	15	16	17
Month of calving							
- February	0	48	120	158	194	271	347
- May	10	0	57	128	197	239	285
- August	0	8	23	58	146	281	407
- November	0	32	141	258	365	468	519

[a] Assuming subsequent calving intervals to be 12 months

Premature disposal

The annual culling rate on commercial dairy farms is, on average, about 30 to 35%, nearly one quarter of which is due to reproductive failure. In quantifying the losses owing to premature disposal, special attention has to be paid to factors associated with age (eg, milk receipts, value of calves, slaughter value of cows, feed costs and probabilities of disposal) and to the costs of replacement heifers[1]. The extent of these losses is strongly influenced by the age and relative production level of the cow under consideration, ranging from about US$60 for low-producing cows (80-85% at Mature Equivalent) to more than US$1400 for high-producing young cows (about 125% at Mature Equivalent). The average loss per cow culled owing to reproductive failure was determined to be US$220 to 280, which is much lower than disposal for several other reasons. This is because these cows can finish their final lactation in a normal way and their slaughter value remains high.

Total reproductive losses per farm

Assuming a typical Dutch herd with an average calving interval of about 380 days (Appendix 4.1), the distribution of cows over the various classes of calving intervals considered in Table 4.3 is 36%, 28%, 17%, 10%, 5%, 3% and 2% respectively. Taking into account the calculated losses for an average cow, total annual losses of the 380-day herd calving interval average 0.36 x 0 + 0.28 x 20 + ... + 0.02 x 382 = US$61 per cow. About 80% of the cows calve in a year, making the losses on herd basis equal to 0.80 x US$61 = US$49 per cow per year. Moreover, 6 to 7% of all cows are culled because of reproductive failure, resulting in a total loss of USS16 per cow per year (ie, 0.06 to 0.07 multiplied by US$220 to 280). Finally, some other costs will turn up, depending on the cause(s) of the problems (eg, additional costs of insemination and veterinary services). So, in total the annual costs of reproductive failure will average about US$80 per cow per year, or US$3600 for a 45-cow herd. This corresponds to 2% of gross return and 10% of the farmer's net return to labour and management (Appendix 4.1).

[1] The methodology underlying these calculations is explained in Chapter 7.

4.2.2 Mastitis

Mastitis is generally considered a disease of major economic importance in dairy cows. In the literature, the outcome of calculations of losses attributed to mastitis differ considerably, depending on the method used, the sources of losses included and the origin of the data. Consequently, those results should be interpreted with care.

Most frequently, economic calculations on mastitis losses are based on annual herd parameters rather than on daily cow performances. Previously, the number of somatic cells in milk was used as a major criterion for estimating the presence and severity of mastitis. There is an on-going discussion, however, whether this criterion is still appropriate. Using **pathogens** in milk as a diagnostic criterion seems to be more preferable. Four different types of pathogens are especially of importance to be considered: coliform, streptococcal, staphylococcal and *Corynebacterium pyogenes*. Additionally, there may be clinical cases in which no pathogens can be detected, usually defined as bacteriologically negative.

The economic effects of mastitis can be divided into three categories (Houben, 1995):

- reduced milk receipts;
- cost of treatment; and
- premature disposal.

No single set of published data is available to quantify these effects. Therefore, they have to be derived from various sources. These data are summarized in Table 4.5 for Dutch conditions, and focus on so-called clinical mastitis.

Table 4.5 Major input data for infections with clinical signs

Type of pathogen	Frequency[a]	Infected quarters per case	Annual milk decrease per quarter (%)	Annual culling rate(%)
Streptococcal	10.8	1.3	22	10
Coliform	7.0	1.1	17	14
Staphylococcal	3.0	1.4	26	14
C. Pyogenes	1.6	1.1	48[b]	80
Bact. Negative	5.6	1.3	21	12
Total/Average	28.0	1.3	23	14

[a] Percentage cow cases per year
[b] Next lactation

As shown in Table 4.5, the total frequency of **clinical mastitis** is estimated to average 28 cow cases per 100 cows per year, with 28 x 1.3 = 36 quarters being involved. Streptococcal infections appear to be the most frequent. The estimated decrease in total milk production is taken to be 23%, ranging from 17% for coliform to 48% for *Corynebacterium pyogenes*.

