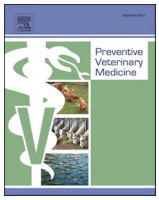
Preventive Veterinary Medicine 204 (2022) 105638

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed



Factors driving pig owners' motivation and satisfaction to perform eradications from Swine dysentery

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ARTICLE INFO

Keywords:
Brachyspira hyodysenteriae
Factor analysis of mixed data (FAMD)
Switzerland
Porcine
Sanitation

ABSTRACT

Brachyspira hyodysenteriae is one of the agents of swine dysentery (SD) and its eradication is an effective, but costly control measure. Being a voluntary measure, knowledge about drivers of motivation and satisfaction regarding the eradication of SD would help to convince farmers to eradicate. We aimed to describe eradications performed in Switzerland and to analyse factors influencing the pig owners' perception (motivation and satisfaction) of SD eradications to provide a basis to formulate recommendations and guidelines. Pig farmers (n = 68) having conducted an SD eradication and being interested in the study were interviewed using a standardised digital questionnaire. We assessed their motivation as moderately or highly motivated. Based on the farmers' evaluation of nine aspects of the eradication, satisfaction was considered to be moderate (<7/9 aspects positively evaluated) or high (≥7/9). Farms with fattening pigs and farms with breeding stock were analysed separately in subsets. First, multivariable factor analysis for mixed data (FAMD) were performed to describe the main patterns of variation. Then, risk factors for motivation and satisfaction were quantified by means of logistic regression models. Mainly total depopulations (73.5%) had been performed. Of the 36 farmers with breeding pigs, 24 were highly motivated, and 20 highly satisfied. Of the 61 farmers with fattening pigs, 45 were highly motivated and 42 highly satisfied. The FAMD revealed that the two main components explained only 17.0% and 11.0% (breeding stock) and 13.0% and 11.0% (fattening pigs) of the total variation, respectively. For farmers with breeding stock no significant factors for motivation were detected, but they were more satisfied (OR 25.0) when they had a batch farrowing of 3 weeks. Farmers with fattening pigs were more likely to be more motivated when providing access to outdoor areas (OR 3.3) and when it was their own initiative (OR 5.5). Farmers were more likely to be satisfied when they had only fattening pigs (OR 5.7), when the eradication was their own initiative (OR 5.5) and when they did not disinfect the barns during the eradication (OR 15.6). Farmers deciding themselves to eradicate are presumably more likely convinced of the benefits of the eradication. Satisfaction associated with a 3-weeks batch farrowing might be related to an easier to organise eradication and no disinfection to reduced labour and costs. In summary, the majority of the farmers were satisfied with the eradication. Education could promote self-motivation of farmers, and subsidies might support the implementation of SD eradications.

1. Introduction

Swine dysentery (SD), caused by *Brachyspira hyodysenteriae*, is a disease with not only a high impact on pigs' health but also on the economy of pig production worldwide. The muco-haemorrhagic typhlocolitis typical for SD results in poor feed conversion, decreased growth rate, and expenses for antimicrobials, while subclinical infection also may generate financial losses (Burrough, 2017; Hampson et al., 2015).

Increasing concerns in respect to antimicrobial use in farm animals in general and the increase of minimal inhibition concentration levels of some drugs used for therapy of SD, in particular, make other control measures other than the application of antimicrobials more important. Eradication from SD is one of these measures. Protocols aiming to

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https://doi.org/10.1016/j.prevetmed.2022.105638
Received 2 February 2022; Received in revised form 25 March 2022; Accepted 28 March 2022
Available online 31 March 2022

eliminate *B. hyodysenteriae* from an infected herd have been described and applied with success (Blaha et al., 1991; Figi et al., 2014; Neirynck et al., 2020). However, the success (meaning complete elimination of the pathogen from the herd and the farm) depends in large parts on the strict compliance of farm-specific measures. These measures include total depopulation or reduction of the herd combined with treatment of remaining pigs with an effective antimicrobial, thorough cleaning and disinfection including slurry or manure, and effective rodent and fly (fomites) control. These measures are supplemented by restocking from *B. hyodysenteriae* free herds. All these measures pose substantial costs and workload to the pig owners (Neirynck et al., 2020; Wood and Lysons, 1988). Therefore, the eradication per se, its effect and sustainability are often under debate. These debates are less frequent when SD positive herds have pig trade restrictions or are under other financial reprisals like lower prices for their pigs. Without such pressure, convincing farmers to perform an eradication may be challenging. However, in front of the increasing antimicrobial resistance, animal welfare, and the potential threat of a spread of *B. hyodysenteriae* to other herds, eradications would be favourable. Apart from single eradication case reports (Figi et al., 2014; Speiser et al., 2011; Tasker et al., 1981; Wood and Lysons, 1988), no studies have been published about the factors influencing the farmers' motivation to perform eradications and satisfaction with the eradication. Yet these data are needed to formulate recommendations and guidelines and to target communication with farmers and help them on the decision process.

