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1 **Voluntary and compulsory eradication of bovine viral diarrhoea virus in**
2 **Lower Austria**

3
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15
16 **Abstract**

17
18 A voluntary BVDV eradication program without vaccination was introduced in Austria in
19 1997, according to the Swedish model employing herd-level antibody tests. Since this time,
20 identified persistently infected (PI) animals have to be slaughtered. In order to protect non-
21 infected herds, the major routes of introduction of BVDV infection into a herd, such as
22 communal grazing and livestock trade, have to be controlled.

23 In 1998 PI animals were identified in 7.5% of affiliated herds of herd book breeders. During
24 the voluntary program, the majority of the 2455 herd book breeders who actively participated
25 in the BVDV program had cleared up their herds. Hence, in 2005 only nine infected herds

26 (0.36%) remained under clearance. These data show that BVDV control can be achieved at
27 the farm level without a nation-wide BVDV eradication program.

28 A federal law was passed in 2004, obligating all herd owners to follow the BVDV eradication
29 program.

30 Between 2005 and 2007, the number of herds with a certified BVDV-free status increased
31 from 7931 to 9952 (2006) and 11,166 (2007), respectively. Currently (2008), 11,017 of
32 12,031 existing herds have been certified as BVDV-free herds (91.57%). Nearly all certified
33 BVDV-free dairy herds can now be monitored by testing milk samples because the cows have
34 no antibodies to BVDV. This signifies a marked improvement since 1998, when 46% of the
35 5024 tested dairy herds had a high level of BVDV antibodies in bulk tank milk.

36 Total eradication of BVDV-infected herds will need a further one or two years.

37

38 Keywords: Eradication, bovine viral diarrhoea virus

39

40 **1. Introduction**

41

42 Infection with the bovine viral diarrhoea virus (BVDV) was first reported in 1946 (Olafson et
43 al., 1946). In Austria, BVDV was first described to have occurred in a mountainous region in
44 the year 1972 (Bürki et al., 1972).

45 Economic losses result from prenatal infections (Houe and Palfi, 1993), which cause
46 abortions, infertility, malformations in calves, and the birth of persistently infected
47 immunotolerant calves (PI) that often die of mucosal disease (MD) (Brownlie et al., 1984,
48 Roeder and Drew, 1984). Diarrhoea and symptoms of respiratory disease are observed more
49 frequently in infected herds (Baker, 1995).

50 Vaccines against BVDV infection have rarely been used for prevention purposes in Austria.

51 Their sporadic use is limited to herds in which significant damage has already occurred. A

52 successful model of a vaccination strategy that entirely eliminates the pathogen has not been
53 reported thus far. In other words, the vaccination must be continued for an indefinite period of
54 time. Comprehensive country-wide implementation of this measure is not conceivable for
55 economic reasons. Moreover, there have been reports of live vaccines contaminated with
56 BVDV (Kreeft et al., 1990) as well as severe outbreaks of type 2 BVDV infections (Lindberg
57 et al., 1999).

58 Knowledge about how BVDV behaves in the host, the pregnant host and its foetus has been
59 utilised to establish a systematic eradication strategy (Alenius et al., 1997).

60 This approach serves as an example to combat other viral infections and confirms the
61 importance and utility of knowledge of epidemiological associations. Eradication strategies
62 for BVDV without vaccination were started in Sweden and Norway in 1993, and in Finland
63 and Denmark in 1994. These strategies have already led to eradication of the pathogens (Houe
64 et al., 2006). The central aspect of a BVDV eradication strategy is to identify born and unborn
65 persistently infected animals and to eliminate these from the herds (Radosits and Littlejohn,
66 1988).

67 Persistently infected animals and dams pregnant with persistently infected calves must be
68 excluded from contact between herds. Protection and control of non-infected herds is as
69 important for eradication programs as is disease clearance in infected herds (Alenius et al.,
70 1997).

71 In order to classify herds as being non-infected, they must be re-examined at least once within
72 a period of twelve months. This minimum period of one year is derived from the successful
73 strategy of the pathogen: it withdraws from the infected dams mature and intact immune
74 system, infects the foetus, and remains concealed here for six to eight months.
75 Simultaneously, an immature immune system is damaged and creates immunotolerance,
76 which causes the pathogen to spread after birth (Peterhans et al., 2004). Without persistently
77 infected animals in the herd, no further infections or seroconversions can occur because

78 animals transiently infected with BVDV are likely not able to infect neighbouring animals
79 under routine conditions (Niskanen et al., 2002).

