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Some Factors Causing Mortality among Female Minks during the Puerperium and Lactation Periods

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Ingo R., M. Luoma and I. Virtanen: Some factors causing mortality among female minks during the puerperium and lactation periods. Acta. vet. scand. 1992, 33, 59-69. – The purpose of this study, in which the farm was used as the statistical unit, was to find factors affecting mink mortality under farm conditions. Mortality was hypothesised to be affected by factors including, among others, variables describing the amount (level) and variation in composition and quality of the feed. Other explanatory variables applied in the study included farm size and age. Factor analyses were performed for variables of feed composition and quality in order to condense the variable information and to facilitate the selection of explanatory variables. This report presents a preliminary regression model for female mink mortality factors describing feed level and variation, and farm size, as explanatory variables. The regression model emphasized among other factors the importance of a constant albumin quality and a constant energy level.

feed composition; feed quality; farm size; farm age; factor analysis; regression analysis.

Introduction

Studies investigating the causes of mink mortality have concentrated mainly on the findings of autopsies. According to *Wahlström* (1987), the main autopsy findings in minks were organ changes caused by metabolic diseases. *Martino & Villar* (1987), who performed autopsies on female minks that had died during pregnancy or lactation, also came to the same conclusion.

In *Wahlström's* studies, the main diagnoses of female minks during the puerperium and lactation period (21 April-15 July) were reproductive disturbances (38%) and metabolic diseases (17%). In autopsies performed during the same period, over 90% of the female minks were found to have a markedly fatty liver. According to *Wahlström* (1987), this finding is due to the fact that an animal that has a metabolic disease is easily liable to get other diseases. However, the diseases which appear secondarily are often diagnosed as the primary cause of mortality. *Martino & Villar* (1987) performed a total of 93 autopsies on female minks which died during pregnancy or lactation. Of the minks, 53 (57%) had fatty liver syndrome. *Martino & Villar* contend that stress and Aleutian disease, i.e. plasmacytosis are some of the most important predisposing factors for fatty liver syndrome, whereas *Wahlström* emphasises the role of poor feed.

Tauson (1984) and *Poulsen & Jörgensen* (1986), among others, studied the effects of feeding on mink reproductivity.

Tauson (1984) descreibed the use of an additive, lactic-acid bacteria, to feed, while *Poulsen & Jörgensen* (1986) studied the use of fish conserved with sulphuric acid. These studies used kit results, kit mortality, and the percentage of empty female minks as reproduction parameters. In addition, the weight development and feed consumption of whelps and female minks were determined. In these studies, the loss of weight among female minks ranged from 7% to 18%. Female mink mortality was not reported.

The effect of feeding on the reproduction of female animals has also been studied among other animals having a single stomach. Many feeding studies have been carried out especially concerning swine. *Kirkwood et al.* (1988) studied the effects of the energy content of the feed given during successive lactation periods on the reproduction of sows. According to their results, a high energy content of feed during the lactation period causes greater weight losses among sows than does normal feed. *Cox et al.* (1983) also came to the same conclusion. No explanation for these results has been presented. A high feed energy content during pregnancy affects the condition of sows also during the lactation period *(Gatel et al.* 1987). Sows which had been given restricted feed portions during pregnancy lost less weight during the lactation period than did sows which had been given normal portions. However, the results were not analogous in every respect.

Aleutian disease, i.e. plasmacytosis, often causes a fatal immunocomplex disease *(Aasted,* 1985). Aleutian disease weakens the animal's resistance and thus affects both morbidity and mortality. The acute form of the disease, leading to a high mortality rate, has found among mink kits *(Bötner & Jörgensen* 1983, *Larsen et al.* 1984).

In this study, we applied statistical methods on existing data. We attempted to create a statistical model for separating factors, their combined effects and interactions affecting mink mortality in farm conditions. We hoped also to get some clues to reducing mink mortality on mink farms.

Materiel and Methods

Follow-up of mortality

In this study we concentrated on observing the female mink population in Bothnia during the puerperium and lactation period. Bothnia is a geographically homogeneous area with approximately 90% of all of the 3,085 mink farms in Finland. In this area there are 29 kitchens which prepare mink feed. One hundred and sixty of the total of 2,802 farms in this area volunteered for the mortality study. The number of farms per feed kitchen varied from 1 to 15. On average, there were 6 farms per feed kitchen.