In the absence of a specific hypothesis, the first step is to collect data on as many aspects as possible to create a first picture. This poses logistic challenges on the data collection and analysis process. Data about characteristics of SD eradications and the pig farmers' perception can be collected by questionnaire-based interviews. The questionnaires can be large when a variety of aspects and variables shall be covered. Traditionally, paper questionnaires are filled by hand. In a second step, the data are entered into a digital database for further analysis. This process is time-consuming and prone to errors while transferring the data. Modern technology provides new tools like digital applications to record and manage data from the interviews. This approach is very interesting for projects including a large number of herds and farmers and using extensive questionnaires. To our knowledge, such applications have not been used often in veterinary field studies using interviews (Nathues et al., 2014).

When dealing with a high number of quantitative and qualitative (mixed) variables, factor analysis of mixed data (FAMD) is a multivariate statistical method (equivalent to principal component analysis for numerical data) to identify the main trends in the data, by analysing proximity or similarity between observations and variables. Researchers have used them in studies e.g. on vaccine evaluation (Nathues et al., 2014), on seals and vocal signals (Stansbury et al., 2015), on effects of antimicrobials and diets on porcine caecal parameters (Zhang et al., 2016), on genes potentially associated to piglet splay-leg (Hao et al., 2017), on behaviour assessment of growers (Czycholl et al., 2017), on colostrum in sow breeds (Picone et al., 2018), on rumen microbiota (Schären et al., 2018), on control of porcine diseases (Baron et al., 2020), or to assess biosecurity (Delpont et al., 2020).

In Switzerland, over 100 eradications from SD had been performed according to guidelines of the pig health service (PHS, SUISAG) (Anonymus, 2011) between 2010 and 2016. Two eradication procedures have been described in detail (Figi et al., 2014; Speiser et al., 2011). One was a modified partial depopulation in a nucleus herd, the other an eradication in a grower-finisher farm with timed depopulation of individual pig pens. However, no analysis of a large number of eradications covering a wide range of herd types, of management practises, of eradication approaches and with different pig farmers has been performed so far.

The aim of the present study is to describe eradications performed in Switzerland and to analyse factors influencing the pig owners' perception (motivation and satisfaction) of SD eradications to provide a basis to formulate recommendations and guidelines. Furthermore, we wanted to test a pragmatic approach to handle large questionnaires on-farm.

2. Material and methods

2.1. Development and validation of the questionnaire

A standardised digital questionnaire (in German) was built using Lime Survey, Version 2.50 + to cover the following topics: herd and farm characteristics, hygiene and biosecurity before and after eradication, eradication characteristics, economic parameters, health parameters, and the pig owners' subjective assessment of motivation and satisfaction. The preliminary questionnaire and the applicability of the technique were tested by one author (RC) with four pig farmers. Unclear questions, missing answer options, and other problems were identified and the questionnaire was subsequently adapted. Furthermore, the duration of the interviews was recorded to have an estimate for the following interviews. The final questionnaire used for the study comprised 320 questions, whereof a maximum of 245 questions was asked per farmer as not all questions were related to all herd and eradication types. As an example of questions and corresponding answers, the options regarding the subjective assessment of motivation (one question) and satisfaction (nine different questions) are provided in Table 1.

2.2. Study population

Between September 2016 and November 2017, 104 Swiss pig farmers which had performed an eradication from SD in the past were contacted by phone, informed about the study content and aims and invited to participate. The inclusion criteria were (a) laboratory-confirmed presence of *B. hyodysenteriae* or farm with an epidemiological link to another laboratory-confirmed farm before the eradication (farms of sow pools systems, SPS), and (b) *Brachyspira* status change (positive to negative) in the PHS database representing an eradication according to the PHS guidelines. Exclusion criteria were (a) language different than German (n = 1), (b) multiple eradications (n = 2), or (c) farm in foreign country (n = 1).

Ninety-nine farmers met the initial inclusion criteria. The data from the four farmers that had been used for the validation of the questionnaire were excluded. Four further farmers did not answer, 19 refused to participate, and four had to be excluded due to highly unusual herd types and management. This rendered a final sample size of 68 data sets.

2.3. Interviews and data recording

At the beginning of the on-site interview, the participants gave written consent to perform the interview and could decide if they also allowed inspection of relevant herd data. Participants' anonymity was preserved, and none of the information allowing identifying the pig owners was included in the manuscript.

All answers were directly entered into the data logging system installed on a tablet. Information on economic or health parameters like average daily weight gain or losses were either directly entered as well, or pictures or copies of bills, therapy records, slaughter data or other sources/records were taken and processed after the interview.

2.4. Data processing and statistical analyses

Data were exported from Lime Survey to MS Excel (Microsoft Office Professional Plus 2010) and R v4.0.3 software (https://www.r-project.org) for further statistical analysis.

The production type was initially collected distinguishing 14 different types and then recoded into four categories for further analysis (1 = Fattening herd, 2 = Piglet rearing herd, 3 = Piglet producer, 4 = Sow pool herd). To take into account the different production types, two

Table 1
Classification of farmers as highly motivated or moderately motivated and highly satisfied or moderately satisfied and the number of corresponding farmers or positive (P) and negative (N) answers, respectively, in the two subsets Reproduction (R, n = 36) and Fattening (F, n = 61; 29 farmers were in both subsets).

