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BVDV eradication, 'Canadian' perspective or…let's get moving…

USAHA 2019

Frank van der Meer
Associate Professor
Global Health and Infectious Diseases

Frank.vandermeer@ucalgary.ca
@frnkvdmr (Twitter)

1

SAVE THE DATE:
16-17-18 JUNE 2020

CALGARY, AB

8th BVDV SYMPOSIUM COMBINED WITH THE UCVM BEEF CATTLE CONFERENCE

'BVDV,
is there a limit to our tolerance?'

The virus, BVD pathogenesis
and a pathway to eradiation.

2

In Providence?

3

Crossing the species barrier

BVDV PI lambs: Hairy shakers

4

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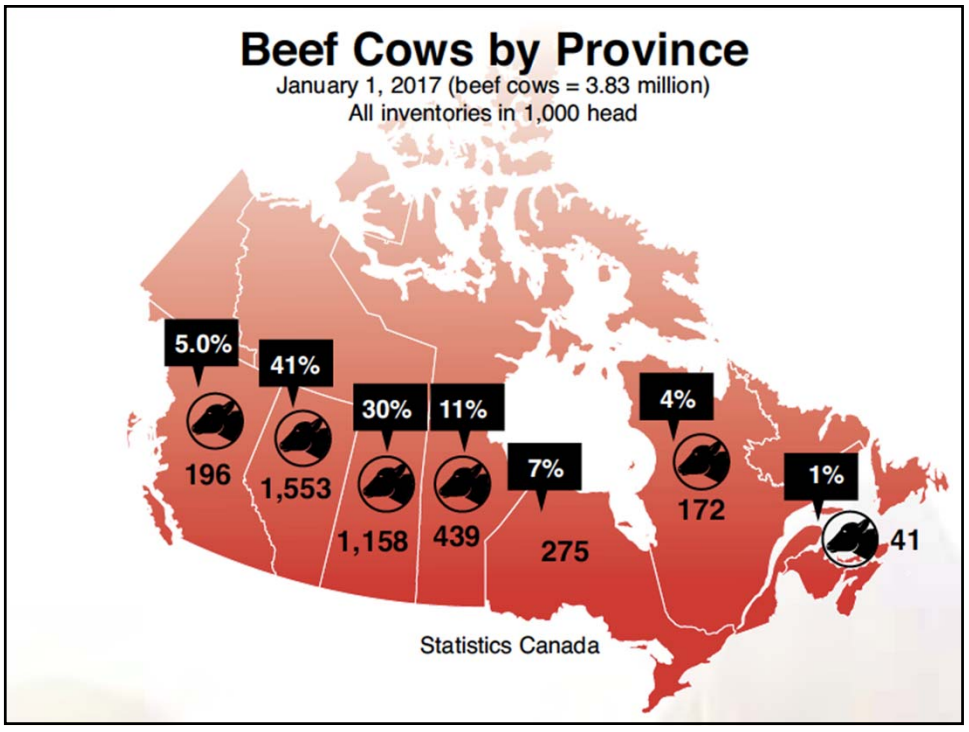
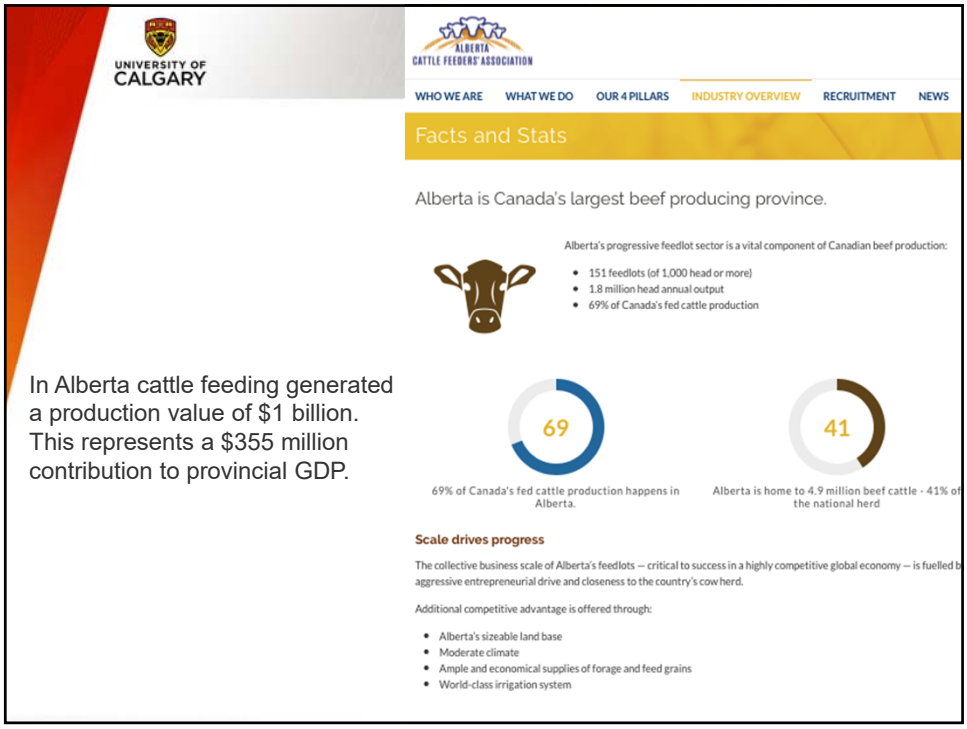
Beef and dairy production in Canada

5



6

In Alberta cattle feeding generated a production value of $1 billion. This represents a $355 million contribution to provincial GDP.



