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Seroprevalence of Bovine Viral Diarrhoea Virus in Hungary - situation before launching an eradication campaign

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2014

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1. List of abbreviations

Ag	=	Antigen
BVD	=	Bovine viral diarrhoea
BVDV	=	Bovine viral diarrhoea virus
CP	=	cytopathogenic
ELISA	=	Enzyme-linked immunosorbent assay
IBR	=	Infectious bovine rhinotracheitis
MD	=	mucosal disease
NCP	=	non cytopathogenic
PCR	=	Polymerase chain reaction
PI	=	Persistent infection (or persistently infected)
RNA	=	Ribonucleic acid
BTM	=	Bulk tank milk

2. Introduction

Bovine viral diarrhoea (BVD) is a leading animal health problem in most European countries due to the special features of the infection. Besides direct losses from enteritis in calves (as reflected in the name of the disease) it also has foetopathic ability, reducing the reproductive capacity of a herd.

This study aims to be the first nationwide representative prevalence survey of the causative agent, bovine viral diarrhoea virus (BVDV), in Hungary, using serological testing from large scale farms. Application of the indirect method (serology) to demonstrate the presence of the virus in a stock, gives more informative results on prevalence because antibodies persist longer in infected and seroconverted animals than the virus itself. The data will potentially aid virus eradication, already established voluntarily in some herds. The study is also aimed to detect the presence of uninfected herds which would serve as “nucleus stocks”, providing virus-free animals for the replacement of heavily infected herds where high seropositivity indicates active circulation of BVDV. Therefore, virus prevalence at herd level was investigated in favour of that of individuals.

3. Literature review

3.1 Bovine Viral Diarrhoea

Bovine viral diarrhoea (BVD) occurs worldwide and is the most important viral disease of cattle in some countries. Most cases of obvious clinical disease occur in cattle six months to two years old. Infection with the virus causes several diseases including:

- Subclinical bovine virus diarrhoea.
- Mucosal Disease. Fatal. Occurs in persistently viraemic animals and those who are specifically immunotolerant following infection with non-cytopathic strain early in foetal life, followed by cytopathic strain infection sixth months or more post-partum.
- Peracute fatal diarrhoea.
- Haemorrhagic disease.
- Reproductive failure.
- Congenital abnormalities if infected in the second trimester *in utero*.
- Lack of thrift.
- General immunosuppression leading to increased susceptibility to other diseases.

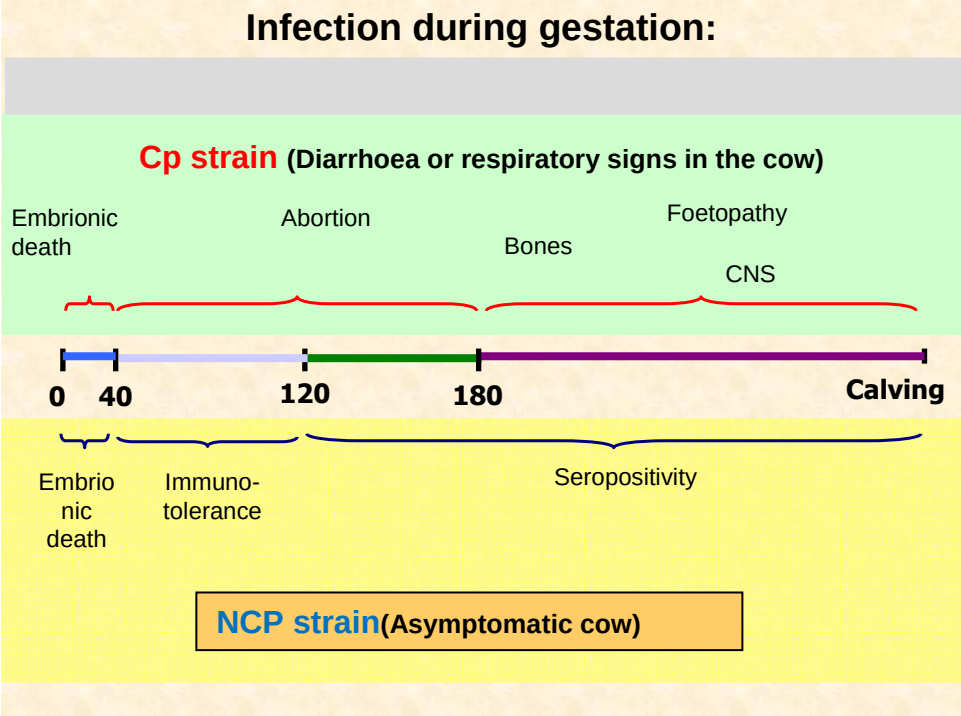
Young cattle persistently infected (PI) with non-cytopathic strain are the major source of infection in a herd - shedding the virus in large amounts in their secretions and excretions, contact with which causes clinical symptoms and reproductive failure in healthy herd mates. The virus may also be spread by biting insects, fomites (enabling iatrogenic transmission), semen (highly important in farms availing of assisted reproduction), contact with other animals and potently the discharges from the reproductive tract of an infected cow (Radostis et al., 2007; Kahn et al., 2010).