Question		Answers in the questionnaire	Recoding	Final classification	R/F
Motivation					
M1	How was your motivation to eradicate?	Not motivated Rather motivated Motivated Highly motivated	1 2 3 4	Moderately motivated if 1 or 2. Highly motivated if 3 or 4.	11/15 24/45
Satisfaction					
S1	How would you describe the overall economic situation of the pig herd after the eradication?	Worse Equal Better	N N P	Highly satisfied if sum ≥ 7 P answers. Moderately satisfied if sum < 7 P answers.	22/28 13/32
S2	How would you describe the overall cost of the eradication?	Too high High but justifiable Acceptable	N N P		20/30 16/31
S3	How would you describe the overall health status of the pig herd after the eradication?	Worse Equal Better	N N P		16/22 19/38
S4	How would you describe the overall drug use in the pig herd after the eradication?	Worse Equal Better	N N P		16/24 19/36
S5	Are you satisfied to have performed the eradication?	No, not satisfied Yes, satisfied	N P		1/2 35/59
S6	How would you describe the overall organisation and workload of the eradication?	Too high High but justifiable Acceptable	N N P		22/33 14/28
S7	Are you satisfied with the result of the eradication?	No, not satisfied Neither nor Yes, satisfied	N N P		31/6 5/55
S8	Would you eradicate SD a second time?	No Yes	N P		6/8 26/46
S9	Would you recommend the eradication to other pig owners?	No Yes	N P		3/5 31/55

overlapping subsets of data were created: (1) farms with breeding pigs (subset 'Reproduction', comprised by herds such as piglet producers (with or without own fattening) or herds of sow pool systems) and (2) farms with weaned to finishing pigs (subset 'Fattening', comprised by herds such as fattening herds or piglet producers with fattening). Farms that had both pig categories were included in both subsets. Every subset was then subsequently analysed separately.

2.4.1. Power calculation

A power calculation was performed using software PASS16 (NCSS, Kaysville, Utah, USA). In theory, a logistic regression (with a two-sided Wald test) of a binary response variable (Y) on a binary independent variable (X) with a sample size of 68 observations (of which 50% are in the group X = 0% and 50% are in the group X = 1) achieves 76% power at a 0.05 significance level to detect a change in Prob(Y=1) from the baseline value of 0.1–0.4. This change corresponds to an odds ratio of 6, which means that a priori, only the strongest factors for motivation and satisfaction would be detected with our sample. However, the odds ratios detected a posteriori (see results) were much lower from which we conclude that the effective power was higher and in any case sufficient to detect factors for motivation and satisfaction.

2.4.2. Multivariate factor analysis for mixed data

In a first step, an exploratory multivariate factor analysis for mixed data (FAMD) was carried out to describe the main patterns of variation with all variables including motivation and satisfaction original variables for each of the data subsets. Factor analysis of mixed data (FAMD) is a principal component method dedicated to analyze a data set containing both quantitative and qualitative variables (Pagès, 2004). Quantitative and qualitative variables are normalised during the analysis to balance the influence of each set of variables. R packages FactoMineR, factoextra were used (Kassambara, 2017; Lê et al., 2008).

Binary coding (yes/no) of the variables was preferred over scores as score's contribution would get overestimated compared to the binary variables. This resulted in 40 variables, selected based on their potential contribution to motivation and satisfaction using biologically plausible arguments. These 40 variables were recoded, when necessary, as yes/no = 1/0 (see Supplementary Material S1 for a list of variables and their full description). Only three variables were strictly numerical: HerdSize – number of animals, NrPer – number of personnel for cleaning and disinfection and Distance (in metres to other farms). These variables were first transformed with Log2 (to 'normalise them') and then standardised by subtracting their mean and dividing by their standard deviation. Thus, in the FAMD, their contribution is not overestimated by their original large variance.

A total of six missing values (see descriptive statistics in Supplementary Material S2) in five variables were imputed to the category (yes/no) that was majoritary in that particular variable. Variable Again ("would you eradicate again?") presented 4 vs. 7 missing values in the Reproduction and Fattening subsets resp. and was excluded. The production type in four categories was set as a supplementary variable.

2.4.3. Categories of motivation and satisfaction

Motivation to eradicate was collected as four possible answers, namely 'Not motivated', 'Rather motivated', 'Motivated', and 'Highly motivated'. A binary variable was created by recoding the first two categories as moderate and the last two categories as high motivation (Table 1).

The overall satisfaction was assessed as a combination of nine different aspects (Table 1). These aspects were the economic situation after the eradication, the costs, the workload, the health status as well as the drug usage after the eradiation, the satisfaction to have performed the eradication, the satisfaction with the result, the recommendation of the eradication and if the farmer would eradicate again (Table 1). Each of these aspects was then assigned to be 1 (positive – higher satisfaction) or 0 (negative – lower satisfaction). A satisfaction score was calculated as the sum of all these aspects. The median value of the obtained satisfaction score was used to assign farmers to two satisfaction categories: highly satisfied versus moderately satisfied. Missing values were excluded from the score calculation which results in a slight underestimation of the satisfaction for those farms who did not provide answers.

2.4.4. Logistic regression

For each subgroup of farms (Reproduction versus Fattening), these two new binary variables (motivation and satisfaction) were then used as outcome variables in logistic regression models to test for associations against all other explanatory farm characteristics.