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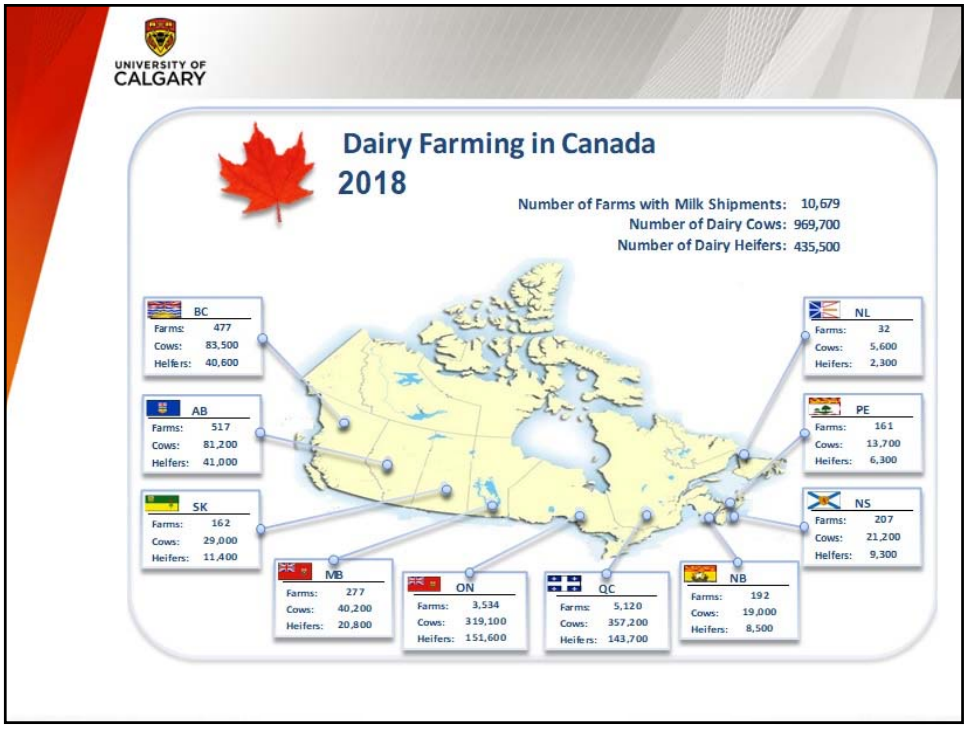

8

A long history of talking
about BVD control/eradication

9

1946

AN APPARENTLY NEW
TRANSMISSIBLE DISEASE OF CATTLE *

By PETER OLAFSON,** A. D. MacCALLUM,** and F. H. FOX †
New York State Veterinary College, Ithaca, N. Y.

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The first report of BVDV in the Canada

X Disease of Cattle — Saskatchewan[1]

By T. Childs *

THE FOLLOWING notes cover personal observations of cattle affected with what is, as yet, a disease of unknown origin, and are assembled from data secured in the Province of Saskatchewan during the months of July and August, 1946.

It is probable that the disease has been present in the Western Provinces for years but, owing to its insidious and unspectacular nature, has not received much attention heretofore.

The disease has been observed in acute and sub-acute forms, young cattle being most commonly affected. One or two animals in a herd may be affected and die, and there may not be further casualties for several weeks. However, over a period of six or eight months, losses among young cattle, from the acute form of the disease, can be serious.

Acute Form

Canadian Journal of Comparative Medicine 1946

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2003

DISCOVER: Quotes Weather Seedstock 100 Reproductive Success Blog: Beef Daily More

MENU BEEF SEARCH LOG IN REGISTER

RECENT

This Week in Agribusiness – Jan. 5, 2019
JAN 05, 2019

The truth about JAY-Z & Beyoncé's vegan diet recommendation
JAN 04, 2019

7 ag stories you might have missed this week - Jan. 4, 2019
JAN 04, 2019

Getting Serious About BVD

Bovine viral diarrhea is one of the most costly diseases of cattle, and most U.S. cow herds are at risk for infection. Now it's attracting more industry attention.

