THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Ear Tag Loss Rate Calculation Methods

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Change Summary

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1 Introduction

The loss rate of ear tags is one of the most important quality characteristics. On the one hand, this has to do with the high labour and administration costs for replacing ear tags while on the other hand, accidents when working with animals cause high economic losses. In addition, ear tags are official means of clearly identifying animals which thus means significant financial losses can occur if misidentified animals are selected in situations such as epidemics or vaccination programs.

To date, comparisons of loss rates have often failed due to non-standardized calculation methods. The reason for this lies in the large differences worldwide between the various systems to produce meat and milk, the available data and the willingness to program complex selection and evaluation procedures. As a result, different approaches to calculate the loss rate are used in different regions of the world. All these approaches have their justification, as they best reflect the respective situation in a region or a specific production system.

The methods proposed in this document represent an attempt to provide different ways of calculating loss ratios for different initial situations and issues, with the aim of standardizing the methods. It is important to carry out a technical comparison between loss rates only if they are based on the same calculation method. Loss rates are given as a number between 0 and 1 or as a percentage. In addition to the loss rate, the retention rate provides the same information but from a different perspective.

It is important to specify a 95% confidence interval to evaluate the loss rate statistically. This interval indicates that in 95 out of 100 samples drawn from a population, the loss rate mean values lie within the lower and upper limits of the calculated interval.

2 Calculation method: Loss rate in selected livestock

A loss rate based in selected livestock is the best method to compare the quality of different ear tags in special holding environments. It is a field test with special framework conditions. The data basis comes from one or more holding systems with selected livestock, whereby all animals are considered from the beginning to the end of the observation period. All animals included in the test need to be tagged before the commencement of the reference period. The (age) group performing the test needs to be defined. In many cases, animals aged between 0 and 6, 0 and 12, 0 and 24, or, respectively, 0 and 36 months are used. Using this loss rate calculation model, all animals leaving before end of the field test <u>must be excluded</u> from the analysis.

2.1 Advantages

1. The method provides a very accurate value for a specific production system.
2. The method can be used in field tests, especially if no data from official registration databases is available.

2.2 Disadvantages

1. The method could provide a value <u>only</u> for a specific production system. A transfer of the results to other production systems may be limited.
2. The result is highly dependent on the holding systems from which the database originates. If the loss rates are low due to the husbandry systems, this can provide just as little information about the ear tag quality as loss rates that are high due to difficult husbandry conditions.

2.3 Calculation method

$$LR_{SL(TP)} = \frac{RT}{ET[A] \times A_{SL}}$$

where:

$LR_{SL(TP)}$	is the loss rate in a selected livestock for a definite time period,
TP	is the time period of the field test in month (e.g. 12 for 12 months, 24 for 24 months, 36 for 36 months),
RT	is the number of replacement tags,
$ET[A]$	is the number of ear tags per animal (1 for single identification, 2 for double identification),
A_{SL}	is the total number of animals that fully perform as observed for the field test.

and – if {(ET[A] x A_{SL}) x $LR_{SL(TP)}$ > 5} and {(ET[A] x A_{SL}) x (1 – $LR_{SL(TP)}$) > 5} – with a 95 % confidence interval of:

$$\mathrm{CI}_{\mathrm{SL(TP)-95\%}} : [p_1 \, ; p_2] \quad \text{and}$$

$$p_{1,2} = LR_{SL(TP)} \pm 1.96 \times \sqrt{\frac{LR_{SL(TP)} \times (1 - LR_{SL(TP)})}{(ET[A] \times A_{SL}) - 1}}$$

2.4 Calculation example

All animals are officially identified with 1 ear tag (single identification). Data is available from 4 farms with a total of 10,000 animals that were involved in the field test over the entire observation period. 672 ear tags were replaced during the observation period of 36 months.

$$LR_{SL(36)} = \frac{672}{1 \times 10{,}000} = 0.0672 = 6.72\ \%$$

Because each {(ET[A] x A_{SL}) x $LR_{SL(36)}$ > 5} and {(ET[A] x A_{SL}) x (1 – $LR_{SL(36)}$) > 5}, the lower and upper limits of the confidence interval can be calculated for binomially distributed parameters (lost / not lost):

$$p_{1,2} = 0.0672 \pm 1.96 \times \sqrt{\frac{0.0672 \times (1 - 0.0672)}{(1 \times 10{,}000) - 1}}$$

$$p_1 \cong 0.0623 \qquad p_2 \cong 0.0721$$

The 95 % confidence interval is:

$$\mathrm{CI}_{\mathrm{SL(36)-95\%}} : [0.0623 \, ; 0.0721]$$

2.5 Presentation of the results

The results should be published in this way:

The loss rate is $LR_{SL(36)} = 6.72\ \%$ with a confidence interval of $\mathrm{CI}_{\mathrm{SL}(36)-95\%}$: [6.23% ; 7.21%].