3. Results

The response rate in our study was 68/91 (74.7%). The final study population comprised 32 fattening herds, 22 farrowing herds of SPSs, 10 piglet producers and 4 herds used for insemination and gestation (IG) within SPSs. Thus, the data subset of farmers with breeding stock included 36 farmers and the data subset with fattening pigs 61 farmers; 29 farmers were included in both subsets. The median herd size of the fattening herds was 285 (range: 92–820) fattening pigs. The median size of the piglet producers was 112 (35−900) sows, of farrowing herds 17 (4−100) and of IG herds 141 (68−225) sows.

3.1. Descriptive analysis of eradication procedures, economy and health

Results of the analyses of the eradication-specific parameters and the economic and health impact have been provided elsewhere (Cadetg et al., 2019). In brief, a majority of farmers (28 fattening herds, 18 farrowing herds and 4 piglet producers) performed total depopulations (73.5%). The eradication procedures followed in large parts the recommendations given by the pig health service (SUISAG SGD) but were individually adapted to each farm. The main reason for a *B. hyodysenteriae* positive status had been the detection of the pathogen in the herd (28/32 fattening herds, 10/22 farrowing herds, 10/10 piglet producers, 2/4 IG herds). In the 18 other herds, e.g. being part of a positive SPS was the reason for the positive status. A description of our sample can be found in Supplementary Material Table 2a (Reproduction) and 2b (Fattening).

The eradications differed between the herd types (with or without breeding pigs), type of eradication (partial or total depopulation), and in respect to duration and costs. In fattening and farrowing herds, mainly total depopulation was used. In most piglet producing herds (6/10) and all IG herds partial depopulation was used. The duration of the eradication largely differed. For instance, farrowing herds with total eradication had completed the procedure after 69 days whereas piglet producers with partial depopulation spent up to 513 days. Eradications with total depopulation were shorter (median: 102 days) than those with partial depopulation (median: 153 days). The costs were highly variable depending on the farm size and type of production, with the highest in piglet producing herds (about 79′000 CHF) and lowest in fattening herds (about 3′000 CHF). More details are provided in Cadetg et al. (2019).

According to the farmers' subjective assessment, the herd health after the eradication was better in 63.2% of the herds. No change was reported by 32.4%, and 4.4% (1/ 68) stated that health was worse after the eradication. Until the time of the study, none of the herds had shown clinical signs or had been diagnosed with *B. hyodysenteriae* again.

3.2. Motivation and satisfaction

The main reason to eradicate was for 57.4% of the farmers their own interest (in contrast to external pressure). A motivation to eradicate was reported by 86.6% (58/67) of the farmers. Based on the binary coding, 50 were classified as highly motivated and 17 as moderately motivated (one missing answer).

Concerning satisfaction, no farmer reported complete dissatisfaction (negative answers to all nine questions). The satisfaction score rendered a roughly symmetric distribution with a mode and median at 6 (range 2–9; Fig. 1). Therefore, the overall satisfaction (binary variable) was then coded as 'high' if the sum was 7 or more and 'moderate' if the sum was equal to 6 or less (Table 1).

The question which yielded the most positive answers (66/68, 97.05%) was S5 ("Are you satisfied to have performed the eradication?"; Table 1),. The question with the least positive answers (30/68, 44.12%) was the one related to the overall organisation and workload of the eradication (S6 in Table 1).

Of the 36 farmers with breeding pigs, 24 (66.7%) were highly motivated, and 13 (36.1%) were highly satisfied. Of the 61 farmers with fattening pigs, 45 (73.8%) were highly motivated, and 31 (50.1%) were highly satisfied. More data about the distribution of the four herd types within selected aspects are provided elsewhere (Cadetg et al., 2019).

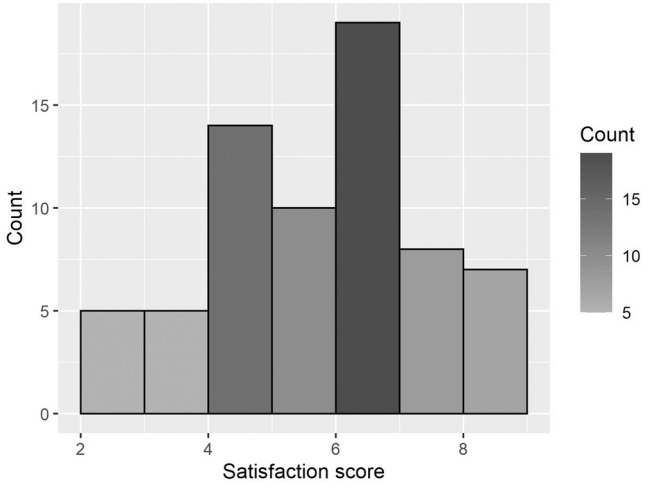

Fig. 1. Histogram of satisfaction, based on the evaluation of nine aspects and summing positive answers.

3.3. FAMD

For subset Reproduction the FAMD revealed that the two first principal components only explained 17% and 11% of the total variation, respectively. The variables that contributed more to both dimensions (although their contributions are small in general) were outdoor access, being satisfied with the eradication, improved health after the eradication and having performed a total eradication. Variables such us herd size, confirmed infection status, belonging to a sow pool system, and number of personnel involved in the eradication contributed to the first dimension, while the access and presence of cat and dogs, distance to other farms, having more than one label and no access to wild animals contributed to the second dimension (Fig. 2).