Fat content of milk is assumed to be reduced by over 4%. For each kg of milk not produced a saving of 0.5 kg of concentrates is taken into account. Treatment costs are considered to include veterinary fees, drug expenses and farmer's labour. Milk from cows treated with antibiotics will not be delivered to the factory for five days, but fed to young calves.This reduces the losses from otherwise discarded milk. Table 4.5 shows that, on average, 14% of the cows with clinical mastitis are culled. *Corynebacterium pyogenes* ranks by far the highest with a culling rate of 80%. The average loss per cow culled owing to mastitis is assumed to be about US$250, which equals the loss per cow culled for reproductive failure. Finally, per year five cows (ie, six quarters) in a 45-cow herd have infections **without any clinical signs**, 60% of which are caused by streptococcal and 40% by staphylococcal bacteria. Losses are restricted to milk reduction (4.6% per lactation) and fat reduction (1.9% per lactation). Mastitis without clinical signs is difficult to detect. Therefore, neither treatment costs nor premature disposal are included in the calculations. The calculated annual losses owing to mastitis, based on all these assumptions, are summarized in Table 4.6.

Table 4.6 Calculated annual losses due to mastitis (US$)

Type of pathogen	Per infected cow With clin. signs	Per infected cow Without clin. signs	Total per average cow in herd
Streptococcal	296	25	35 (40%)
Coliform	240	-	17 (19%)
Staphylococcal	337	41	14 (16%)
C. Pyogenes	349	-	6 (7%)
Bact. Negative	284	-	16 (18%)
Total/Average	517	57	88 (100%)

Per clinically infected cow, the *Corynebacterium pyogenes* pathogen causes the highest losses, especially because of its extremely high culling rate. Staphylococcal infections rank second, due to a combination of a relatively high number of infected quarters per case and a considerable loss in production. Infections without any clinical signs are, from an economic point of view, far less important. At farm level streptococcal infections have the greatest economic impact, ie, 40% of total losses, while *Corynebacterium pyogenes* ranks lowest. The differences in costs per case are offset by differences in frequency rates. Total losses per farm average US$88 per cow per year (or about US$4000 for a 45-cow herd), which equals approximately 11% of farmer's net return to labour and management (Appendix 4.1). Reduction in milk and fat production accounts for 70% of these losses, 18% of which owing to treatment and 12% caused by premature disposal.

4.2.3 Clinical digital diseases

Calculations on the economics of lameness in dairy cattle are sparse, because there is a serious lack of data on both frequency and effects of the disease. Available research for the Netherlands shows that in 21% of the lactations one or more cases of clinical digital diseases are diagnosed. Twenty-eight percent of the affected cows are replaced, which make up 7.6% of all cows culled. Losses are expected to include:

- reduced milk receipts;
- longer calving interval;
- treatment costs;
- extra labour input by the farmer;
- premature disposal; and
- reduced - energy - efficiency due to weight fluctuations.

Reduction in milk yield turns out to be limited, but varies highly between cows that are not culled and cows that are culled because of digital diseases. Culled cows have considerably and significantly lower milk, fat and protein productions (Table 4.7).

Table 4.7 Production data and calving intervals of cows with clinical digital diseases, divided into cows culled and not culled

	Loss of production (in %)			Longer calving
	milk (kg)	fat (kg)	protein (kg)	interval (days)
cows culled	11.3%	14.1%	16.3%	—
cows not culled	0.8%	1.1%	1.1%	9.0

It is also shown in Table 4.7 that cows with digital diseases have on average a 9-day longer calving interval: 385.5 days compared with 376.5 days for cows without digital diseases.

Considering treatment costs, it is known that 60% of the cows with clinical digital diseases receive veterinary treatment. Farmer's additional labour input required for cows with this type of problems is estimated to be slightly more than 30 minutes per lactation. Assuming that this time could have been used alternatively, opportunity costs are taken into account in the calculation of the losses.

Losses due to premature disposal consist of loss of slaughter weight and carcass quality, loss of future income and losses associated with idle production factors. The way these losses are calculated is discussed in detail in Chapter 7.

Quite often, lameness results in loss of body condition, because the cow is not able to take in the required amount of energy for maintenance and production. This loss of live weight of cows with clinical digital diseases amounts to 3 to 5% of the total live weight. Moreover, the maintenance requirement may be increased due to immune responses.

Combining these assumptions provides an estimate of the losses, as summarized in Table 4.8. Total losses amount to almost US$30 per cow per year, ranking third after mastitis and reproductive failure.

Table 4.8 Average annual losses owing to clinical digital diseases (US$)

	Per case	Per cow present in herd
Reduced milk receipts	36	8
Longer calving interval	16	3
Treatment costs	12	3
Extra labour input by the farmer	17	4
Premature disposal	45	9
Weight fluctuations	1	-
Total	127	27

4.2.4 Total losses and differences among farms

Total calculated losses owing to reproductive failure, mastitis and lameness average US$80 + 88 + 27 = US$195 per cow per year. Considering other diseases not yet included, total losses in dairy cattle may increase to - at least - US$300 per cow per year on average. This corresponds to almost 10% of gross return and 40% of farmer's net return to labour and management (Appendix 4.1).