It must also be highlighted that vertical transmission occurs transplacentally. Persistent infection only occurs when the virus crosses the placenta during the first half of pregnancy. Logically, a PI female remaining clinically normal for many breeding seasons will produce PI lineage continuing for several generations who will shed the virus indefinitely (Radostis et al., 2007).

The outcome of intrauterine infection depends on the biological properties of the strain causing the infection. On the basis of biological properties, the different BVDV strains are grouped either as more virulent, cytopathogenic (CP) or less virulent, non cytopathogenic

(NCP) strains (see later). The consequences of the in utero infections with the two different pathotypes are summarized in Figure 3.1.1.

Figure 3.1.1



Comparison of the impact of strain and timing of Bovine Viral Diarrhoea Virus (BVDV) infection on the gestating cow and the foetus.

3.2 Bovine Viral Diarrhoea Virus

BVDV is a single stranded RNA virus belonging to the *Pestivirus* genus of the *Flaviviridae* family. There are two biotypes: Cytopathic (CP) and non-cytopathic (NCP). Only the non-cytopathic type crosses placenta to enter the foetus. Infected foetuses may become persistently infected (PI) post-partum and are critical to the spread of the virus. The cytopathic strain is most dangerous when it enters a PI animal as the calf will then succumb to mucosal disease. CP is a mutant of the NCP strain within PI animals (Goens, 2002).

In addition to strain classification antigen diversity divides the virus into BVDV types 1 and 2, with BVDV-1 comprising many important sub-genotypes. BVDV 1a is of American origin; 1b, mainland European (though the British isles are 1a dominant) – proposed to have arrived with Holstein cattle imported from North America. The single European market presents an opportunity for a serotypical matrix to occur across Europe and present a major problem for vaccination and surveillance for the virus (Hamers, 2001; Graham, 2001).

Genotype variation is more significant to detection and control than variation in biotype. Virulent BVDV-2 strains cause clinically severe disease characterised by fever, diarrhoea, leukopenia, lymphopenia, neutropenia, thrombocytopenia and death (Ridpath, 2003; Ridpath, et al, 2000).

3.3 Economic impact

The costs incurred by farms raising sucker herds infected with BVDV are due to abortion, congenital defects, stillbirths, increased neonatal mortality, reduced immunocompetence, growth retardation, reproductive disorders, early disposal of PI animals and deaths from mucosal disease (Radostis, et al, 2007).

The cost of infection depends on the statistical weighting towards a given disease impact – for example production/efficiency or animal welfare. Quantitative analysis of BVDV relies almost entirely on economic aspects, overlooking the impact of animal welfare e.g. pain and stress and their impact on feed conversion ratios (Linberg and Alenius, 2006).

Considering BVDV as a production limiting disease (in the same manner as Johne's disease, neosporosis or enzootic bovine leukosis) losses can be described as direct production losses (reduced milk yield on dairy farms, reduced beef cattle slaughter value, abortion and reproductive losses) and treatment costs (veterinary and medication costs, increased labour demands) (Chi, et al, 2002).

Most transient BVDV infections are not detected on farms, with costs calculated as the direct results of MD outbreaks, reproductive failures and PI animals. These uncomprehensive reports place the cost of BVDV between €21 and €135 per cow in the affected herd (Ózsvári et al., 2004).

Losses from BVDV outbreaks concomitant with other disease or due to high mortality attributable to a BVDV strain can be in excess of €340 per cow in the outbreak herd (Houe, 2003). For beef herds a mean loss of €54 p.a. per cow has been calculated. In the United Kingdom (where the disease is endemic), Denmark and Norway, national losses at population level are estimated to be between €8.5 and €34 per calving (Houe, 1999). Additionally, in Scotland BVD outbreak losses (estimated £37 per cow) are compounded by the loss of premiums awarded to herds with BVD-free status (Gunn, et al, 2004).

Macroeconomic projections from the USA and Canada estimate losses on national level to be between $10 and 40 million per million calvings (Houe, 2003).

The passage of time has rendered these data obsolete and it is reasonable to assert that these costs and their impact have raised considerably given inflation and the commonly accepted fact that shortages have increased the price of fuel and feed.

Furthermore, in the absence of estimated losses due to indirect effects such as reduced resistance to other diseases and higher rates of reproductive failure, these projections must be considered conservative.

3.4 Direct demonstration of the virus

Testing for BVD may be conducted using blood serum or plasma, milk or tissue samples as shown in Table3.4.1.Polymerase Chain Reaction (PCR), immunohistochemistry, Antigen-binding Enzyme-linked Immunosorbent Assay (ELISA) are employed according to the sampling technique.

Table 3.4.1: Methods for direct demonstration of BVD virus (World Organisation for Animal Health, 2012).

Sample	**Method**	**Component identified**
Tissue (skin, ear notch, peripheral blood lymphocytes)	ELISA	Antigen
Milk	Polymerase Chain Reaction	Nucleic Acid
Tissue (Skin)	Immunohistochemistry	Antigen

3.5 Serology

Cost-effective, sensitive monitoring of BVDV is required to accurately describe the status of the disease in the national herd and can be achieved using herd-level serological testing.

Serological epidemiology examines disease and infection in populations by measuring variables present in a serum (Thrusfield, 2005).

Seroconversion describes the development of detectable antibodies in an animal's serum following exposure to a disease or antigen, whereupon the individual is termed seropositive. The number of seropositive animals in a cohort can be used to describe seroprevalence, usually written as a percentage term.