For subset Fattening, the FAMD revealed that the two first principal components only explained 13% and 11% of the total variation, respectively. Variables such us having exclusively fattening pigs, external motivation, belonging to a sow pool system or having outdoor access contributed to the first dimension, while herd size, number of personnel involved in the eradication, and having employed additional personnel for the eradication contributed to the second dimension (Fig. 3).

This low contribution of the first two components means that it is not possible to reduce the number of variables into a few main components of variation. When plotting the individual farms' coordinates on the main components, a high scatter or heterogeneity (even higher for subset Reproduction) or low redundancy or low correlation is observed (Fig. 4). For subset Reproduction, the piglet producers (production type 3) and for subset Fattening, the fattening farms (production type 1) are more similar to each other than the other production types, respectively.

In the logistic regression, no evidence of associations for motivation was detected for farmers with breeding stock (data subset Reproduction) (n = 36). However, this group of farmers was more satisfied when they had a batch farrwoing of 3 weeks compared to those who had continuous farrowing (OR±95%CI = 25.00 ± 2.44–662, p = 0.0164).

For the data subset of fattening farms (n = 61), there was weak evidence that farmers who provided outdoor access were 3.32 times more likely to be more motivated than farmers who did not have outdoor access (OR±95%CI = 3.32 ± 1.01–11.70, p = 0.0519). Besides, farmers were five times (OR±95%CI = 5.50 ± 1.62–20.92, p = 0.0083) more likely to be more motivated when the eradication was their self-

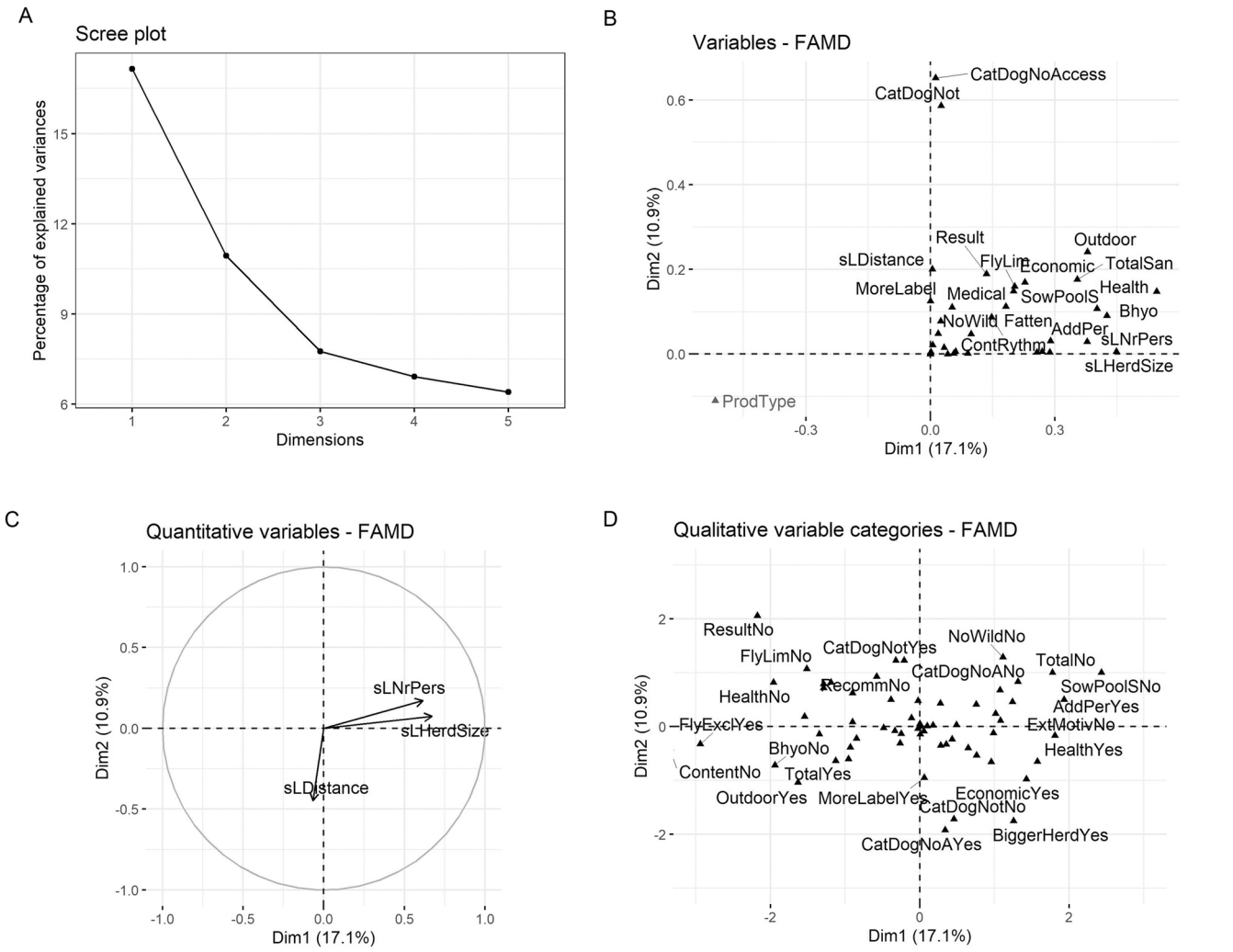

Fig. 2. FAMD analysis subset Reproduction: a) screeplot; b) coordinates of the variables plot on the two main components (production type is a supplementary variable), c) quantitative variables and their correlation circle plot (in which the correlation between a variable and a principal component (PC) is used as the coordinates of the variable on the PC; d) qualitative variables and the contribution of each category on the PC.