It will not be possible - and profitable - to avoid all calculated losses. Differences among farms can help to gain insight into what is attainable under current conditions. Farm-specific data suitable for research on animal health economics are sparse, however. Available data on differences in calving interval suggest big differences among farms, easily exceeding the calculated average loss. Moreover, the best 20% of farms prove to realize only half of the calculated losses on the average farm. So, there is reason to expect that considerable economic improvement can be achieved, especially for farms with higher than average losses.

4.3 Applications in swine

4.3.1 Sow performance

Differences among farms

Available data on health and fertility problems in swine are too fragmental to be included in economic calculations. Another way to gain more insight into their - potential - economic impact is to analyse differences in productive performance among farms, the data of which are more readily available. In the Netherlands, for instance, sow herds with the best performances raise more than 23.4 pigs per sow per year, while the 20% with the poorest results do not exceed 17.8 pigs (Table 4.9). Assuming an average net economic value of roughly US$45 for each additional pig raised, such a difference corresponds with US$252 per sow per year, which is even more than the average net return to labour and management on a typical farm (Appendix 4.2).

Table 4.9 Differences in performance among Dutch sow herds

Performance indicator	**Five classes with 20% of farms in each**				
	Worst	**Poor**	**Average**	**Good**	**Excellent**
Litters per sow per year	<2.14	2.14-2.19	2.20-2.24	2.25-2.34	>2.34
Pigs born alive per litter	<10.4	10.4-10.6	10.7-10.9	11.0-11.2	>11.2
Pig mortality rate	>16.5	16.5-14.6	14.5-12.6	12.5-10.6	<10.6
Pigs raised per litter	<8.4	8.4-9.0	9.1-9.5	9.6-10.0	>10.0
Pigs raised per sow per year	<17.8	17.8-19.6	19.7-21.5	21.6-23.4	>23.4

It is not known, however, what portion of these differences is directly related to health and fertility problems in a strict sense. Assuming these problems to be responsible for half the difference would imply an impact equal to 10% of gross return and 50% of farmer's net return to labour and management. Such values are not unlikely when compared with dairy cattle. The economic weights for single performance indicators will now further be determined and explained, using the partial budgeting technique.

Number of litters per sow per year

If conception is delayed by one cycle (21 days), income that could otherwise have been obtained over the course of a year will be obtained over 386 days (365 + 21 days). Annual performance as indicated in Appendix 4.2 will then be 365/386 x 2.22 = 2.10 litters and 365/386 x 20.6 = 19.5 pigs raised per sow per year, which means a reduction of 0.12 litters and 1.1 pigs respectively. The resulting losses because of a 3-week delay in conception include (Jalvingh, 1993):

Revenues foregone

- 1.1 pig x US$64 = US$70.40

Reduced costs

- Feed for the sow

The allocation of time to gestation, lactation and days open per sow per year changes with a delay in conception from 255 (2.22 x 115), 67 (2.22 x 30) and 43 (365 - others) to 242, 63 and 60 respectively. Assuming a common feeding scheme this results in a saving of about 15 kg x US$0.24 = US$3.60.

- Feed for the pigs

1.1 pig x 30 kg x US$0.40 = US$13.20.

- Others

There are hardly any other savings, except for transportation and (medical) treatments, estimated at US$4.00 x 1.1 piglet = US$4.40.

Net result

- Total revenues foregone minus reduced costs equal US$70.40 - (US$3.60 + 13.20 + 4.40) = US$49 per three weeks of delay in conception, or slightly more than US$2 per extra day open.

A shortening of the interval between weaning and conception by three weeks increases the annual results presented in Appendix 4.2 to 365/344 x 2.22 = 2.36 litters (plus 0.14) and 365/344 x 20.6 = 21.9 pigs raised per sow per year (plus 1.3). Such an increase implies an extra profit of about US$58 per three weeks of earlier conception, or about US$2.75 per - avoided - day open. So, other than with dairy cattle, the cost per additional day open in sows decreases with longer intervals.
Taking into account the difference between the best performing farms realizing more than 2.34 litters per sow per year and the worst performing ones with fewer than 2.14 litters (Table 4.9) implies a difference in income of approximately US$90 per sow per year or even 37% of a farmer's typical income (Appendix 4.2).