Because any exposure to the viral antigen causes seroconversion, analysis should be restricted to unvaccinated herds.

Table 3.5.1.: Serological demonstration of BVD Virus (World Organisation for Animal Health, 2012).

Sample	**Method**	**Component identified**
Blood serum	ELISA	Antibody
Blood plasma	ELISA	Antibody

The host immune response to BVDV glycoprotein-E results in serum antibody generation, demonstrable accurately and reliably via ELISA (Roehrig, 2003); test procedures are easily conducted and economical, making it a valuable tool in large scale eradication programs. ELISA is technically superior to virus neutralisation testing as a BVDV antibody detection tool, due to higher accuracy, sensitivity and reproducibility (Durham and Lasard, 1990; J. Brinkhof, et al, 1996; Cho, et al, 1991).

Performing ELISA on samples from calves fed colostrum from seropositive cows can yield false positives: antibodies from the cow can enter the calf's blood stream resulting in seropositivity in absence of exposure to BVDV (Brinkhof, et al, 1996).

It must also be noted that false negatives can occur if calves infected between days 40-120 of gestation are tested. These calves are immunotolerant, as detailed in Figure 3.1.1, and therefore no antibody occurs in their serum.

The absence of PI animals can prevent seropositivity in a herd. Introduction of a PI animal to a feedlot herd results in seroconversion throughout the herd within weeks of its arrival (Radostis et al, 2007).

3.6 Approaches to BVDV prevention in other countries

BVDV surveillance, control and eradication measures in Hungary's neighbours and other European countries are influential in shaping Hungary's own BVDV strategy. Eradication and control are more effective than prevention of clinical symptoms by vaccination with regard to preventing macro and micro economic losses to the virus (Brock, 2004).

Prevention of the disease in infected animals does not prevent transmission. Therefore the most effective means of reducing the threat of BVDV is with an eradication programme involving the elimination of PI animals to prevent foetal infection and spread of the disease by the means previously mentioned (Lindberg and Alenius, 1999).

Vaccination against the virus prevents foetal infection with questionable efficacy - PI calves have been born into vaccinated herds. Researchers have shown that because 100% efficacy is

required to prevent infection when a herd is exposed to the disease, vaccination does not reduce the prevalence or incidence of BVDV (Lindberg, et al, 2006).

The Scandinavian countries (Norway, Sweden& Denmark) and Finland pioneered BVD eradication in the 1990's, achieving very low seroprevalence within ten years. Currently only Sweden and Denmark have reported cases on the past few years, isolated to less than one per year (Stahl and Alenius, 2012).These programmes have shown that BVDV can be eradicated cost-effectively, allowing many other countries to establish control programs in response.

Austria, Germany, France and Scotland piloted schemes regionally before nationwide expansion. The German approach also uses vaccination as an additional biosecurity protocol, in contrast with other European schemes.

Switzerland implemented a nationwide compulsory scheme in recognition of shared summer grazing on densely stocked alpine pastures. This approach used an initial 'Control' phase antigen testing of all newborn calves and elimination of PI animals throughout the national herd followed by a long term 'Surveillance' phase wherein methods vary according to type of herd and PI history. The Swiss model reports rapid initial success, the percentage of newborn PI calves falling by >98% from October 2008-December 2012, and cites highly motivated and well informed agricultural community as central to its achievements to date (DiLabio, 2013).

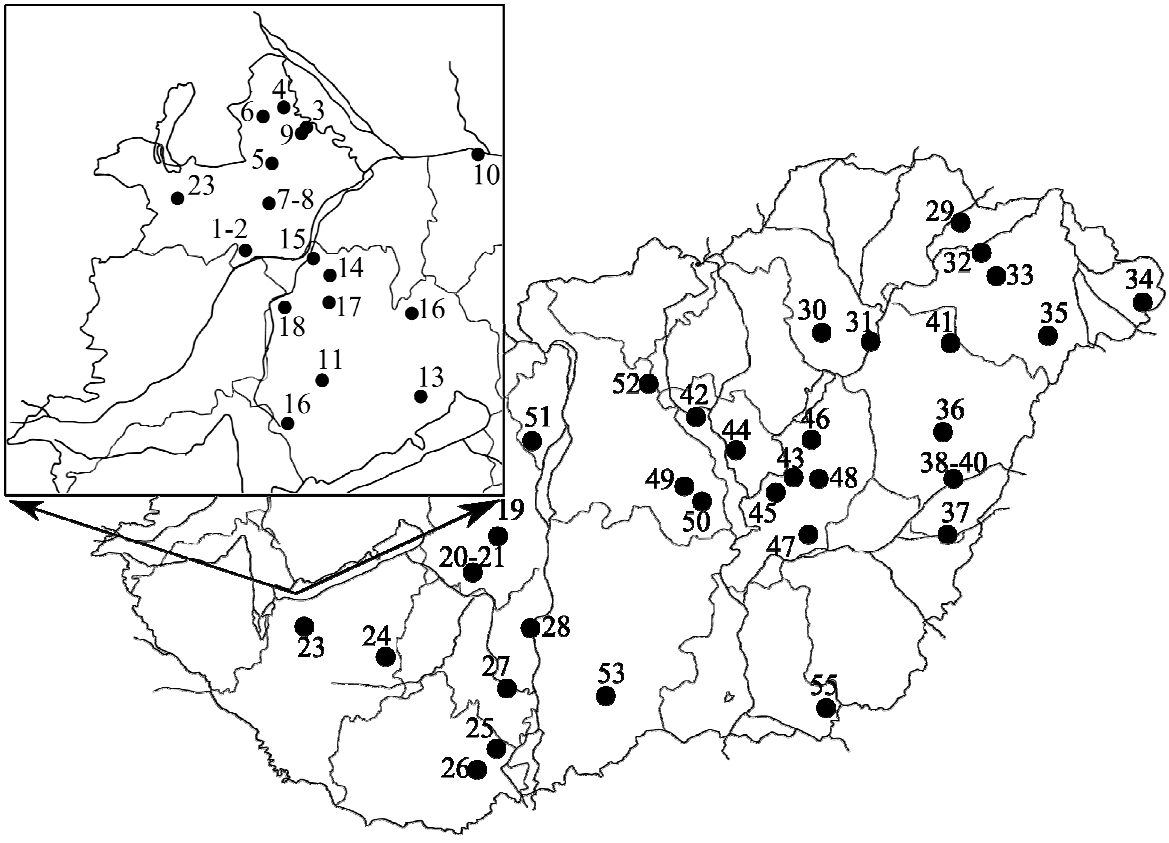
The Scottish government offered financial support to farmers testing cattle as part of its voluntary phase, encouraging participation prior to mandatory nationwide engagement. Ireland initiated its voluntary scheme in 2012, progressing to its compulsory phase in 2013 (Barrett et al., 2011).