3 Calculation method: Loss rate shown as a snapshot for a population

3.1 Loss rate per year weighted by days in the observation period

A loss rate which is shown as a snapshot can be used for all livestock systems in which calves are born. The figure is one of the best estimators for an average loss rate, taking into account the sum of days an observed animal was hold in the housing system (average value weighted by the number of days an animal was in the herd). The ratio of the number of replacement ear tags ordered in the reference year to the number of cattle kept in the observed area is calculated. Information comes from an official database and contains many observations relating to a defined region or country.

3.1.1 Advantages

1. The current animal population on a key date is always entered.
2. A large database allows the effects of individual very good or very poor husbandry conditions to be equalised.
3. Disposals, imports, and exports are included in the calculation and do not change the result if they are relatively continuous (year-round calving, largely the same number of cattle throughout the year).
4. An evaluation does not have to be limited to the farm where the animal was born but can also take into account purchased/imported animals if these are continuously distributed over the evaluation period.

3.1.2 Disadvantages

1. There is no direct allocation of replacement ear tags to the ear tags used.
2. The calculation assumes that only one ear tag manufacturer / supplier is active in the observed region.
3. If several ear tag manufacturers are active in the observed region, an exact calculation of the loss rate is difficult, as livestock holders may change providers for their replacement ear tags; in this respect, these effects can influence the result.

3.1.3 Calculation method

$$LR_{WS(Year)} = \frac{RT}{ET[A] \times AvA}$$

where:

$LR_{WS(Year)}$ is the loss rate (weighted snapshot) in an observed year,

$Year$ is the calendar year (e.g. 2025 as the period of 1st of Jan till 31st of Dec),

RT is the number of replacement tags ordered in the observed year,

$ET[A]$ is the number of ear tags per animal
(1 for single identification, 2 for double identification),

AvA is the average number of live animals in the observed year.
(365/365 for an animal born at 1st of Jan 2025 = 1.000 animal)
152/365 for an animal born at 1st of Aug 2025 = 0.461 animal)

and – if {(ET[A] x AvA) x $LR_{WS(Year)}$ > 5} and {(ET[A] x AvA) x (1 – $LR_{WS(Year)}$) > 5} – with a 95 % confidence interval of:

$CI_{WS(Year)-95\%} : [p_1 ; p_2]$ and

$$p_{1,2} = LR_{WS(Year)} \pm 1.96 \times \sqrt{\frac{LR_{WS(Year)} \times (1 - LR_{WS(Year)})}{(ET[A] \times AvA) - 1}}$$

3.1.4 Calculation example

All animals are officially identified with 2 ear tags (double identification). Data is available from an I&R database in defined region. In 2025, 48,706 ear tags were replaced observing an average of 1,093,710 animals living in the defined region.

$$LR_{WS(2025)} = \frac{48{,}706}{2 \times 1{,}093{,}710} = 0.0223 = 2.23\ \%$$

Because each {(ET[A] x AvA) x $LR_{WS(2025)}$ > 5} and {(ET[A] x AvA) x (1 – $LR_{WS(2025)}$) > 5}, the lower and upper limits of the confidence interval can be calculated for binomially distributed parameters (lost / not lost):

$$p_{1,2} = 0.0223 \pm 1.96 \times \sqrt{\frac{0.0223 \times (1 - 0.0223)}{(2 \times 1{,}093{,}710) - 1}}$$

$$p_1 \cong 0.0221 \qquad p_2 \cong 0.0225$$

The 95 % confidence interval is:

$$CI_{WS(2025)-95\%} : [0.0221 ; 0.0225]$$

3.1.5 Presentation of the results

The results should be published in this way:

The loss rate is $LR_{WS(2025)} = 2.23\ \%$ with a confidence interval of $CI_{WS(2025)-95\%}$: [2.21% ; 2.25%].