80 This article will highlight the advantages of the Scandinavian BVDV eradication model and
81 the advancements made during the initially voluntary, and later compulsory, phase of the
82 eradication program in Lower Austria.

83

84 **2. Material and Methods**

85

86 2.1. Herds involved in the study

87

88 At the start of the voluntary BVDV eradication program (1997) 5,024 herds participated in
89 the project. Nearly all of them were from herd book breeders who performed at least one or
90 several herd-level tests for determination of the animals' BVDV status. From the year 1999
91 onward, the organizers of breeding cattle auctions decided to prohibit pregnant dams with
92 BVDV antibodies from entering the livestock trade market. From this time on, the 2,455
93 farms that regularly participated in the market made efforts to keep their herds free of BVDV
94 infection or initiated virus clearance.

95 From the year 2005 onward, nearly all herds in Lower Austria (13,382) with animals for
96 breeding have been included in the compulsory BVDV eradication program while feeder
97 herds are excluded from the program.

98

99 2.2. Herd-level test for determination of BVDV status and follow-up monitoring

100

101 All aspects of the Swedish eradication strategy (Alenius et al., 1997) implemented during the
102 voluntary eradication program in Lower Austria (1997-2004) have been incorporated into the
103 Austrian BVD regulation. The initial herd investigation is complete and the herds are

104 considered to be free of BVDV when tests for specific antibodies to BVDV in bulk milk or
105 milk samples from young cows or spot tests of the replacement stock at three investigations
106 performed over a period of at least twelve months yield appropriate results. After this time,
107 yearly follow-up investigations are required.

108

109 2.3. Initial herd investigation and follow-up for virus clearance

110

111 If the spot test of the replacement stock reveals a current BVDV infection or if a PI animal is
112 found in the herd, an initial herd investigation must be performed. The initial herd
113 investigation must include all animals in the herd. The follow-up investigation should be
114 performed after the initial examination and include testing of all animals in the herd that were
115 born within one year after the initial herd investigation or after eradication of the last PI
116 animal. The follow-up investigation must be performed at the earliest one year after the initial
117 herd investigation or one year after elimination of the last PI animal and must be concluded
118 by investigating a group of young animals aged 6 to 12 months. All blood samples of these
119 animals must be free of specific antibodies to BVDV.

120

121 2.4. Rules and regulations for owners of herds prior to transaction of cattle

122

123 Prior to transaction of cattle, the owners are obliged to conduct appropriate control
124 investigations of their herds (bulk milk or a group of young cows or replacement stock).

125 Animals from suspicious herds must be subjected to individual testing.

126

127 2.5. Laboratory methods

128

129 Since the initiation of the program, specific antibodies to BVDV in blood and milk samples
130 are detected by the use of an indirect ELISA (SvanovirTM, Svanova, Biotech, Uppsala,
131 Sweden). Potassium-EDTA tubes are used for blood samples and polypropylene tubes for
132 milk samples; the tubes contain ProClinTM (Supelco, Bellefonte, USA) as preservative.

133 From the beginning of the voluntary program until August 2004, BVDV-specific antigen
134 testing was done on leukocyte preparations (HerdCheck BVDV antigen/leucocytes, IDEXX
135 Scandinavia, Österbybruck, Sweden). Modified leukocyte preparations were used from 1999
136 onward (Rossmann et al., 2001) while the BVDV antigen/serum ELISA is in use since 2004
137 (HerdCheck BVDV antigen/serum, IDEXX). The results (positive and negative) of the Ag-
138 ELISA are checked by RT-PCR (Vilcek et al., 1994). Samples testing positive on the
139 Ag/serum ELISA are re-tested with the Ag/leukocyte ELISA to confirm the result of the
140 Ag/serum ELISA.

141 Administration of relevant data for the diagnosis, eradication and monitoring of BVD is done
142 by the use of a database that permits web-based as well as laboratory application.

143 The animals and their samples are registered and administered, and the obtained test readings
144 are assigned to the samples, by the use of the laboratory application.

145 The web-based application shows the animals of a herd, their data, and their examination
146 results. Authorised users can perform herd classifications.