In the statistical analyses only 81 farms were used due to lack of information in the remaining 79 farms. The farms were from an area of 12 feed kitchens. The number of farms per feed kitchen varied from 1 to 15. On these 81 farms there were 75,008 female minks in the beginning of the follow-up period. This is about 3% of the total female mink population in Bothnia and 18% of the female mink population in the area of these 12 feed kitchen. The number of females per feed kitchen varied from 40 to 12,028.

The monthly female attack rate α per farm and per feed kitchen, and for the whole study population, were calculated as follows:

$$(1) \quad \alpha = \frac{d}{n}$$

where

d = the number of females dead during the month

n = the number of females at the beginning of the month.

The monthly attack rates of the farms in the analysis varied between 0.0017 and 0.0436.

Feed analyses

Feed from each feed kitchen was analysed twice a month. The samples were analysed chemically each time. The analysis included, among others , estimation of the protein, fat, and carbohydrate contents as well as the quality of fat and proteins. A total of 17 chemical parameters were determined as follows:

Once a month the mocrobiological quality of feed was studied by the following bacterial determinations: total bacteria (mesofilic aerobic), faecal streptococcei, coliform bacteria, haemolytic bacteria and anaerobic sulphite deoxidising bacteria. The bacteria cultivation methods are given in Appendix 2. Yeasts and moulds were analysed only at random; those data were not used in the statistical analyses.

We thus obtained information on 22 different variables by analysing feed. Feed was analysed only twice a month, although during May and June the feed kitchens prepared feed 6 or 7 days a week. For the regression model of mortality we therefore chose the whole year's data (from autumn 1984 to spring 1985) on the feed kitchens, as the whole year's data were considered to be a better reflection of the general level of feed prepared in the feed kitchens. Especially for the precise derivation of standard deviations, the use of whole year's data was necessary. Standard deviations were introduced as a stability measure for the quality of feed prepared in the kitchens.

Feed consumption

Because preliminary statistical analyses showed a statistically significant dependence between mortality and feed variables we dedided to make an attempt to find out the feed consumption and its significance for mortality. The feed consumption was determined in weight units (g/animal/day) and in energy units (kcal/animals/day). In addition, we studied which farms got feed from the same consignment of feed.

Additional variables

The total number of foxes and minks used for breeding was used as a measure of farm size. Because it is known from experience that mink mortality on family-owned farms with farming as the family's main occupation is the lowest, we also tried to determine the optimal farm size (see Statistical analysis and results) as a variable.

The age of the farm was used as a possible explanatory variable for the mortality.

Plasmacytosis or Aleutian disease was an important candidate for use as an explanatory variable. The problem was that only a minority of farms had been examined for plasmacytosis which therefore could not be used in the final analysis.

Statistical methods

Two main statistical methods were used: the factor analysis to reduce redundant information and the regression analysis to find explanatory variables for mortality. All the runs in the factor and regression analyses were performed using the Statistical Analysis System (SAS 1985)

The basic idea of factor analysis is that those variables which, in the sense of correlation, measure the same issues are classified into the same groups. Then it is possible to substitute with the original variables a smaller number of new variables, know as factors. The factor analysis is here used only as a descriptive tool, not as a model. *Kim &*

Mueller (1981, 1982) provide an excellent introduction to factor analysis.

The average value of the whole year's measurements for each feed kitchen, and the standard deviations of all the feed analysis variables were used in the analyses. This increased both the number of the potential explanatory variables for the model and the possibility to investigate interesting interactions between variables.

The separate factor analyses were performed for the composition variables and the quality variables of feed. The composition values determined per samples and the dry matter contents were used. Interpretation of factors was more obvious when composition values were used. They also had a better explanatory power in the regression analysis. For this reason the average values, and the standard deviations of feed carbohydrate, albumin and energy contents were determined as values per sample, i.e. as wet weight values.

It is not obvious how to model the dependence between mortality and explanatory variables. Because the linear regression model is simple and includes various opportunities for diagnosing both the model and the data, it is adequate for the first modelling. Different kinds of generalised linear models would also have been natural and theoretically even more correct. The model used in this paper can be written as follows:

$$(2) \quad Y = a + b_1 X_1 + b_2 X_2 + ... + b_p X_p + u,$$

where Y = mortality on a farm
$X_1, ..., X_p$ = explanators of mortality,
u = random error term

In order to improve the statistical attributes of the model, a square-root transformation of the mortality was performed. This was expected to stabilise the variance of the random error term *(Montgomery & Peck* 1982). Because the transformation is monotonic, the interpretation does not become more complicated.