3.2 Loss rate per year by reference day

The above definition of a loss rate quickly reaches its limits due to the availability of data and the complex evaluation algorithms. Optionally, in populations that have a relatively continuous number of animals in the observation period could be set in relation to the number of animals on a reference date (reference date report). It then makes sense to designate this loss rate separately.

3.2.1 Calculation method

$$LR_{RD(Year)} = \frac{RT}{ET[A] \times A_{RD}}$$

where:

$LR_{RD(Year)}$ is the loss rate (animals at reference day) in an observed year,

Year is the calendar year (e.g. 2025 as the period of 1st of Jan till 31st of Dec),

RT	is the number of replacement tags ordered in the observed year,
$ET[A]$	is the number of ear tags per animal (1 for single identification, 2 for double identification),
A_{RD}	is the number of animals at a reference day (e.g. 31st Dec 2025)

and – if $\{(ET[A] \times A_{RD}) \times LR_{RD(Year)} > 5\}$ and $\{(ET[A] \times A_{RD}) \times (1 - LR_{RD(Year)}) > 5\}$ – with a 95 % confidence interval of:

$$\mathrm{CI}_{\mathrm{RD(Year)-95\%}} : [p_1 \, ; p_2] \quad \text{and}$$

$$p_{1,2} = LR_{RD(Year)} \pm 1.96 \times \sqrt{\frac{LR_{RD(Year)} \times (1 - LR_{RD(Year)})}{(ET[A] \times A_{RD}) - 1}}$$

3.2.2 Calculation example

All animals are officially identified with 2 ear tags (double identification). Data is available from an I&R database in defined region. In 2025, 5,213 ear tags were replaced observing an average of 99,834 animals living in the defined region.

$$LR_{RD(2025)} = \frac{5{,}213}{2 \times 99{,}834} = 0.0261 = 2.61\,\%$$

Because each $\{(ET[A] \times A_{RD}) \times LR_{RD(2025)} > 5\}$ and $\{(ET[A] \times A_{RD}) \times (1 - LR_{RD(2025)}) > 5\}$, the lower and upper limits of the confidence interval can be calculated for binomially distributed parameters (lost / not lost):

$$p_{1,2} = 0.0261 \pm 1.96 \times \sqrt{\frac{0.0261 \times (1 - 0.0261)}{(2 \times 99{,}834) - 1}}$$

$$p_1 \cong 0.0254 \qquad p_2 \cong 0.0268$$

The 95 % confidence interval is:

$$\mathrm{CI}_{\mathrm{RD(2025)-95\%}} : [0.0254 \, ; 0.0268]$$

3.2.3 Presentation of the results

The results should be published in this way:

The loss rate is $LR_{RD(2025)} = 2.61\,\%$ with a confidence interval of $\mathrm{CI}_{\mathrm{RD(2025)-95\%}}$: [2.54% ; 2.68%].

4 Calculation method: Loss rate as reference observation

4.1 Loss rate related to year of application

The loss rate in relation to the year of application is the best estimate for looking at ear tag quality over a longer period. In particular, the development of quality can be tracked over a period of several years. To compare the quality of different ear tags at different ages, the loss rates in relation to the year of application could be used as a reference for the number of ear tags applied in a reference year. If it can be assumed that the ear tags were applied close to the birth of the animals, the age of the originally applied ear tags can be equated with the age of the animals. The calculation methods are challenging as the ear tags issued are set in relation to the date of application. A very good data basis over several years must be available for this evaluation. This analysis is particularly suitable for multi-year monitoring of the loss rate in a region or for comparing different providers, but less suitable for comparison across different regions.

An overall loss rate can be calculated for one year. However, the loss rate of an application year in relation to the losses within one or more years after the application date is more informative. Then, a change in the quality of the ear tags can be recognised at early stage.

4.1.1 Advantages

1. There is a direct assignment of the replacement ear tag to the applicated ear tag.
2. The development of the loss rate can be tracked over a period of several years.

4.1.2 Disadvantages

1. The losses in the following years are offset by a reducing livestock population.
2. Difficulties arise when comparing different regions regarding production systems: populations with a higher average age may perform worse, as the failure rate tends to increase with increasing age.
3. If several ear tag manufacturers / suppliers are active in the observed region, an exact calculation of the loss rate is difficult if this information is not available or as livestock holders may change providers for their replacement ear tags; in this respect, these effects can influence the result.