147

148 **3. Results**

149

150 3.1. Detection of specific antibodies to BVDV

151

152 Since the beginning of the voluntary eradication program and during the compulsory BVDV
153 eradication program, more than 400,000 blood and milk samples have been examined by the
154 indirect ELISA and no false negative results have been obtained.

155 Based on the last 20 herds in which PI animals were found in the year 2008, Table 1 shows
156 that seroconversions were diagnosed in 15 of 20 herds before the occurrence and
157 identification of PI animals. Thus, it was possible to classify a herd as being possibly infected
158 before the birth of a PI animal.

159

160 Table 1:

161

162 3.2. Detection of BVDV antigen

163

164 The commercially available antigen test used during the first two years of the voluntary
165 eradication program in Lower Austria were, in part, not sensitive enough to detect PI animals.

166 By modifying the leukocyte preparation and testing the results of the Ag-ELISA by RT-PCR
167 from the year 1999 onward, the sensitivity of the antigen test could be significantly improved.

168 The number of samples that showed a negative or ambiguous result on Ag-ELISA and a
169 positive result on RT-PCR could be reduced from 4.71% to 0.82% (Rossmann et al., 2001).

170 After the manufacturer had introduced a new configuration of the Ag-ELISA in the year
171 2000, nearly identical results were achieved with the new Ag-ELISA and RT-PCR.

172 From 2004 onward, the HerdCheck BVDV Ag/serum ELISA is used. This ELISA is simple in
173 terms of handling and permits a high throughput of samples. In the year 2005, for instance,

174 59,626 samples were tested for the BVDV antigen and 511 PI animals were identified. In
175 order to avoid potentially false positive results of the Ag/serum ELISA or positive results

176 from samples of transiently infected animals, samples whose positive outcome on the
177 Ag/serum ELISA could not be confirmed in the other two test systems were re-tested at the

178 earliest after three weeks. For 52 samples the Ag/serum ELISA was positive, but the
179 Ag/leukocyte ELISA and RT-PCR were negative. Of these, six samples were repeated and

180 seroconversion was detected for all of them. The initial investigation yielded a positive result

181 for a further 35 samples only on the Ag/Serum ELISA and RT-PCR. At re-testing,
182 seroconversion was proved for 19 samples. A further seven repeated samples were positive on
183 the Ag/serum ELISA and simultaneously on RT-PCR, but remained negative on the
184 Ag/leukocyte ELISA. For the remaining 9 of 35 repeated samples, the Ag/serum ELISA, the
185 Ag/leukocyte ELISA and RT-PCR were positive. At the initial investigation, three samples
186 tested positive on RT-PCR but remained negative on the two ELISA test systems. The repeat
187 investigation showed seroconversion for all three samples.

188 In the year 2005, only one sample was positive on the Ag/leukocyte ELISA and RT-PCR but
189 negative on the Ag/serum ELISA. Regrettably, this sample was not sent for re-testing.

190 Worthy of note is the high percentage (54%) of proven seroconversions in samples that were
191 positive on the Ag/serum ELISA and negative on the Ag/leukocyte ELISA at the initial
192 investigation.

193

194 3.3. Results of the voluntary eradication program

195

196 At the start of the voluntary eradication program in 1997, bulk milk samples were tested for
197 specific antibodies to BVDV in 5,024 dairy farms of Lower Austria, nearly all of which were
198 herd book breeders.

199 Either no BVDV antibodies or only small quantities of BVDV antibodies were found in 54%
200 of the investigated bulk milk samples. In sections of the province north of the Danube, with
201 no common grassland and very little private grassland, clearly unsuspecting results were
202 obtained in 59%. In areas with common grassland and private grassland, a markedly lesser
203 proportion of bulk milk samples, namely 49%, were unsuspecting.

204 Blood testing of replacement stock was performed in 759 herds with suspicious bulk milk
205 samples. The replacement stock had no BVDV antibodies in 76.8% of the herds whereas they
206 did have antibodies to BVDV in 23.2% of the herds.

207

208 Table 2:

209

210 At the initial herd investigations in 1998 and 1999, PI animals were found in about 7.5% of
211 the 2,455 actively involved herds. By 2002 this percentage had reduced to 3.4%. In 2005 only
212 nine (0.36%) of these 2,455 breeders who regularly traded their livestock at the market had PI
213 animals.