We performed many experiments while choosing the explanatory variables. The idea was to combine a priori knowlegde with statistical selection criteria. The typical method which we used was as follows. As explanatory variables we chose one variable from each factor of feed composition and of quality. These variables were chosen to be well presented in factors and to be central by their contents. Furthermore, as explanatory variables we chose the farm age and the farm size, both in the logarithmic form. With the logarithmic transformation the age and the size receive a decreasing marginal effect on the mortality. The farm's age was hypothesized to measure possibly the quality level of the farm. That the farm's size is related to mortality is known from experience.

It is also argued that mortality is lowest on full-time family farms. Part-time farming or use of outside labour, on the other hand, may increase mortality. In that case the use of the logarithmic size with decreasing marginal effect would be wrong. Therefore we experimented with the following transformed size variable:

$$(3) \quad \text{Size} = \sqrt{|\text{Number-Optimal Size}|}$$

where Number = total number of fox and mink breeders and Optimal Size = size of the farm with the lowest mortality to be estimated in the regression analysis.

Results

Factor analyses

The results of the factor analysis of the composition variables are shown in Table 1. Appendix 1 explain the composition variab-

Table 1. Factor analysis of feed composition variables.

	FACTORS[1]					
	1	2	3	4	5	h^2
Digestible raw albumin, SD[2]	92	.	.	.	.	0.92
Raw albumin, SD	90	.	.	.	.	0.91
Digestibility coefficient of albumin SD	73	.	.	.	.	0.75
Digestibility coefficient of carbohydrate, mean	71	–40	.	.	.	0.87
Ash content, SD	71	.	.	.	52	0.84
Digestibility coefficient of carbohydrate, SD	–81	.	.	.	.	0.85
Convertible energy, mean	.	91	.	.	.	0.96
Total energy, mean	.	90	.	.	.	0.97
Dry substance, mean	.	76	.	58	.	0.99
Digestible raw fat, mean	.	73	.	.	.	0.77
Digestible raw albumin, mean	.	73	.	.	.	0.85
Raw albumin, mean	.	72	.	.	.	0.86
Total energy, SD	.	.	94	.	.	0.92
Convertible energy, SD	.	.	93	.	.	0.91
Dry substance, SD	.	.	84	.	.	0.92
Digestible raw fat, SD	.	.	82	.	.	0.91
Digestible raw carbohydrates, mean	.	.	.	96	.	0.95
Raw carbohydrate, mean	.	.	.	96	.	0.95
Digestible raw carbohydrates, SD	.	.	42	77	.	0.80
Raw carbohydrate, SD	.	.	61	69	.	0.88
Ash content, mean	.	.	.	.	82	0,98
Digestibility coefficient of albumin, mean	.	.	.	.	–88	0.93
Variance explained (%)	20.7	20.2	20.1	19.0	9.4	
Cumulative explanation of variance (%)	20.7	40.9	61.0	80.0	89.4	

[1] To save space, the factor loadings have been multiplied by 100. To improve readability, loadings with absolute values below 0.40 have been shown as dots.
[2] SD = standard deviation

les and the quality variables. Appendix 2 explains procedures to culture bacteria. The composition variables of feed are reduced to 5 factors. They contained 89.4% of the variation of the original variables, which is rather good. The communality (h^2) is a number between 0 and 1. It is a measure for the share of the variation of the original variables included in factors. On the other hand, it can be interpreted as a squared multiple correlation coefficient between the variable in question and the factors. The communalities are also high, the lowest is 0.75. Hence we can conclude that the original variables may with

a good statistical accuracy be replaced with 5 variables, either the original ones or the factors (factor scores).

The interpretation of the factors is made using factor loadings, i.e. the correlations between the variables and the factors.

Factor 1 is the factor of albumin variation (Table 1). It gave high positive loadings especially to standard deviations of digestible raw albumin and raw albumin. This factor gave relatively high loadings to some other variables, too (Table 1).

Factor 2 is interpreted to show the energy level. In particular, the energy level variables and the fat and albumin variables are included.

Factor 3 measures variations in energy.

Factor 4 is the carbohydrate factor.