Clint Peck Senior Editor | Apr 01, 2003

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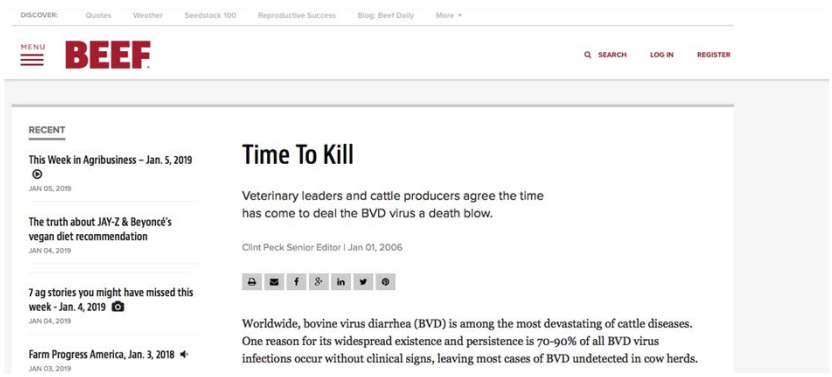
2006



https://www.beefmagazine.com/mag/beef_time_kill

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BRD project: October 2010

746 market-derived mixed-breed beef calves
mean arrival weight 712 lbs.
548 (73.45%) calves pulled within 35 days on feed

IDEXX Herdchek BVBVAb

Interpretation S/P value
<0.2 = negative
0.2-0.3 = suspect
≥ 0.3 = positive

Results:
506 (67.83%) negative
76 (10.19%) suspect
164 (21.98%) positive

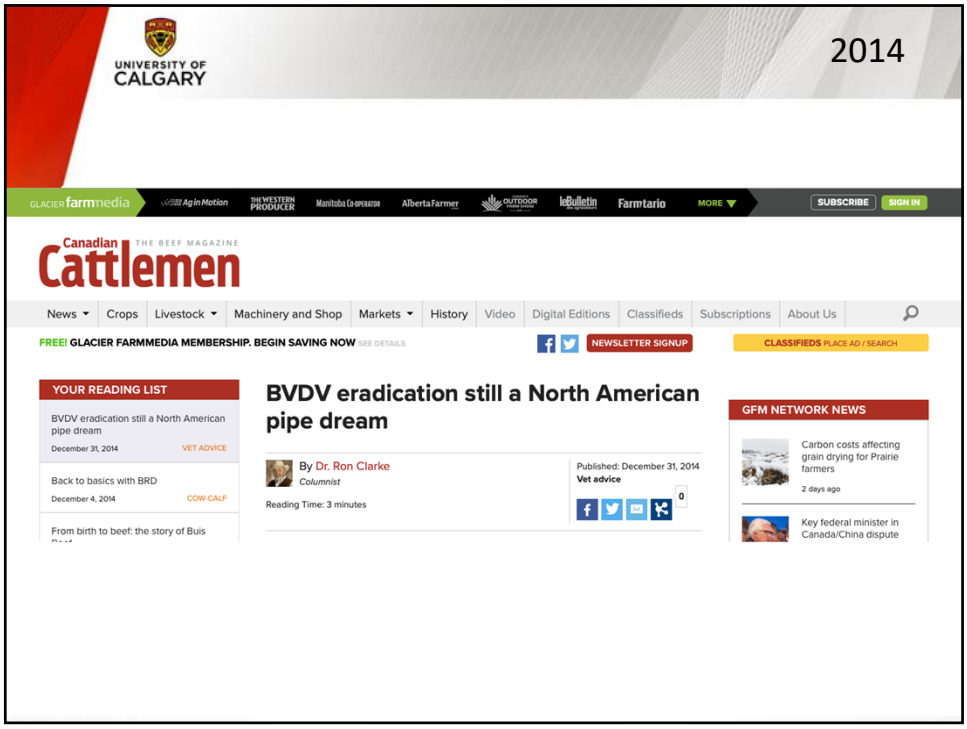
IDEXX Herdchek* IBRgB

Interpretation blocking %:
<45% = negative
45-55 = suspect
≥ 55 = positive

Results:
398 (53.35%) negative
52 (6.97%) suspect
296 (39.68 %) positive

Courtesy of Barbara Wolfger and Karin Orsel used with permission

14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2014
GLACIER farmmedia
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BVDV eradication still a North American pipe dream
December 31, 2014
VET ADVICE
Back to basics with BRD
December 4, 2014
COW-CALF
BVDV eradication still a North American pipe dream
By Dr. Ron Clarke
Columnist
Reading Time: 3 minutes
Published: December 31, 2014
Vet advice
GFM NETWORK NEWS
Carbon costs affecting grain drying for Prairie farmers
2 days ago
Key federal minister in Canada/China dispute

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THE WESTERN PRODUCER
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BVD costs U.S. cattle producers millions
Apr 7, 2016
NEWS
Fund to develop community websites, social media
Apr 6, 2016
NEWS
Workplace death results in $98,000 fine
Apr 5, 2016
NEWS
BVD costs U.S. cattle producers millions
By Barbara Duckworth
FOLLOW
Published: April 7, 2016
News
0 comments
KANSAS CITY, Mo. — Bovine viral diarrhea is costing the U.S. cattle industry as much as $2.5 billion a year due to sick animals, treatment expenses and untimely deaths.
Affordable alternative to surgery without the down time
Hundreds of Western Canadian farmers treated
Located in Park City, Utah close to Salt Lake City airport
DOCERE
click here...
LATEST OPINION PIECES
Farming needs a new policy direction

16

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2017

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SF Successful Farming

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TIP OF THE DAY

Truck-Rim Power Station for Shop

Install a covered and protected power-box by installing a truck rim somewhere convenient to hold outlets.