214 Only some (58%) of the 4,220 herd book breeders were actively involved in the voluntary
215 program. Of the 4,220 herd book breeders, about 1.9% still had PI animals in the year 2005.

216

217 3.4. Results of investigations and eradication of BVDV infection on common grassland

218

219 In 1999, 4,630 animals from 732 herds with an unknown BVD status were investigated before
220 transhumance. At this investigation, 24.4% of the animals had specific antibodies to BVDV
221 and 33 PI animals were identified. The investigation program for animals prior to
222 transhumance to common grassland was continued during the next few years. At the end of
223 the respective grazing season, 10% of the animals on the respective common grassland were
224 tested for specific antibodies to BVDV. The last increase in antibodies was observed at the
225 end of the grazing season in the year 1999; it originated from a PI animal that had been
226 moved to the common grassland without having undergone the examination. In the year 2002
227 the seroprevalence in animals examined prior to transhumance was only 12.96%.

228

229 Table 3:

230

231 In administrative districts of grassland areas, in which about 960 farms have some of their
232 animals grazing on common grassland and about 50% of all farms (8,084) have their animals

233 grazing on private grassland, the percentage of certified herds (7,399) is currently (2008)
234 91.52%, which is about the same as that in the remaining administrative districts with no
235 transhumance to common grassland and very little private grassland. Of 3,947 farms, 3,618
236 (91.66%) have achieved a certified BVDV-free status.

237

238 Table 4:

239

240 3.5. Results of the compulsory BVDV eradication program

241

242 Progress in BVDV eradication resulted in a decline of PI animals between 2005 and 2007.
243 511 PI animals in 248 herds were found in 2005; 269 PI animals in 124 herds were found in
244 2006 and, finally, 115 PI animals in 46 herds were found in 2007. This trend continued in the
245 year 2008. On 31st August 2008, only 30 PI animals were found in 20 herds. During the same
246 time period, the number of herds with a certified BVDV-free status increased from 7,931
247 (2005) to 9,952 (2006) and finally to 11,166 (2007).

248 Currently, of 11,017 BVD-free herds 6,709 can be monitored by examinations of bulk milk
249 because bulk milk samples contain no or only small quantities of BVDV antibodies. A further
250 1,453 herds are monitored by milk samples of young cows whose samples are free of BVDV
251 antibodies. The remaining 2,855 herds must be monitored by blood samples because a large
252 number of these comprise no milkable cows or the herds contain older dairy cows with
253 antibodies to BVDV, which renders monitoring by bulk milk impossible.

254

255 Table 5:

256

257 **4. Discussion**

258

259 4.1. Experience with diagnostic methods

260

261 The indirect ELISA to detect specific antibodies to BVDV is a reliable procedure whose
262 results provide a large quantity of essential information. False negative results were only
263 registered at the initial investigations of sour milk samples in 1996. The samples had been
264 inadequately cooled and brought for investigation in a non-preserved state. The fact that the
265 milk had turned sour was not realised before and during the investigation. Even a small shift
266 in pH due to milk turning sour (and not identifiable by the naked eye) disturbs the antigen-
267 antibody reaction of the indirect ELISA and leads to false negative results.

268 Shortly afterwards, the use of ProClinTM for preservation of milk samples became a
269 mandatory measure prescribed by law.

270 Re-testing of bulk milk or groups of young animal permits classification of herds into non-
271 infected and infected ones (Niskanen, 1993; Alenius et al., 1997). The prevalence of specific
272 antibodies to BVDV in bulk milk samples and particularly in the samples of young animals is
273 highly over-estimated and employed as a justification for not using this economical method to
274 monitor herds. From Bavaria it has been reported that, in 42.6% of 777 non-vaccinated herds,
275 no or only small quantities of BVDV-specific antibodies were found (Brendel, 2005). In the
276 Bavarian study, less than one half of herds with antibody-positive bulk milk samples had
277 BVDV antibodies in samples of young animals as well. Therefore, 70-80% of the herds had to
278 be monitored by the serological method. This coincides with our experience from Lower
279 Austria. In a study from Switzerland as well, only 22.9% of samples from animals aged 7 to
280 12 months were found to be antibody-positive (Rüfenacht et al., 2000). Examination of bulk
281 milk is the most sensitive method to detect new infection of herds in dairy farms (Lindberg et
282 al., 1999). This method registers all lactating cows; the latter constitute 50% of herds with
283 young animals in Lower Austria. Once a lactating cow has been infected with BVDV, the

284 infection can be identified after 14 days. BVDV antigen testing of a PI calf born afterwards
285 can be successfully performed at the earliest five months after infection of the dam.