initiative. Concerning satisfaction, farmers in the fattening group purely dedicated to fattening compared to those who did have flatdeck pigs (such as 'farrowing herd with flatdeck') were 5.70 more likely to be satisfied (OR±95%CI = 5.70 ± 1.40–30.04, p = 0.0223), 5.45 times more likely to be satisfied if the eradication was their own initiative (OR ±95%CI = 5.45 ± 1.80–18.34, p = 0.0038) and 15.6 times more likely to be satisfied (OR±95%CI = 15.60 ± 1.99–337, p = 0.0222) when they did not perform disinfection of the pens and barns during the eradication (only cleaning).

3.4. Data handling

The duration of the interviews was in median 3 h (1.5–4.5 h). The processing of additional material provided by some of the farmers and entering these data in the system took up to several days per herd but was not recorded in detail. The transfer of the data from the app to the excel table and consecutive data processing was without problems.

4. Discussion

We analysed interview data from 68 Swiss pig farmers who had performed an eradication from SD in their herds for different reasons. Knowing the factors that had the biggest influence on the group of highly satisfied pig farmers allows modulating consultancy from herd attending veterinarians, authorities or consultants to pig owners. Targeted strategies can be implemented to convince pig farmers and hence support eradication.

4.1. Factors driving pig farmers perception of the eradication

4.1.1. Farmers with breeding pigs

Although 66.7% of the farmers with breeding pigs were highly motivated, this sample did not allow to detect factors for motivation. However, the relatively high number of highly motivated farmers indicates agreement with the eradication even though it might not have an obvious effect on the health and performance of their herds, but rather on downstream herds. Selling infected replacement or fattening pigs to other herds is one of the main transmission routes for *B. hyodysenteriae* (Álvarez-Ordóñez et al., 2013; Giacomini et al., 2018; Zeeh et al., 2020). Therefore, farms producing replacement or fattening pigs have an essential role in sustainable SD control and eradication.

Concerning satisfaction, only 36.1% of farmers with breeding stock were highly satisfied with the eradication. We assume that more laborious and complex eradications often required in farms with breeding pigs led to the lower number of highly satisfied farmers. aThe complex eradications can result in a longer duration, higher costs or a combination of both (Cadetg et al., 2019; Neirynck et al., 2020; Wood and Lysons, 1988). Also in our study population, the factors workload (S6)