TALK IN MARKETING

TID BITS

As fun as watching the back and forth of the Tru mp haters. This ultimately will trump the politics .... https://www.weather-forecast.com/maps/Br azil?symbols=none&type=prec

Author: Hobbyfarmer Posted: 10-27-2019

John`s World on Ethanol

Home › Livestock › Cattle

CATTLE INDUSTRY CONTEMPLATES ERADICATING BVD

By Gene Johnston
4/3/2017

It seems unlikely that bovine viral diarrhea (BVD) virus could be made to disappear, given the size of the U.S. cattle industry and the diversity of ranches and feedlots.

However, that didn't stop a group of veterinarians, producers, and industry leaders from considering it at a recent meeting organized by Thermo Fisher Scientific.

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Eradication efforts of BVDV in North America

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Eradication efforts in the US

Table 6. Comparison of four regional control programs in the U.S.

Program	Time period	Herds (animals tested)	Herd status	PI	Cost of test to producer	Population tested	Production unit type	Online Information
Washington State BVD Control and Eradication Project[e]	2008–2009	60 (9881)	13.30%	0.92% of calves tested	$1.00	84% calves, 16% older animals	beef	http://www.vetmed.wsu.edu/bvdcep/vets/BVDCEP%20Oct%202008%20Results.pdf
Montana BVD-PI Herd Biosecurity Project[f]	2006–2009	585 (190,000)	6.5 %	0.10%	$1.95	primarily calves	beef	http://www.mtbqa.org/news/09BVDPI/2009%20Overview.pdf http://www.mtbqa.org/bio6.cfm http://www.ag.ndsu.edu/HettingerREC/beef/2008-beef-day-presentations/AAHRECBiosecurity-BVD-PIScreening.pdf
Alabama Voluntary BVDV Control Program[g]	2006–Present	335 (21,879)	4.7 % (2008 and 2009 only)	0.25%	$3.00	Not determined	Not determined	http://www.alafarmnews.com/index.php?option=com_content&view=article&id=579:from-the-state-vets-office&catid=38:from-the-state-vets-office
Michigan Upper Peninsula BVDV Eradication Project[h]	2008–2011	232 (17,917)	3.90%	0.13%	No cost	whole herd	mixed beef and dairy	http://cvm.msu.edu/alumni-friends/continuing-education/bvdup

Japanese Journal of Veterinary Research 60(Supplement): S41-S49, 2012

In Michigan: Twenty-two of the 140 (16%) survey respondents did not participate in the project.
"Project would be too much work," "Do not believe BVDV is a problem," "Did not know about the project," "Did not understand the project," and "Other"

J Am Vet Med Assoc. 2013 Aug 15;243(4):548-54.

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Lessons learned:

1. Target an entire region at one time in order to capitalize on the enthusiasm and interest of a new disease management program. Interest seems to wane in the ensuing years of a program.
2. Ensure that adequate manpower is available to manage the workload.
3. Create a written plan detailing required resources and manpower with a realistic time line.
4. There must be a marketing and communication plan for the entire length of the project.

A lesson learned from all four projects is that BVDV control programs are as much about working with people as they are about the technical aspects of detection, vaccination and biosecurity.

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BVD screening in Saskatchewan

BVD program fights disease that costs the cattle industry millions annually

Wendy Wilkins, DVM, MSc
Disease Surveillance Veterinarian
Livestock Branch

Bovine viral diarrhea (BVD) costs the cattle industry millions of dollars annually. Herds with BVD problems have significantly lower weaning weights and more health problems overall. The effect that BVD has on herd fertility can vary from a nagging problem to a catastrophe with the potential to devastate a herd in a single year.

Persistently infected animals, the primary reservoirs of the disease, are present in more than 10 per cent of cow-calf herds tested in Western Canada. These animals shed large amounts of the virus constantly throughout their lives, from birth to death. To identify herds with circulating BVD—as evidenced by the presence of a persistently infected animal—Saskatchewan Agriculture implemented a provincial BVDV Screening and Control Program in 2013 with funding provided under the federal-provincial-territorial Growing Forward 2 initiative. Once the infected herds have been identified, the program helps those producers manage the disease in their herds. The program provides free testing to detect persistently infected animals in a herd. Any aborted, stillborn, deformed or dead calf from the current calf crop, and any yearling with symptoms consistent with persistent BVD infection, is eligible for screening, provided the animal still resides on its farm of birth.

Veterinarians can collect samples from cases submitted by producers or animals seen during daily practice. Each veterinary clinic participating in the program is sent sampling supplies and instructions, and the cost of shipping a sample is covered by the program when the clinic uses the pre-paid shipping labels provided by the Ministry. Producers can collect skin samples from suspected cases (an ear notch is the preferred method), but are asked to contact their local veterinarian for collection and submission instructions.