4. Materials & Methods

4.1. Herds

The sample population was diverse geographically (see Figures 4.1.1 and 4.2.2) and in terms of the age, sex and purpose of the animals: Sera for analysis were taken from calves, heifers, cows and bulls from 54 herds throughout Hungary listed in Tables 4.1to 4.6. and detailed in the Appendix. Some farms owned herds at multiple premises sampled in the study. The farms were selected on the basis of their vaccination strategy against IBR (infectious bovine rhinotracheitis). Farms applying the Rispoval vaccine (Pfizer) were taken into the cohort, since the survey was sponsored by the Pfizer Animal Health (now Zoetis, Kalamazoo, Michigan, USA).

Figure 4.1.1 and 4.1.2:



Geographical distribution of the herds sampled

Blood samples were obtained via jugular venepuncture and allowed to clot. Serum was isolated via centrifugation at 1000 r.p.m for 3 minutes and removed from the samples were then stored at -20 °C until analysis.

4.2. Serological tests

BVD antibodies were identified in the sera using an antibody test kit (IDEXX HerdChek BVDV Antibody ELISA Test Kit, IDEXX Laboratories Inc., Westbrook, ME, USA) according the instructions written in the manual provided by the manufacturer. See appendix 1 for detailed information.

5. Results

The tables below show abridged results, with herds grouped according to disease prevalence.

Table 5.1: Herds with 100% seropositivity

Herd code	Origin	Location	Sample size	Positive	Inconclusive	Age range
4	Lajta-Hanság Zrt. Tanüzem	Mosonmagyaróvár	10	10	0	no data
5	Lajta-Hanság Zrt.	Hanságliget	10	10	0	no data
10	Komáromi MgZrt.	Komárom	13	13	0	no data
25	Somberek Zrt.	Somberek	15	15	0	cows
34	Erdőhát Zrt.	Csaholc	20	20	0	cows
35	Bátortrade Kft.	Nyírbátor	20	20	0	no data
37	Komádi Tehenészet Kft.	Komádi	20	20	0	cows
42	Agro-Lehel Kft.	Jászberény	5	5	0	no data
43	Kunhalom Agrária Kft.	Fegyvernek	20	20	0	no data
54	Agrár-Ker Kft.	Csanádpalota	20	20	0	no data

Herds in this sub-set may be classified as truly seropositive for BVD. Total or near-total seropositivity was exhibited. These are 'problem herds' that would benefit from the implementation of an eradication strategy.

Table 5.2: Highly seropositive herds with variable seroprevalence, age data and age range.

Herd code	Origin	Location	Sample size	Positive	Inconclusive	Age range
1	Előre Szövetkezet	Beled	10	5	0	no data
3	Lajta-Hanság Zrt.	Kimle	10	5	2	cows
7	Farádi Mg. Szöv.	Farád	6	2	2	no data
8	Farádi Mg. Szöv.	Farád	15	0	0	no data
9	Lajta-Hanság Zrt. Károlyháza	Károlyháza	21	15	1	no data
11	Vicenter Kft. Devecser Szak. Telep	Devecser	36	30	0	calves
12	Bakony HO-Li Kft.	Borzavár	20	2	0	cows