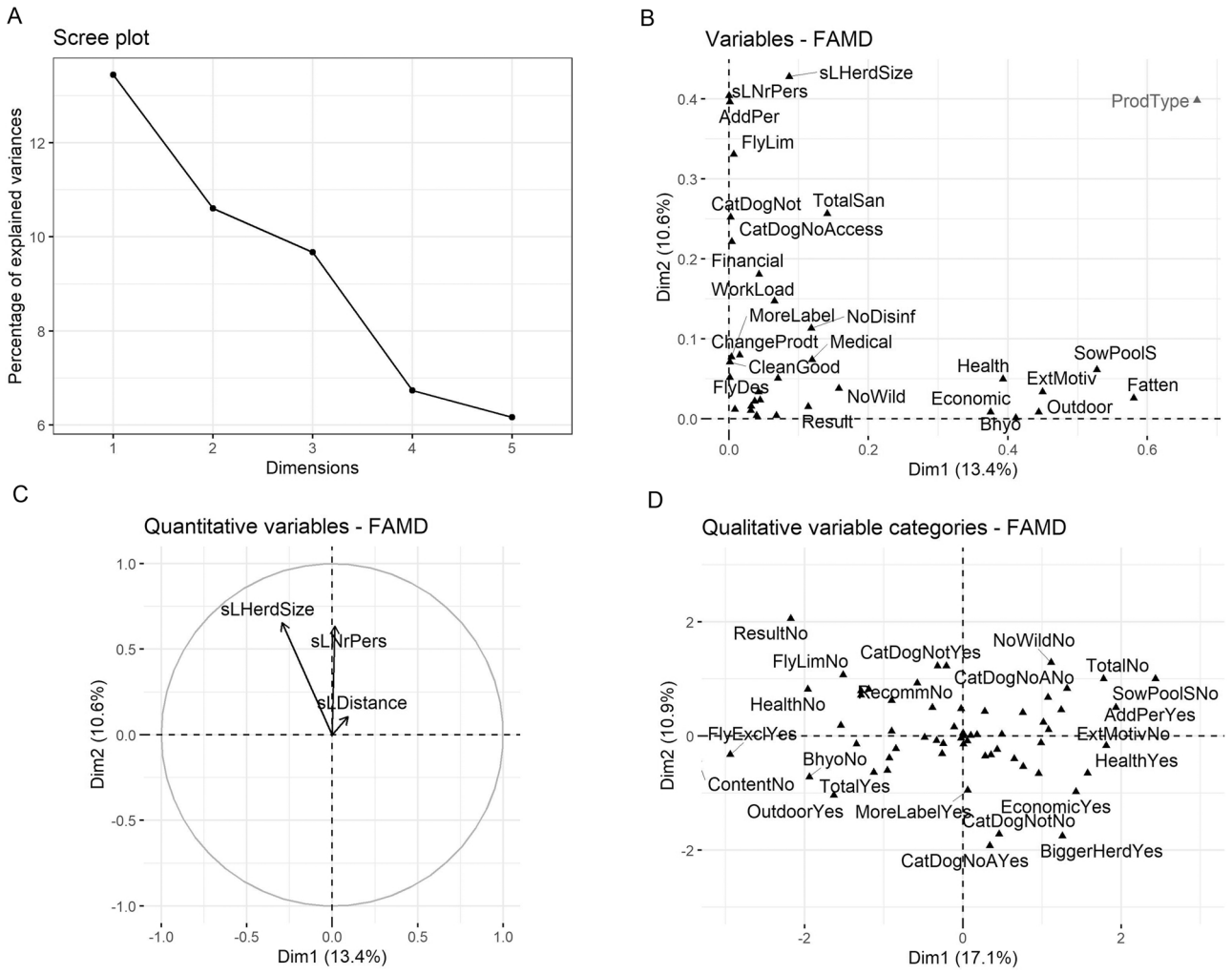

Fig. 3. FAMD analysis subset Fattening: a) screeplot; b) coordinates of the variables plot on the two main components (production type is a supplementary variable), c) quantitative variables and their correlation circle plot (in which the correlation between a variable and a principal component (PC) is used as the coordinates of the variable on the PC; d) qualitative variables and the contribution of each category on the PC.

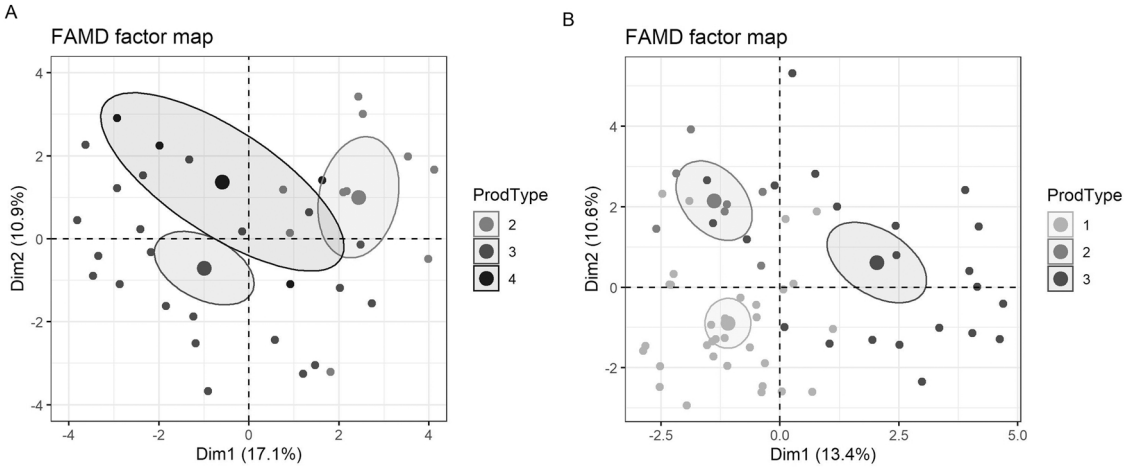

Fig. 4. Individual farms' plots (their coordinates) on the two main components for both subsets (left panel: Reproduction, right panel: Fattening), plotted on a grey scale by production type (1 = fattening herd, 2 = piglet rearing herd, 3 = piglet producer, 4 = Sow pool herd). For each grey scale group, a barycentre is calculated as the group mean and plotted. The concentric ellipses are defined by a 95% confidence interval (around group mean points or barycenters).

and costs (S2) were the factors that yielded the lowest numbers of positive answers. In addition, the benefit of the eradication is sometimes not obvious to these farmers because they do not necessarily house the age category affected by SD (Álvarez-Ordóñez et al., 2013; Hampson et al., 2015) and trade restrictions are not always present in Switzerland. However, farmers with a 3-weeks batch farrowing were more likely to be satisfied. Having scheduled farrwoing might allow an easier to organise eradication and hence increase satisfaction. On the other side, farmers with continuous management were less likely to be satisfied as this might make the eradication procedure more complicated.

4.1.2. Farmers with fattening pigs

Over three-quarters of the farmers with fattening pigs (76.3%, 1 missing answer) were highly motivated which is congruent with the expected improvement of health and performance of their herds. However, compared to farmers with breeding pigs, the percentage is only slightly higher. The 15 (25.4%) less motivated farmers included seven farmers of SPS herds, and a majority (10 farms) reported external pressure to eradicate.