If BVD is confirmed via a positive test result, the program will reimburse up to $500 of the veterinary fees associated with the development and implementation of a BVDV control strategy for the infected herd. **This funding is available to any Saskatchewan producer with a confirmed BVD infection, whether testing was done under the provincial program or paid for by the producer.** ■

FOR MORE INFO Contact Wendy Wilkins, Disease Surveillance Veterinarian, at 306-798-0253 or wendy.wilkins@gov.sk.ca.

"We have found that this program is underutilized, when we compare the tests requested at PDS versus those paid through our program."

Will it be continued?

21

Heart, lung, liver, kidney, spleen, duodenum, muscle, mes Lnn, lung lnn, urine bladder, gall bladder, bile, feces, urine, ovary/testicle, obex, jejunum, ileum, milk udder tissue, colon, caecum, skin (=ear), nasal swab, tonsil, esophagus, serum, white blood cells (PBL)

And the same from the fetus (if present and possible)

Everything PCR positive except bile and feces

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Canadian beef production: Challenges for disease control

Disease status of calves for finishing difficult to control

- The Canadian beef industry ships to 56 countries but is reliant on the U.S. for 74 per cent of all beef exports
- Influx of US calves in the fall
- Long distance transport of calves within Canada
- Limited Identification and Registration
- Disease status of calves at market is not known

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Dairy production, challenges and opportunities

- Supply management
  - Relatively small family farms (especially in the east)
  - Higher milk prices for farmers (price/L Ca$ 0.75)
  - Quota have to be filled
  - Quotum changes create animal dynamics on farm (culling, purchasing)
  - Limits initiative for production of yoghurt/cheese etc
  - Highly educated producers
  - ProAction initiated by Dairy Farmers of Canada
  - Influx of untested US dairy cows when large herd expansions take place
  - I&R is well organized

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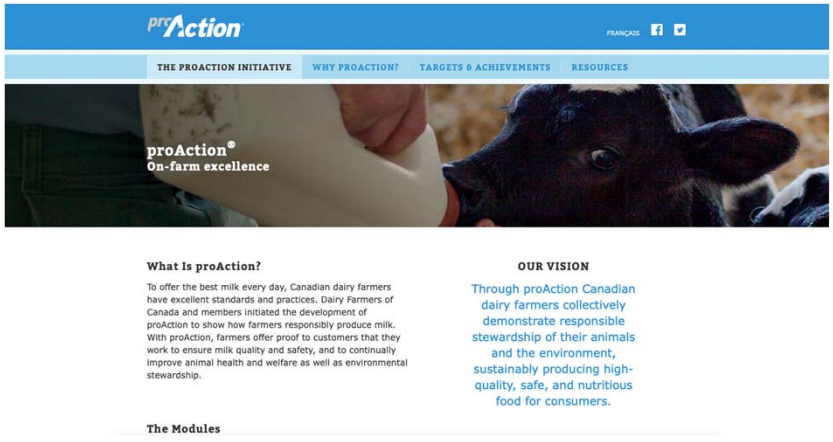
ProAction initiated by farmers



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BVDV in Canadian dairy herds

Among unvaccinated dairy heifers, seroprevalence

Alberta: 28.4% BVDV1 and 8.9% BVDV2; herd-level 53.4% and 19.7%
Scott et al. Can Vet J. 2006 Oct;47(10):981-91.

Saskatchewan: 28.1% BVDV+; herd level 48.7%
Van Leeuwen et al. Can Vet J. 2005 Jan; 46(1): 56–58.

Manitoba: 16.4% BVDV+; herd level 32.0%
Van Leeuwen et al. Can Vet J. 2006 Aug; 47(8): 783–786.

Table 1: Bulk Tank Milk test results for 619 dairy herds in Atlantic Canada in 2016

	PEI	NS	NB	NL	Total
Herds tested	170	217	199	33	619
BTM PCR +	4	3	2	0	9
BTM ELISA +	9	15	8	3	35
Herds Suspect +	13	18	10	3	44

Maritime Quality Milk
www.milkquality.ca

https://www.dfns.ca/files/documents/Atlantic-Healthy-Herds-Producer-Report-2018.pdf

26

Voluntary BVDV control

”During recent decades, BVD control approaches in various European countries and regions have clearly demonstrated that measures on a voluntary basis are inadequate to achieving freedom from the disease. ”

Wernicke et al. Pathogens. 2017 Dec; 6(4): 50.