14	Bovinia Kft.	Takácsi	17	15	0	no data
15	Aranykocsi Zrt.	Malomsok	10	4	6	6-7 month old pregnant heifers
16	Tóth Tamás	Sümeg	48	33	1	39 cows, 9 pregnant heifers
17	Agroprodukt Zrt.	Pápa	10	7	0	no data
18	Agroprodukt Zrt.	Marcal-gergelyi	20	10	3	no data
19	Szabó Zsolt e.v.	Nagylók	209	101	20	197 cows; 12 pregnant heifers
24	BosFruchtAgrár	Kazsok	20	18	0	no data
38	Agro-Cow Kft.	Berettyóúj-falu, Pozsár farm	15	12	0	3-5 month old calves
39	Agro-Cow Kft.	Berettyóúj-falu, Tetőtlen farm	15	14	0	8-20 month old calves
40	Agro-Cow Kft.	Berettyóúj-falu, Balogh farm	20	3	1	3-5 month old calves
44	Jász-FöldZrt.	Jászladány	20	17	1	no data
45	Törökszentmiklósi Mg. Zrt. (2 telep)	Törökszentmiklós	40	37	1	Cows
50	DPMG Zrt.	Törtel	20	13	0	no data
51	Agrifutura Kft.	Tárnok	25	19	0	no data
53	Agro-Business Kft.	Jánoshalma	13	1	1	no data

This cohort showed variable rates of disease throughout various herds and geographical regions. It is possible that animals in these herds have PI offspring each year which propagate the disease through other calves, purchase infected animals or have breeding animals who were exposed to the disease at various stages of gestation.

Table 5.3: Seropositive farms with low infection rate - one sample is positive or questionable

Herd code	Origin	Location	Sample size	Positive	Inconclusive	Age range
6	Lajta-Hanság Zrt.	Mosonszolnok	11	1	0	no data
13	Vám-Tej Kft.	Nemesvámos	13	1	0	no data
20	Mezőföld Mg. Szöv.	Mezőszilas	20	1	0	cows
29	Geo-Milk Kft.	Sárospatak	20	1	0	cows
32	Ibránytej Kft.	Ibrány	20	0	1	cows
52	Galgamenti Szövetkezet, Haraszt	Tura	20	1	0	no data

These herds display very low seropositivity: one individual testing positive or inconclusive. In a sample size of 1200 animals, this low prevalence may be interpreted as test error as it is within the ELISA error range. These herds should be re-examined to increase the reliability of their data.

Table 5.4: Seronegative farms without age data and low sample size.

Herd code	Origin	Location	Sample size	Positive or inconclusive	Age range
23	Marcali Mg. Rt.	Marcali	13	0	no data
28	Milkmen Kft.	Paks	15	0	no data
41	Bocskai Szarvasmarha Teny. Kft.	Hajdúdorog	12	0	no data
21	Mezőföld Mg. Szöv.	Mezőszilas	5	0	6 month old calves
49	PirkóKft	Cegléd	13	0	3-6 month old calves

The results from these herds can be regarded as statistically invalid due to lack of data and sample size of low statistical validity. The results may be accurate for the individual herd but are discounted from the study as inclusion would induce artificially seronegative skewed herd-level seroprevalence.

Table 5.5.: Seronegative farms with no age data with a sample size greater than or equal to twenty animals.

Herd code	Origin	Location	Sample size	Positive or inconclusive	Age range
2	Előre Szövetkezet	Beled	25	0	no data
30	Aranykalász Mg. Szöv.	Mezőkeresztes	20	0	no data
47	Belán-Alcsi Red Kft.	Mezőtúr	20	0	no data

BVD-free status in these herds is highly probable. High populations were sampled but no age data was recorded, thus reducing the degree of certainty with which results can be analysed.

Table 5.6: Seronegative farms where samples originated from cows.

Herd code	Origin	Location	Sample size	Positive or inconclusive	Age range
22	HegykőMgZrt.	Hegykő	20	0	at least one calving
			10		pregnant heifer
			10		13-14 month
			10		3 month
			10		4 month
			10		7 month
26	SzajkiZrt	Szajk	20	0	cows
27	Szekszárd Rt.	Szekszárd	15	0	cows
31	Tiszamenti Szövetkezet	Tiszakeszi	20	0	cows
33	Farm-Tej Kft.	Kemecse	20	0	cows
36	Hajdúszováti Sz. T. H. Kft.	Hajdúszovát	20	0	cows
46	Középtiszai MgZrt.	Kunhegyes	20	0	cows
48	Kenderes 2006. Kft	Kenderes	15	0	cows

The animals sampled in this group were of sufficient age to have been exposed to the disease if it had been present in their environment for a clinically significant time period. In addition the sample sizes at these locations were large enough to provided statistical validity & thus be conclusively branded 'BVD-free'.