4.1.3 Calculation method

$$LR_{RO/Year} = \frac{RT}{ET[A] \times A_{Year}}$$

where:

$LR_{RO/Year}$ is the loss rate of all ear tags applied in an observed year,

$Year$ is the year of ear tag application (e.g. 2025),

RT is the number of replacement tags ordered in the observed year (1st year,

2nd year, subsequent years...),

$ET[A]$ is the number of ear tags per animal
(1 for single identification, 2 for double identification),

A_{Year} is the total number of animals applicated in the observed year.

and – if $\{(ET[A] \times A_{Year}) \times LR_{RO/Year} > 5\}$ and $\{(ET[A] \times A_{Year}) \times (1 - LR_{RO/Year}) > 5\}$ – with a 95 % confidence interval of:

$$\mathrm{CI}_{\mathrm{RO/Year-95\%}} : [p_1 ; p_2] \quad \text{and}$$

$$p_{1,2} = LR_{RO/Year} \pm 1.96 \times \sqrt{\frac{LR_{RO/Year} \times (1 - LR_{RO/Year})}{(ET[A] \times A_{Year}) - 1}}$$

4.1.4 Calculation example

All animals are officially identified with 2 ear tags (double identification). Data is available from an I&R database in defined region. For the ear tags applicated in 2024, 97,412 ear tags were replaced observing 1,093,710 animals born in the defined region and year.

$$LR_{RO/2025} = \frac{97{,}412}{2 \times 1{,}093{,}710} = 0.0445 = 4.45\ \%$$

Because each $\{(ET[A] \text{ x } A_{Year}) \text{ x } LR_{RO/2025} > 5\}$ and $\{(ET[A] \text{ x } A_{Year}) \text{ x } (1 - LR_{RO/2025}) > 5\}$, the lower and upper limits of the confidence interval can be calculated for binomially distributed parameters (lost / not lost):

$$p_{1,2} = 0.0445 \pm 1.96 \times \sqrt{\frac{0.0445 \times (1 - 0.0445)}{(2 \times 1{,}093{,}710) - 1}}$$

$$p_1 \cong 0.0443 \qquad p_2 \cong 0.0448$$

The 95 % confidence interval is:

$$\mathrm{CI}_{\mathrm{RO}/2025-95\%} : [0.0443\ ; 0.0448]$$

4.1.5 Presentation of the results

The results should be published in this way:

The loss rate is $LR_{RO/2025} = 4.45\ \%$ with a confidence interval of $\mathrm{CI}_{\mathrm{RO}/2025-95\%}$: [4.43% ; 4.48%].

To compare ear tag qualities over several years, loss rates of an application year could be set in relation to the length of time an ear tag remains in the animal (accumulated over several years):

Year of application	Loss rate within years after ear tag application (in %)				
	1	2	3	4	5
2025	2.21				
2024	2.13	4.45			
2023	1.99	4.73	7.59		
2022	2.38	4.89	8.02	11.36	
2021	2,76	4.74	7.93	11.17	15.60

4.2 Loss rate related to a defined production batch

Like the loss rate in relation to the application year, a loss rate can be defined in relation to a production batch. In this case, the same calculation method is used as in the previous case, but in relation to the production batch instead of the application year. This calculation method has the same advantages and disadvantages as before. However, changes in ear tag quality can already be observed for individual production batches or within the manufacturer for individual production machines or processes.

4.2.1 Advantage

In comparison to $LR_{RO/Year}$, the ear tag quality of different manufacturers / suppliers can be assessed in the same region at the same time period.

4.2.2 Calculation method

$$LR_{RO/Batch} = \frac{RT}{ET[A] \times A_{Batch}}$$

where:

$LR_{RO/Batch}$ observed — is the loss rate of all animals being identified with ear tags of an production batch related to year of application,

$Batch$ — is a register number (an identifier) of the observed batch,

RT — is the number of replacement tags ordered for the observed batch,

$ET[A]$ — is the number of ear tags per animal (1 for single identification, 2 for double identification),

A_{Batch} — is the total number of animals being identified with ear tags of the observed batch.