27

BVDV control in Europe

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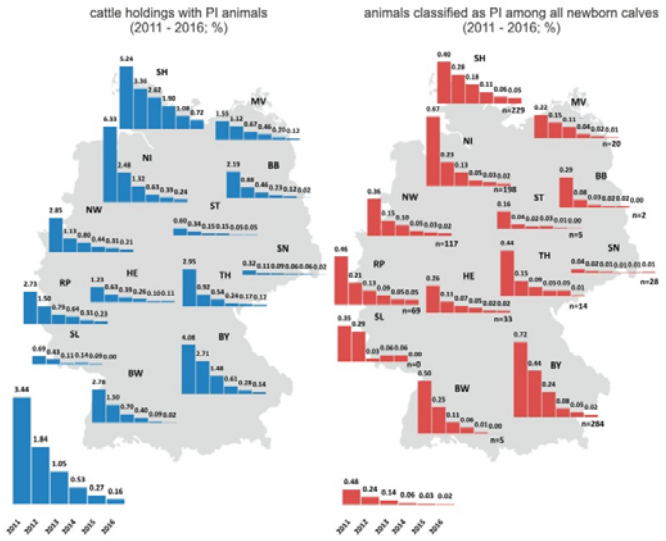
Germany



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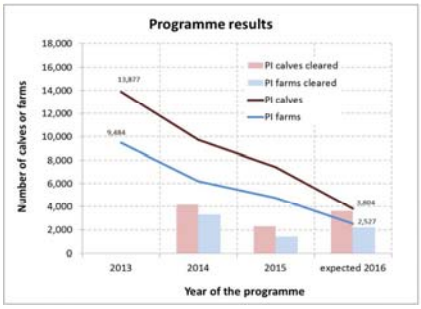
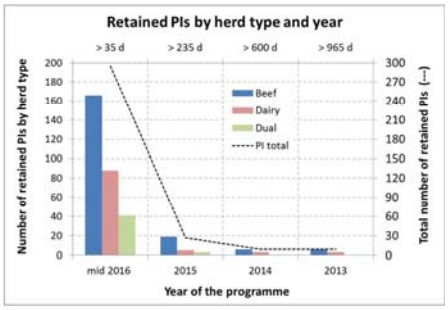
Ireland





Preventive Veterinary Medicine Volume 150, 1 February 2018, Pages 151-161

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Switzerland

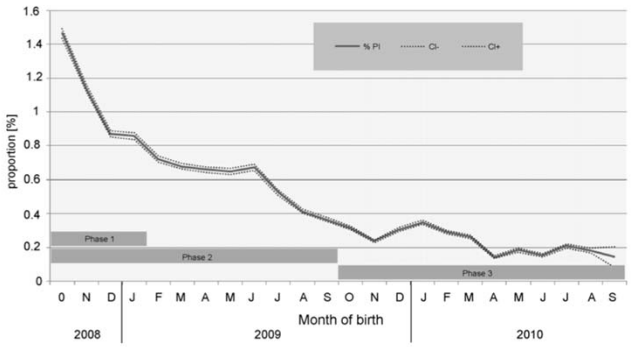

Fig. 1. The monthly proportion of newborn calves that were born BVDV-positive (with 95% confidence interval) during the Swiss BVD eradication campaign up to September 2010. The duration of the different phases of the eradication programme is displayed in the graph.

Preventive Veterinary Medicine Volume 99, Issues 2–4, 1 May 2011, Pages 112-121

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Austria

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 August)	12,031	20	0.16	30	11,017	91.57

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#1 motivator,
it must be financially worth the effort…

But often we do not have a clue how much it all cost

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What are the losses due to BVDV in dairy production?

- Losses in dairy herds are 20% higher than beef herds
- Overall (the western world) average direct losses were 199.50 US$/naïve cow (vs. 174.60 US$ beef)
- Only a few papers assessed the economic impact of immune suppression
- Canada:
  - Carman 1998: CAD 40,000.00-100,000.00/herd for the acute BVDV infection
  - Chi 2002:~CAD 47.30/dairy cow in an infected herd

Richter et al. The Veterinary Journal 220 (2017); 80-87

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BVDV costs in Canada

Country	Type of direct losses (%) [a]	Additional losses/gains	Direct losses per animal [b]	Production system	Herd-specific initial status	References
*Canada (Ontario)	Direct losses in general Lost animals Decreased milk production Abortion	-	USD393-982 (EUR 240-600)	Dairy and Beef	Infected herd	Carman et al., 1998
(Maritime)	Direct losses in general Milk production loss Premature culling Mortality Abortion Reproduction loss	Vaccination costs Treatment costs Replacement costs Reduced slaughter value	USD960-2,174 (CAD 1,207-2,734) PER HERD	Dairy	Naïve and/or Infected herd	Chi et al., 2002a
*(Maritime)	Premature culling (43%) Mortality loss (40%) Abortion and Reproductive loss (17%) Milk loss (0%)	Treatment costs (veterinary services, medication cost) Extra farm labour cost Replacement cost	USD43 (CAD 47)	Dairy	Infected herd	Chi et al., 2002b

Richter et al. The Veterinary Journal 220 (217); 80-87

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What is the most economical option to control BVDV

"We need more studies to demonstrate that the implementation and inherent costs of BVDV prevention and/or mitigation activities are justified"

"There is a lack of studies relating to efficiency calculations, in particular at national and regional level"

Is intervention A more cost effective than B?

Canada: 1 paper

- Chi et al. 2002

Pinior et al. Prev. Vet. Med. 137 (2017) 77-92

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Eradication
We have the tools and the knowledge

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Strategy towards eradication? Kill the PI's!