Factor 5 has only 2 loadings with high absolute values. The factor is called an ash factor. The variance explained by factor 5 is clerly less than the variance explained by the other factors (see Table 1).

The factor analysis of the feed quality variables, including the bacteria variables is shown in Table 2. Twenty variables were

Table 2. Factor analysis of feed quality variables.

	FACTORS[1]						
	1	2	3	4	5	6	h^2
TVN[2], mean	98	.	.	.	.	.	0.98
TVN %, mean	97	.	.	.	.	.	0.99
TVN, SD	94	.	.	.	.	.	0.97
TVN %, SD	81	42	.	.	.	.	0.90
Total bacterial count, mean	75	.	59	.	.	.	0.99
Peroxides, SD	.	98	.	.	.	.	0.98
Peroxides, mean	.	97	.	.	.	.	0.99
pH, SD	.	91	.	.	.	.	1.00
Coliform bacteria, SD	.	.	97	.	.	.	0.99
Coliform bacteria, mean	.	.	89	42	.	.	0.98
Total bacterial count, SD	64	.	68	.	.	.	0.96
Free fatty acids, SD	.	.	67	.	–40	.	0.88
Haemolytic bacteria, SD	.	.	.	90	.	.	0.95
Haemolytic bacteria, mean	.	.	.	88	.	.	0.96
Anaerobic bacteria, SD	.	.	.	64	.	50	0.97
Anaerobic bacteria, mean	–41	–51	.	54	.	.	0.91
Faecal bacteria, SD	.	.	.	.	97	.	0.96
Faecal bacteria, mean	.	.	.	.	97	.	0.98
Free fatty acids, mean	.	.	.	.	.	87	0.93
pH, mean	.	.	.	.	.	–65	0.95
Variance explained (%)	24.6	17.9	17.6	13.7	13.3	8.9	
Cumulative explanation of variance (%)	24.6	42.5	60.1	73.8	87.1	96.0	

1) To save space, the factor loadings have been multiplied by 100. To improve readability, loadings with absolute values below 0.40 have been shown as dots.
2) TVN = total volatile nitrogens.

reduced to 6 factors, explaining 96,0% of the total variance. The communalities were high; the lowest is 0.88. Thus, the factors describe the variation of the original variables rather well. We derived the following interpretations for the factors.

The first factor is the total volatile nitrogen or TVN factor, which shows the degree of proteolysis. It accounts nearly 25% of the variance, and can be called the albumin quality factor. The second factor is the factor of fat quality. The standard deviations and the mean values for peroxides and for pH attained high loadings. The third factor consisted of the variables of the total bacterial count and of the coliform bacteria variables which had higher loadings. The standard deviation for free fatty acids had a moderate loading. So, the third factor is mainly the factor of coliform bacteria. The fourth factor is called the factor of haemolytic bacteria, though anaerobic bacteria had less loading. The fifth factor consisted of faecal streptococcus bacteria. The sixth factor is the factor for the level of free fatty acids. The loading of the corresponding variable is 0.87. The loading of the mean value of pH is -0.65, i.e. an increase in the amount of free fatty acids corresponds to lower mean pH value, which is as it should be.

It is often difficult to decide the number of factors to be used in factors analysis. In cases above it was, however, rather easy because by changing the number of factors the interpretation of the factors become less obvious.

Regression analyses

The stepwise regression analysis was applied in order to select the statistically significant variables for the mortality model(see, e.g. *Draper & Smith* 1981). After various experiments, including e.g. use of factorised variables (factor scores) and statistical diagnostics, the result was the estimated model shown in Table 3 and correlation coefficients between model variables are presented i Table 4.

The model is statistically highly significant ($p = 0.0002$) with $R^2 = 0.269$; i.e. the model explains 27% of the variation in mortality. The signs of the coefficients in the model are sensible.

The size variable, which indicates the deviation of farm size from the 'full-time family farm' (in the square-root form), has a positive sign. The greater the deviation from the

Table 3. Regression model for the square root of mortality.

Explanatory variable	Coefficient	t-value	p-value
Constant	0.552		
Size (estimated optimal size = 1.100)	0.000542	1.627	0.108
Digestible raw albumin, SD	0.0281	2.141	0.036
Convertible energy, SD	0.000339	2.946	0.004
Digestible raw carbohydrate, mean	–0.0146	–3.404	0.001
pH, mean	–0.0688	–3.541	0.001
$R^2 = 0.2693$			
F (7.75) = 5.529			
Residual standard deviation = 0.0305			

Table 4. Correlation coefficients between model variables.