286 Even in the last 20 herds in Lower Austria, which had PI animals in the year 2008,
287 seroconversion was diagnosed in 15 of 20 herds before the birth and identification of the first
288 PI animal.

289 Small quantities of BVDV antibodies found on indirect ELISA in bulk milk tests, although
290 the herd contained only one PI animal, was reported just once (Obritzhauser et al., 2002).

291 Inclusion of the strongly viraemic milk of the PI cow was considered to have facilitated the
292 formation of antibody-antigen complexes, which negatively influenced the analysis of
293 antibodies. This situation was never encountered during the eradication program in Lower
294 Austria.

295 Detection of specific antibodies to BVDV also provides essential information for virus
296 clearance. Animals that developed antibodies after an infection are considered
297 immunocompetent and are themselves not persistently infected under routine conditions.
298 BVDV antigen testing need not be performed in these animals. If antibody-negative, sexually
299 mature heifers are found at initial herd investigations, one may expect virus clearance to take
300 longer. If the entire herd is infected and antibody-positive, the continuance of BVDV in the
301 herd is limited (Lindberg et al., 1999).

302 As actively acquired antibodies remain detectable for an entire lifetime and no seroconversion
303 occurs without the presence of a PI animal in the herd (Houe, 1992), the age of the youngest
304 animal that is still antibody-positive is an indicator of how long ago the PI animal was present
305 in the herd.

306 The examination of a group of young animals with an antibody-negative outcome is therefore
307 a prerequisite for completing virus clearance in the herd or, at worst, indicates that virus
308 clearance must be continued for a longer period of time. In 1997 and 1998, before the Ag-
309 ELISA was rendered more sensitive by modification of the leukocyte preparation and before

310 its result was re-tested by RT-PCR, detection of unexpected seroconversions at the final
311 examination of the group of young animals was a saving indicator of the fact that the Ag-
312 ELISA had yielded a false negative result and one PI animal had remained undetected.
313 Experience has also shown that not every calf that dies early or is stillborn is submitted for
314 investigation. Infections may spread even from these animals - which remain in the herd for a
315 very short period of time - provided there are enough susceptible animals in the herd.
316 However, the results of the indirect ELISA also permit valuable interpretations with regard to
317 the individual animal; these interpretations could be significant for an eradication program.
318 Animals that have developed active antibodies are immunocompetent; they are not PI
319 animals. Degradation of maternal antibodies in PI calves is completed at the age of 10 weeks
320 (Palfi, 1993). Only in exceptional cases do PI animals have low titres of maternal antibodies
321 until the fourth month of their lives. In cases of non-persistently infected calves, maternal
322 antibodies can be detected by indirect ELISA until the sixth to eight month of their lives.
323 Antibody-negative pregnant dams tested after the 150th day of pregnancy do not produce PI
324 calves if they are not persistently infected themselves. Animals that have actively formed
325 antibodies through infection with BVDV prior to sexual maturity are highly protected from
326 new infection of their foetus.
327 Due to the poor sensitivity of the commercially available BVDV antigen ELISA which was
328 used in 1997 and 1998, at herd investigations one frequently found seroconversions caused by
329 undetected PI animals. This has been reported by other authors as well (Shannon et al., 1997).
330 These undetected PI animals might be the reason for the more prolonged circulation of BVDV
331 reported in herds without the presence of PI animals (Barber et al., 1985; Moermann et al.,
332 1994; Moen et al., 2005).
333 Alternatively, calves that were aborted or died early, or strongly viraemic lochia, might have
334 infected susceptible animals. Modification of the leukocyte preparation of the Ag-ELISA and
335 re-testing its results with RT-PCR were able to improve the sensitivity of antigen detection

336 (Rossmanith et al., 2001). The new configuration of the Ag/leukocyte ELISA introduced in
337 the market at the beginning of 2000 led to nearly identical results being obtained with Ag-
338 ELISA and RT-PCR.