- Finding PI's where to start?
  - Serological evaluation of oldest non-vaccinated animals
  - Bulk tank PCR

Using DHI milk samples, producers have the ability to:

1. Screen adult milking herd with the sensitive PCR test, through pooled samples
   - *DHI lab will sub-sample cows into Group pools (up to 250 cows maximum)*
   - *The Group pool(s) will be tested by PCR. If Positive, customers will be notified immediately and provided the option to test individual cows by ELISA*

- Individual animal assessment
  - Ear notch
  - Blood
  - Milk

2. Test selected cows with the cost-effective ELISA antigen test using the regular DHI sample (cows only need to be tested once in their lifetime). Possibilities include:
   - *All cows when PCR group screening result is Positive*
   - *Purchased cows*

http://www.canwestdhi.com/pdf_files/BVD%20fact%20sheet.pdf

38

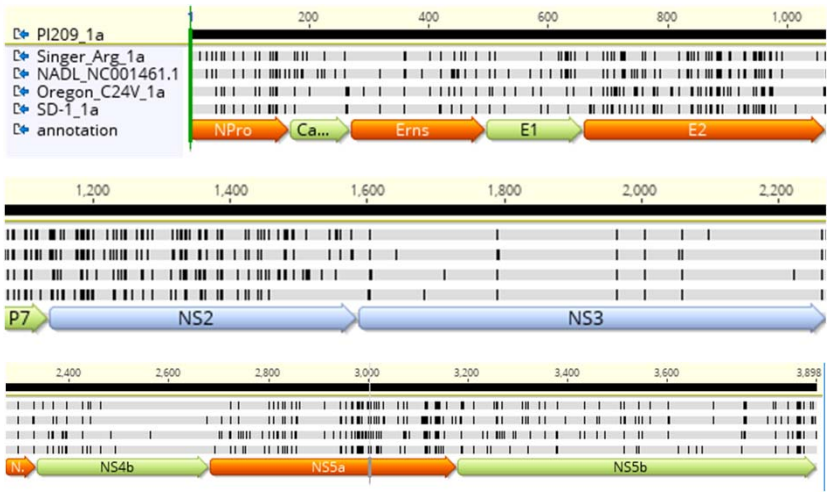
Vaccination to control BVDV

"Despite progress in the development of BVD vaccines, the assessment of the effect of widespread vaccination against BVD over several decades is disappointing. Vaccination has not changed BVD prevalence over time"

Moennig and Beer Pathogens. 2018 Mar; 7(1): 29.

39

Differences PI209_1a to reference strains



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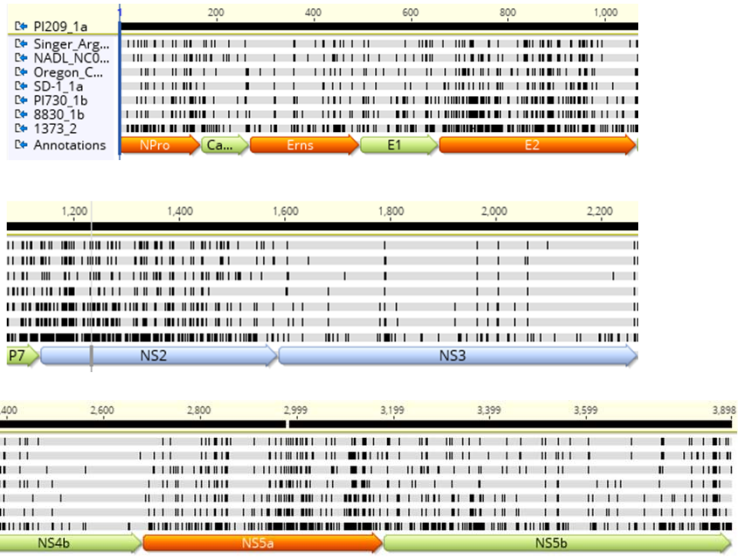
How different are 1b and 2 from PI209_1a?



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BVDV vaccination in Western Canada

>90% of cow calf producers in Western Canada vaccinate their cows and >95% their replacement heifers against BVDV

(Survey of 93 herds)

Waldner et al. CVJ / VOL 60 / APRIL 2019

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Wrecks on cow/calf Ranches. If it goes wrong….it goes very wrong

- Unvaccinated herds, new introduction of virus
- Synchronized breeding (all fetuses approx. the same age)
- All (or almost all) calves become PI.
- Usefull as research material: influence of 'host' on virus evolution/adaptation

43

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1992

Performance, survival, necropsy, and virological findings from calves persistently infected with the bovine viral diarrhea virus originating from a single Saskatchewan beef herd

Lee F. Taylor, Eugene D. Janzen, John A. Ellis, Jan V. van den Hurk, Pearse Ward

persistently infected calves were "poor doers" and had poor survivability, with only 4 persistently infected calves surviving to 1 year of age.