A higher motivation was significantly associated with the farmer's own initiative and with access to outdoor areas. Farmers who had decided themselves to eradicate are very likely farmers who expected a benefit from the eradication. This was supported by the reasons the farmers mentioned, like financial pressure, pigs' health, the progress of their pig farm, or drug usage (Cadetg et al., 2019). Pressure from outside, on the other hand, might cause negative associations and might have been necessary for less motivated farmers. The external pressure had been exerted e.g. by the pig health service or pig traders (Cadetg et al., 2019). Also in another Swiss report, external pressure was one of the reasons to eradicate (Figi et al., 2014), but nothing was noted concerning the motivation of the farmer. In a study from Belgium, no direct external pressure seemed to be present as most of the 50 farmers of infected herds decided not to eradicate (Neirynck et al., 2020). Also a low level of internal pressure because of the absence of clinical signs or a high financial burden caused by the eradication was mentioned. As the farmers' own decision to eradicate significantly enhanced the motivation in our study, measures promoting such decisions would support the SD eradications. A measure should be an education about SD and its effects and the eradication including the procedure, the advantages and disadvantages. Education has been shown to be one of the corner stones of improving farmers (and veterinarians) understanding and communication (Albernaz-Gonçalves et al., 2021; Guinat et al., 2016; Valeeva et al., 2007) and hence promote informed decisions.

Although a higher percentage of farmers with fattening pigs (50.1%) was highly satisfied when compared to the farmers with breeding pigs (36.1%), there is room for improvement. Factors positively influencing farmers' satisfaction were the absence of breeding stock on the farm, again the own initiative and when barns were not disinfected during the eradication. Keeping only fattening pigs means that the eradication is easier to organise and perform, as it can be a total depopulation. This has been the case in 28 of the 32 pure fattening farms, but in only 22 of the 36 farms which kept also breeding pigs. Total depopulations of fattening farms are less expensive than partial depopulations of farms with breeding stock (Cadetg et al., 2019; Neirynck et al., 2020). Not to disinfect the barns means reduced labour and costs. In farms where the disinfection was part of the eradication procedure, up to 510 h of labour for cleaning and disinfection (or up to 12′750 CHF) and up to 860 CHF for the disinfectant (excluding material and product to disinfect the slurry) were necessary (Cadetg et al., 2019). In another Swiss study, cleaning and disinfection consumed most of the labour hours (510 h) and cost 860 CHF (Figi et al., 2014).

Although we did not analyse the impact of (low) market prices on the decision to eradicate, we assume that it might be less important in our study farms. In Switzerland, the eradications need to be performed during the warm season when B. *hyodysenteriae* is less likely to survive in the environment. And in the summer months, the pig prices are usually higher in Switzerland.

4.2. Herd characteristics and application of findings to other herds

The average herd sizes of fattening (285 pigs) and piglet producing (112 sows) herds were larger than the Swiss averages of 200 fattening pigs and 50 sows in that period (Anonymus (SGD, SUISAG (2018)). However, we assume that the factors 'work load' and 'financial pressure' are also relevant for smaller herds as the herd size is not the only aspect in eradication from SD. The study herds were largely located in the areas with the main pig production of Switzerland (data not shown), therefore representing other Swiss herds and aspects related to geographic localisation.

4.3. Data handling and statistical approach

In most questionnaire-based veterinary field studies, printed questionnaires were used. Data were transferred afterwards into digital systems allowing further data processing and analysis. However, digital evolution with mobile devices and applications (apps) allows the direct collection of digital data. We have chosen an application that is independent of access to the internet (no online version) because of the unknown availability of access to the internet on the farms.

The extensive preparatory work allowed efficient processing during and after the interviews. Editing and entering of data from the copies or pictures were done manually. This post-interview work took a considerable part of the time and effort within the study. However, as an increasing number of digital applications and databases have become available for pig farmers and veterinarians, and as they are increasingly used, future studies will profit from digital data (Egle et al., 2021).

4.4. Strengths and limitations

Participation in the interviews was voluntary. In the absence of mandatorily recorded data on SD, studies are dependent on the willingness of the farmers to participate which is not optimal (68/99 = 68.68% response rate). This response rate might introduce biases in that not all opinions could be pictured and the more critical or disinterested farmers might have been missed. However, our sample included all herd types except nucleus herds and all regions with a high density of pig farms. Our sample showed high heterogeneity, characteristic of the farms, farmers and eradications in Switzerland. The FAMD shows consequently that it is not easy to generalize a few common factors for motivation or satisfaction for all farmers.

The further back the eradication had taken place, the higher the recall bias. The variables regarding health before the eradication or hours used for cleaning and disinfection, e.g., were largely based on guess-estimates. Therefore, we cannot exclude recall bias especially for those farms in which the eradication was carried out more than 3 years in the past (46/68).

The study was performed in Switzerland. The opinions and attitudes of these Swiss pig farmers may not represent those of other pig farmers elsewhere.

5. Conclusion

In summary, the majority of the participating farmers were satisfied with the eradication. Education could promote self-motivation of farmers, and subsidies might ensure the implementation of SD eradications, as long as they continue to be mainly voluntary in Switzerland.

Funding

This work was supported by the Swiss Federal Veterinary Office (grant no. 1.16.04).

Conflict of interest statement

The authors declare that they have no conflict of interest.

Acknowledgements

We would like to thank the pig owners who provided time and information and thus supported this research. The SUISAG SGD provided information about herds that had undergone an eradication from SD.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.prevetmed.2022.105638.

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