Litter size

Calculating the economic value of one additional pig raised per sow per year includes:

Additional revenue

- 1 pig x US$64 = US$64

Additional costs

- Feed for the sow: 30 days x 0.4 kg = 12 kg x US$0.24 = US$2.88
- Feed for the pig: 30 kg x US$0.40 = US$12.00
- Others: transportation, (medical) treatment etc. = US$4.00

Net result

- The additional revenue minus costs equals about US$64 - (US$2.88 + 12.00 + 4.00) = US$45 per pig raised.

The same approach can be used when calculating the economic value of one additional pig born alive, but then the probability of survival should be taken into account. On average, total pig mortality equals about 14% (Table 4.9) implying a survival rate of 86%. Given that the majority of pig deaths occur within the first few days of life, the economic value of one additional pig born alive is US$45 x 0.86 = USS39. The lower the survival rate, the lower the economic value. This may especially be true with increasing litter size.
The 20% of farms with the best and those with the worst results differ at least 0.8 pig born

alive and 1.6 pig raised per litter, as indicated in Table 4.9. With 2.22 litters per sow per year and an economic value of US$39 and US$45 per pig respectively, the differences in income caused by these factors equal US$70 to US$160 per sow per year. This is even 30 to 65% of a farmer's typical income (Appendix 4.2).

Premature disposal

In the Netherlands about 45% of the sows are replaced annually. The average productive lifespan of the sows, therefore, is 100/45 = 2.2 years or about 5 litters only. Reproductive problems are the major reasons for disposal (35%), with failure to conceive as its major component. Low productivity is the second most important reason (17%), together accounting for more than half of the annual culling rate.

Increasing the herd life is economically attractive, because (1) fewer replacements have to be bought or raised, and (2) more sows will reach the most productive parity numbers 4 to 8 (Huirne, 1990; Jalvingh, 1993). Dynamic programming was used (explained in Chapter 7) to quantify the profitability of increased herd life. Results are summarized in Table 4.10.

Table 4.10 Average profitability of herd life in sows

	+1 litter	Herd average	-1 litter
Litters per total sow life	6.1	5.1	4.1
Annual replacement rate	38.2	45.6	56.7
Litters per sow per year	2.31	2.31	2.31
Pigs raised per sow per year	21.0	20.8	20.6
Pigs raised per total sow life	55.3	46.0	36.6
Income margin/sow/year (US$)	481 (+16)	465	442 (-23)

Table 4.10 shows that income per sow per year increases by US$16 if the average age at culling is increased by one litter. One litter less decreases income by more than US$20, indicating that a reduction of the risk of removal is subject to diminishing additional returns. Assuming a difference in average herd life of two years between the 20% of farms with the best and those with the worst results would - according to Table 4.10 - cause a difference in income per sow per year of about US$40, or 16% of a farmer's typical income (Appendix 4.2).

4.3.2 Pig fattening performance

Differences among farms

The economic performance on pig fattening farms is highly influenced by feed conversion efficiency, daily weight gain and mortality rate. Differences in these parameters among farms are summarized in Table 4.11.

Table 4.11 Differences in performance among Dutch pig fattening herds

Performance indicator	**Worst**	**Poor**	**Average**	**Good**	**Excellent**
	Five classes with 20% of farms in each				
Feed conversion effic. (kg feed/kg weight gain)	>2.99	2.99-2.92	2.91-2.84	2.83-2.76	<2.76
Daily weight gain (grams)	<681	681-699	700-730	731-755	>755
Mortality rate (%)	>3.65	3.65-3.06	3.06-2.54	2.53-1.56	<1.56

As with sow herds, it is not precisely known what part of these differences is directly related to health problems as such. But even if this is a minor part, the effect on income for a typical farm (Appendix 4.3) will still be considerable, as can be derived from the following economic calculations for the single performance indicators.

Feed conversion efficiency

A difference in feed conversion ratio (kg feed per kg of weight gain) of 0.1 affects feed consumption by 8.5 kg per hog sold and income by 8.5 kg x US$0.28 = US$2.38 per head. According to Table 4.11, the difference between the lower bound of the 20% best performing farms and the upper bound of the 20% of the worst performing farms equals 0.25 (3.0 minus 2.75) and, therefore, causes a calculated total difference in income of 0.25/0.1 x US$2.38 = US$5.95 per hog sold. Such a difference equals 3% of gross return and 66% of net return to labour and management on a typical fattening farm (Appendix 4.3).