	1	2	3	4	5	6
1 Dependent variable						
2 Size (estimated optimal size = 1,100)	0.254					
3 Digestible raw albumin, SD	0.154	0.195				
4 Convertible energy, SD	0.392	–0.075	0.095			
5 Digestible raw carbohydrate, mean	–0.190	–0.064	0.285	0.266		
6 pH, mean	–0.224	–0.110	0.078	0.370	–0.118	

ideal size was, the higher was the mortality. On the basis of this material, the optimal size was 1,100 animals, whether minks or foxes. The p-value for the variable was, however, as high as 0.108, and thus not statistically significant. Nor was the model very sensitive to the size value, i.e. 1,100 animals could not be claimed to be the exact optimal farm size ; rather, the optimal farm size would appear to be 'somewhat more than 1,000 animals'.

The other variables used in the model, on the contrary, were statistically significant, at the level of at least 5%. Both standard deviation variables, digestible raw albumin and convertible energy, had a positive sign for their coefficients. Thus, the greater the range of variation in these variables was, the greater was the mean mortality, i.e. for these variables, a constant level of quality is a positive feature.

The coefficients for both remaining variables - the level of digestible raw carbohydrate and the pH-value were negative. In other words, mortality decreases as the values for these variables increase.

The farm age variable (in the logarithmic form) and the amount of feed consumption were no longer included in the analysis because in this study they were not statistical significant. This is not to question the importance of the latter variable. The problem was a lack of accurate data.

Discussion

In choosing the data - both variables and observations - we used mainly information which alreay existed. Further investigation were made with regard to only 2 variables. Naturally, the already existing data is a restrictive factor in building a model. One specific lack we experienced was the scarcity of data about each farm. The size and age of the farm were the only explanatory variables which were known precisely. The plasmacytosis situation was known only for a minority of farms, and the feed cunsumption per mink was merely a rough estimation because on many farms there were other fur animal species, too.

We strived to estimate the effects of lacking explanatory variables on the model by means of the following conclusions.

The mortality of female minks and the kit result per one female mink are mainly explained by common explanatory variables. In addition to these explanatory variables, they may each have specific explanatory variables of their own. If the mortality model lacks common explanatory variables, then the kit result - which is considered to be one explanatory variable - should increase the coefficient of determination of the model. This, in fact, happened: the kit result per female mink increased the coefficient of determination of the model from 0.2693 to

0.3453. Thus, 0.345 is a kind of theoretical maximal limit of the coefficient of determination, because it was difficult to think of any other lacking variables specific to mortality. From this point of view, the model has a fully acceptable explanatory power. It was evident in advance that both random factors and factors not measured and not included in the analysis have a considerable effect on mortality.

Sample selection can influence the individual and interactive affects of the explanatory variables. For example, it is possible that the role of composition factors of feed is accentuated on farms which are qualitatively above the average level, because feed spoilage is not allowed even in warm weather. Natural differences in vitality between different colour types may be confounding factors. Epidemics of diseases can also affect mortality. However, the animal losses on the farms studied were not exceptionally high, because those farmers have not applied for compensation from insurance companies. Sporadic noise was not proved to effect the mortality of mink kits in the puerperium period *(Brach* 1983), so noise can also be excluded as a reason for the mortality of female minks.

The factor analyses gave interesting and new information on feed analyses. The most important quality factors represented the quality of albumin and fat. Of the bacteria variables, the anaerobic bacteria were loaded mainly on the same factor as haemolytic bacteria. Anaerobic bacteria analysed by iron sulphite agar should be substituted by more accurate methods in the future. The corresponding variable was not needed in the regression model either.

The regression model emphasized the importance of a constant albumin quality and a constant energy level. The mortality rises as the standard deviations of digestible raw albumin and of convertible energy increase. The regression analysis emphasized the carbohydrate content of feed as a factor explaining mortality. The finding is similar to *Henriksen* (1985) in studies of lactation anaemia among minks. The importance of feed energy content is understandable, as the weight loss lactating female minks can be as much as 18% of their weight *(Tauson,* 1984, *Poulsen & Jörgensen* 1986). *Kirkwood et al.* (1988) and *Cox et al.* (1983) have come to a completely opposite conclusion when studying the energy supply of suckling sows. One reason for this may br the differences between animal species.