and – if $\{(ET[A] \times A_{Batch}) \times LR_{RO/Batch} > 5\}$ and $\{(ET[A] \times A_{Batch}) \times (1 - LR_{RO/Batch}) > 5\}$ – with a 95 % confidence interval of:

$$\mathrm{CI}_{\mathrm{RO/Batch-95\%}} : [p_1 ; p_2] \quad \text{and}$$

$$p_{1,2} = LR_{RO/Batch} \pm 1.96 \times \sqrt{\frac{LR_{RO/Batch} \times (1 - LR_{RO/Batch})}{(ET[A] \times A_{Batch}) - 1}}$$

4.2.3 Calculation example

All animals are officially identified with 2 ear tags (double identification). Data is available from an I&R database in defined region. For a defined production batch registered as no. “C-3ZT-24341”, 2,219 ear tags were replaced observing 223,710 animals born in the defined region and year.

$$LR_{RO/C-3ZT-24341} = \frac{2{,}219}{2 \times 223{,}710} = 0.0496 = 4.96\,\%$$

Because each $\{(ET[A] \times A_{Batch}) \times LR_{RO/C\text{-}3ZT\text{-}24341} > 5\}$ and $\{(ET[A] \times A_{Batch}) \times (1 - LR_{RO/C\text{-}3ZT\text{-}24341}) > 5\}$, the lower and upper limits of the confidence interval can be calculated for binomially distributed parameters (lost / not lost):

$$p_{1,2} = 0.0496 \pm 1.96 \times \sqrt{\frac{0.0496 \times (1 - 0.0496)}{(2 \times 223{,}710) - 1}}$$

$$p_1 \cong 0.0490 \qquad p_2 \cong 0.0502$$

The 95 % confidence interval is:

$$\mathrm{CI}_{\mathrm{RO}/C-3ZT-24341-95\%} : [0.0490 ; 0.0502]$$

4.2.4 Presentation of the results

The results should be published in this way:

The loss rate is $LR_{RO/C-3ZT-24341} = 4.96\ \%$ with a confidence interval of $\mathrm{CI}_{\mathrm{RO}/C-3ZT-24341-95\%}$: [4.90% ; 5.02%].

To compare ear tag qualities of different production batches, loss rates can be set in relation to the length of time an ear tag remains in the animal:

Batch no.	**Loss rate within years after ear tag application (in %)**				
	1	**2**	**3**	**4**	**5**
A-I9Z-25196	2.21				
C-3ZT-24341	2.43	4.96			
C-TZ6-24295	1.99	4.73	7.59		
T-XP9-24102	2.38	4.89	8.02	11.36	
X-ADR-22197	2,76	4.74	7.93	11.17	15.60

5 Retention Rate

Instead of the loss rate, all results can also be displayed as a retention rate. This may result in a more positive presentation or wording. In general, the retention rate is defined as RR = 1 - LR.

In particular, the retention rate is:

$$RR_{SL(TP)} = 1 - LR_{SL(TP)}$$

$$RR_{WS(Year)} = 1 - LR_{WS(Year)}$$

$$RR_{RD(Year)} = 1 - LR_{RD(Year)}$$

$$RR_{RO/Year} = 1 - LR_{RO/Year}$$

$$RR_{RO/Batch} = 1 - LR_{RO/Batch}$$

Also, if using retention rate instead of loss rate, it makes sense to specify a 95 % confidence interval to evaluate the calculated value. In general, lower and upper limits can be calculated as

$$p_{1,2} = RR \pm 1.96 \times \sqrt{\frac{RR \times (1 - RR)}{(ET[A] \times n_{animals}) - 1}}$$

The results. e.g. for retention rate of a selected livestock, should be published as:

The retention rate is $RR_{SL(36)} = 93.28\ \%$ with a confidence interval of

$$\text{CI}_{\text{SL}(36)-95\%}: [92.79\% ; 93.77\%].$$

To compare e.g. ear tag qualities of different production batches related to year of application, retention rates can be set in relation to the length of time an ear tag remains in the animal:

Batch no.	**Retention rate within years after ear tag application (in %)**				
	1	**2**	**3**	**4**	**5**
A-I9Z-25196	97.79				
C-3ZT-24341	97.57	95.04			
C-TZ6-24295	98.01	95.27	92.41		
T-XP9-24102	97.62	95.11	91.98	88.64	
X-ADR-22197	97.24	95.26	92.07	88.83	84.40