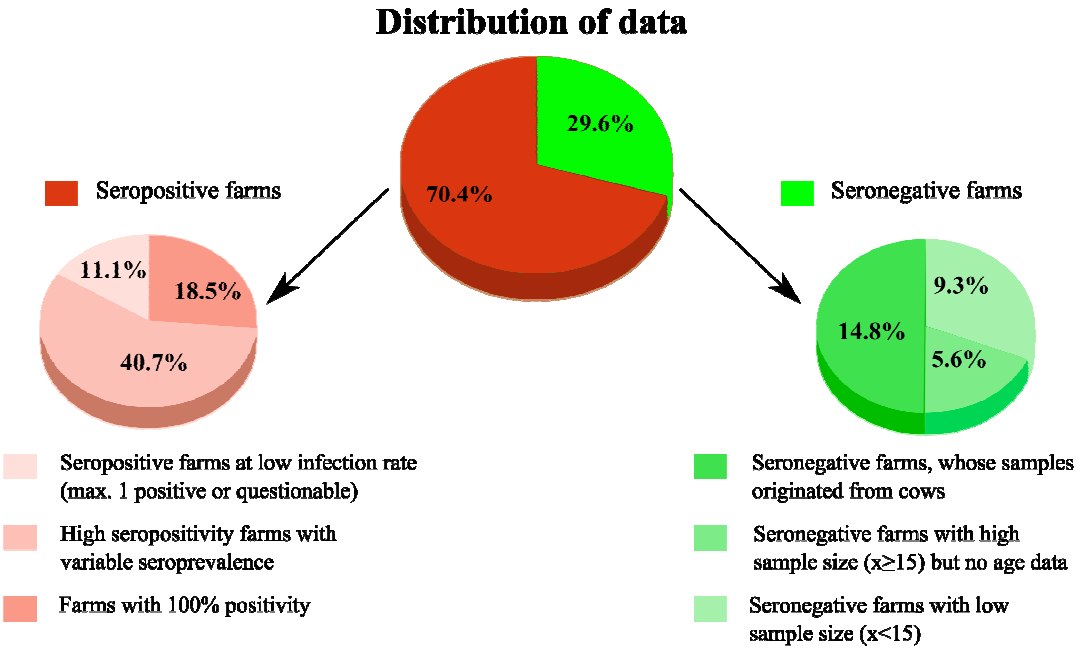
Table 5.7 Summarised data

Total sample size	54 farms (1200 animals)
TOTAL seropositive farms	38 (521 out of 867 animals)
TOTAL seronegative farms	16 (333 animals)
Ratio of seropositive farms	70.37%
Ratio of seronegative farms	29.63%
Ratio of seropositive farms with low seropositivity (maximum 1 positive or inconclusive)	11.11%
Ratio of seropositive animals within seropositive farms	60.09%

6. Discussion

This data demonstrates individual seropositivity of 43.42% (521 seropositive animals of the 1200 sampled). Compared to data from other countries, it is higher than in the Scandinavian countries prior to the launch of their eradication campaigns, but lower than certain regions of Germany.

Table 6.1



Distribution of data

Regarding herd level seropositivity, 29.6% of the investigated farms (16 out of 54 farms) were not infected (Figure 3.). The ratio of seronegative farms is important as these herds may provide sources for animal replacement - eradication programs require that only animals from BVD-free herds are introduced to farms where the program has started. Hence completely seronegative herds should be used as market seeds. The proprietors of these herds can potentially demand higher premiums for their stock as sales come without risk of BVD propagation. The monetary value of the herd is enhanced by BVD-free status as various countries among Hungary's neighbours screen for BVD when importing stock. Seronegativity guarantees export to these countries - particularly valuable for farmers wishing to establish such trade links, should Hungary join the Single European Currency.

Furthermore, a significant proportion of positive herds (13%) show very low seropositivity (1 or 2 sample is positive from 15-20), meaning that the test result could be false, and should be repeated,or the virus was only recently introduced into the stock. At these locations identification and selection of PI animals (by PCR from peripheral lymphocytes or by Ag ELISA from ear notches) and subsequent removal may result in successful eradication of BVD from the herd.

The age of subjects should also be considered: Increased reliability can be attributed to data from with older animals, owing to the greater duration of potential exposure (in cows than in 6 month old calves, for example). Thus it can be said with greater certainty that a herd is BVD-free if the population sampled were all multiparous cows.

In farms where all positive samples came from cows, these individuals' parent stock may have been exposed to a PI animal. The infection will perpetuate in these farms unless all infected stock is replaced. It is also possible that such farms used a live attenuated vaccine in the past and that this strain is causing antibody generation in subsequent offspring. This kind of vaccine was widely used to prevent the clinical symptoms of the disease in Hungarian herds in the 1990’s with success. However, pregnant animals who were vaccinated in the first half of gestation transmitted the virus to their offspring, resulting in the birth of very high numbers of PI animals in this time period.

If seropositivity is very high within a herd, selection is not a viable means of eradication. In this case only total stock replacement or the prompt separation of calves from their mothers followed by testing for PI status (from ear notches) and raising on separate premises, are acceptable. Heifers raised in this new, separated stock and should not be mixed with cows. This is possible if a farm has more than one location.

Farms in which multiple premises were tested and results showed subsets of seropositivity and seronegativity should designate the seronegative herds as breeding stock. Using offspring from these herds will allow the farm to phase out BVD completely without having to pay higher prices for guaranteed BVD-free stock. Such farms must also prevent exposure to disease by only purchasing from other BVD-free herds and not allowing their animals to mix with those of undefined or BVD-positive herd status.

BVD-free herds must prioritise protection of their status. This requires the design of disease prevention protocols, ideally including breeding, animal purchase & stock replacement, herd and operator hygiene policies.

7. Summary

Bovine viral diarrhoea through its various manifestations is the leading cause of economic loss in the Hungarian cattle industry. This study used ELISA analysis of blood samples taken from a cohort that would be representative of the national herd with the aim of determining prevalence of the disease nationwide. This was the first such survey in Hungary in over thirty years and has the potential to be used as a benchmark for further surveillance and the monitoring of an anticipated BVD eradication campaign.