339

340 Based on Ag/serum ELISA testing it may be concluded that the sensitivity of this antigen
341 detection procedure renders it very useful for an eradication program.

342 The seroconversions demonstrated by repeated investigation make it clear that the Ag/serum
343 ELISA also detects transient BVDV infections. When this ELISA is used without
344 confirmation by Ag/leukocyte ELISA or without a repeat investigation, it is not possible to
345 distinguish between persistently and transiently viraemic animals.

346 Therefore, it is essential to test for specific antibodies to BVDV at the initial investigation,
347 followed by the repeat investigation. A proven seroconversion excludes the fact that the
348 sample originates from a PI animal.

349

350 4.2. Progress of the eradication program in Lower Austria

351

352 Nearly all participants of the voluntary eradication program from 1997 to 2004 were herd
353 book breeders, who keep records of their operational results and fertility parameters. One
354 study from Lower Austria reports on herds with PI animals that had significantly poorer
355 inseminations per pregnancy, non-return rates, and service periods, compared to control
356 groups (Wetchy, 1999).

357 The voluntary nature of the program was changed from 1998 onward because the compulsory
358 examination for common grassland was introduced at this time. In 1999 the organisers of
359 breeding cattle auctions imposed a compulsory examination for livestock being traded at the
360 auctions. Pregnant dams from infected herds were prohibited from the market. Antibody-
361 positive pregnant dams had to be from unsuspecting herds.

362 At the beginning of the inspection regulation for animals on common grassland, the
363 seroprevalence on common grassland was 24.4% (1999). In the year 2002 only 12.96%
364 seropositive animals were found on transhumance.

365 Reliable detection of PI animals before transhumance can prevent the spread of BVDV on
366 grazing land even if some of the herded animals originate from infected farms and the
367 presence of a transiently infected animal on transhumance cannot be excluded (Deinhofer et
368 al., 2004).

369 Circulation of BVDV without the presence of a persistently infected animal was never
370 observed on common grassland in Lower Austria. Ten per cent of the animals that had been
371 antibody-negative at transhumance in the spring were re-tested for antibodies when they
372 returned from transhumance in the autumn.

373 In Switzerland the animals were tested for BVDV-specific nucleic acids by real-time PCR
374 one week before transhumance, and for BVDV antibodies at the time of transhumance.
375 Although no PI animal was found, four seroconversions were detected in the autumn (Bodmer
376 et al., 2008).

377 Abortions were offered as one explanation for the seroconversions. Transient infections that
378 were possibly not detected by RT-PCR, and seroconversion that had possibly occurred later
379 than one week, may be an alternative explanation. Inquiring whether there had been a PI
380 animal in the farm of origin, which had caused the transient infection, might help to clarify
381 this situation.

382 An increased risk of infection on common grassland and private grassland no longer exists in
383 Lower Austria.

384 The percentage of herds without BVDV in 2008 was more or less equal in districts with
385 common grassland and private grassland (91.52%) and in districts without these types of
386 grassland (91.66%).

387 Retrospectively, the limitations on transaction of cattle from infected herds, designated for
388 breeding cattle auctions, have exerted a positive effect on the progress of the voluntary
389 eradication program.

390 The 2,455 farms that regularly brought their stock to breeding cattle auctions tried to achieve
391 disease clearance in their herds or keep them free of BVDV infection. Among the 2,455 farms
392 that regularly traded their cattle at the auctions, only nine farms had a PI animal in 2005
393 (0.36%). Nevertheless, the mean number of farms with PI animals among 4,220 herd book
394 breeders was still 1.9% in 2005. Thus, the mean number of farms with PI animals of herd
395 book breeders (1,765) who did not actively participate in the voluntary program was about
396 4%.

397 The small number of infected herds in these 2,455 farms is a strong indicator of the fact that
398 the BVDV eradication program can be successfully implemented in some herds even if the
399 remaining farms do not participate in the program. Our experience from Lower Austria
400 showed that maintaining the status of a BVDV-free herd is not as labour-intensive or
401 expensive as farmers in other countries believe it is (Gunn et al., 2005).

402 The proportion of non-herd-book breeders (9,162) in which a PI animal was found in the year
403 2005 was 1.83%. The somewhat higher percentage of herds with PI animals among herd book
404 breeders can be explained by the more intensive exchange of animals for breeding purposes.