The statistical significance of the pH-value of feed as a factor explaining female mink mortality is an interesting result. All the pH values which were measured in feed samples (5.6 - 6.4) were within the range of recommendations. The mean pH value was 6.0. According to *Poulsen & Jörgensen* (1977) those feed pH values which occurred within the pH range over 5.5 had no effect on the acid - alkaline balance of minks. If it is true that even slight decreases in the pH value indicate acid-conserved raw materials of poor quality (acid-conserved fish and slaughtering offal), the control of raw materials should be made more stringent. In the factor analysis, the pH-value was one of the factors indicating fat quality. This implies that besides the low pH-value; the fat in so-called risk-prone raw materials has already begun to turn rancid.

Our model lacks many variables known to play an important role in mortality. This may simply be because these variables varied only slightly in the samples used for this study, and therefore they did not reach statistical significance. It is also possible that the voluntariness of farmers' participation caused some kind of selection bias in the material.

For this reason it would be important to test the model with data from other farms.

In this study we did not examine the magnitude of the effects of explanatory variables, but their statistical significance. The magnitude of effects is of course important from the practical point of view. Futher research is, however, needed before any recommendations for the farmers can be made.

Appendix 1. Chemical parameters analysed from the feed given to fur-bearing animals

Composition variables

1. Dry matter, g/100 g
2. Ash content in dry matter, g/100 g
3. Raw albumin content, g/100 g
4. Digestibility coefficient of albumin, 0.8 - 0.9 (dependent on the ash content of the feed)
5. Digestible raw albumin, g/100 g
6. Raw fat content, g/100 g
7. Fat digestibility coefficient 0.9
8. Digestible raw fat, g/100 g
9. Raw carbohydrate content, g/100 g
10. Carbohydrate digestibility coefficient 0.683 - 0.723
11. Digestible raw carbohydrates, g/100 g, raw carbohydrate content multiplied by carbohydrate digestibility coefficient
12. Gross energy and convertible energy (kcal/kg) calculated according to the following table:
    1 g raw albumin/digestible raw albumin - 4.5 kcal.
    1 g raw fat/digestible raw fat - 9.3 kcal.
    1 g raw carbohydrates/digestible raw carbohydrates - 4.1 kcal

Quality variables

13. TVN (total volatile nitrogens) mg nitrogens/100 g of sample
14. TVN % (percentage of TVN of all nitrogens)
15. Peroxides, meq 0_2/kg fat
16. Free fatty acids (FFA), % of fat
17. pH

Appendix 2. Culture methods used to determine the bacteria groups in feed samples.

45 ml of peptone water (Neopeptone, Difco) was mixed into 5 g of sample. Dilution series were made until $10^{-6/-8}$.

Bacteria group	Culture medium	Incubation	
		temperature	duration
mesophilic aerobic bacteria (total bacteria)	Plate Count Agar (Difco) plate flow	30°C	48h
haemolytic bacteria	Blood agar (5% horse blood surface culture	37°C	24h
coliform bacteria	Violet Red Bile Ager (Difco) plate flow	37°C	24h
faecal bacteria	Slanez and Bartley (Merck) surface culture	37°C	48h
sulphite-deoxidizing anaerobic bacteria	Iron sulphite agar (Difco) tube flow	37°C	48h

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Sammanfattning

Några faktorer som påverkar dödligheten hos minkhonor under dräktighets- och digivingsperioderna.

Avsikten med undersökningen, i vilken den enskilda minkfarmen användes som statistisk enhet, var att finna faktorer, som påverkar dödligheten hos farmade minkar. Dödligheten antogs bero av faktorer som inkluderar bland andra sådana variabler som beskriver mängden och variationen samt kvaliteten hos fodret. Andra förklarande variabler som användes i denna undersökning var farmens storlek och ålder. För att komprimera variablinformationen och för att underlätta valet av förklarande variabler för sammansättning och kvalitet användes faktoranalys. Den här rapporten presenterar en preliminär regressionsmodell för faktorer, vilka beskriver dödligheten hos minkhonor med användandet av foderhalten och dess variation samt farmstorlek som förklarande variabler. Regressionsmodellen påvisade särskilt bland andra faktorer vikten av en konstant protein kvalitet och en konstant energihalt.

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