1200 samples were taken from 54 herds, of which 521 (43.42%) proved positive, 40 (3.3%) were questionable and 639 (53.3%) were negative. Seronegativity of cows who had served multiple lactations indicated BVD-free status with the greatest degree of certainty. Some herds recorded low seropositivity (<5%) and could aim for BVD-free status by making small management changes and careful surveillance. The ratio of BVD-free herds was higher than expected (29.63%), based on previous studies using lower sample sizes and smaller geographic distributions.

In conclusion, a well structured eradication campaign wtih the support and engagement of veterinarians and farmers would benefit Hungarian agriculture massively and could achieve results at the same rate as seen in other countries. It would be possible to enhance the efficiency of the campaign by running in parallel with that of another disease such as Infectious Bovine Rhinotracheitis.

8. Összefoglalás és cím magyarul

(Hungarian title and summary)

A borjak vírusos hasmenését okozó vírus szeroprevalenciája
Magyarországon – helyzetkép az országos mentesítés megkezdése előtt

A szarvasmarhák vírusos hasmenése (Bovine Viral Diarrhoea, BVD) változatos kórképek kialakulásával járó betegség, melynek gazdasági jelentősége igen nagy a magyarországi szarvasmarha-tartó gazdaságokban. A hazai fertőzöttség felmérésének érdekében indított vizsgálatunk, melyet ELISA (Enzyme Linked Immunosorbent Assay) módszert alkalmazva az egész ország területéről gyűjtött vérmintákon végeztük, reprezentatívnak tekinthető. Mivel hazánkban az utóbbi harminc évben nem történt ilyen felmérés, vizsgálatunk a későbbiekben a BVD várható visszaszorulásának nyomon követését célzó monitoring vizsgálatsorozat alapjául szolgálhat.

Az 54 szarvasmarha-tartó telepről származó 1200 mintából 521 volt pozitív (43,42%), 40 kétes eredményt adott (3,3%), 639 pedig negatívnak bizonyult (53,3%). Ha a gazdaságok viszonylatában nézzük az eredményeket, akkor a mintát küldő 54 telep közül 38 vérmintái között volt legalább egy pozitív (70,37%) míg 16 telepről valamennyi vérminta negatívnak bizonyult (29,63%). Ez utóbbi csoportban számos olyan gazdaság is található, ahol a vérmintákat, többször ellett, idősebb tehenekből vették, vagyis a negativitás egyértelműen utal az adott telep BVD-mentességére. A pozitív telepek között is több esetben igen alacsony ($x<5\%$) fertőzöttségi arányt tapasztaltunk, ami jó telepi menedzsment és megfelelő ellenőrző vizsgálatok alkalmazásával akár szelekciós mentesítést is lehetővé tesz. A vizsgálatok alapján Magyarországon a szarvasmarha-tartó telepek jelentős része (29,63%) mentesnek tekinthető, ami sokkal kedvezőbb a korábbi, az ország egy-egy régiójában, kisebb számú telepen végzett felmérések alapján elvárható eredménynél.

Ennek alapján az esetleg meginduló BVD-mentesítés esélyei a folyamatban résztvevő állatorvosok és tulajdonosok közreműködésével, nagyban segítené a Magyar mezőgazdaság teljesítményét, és jó esélyekkel a más országokban tapasztalt alacsony fertőzöttség vagy mentesség gyorsan elérhető lenne. Különösen hasznos lehetne egy az IBR mentesítéssel párhuzamosan végzett BVD mentesítés

9. Acknowledgements

The author wishes to thank Prof. Rusvai Miklós, Dr. Csaba Kővágó and all the teachers at Szent István University, Budapest who were involved in this research.

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11. Appendices

Appendix 1: List of farms participating in the survey and the results of the investigations in full

	Origin	Short address	Date of arrival	Number of samples	Positive	Questionable	Age group
	I. Győr-Moson-Sopron county						
1.	ElőreSzövetkezet	Beled	22/08/2006	10	5	0	no data
2.	ElőreSzövetkezet	Beled	26/10/2006	25	0	0	no data
3.	Lajta-HanságZrt.	Kimle	13/11/2006	10	5	2	cows
4.	Lajta-HanságZrt. Tanüzem	Mosonmagyaróvár	13/11/2006	10	10	0	no data
5.	Lajta-HanságZrt.	Hanságliget	13/11/2006	10	10	0	no data
6.	Lajta-HanságZrt.	Mosonszolnok	13/11/2006	11	1	0	no data
7.	Farádi Mg. Szöv.	Farád	02/03/2007	6	2	2	no data
8.	Farádi Mg. Szöv.	Farád	23/05/2007	15	0	0	no data
9.	Lajta-HanságZrt. Károlyháza	Károlyháza	03/03/2008	21	15	1	no data
	II. Komárom-Esztergom county						
10.	KomáromiMgZrt.	Komárom	25/07/2007	13	13	0	no data
	IV. Veszprém county						
11.	VicenterKft. DevecserSzak. Telep	Devecser	19/09/2006	36	30	0	calves
12.	Bakony HO-Li Kft.	Borzavár	26/10/2006	20	2	0	cows
13.	Vám-TejKft.	Nemesvámos	21/11/2006	13	1	0	no data
14.	Bovina Kft.	Takácsi	11/01/2007	17	15	0	no data
15.	AranykocsiZrt.	Malomsok	17/05/2007	10	4	6	6-7months old pregnanat heifer
16.	TóthTamás	Sümeg	29/10/2007	48	33	1	37: cows, 9: pregnanat heifer
17.	AgroproduktZrt.	Pápa	08/05/2008	10	7	0	no data
18.	AgroproduktZrt.	Marcalgergelyi	10/05/2008	20	10	3	no data
	V. Fejér county						
19.	SzabóZsolte.v.	Nagylók	26/10/2006	209	101	20	cows; 12: pregnanat heifer;
20.	Mezőföld Mg. Szöv.	Mezőszilas	07/12/2007	20	1	0	cows
21.	Mezőföld Mg. Szöv.	Mezőszilas	07/12/2007	5	0	0	6 months old calves