405 During the next three years, the BVDV status of all herds was markedly improved.

406 In the year 2005, 511 PI animals were still found in 248 herds. In 2006, only 269 PI animals
407 were identified in 124 herds. In 2007, 115 PI animals were detected in 46 farms and in 2008 –
408 until 31st August 2008 – only 30 PI animals have been found in 20 herds.

409 Currently (2008), 11,017 of 12,031 existing herds subject to the BVDV regulation have been
410 certified as BVDV-free herds (91.57%). The decline in the absolute number of certified
411 BVDV-free herds can be explained by the declining number of cattle herds. Nevertheless, the
412 percentage of certified herds in 2008 has increased.

413 If the eradication program can be continued, a similar BVDV status as that in Sweden will be
414 within easy reach (Hult and Lindberg, 2005). No PI animal has been found in Finland since
415 the year 2003 (Rikula et al., 2005).

416 A large percentage of herds with milkable cows can be monitored by serology testing of bulk
417 milk samples or milk samples from groups of young cows. The cost of the BVDV program
418 will thus be reduced because blood tests will not be needed. Additionally, the status of the
419 herds can be monitored with just one sample. A cost-benefit analysis performed in Norway
420 applying bulk milk sampling approach, yielded very good results (Valle, 2005).

421 In conclusion, the voluntary program demonstrated that BVDV can be controlled at the farm
422 level without a nation-wide BVDV eradication program. The promising results of the
423 voluntary eradication program were also seen during the compulsory program. Using low-cost
424 serological screening methods on milk samples keeps costs low for the farmers participating
425 in the program.

426 It would be realistic to estimate that complete extermination of BVDV in Lower Austria will
427 be achieved by 2009 or 2010.

428

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430

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434

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533

Table 1: Comparison of the respective time point of established seroconversion and the birth of the first PI animal in 20 herds in which PI animals were found in 2008. * No seroconversion was identified before the birth of first PI animal.

Herd number	Detection of seroconversion month/year	Birth of the first PI animal month/year	Detection of the first PI animal month/year
1	11/2005	11/2006	1/2007
2	12/2006	7/2007	1/2008
3	2/2006	3/2007	4/2007
4	7/2002	11/2003	11/2004
5	4/2007	9/2007	1/2008
*6	-	11/2007	1/2008
7	8/2006	2/2007	3/2007
*8	-	12/2007	2/2008
9	7/2006	3/2007	5/2007
*10	-	5/2007	7/2007
11	8/2007	10/2007	11/2007
12	1/2008	2/2008	4/2008
13	1/2008	12/2007	4/2008
14	11/2007	3/2007	5/2008
15	4/2007	3/2007	8/2007
16	9/2006	10/2006	3/2007
*17	6/2005	6/2005	6/2008
18	5/2007	3/2008	6/2008
19	3/2007	8/2007	9/2007
*20	-	6/2008	8/2008

Table 2: BVDV antibodies in bulk milk samples ($OD \geq 0.24$): herds with antibody-positive spot tests of replacement stock (8 to 10 blood samples per herd) in 1997.

Bulk milk samples	% positive ($OD \geq 0.24$)	Herds in which spot tests of replacement stock were performed	% positive
5,024	45.7	759	23.2

Table 3: Transhumance examinations in 1999 and 2002.

Year	Number of herds	Number of animals	% antibody positive
1999	732	4630	24.40
2002	745	3163	12.96

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Table 4: Comparison of percentages of certified herds in grassland areas and the remaining areas

2008	Total number of herds	Certified herds	Percentage of certified herds
Grassland areas	8,084	7,399	91.52
Remainder	3,947	3,618	91.66

Table 5: Development of PI and certified herds from 2005 to 2008 in Lower Austria

Year	Herds	Herds with PI		PI	Certified herds	
	n	n	%	n	n	%
2005	13,382	248	1.85	511	7,931	59.26
2006	12,857	124	0.96	269	9,952	77.40
2007	12,273	46	0.37	115	11,166	90.98
2008 (until 31 st August)	12,031	20	0.16	30	11,017	91.57

Conflict of interest statement:

All authors declare to have **no conflict of interest**. Such as financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work.

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