Daily weight gain

In quantifying the economic impact of differences in daily weight gain, it is necessary to determine which single cost item (specified in Appendix 4.3) is related to the length of the fattening period, and which is not. Purchase price of the piglet and cost of transportation of the fattened hog are examples of costs which are **not** related in this way. Moreover, no relationship should be included for total feed costs, because differences in this parameter manifest themselves already in the feed conversion efficiency and thus should not be counted twice. The other cost items are more likely to be related to the length of the fattening period. So, the income margin per day of fattening period in the starting situation (Appendix 4.3) equals: gross return - (purchase price piglet + feed costs + cost of transportation) = US$178 - (US$64 + 69 + 3) = US$42 in 119 days or US$0.35 per day. A 10-gram increase in daily weight gain decreases the initial fattening period of Appendix 4.3 by 1.7 days, implying an economic value of 1.7 x US$0.35 = US$0.60. With a 10-gram decrease these values are the same. So, the economic value per gram of daily weight gain equals about US$0.06. Considering the upper and lower bounds of the 20% best and 20% worst performing farms (Table 4.11) this implies a difference in income of US$4.50 per hog sold. Such a difference equals about 3% of gross return and 50% of net return to labour and management on a typical fattening farm (Appendix 4.3), ranking second after feed conversion efficiency.

Mortality rate

Assuming that, on average, mortality occurs halfway the fattening period, the losses include:

- costs before death: purchase price piglet + 59.5/119 x (gross return - purchase price piglet) = US$64 + 0.5 x (US$178 - 64) = US$121; and
- return to labour and housing foregone after death: 59.5/119 x (housing + labour + net profit) = 0.5 x (US$20 + 10 - 1) = US$15.

So, in total, these costs average US$136 per dead fattening hog, or US$1.36 per percentage of hog mortality. For the corresponding differences between the highest and the lowest classes in Table 4.11 this implies a difference in income of 2.1% x US$1.36 = US$2.86 per hog sold. This difference equals almost 2% of gross return and 32% of net return to labour and management on a typical fattening farm (Appendix 4.3), ranking third after feed conversion efficiency and daily weight gain.

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Appendix 4.1 Typical results for commercial Dutch dairy farms

Herd size 45 cows - young stock 14 heifers and 16 calves - annual milk yield 7000 kg per cow containing 4.35% of fat and 3.4% of protein - herd calving interval 380 days - annual culling rate 30%

Gross return (per cow per year)				
milk (7000 kg x US$0.42)	US$	2940		
cattle inventory	-	440		
			US$	3380
Costs (per cow per year)				
labour (50 hrs x US$18)	US$	900		
machinery costs	-	460		
feed costs	-	672		
housing (depreciation, interest and maintenance)	-	540		
rent for land	-	203		
fertilizer	-	116		
health care	-	83		
others (artif.insem., electricity, interest, etc.)	-	500		
			US$	3474
Net profit (per cow per year)		-/-	US$	94
Net return to labour and management (per cow / year)			US$	806
Net return to labour and management (total herd / year)			US$	36270

Appendix 4.2 Typical results for commercial Dutch sow farms

Herd size 150 sows - weaning at 30 days - 2.22 litters per sow per year - 10.8 pigs born alive per litter - mortality rate 14% - 9.3 pigs raised per litter - 20.6 pigs raised per sow per year

Gross return (per sow per year)					
20.6 pigs x US$64		US$	1318		
sow inventory	-/-	-	20		
				US$	1298
Costs (per sow per year)					
feed: sow (incl.repl.gilts) 1157 kg at US$0.24, and piglets 20.6 x 30 kg at US$0.40		US$	525		
housing (depreciation, interest and maintenance)		-	314		
labour		-	306		
health care		-	45		
interest (herd and feed stock)		-	36		
cost of transportation piglets		-	29		
others (artif.insem., water, electricity, etc.)		-	105		
				US$	1360
Net profit (per sow per year)			-/-	US$	62
Net return to labour and management (per sow / year)				US$	244
Net return to labour and management (total herd / year)				US$	36600

Appendix 4.3 Typical results for commercial Dutch pig fattening farms

Herd size 1600 hogs - 2.61 deliveries per year - mortality rate 2.8% - 4058 hogs sold per year - starting weight 25 kg - ending weight 110 kg - daily weight gain 715 gr - net fattening period 119 days

Gross return (per hog sold)					
85.3 slaughter weight x US$2.09				US$	178
Costs (per hog sold)					
feed: feed conversion 2.88 and 85 kg of weight gain makes 245 kg of feed at US$0.28	US$	69			
purchase piglet	-	64			
housing (depreciation, interest and maintenance)	-	20			
labour	-	10			
interest (herd and feed stock)	-	3			
cost of transportation hogs	-	3			
health care	-	2			
others (water, electricity, mortality, etc.)	-	8			
				US$	179
Net profit (per hog sold)			-/-	US$	1
Net return to labour and management (per hog sold)				US$	9
Net return to labour and management (total herd / year)				US$	36522