	VI. Zala county						
22.	HegykőMgZrt.	Hegykő	27/08/2007	70	0	0	20: min 1×gave birth; 10: pregnanat heifer; 10: 13-14month; 10: 3month; 10: 4month; 10: 7month
	VII. Somogy county						
23.	Marcali Ma Rt.	Marcali	08/09/2006	13	0	0	no data
24.	BosFruchtAgrár	Kazsok	26/10/2006	20	18	0	no data
	VIII. Baranya county						
25.	SomberekZrt.	Somberek	26/09/2006	15	15	0	cows
26.	SzajkiZrt	Szajk	26/10/2006	20	0	0	Cows
	IX. Tolna county						
27.	Szekszárd Rt.	Szekszárd	12/12/2006	15	0	0	Cows
28.	Milkmen Kft.	Paks	18/12/2006	15	0	0	no data
	XII. Borsod-Abauj-Zemplén county						
29.	Geo-Milk Kft.	Sárospatak	16/11/2006	20	1	0	Cows
30.	Aranykalász Mg. Szöv.	Mezőkeresztes	15/12/2006	20	0	0	no data
31.	Tiszamentiszövetkezet	Tiszakeszi	10/01/2007	20	0	0	Cows
	XIII. Szabolcs-Szatmár-Bereg county						
32.	IbránytejKft.	Ibrány	07/11/2006	20	0	1	Cows
33.	Farm-TejKft.	Kemecse	08/11/2006	20	0	0	Cows
34.	ErdőhátZrt.	Csaholc	05/12/2006	20	20	0	Cows
35.	BátortradeKft.	Nyírbátor	21/12/2006	20	20	0	no data
	XIV. Hajdú-Bihar county						
36.	HajdúszovátiSz. T. H. Kft.	Hajdúszovát	26/10/2006	20	0	0	Cows
37.	KomádiTehenészetKft.	Komádi	31/10/2006	20	20	0	Cows
38.	Agro-Cow Kft.	Berettyóújfalu, Pozsár farm	03/11/2006	15	12	0	3-5 months old calves

39.	Agro-Cow Kft.	Berettyóújfalu, Tetőtlen farm	03/11/2006	15	14	0	8-20 month old calves
40.	Agro-Cow Kft.	Berettyóújfalu, Balogh farm	12/12/2006	20	3	1	2-5 day old calves from heifers; 15: 3-5 months
41.	BocskaiSzarvasmarhaTeny. Kft.	Hajdúdorog	07/03/2008	12	0	0	no data
	XV. Jász-Nagykun-Szolnok county						
42.	Agro-LehelKft.	Jászberény	11/09/2006	5	5	0	no data
43.	KunhalomAgráriaKft.	Fegyvernek	26/10/2006	20	20	0	no data
44.	Jász-FöldZrt.	Jászladány	26/10/2006	20	17	1	no data
45.	Törökszentmiklósi Mg. Zrt. (2 telep)	Törökszentmiklós	26/10/2006	40	37	1	Cows
46.	KözéptiszaiMgZrt.	Kunhegyes	13/11/2006	20	0	0	Cows
47.	Belán-Alcsi Red Kft.	Mezőtúr	07/12/2006	20	0	0	no data
48.	Kenderes 2006. Kft	Kenderes	07/12/2007	15	0	0	Cows
	XVI. Pest county						
49.	PirkóKft	Cegléd	26/11/2007	13	0	0	84-128 days old calves
50.	DPMG Zrt.	Törtel	15/02/2008	20	13	0	no data
51.	AgrifuturaKft.	Tárnok	15/02/2008	25	19	0	no data
52.	GalgamentiSzövetkezet, Haraszt	Tura	11/04/2008	20	1	0	no data
	XVII. Bács-Kiskun county						
53.	Agro-Business. Kft.	Jánoshalma	23/11/2006	13	1	1	no data
	XVIII. Csongrád county						
54.	Agrár-Ker Kft.	Csanádpalota	03/03/2008	20	20	0	no data
TOTAL				1200	521	40	

TOTAL seronegative farms	17	TOTAL seropositive farms	36
Ratio of seronegative farms	30.91%	Ratio of seropositive farms	65.45%
Ratio of non seronegative samples	43.42%		
Ratio of seropositive farms with low seropositivity (max 1 pos. or inconclusive)	1.15%	Ratio of seropositive samples originated from seropositive farms	61.88%

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