51(+20) calves out of 652 cows were PI and part of the study

Can Vet J 1997; 38: 29-37

44

28 MD cases out of 40 necropsied

Table 2. Distribution of lesions in necropsied calves that died of bovine viral diarrhea virus (BVDV)-related disease during 1992 and 1993. Virological findings from these calves are also summarized for comparison

Calf ID	Date of Death	Age (d)	Ulceration of gut	Ulceration of skin	Respiratory lesions	Growth arrest lines	Lymphoid depletion	Hemorrhages	BVDV tissues	BVDV blood	Gross diagnosis
1	4/21/92	58	O,E,P	–	—	–	+	–	n/a	0	MD
2	6/26/92	120	O,E,A	–	L	–	+	+	Yes	1	MD
3	6/30/92	97	A	–	L	+	+	+	Yes	1	BRD/HD
4	7/10/92	93	O,A,C	–	L	+	+	+	Yes	1	MD/HD
5	7/22/92	151	O,E,A	+	L	+	–	–	Yes	0	MD
6	7/27/92	119	A	–	L	–	+	–	Yes	1	BRD
7	8/17/92	158	O,E,A	–	—	–	+	+	Yes	1	MD
8	9/8/92	144	O	–	L	–	+	–	Yes	2	BRD
9	10/1/92	239	O,E,A,I	–	U,L	–	+	–	Yes	1	MD/BRD
10	10/16/92	248	O,E,R	+	—	–	+	–	n/a	2	MD
11	10/26/92	197	E	–	—	+	–	–	Yes	2	Anemia
12	11/8/92	269	I	–	—	–	–	–	Yes*	2	MD
13	11/18/92	270	—	–	L	+	+	–	Yes	3	BRD
14	11/22/92	295	—	–	L	+	–	–	Yes	4	BRD
15	12/7/92	292	O,P	–	—	–	+	+	Yes	7	MD
16	12/7/92	262	I,P	+	—	+	+	+	Yes	9	MD
17	12/16/92	275	—	–	L	–	–	+	n/a	7	BRD
18	12/25/92	276	O,R,A,I,P	–	—	+	+	+	Yes	9	MD
19	1/1/93	308	O,A	+	L	–	–	–	n/a	8	BRD
20	1/8/93	339	O,A,P	–	—	–	+	+	Yes	8	MD
21	1/8/93	312	P	–	—	–	+	–	n/a	8	MD
22	1/13/93	339	A,P	–	—	–	+	+	Yes	8	MD
23	1/13/93	345	P	–	—	–	+	–	Yes	8	MD
24	1/30/93	334	O,E,Om,A,P	–	—	–	+	+	Yes	9	MD
25	1/30/93	351	O,E,Om,A,P	–	—	+	+	–	Yes	9	MD
26	2/2/93	316	O,E,A,P	+	L	–	+	–	No*	11	MD
27	2/4/93	365	A,C	–	—	+	–	–	No*	9	MD
28	2/4/93	358	O,E,A	+	L	–	+	–	Yes	9	MD/BRD
29	2/4/93	361	O,E	+	—	+	–	–	Yes	9	MD
30	2/4/93	342	O,E,A	–	—	+	–	–	No	9	MD
31	2/11/93	339	O,I	+	—	+	–	–	Yes*	9	MD
32	2/19/93	382	A,I,P	–	—	–	+	–	Yes	9	MD
33	3/3/93	359	—	–	—	–	–	–	No	10	MD
34	3/12/93	397	O,E,R,A,C	–	—	–	+	–	n/a	10	MD
35	3/16/93	401	E,A,P,C	+	—	–	+	+	Yes	10	MD
36	3/16/93	368	O,E,C	–	—	+	+	–	Yes	10	MD
37	3/24/93	349	—	–	—	–	+	–	Yes	3	SLAUGHTER
38	4/14/93	439	—	–	—	–	+	–	Yes	11	SLAUGHTER
39	4/14/93	401	—	–	—	–	+	–	Yes	11	SLAUGHTER
40	4/14/93	400	—	–	—	–	+	–	Yes	11	SLAUGHTER

O — Oropharynx, E — Esophagus, R — Rumen/reticulum, Om — Omasum, A — Abomasum, I — Ileum, P — Peyer's patches, C — Colon/rectum
U — Upper respiratory tract (larynx and trachea), L — Lower respiratory tract (Lower airways and lungs)
BVDV isolations from blood was the number of times bovine viral diarrhea virus was isolated from blood prior to death
MD Mucosal disease
BRD Bovine respiratory disease
n/a Not attempted
*Immunohistochemistry was attempted on tissues from these cattle

No MLV vaccine provided

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South Dakota 2004

Age	BVDV test status	Mean weight (kg)	Mean weight increase (kg [%])
Birth	Positive	35.0*	—
	Negative	42.4	—
7 weeks	Positive	84.0*	47.6 (141.0)
	Negative	108.8	66.3 (159.1)
14 weeks	Positive	127.9*	42.8 (50.7)
	Negative	167.5	58.8 (55.1)

Calves were tested for the presence of BVDV antigen by immunohistochemical staining of ear notch specimens. At each age, the weight of each calf was obtained and the mean was calculated for each group. Similarly, the amount and percentage of weight gained between measurements was determined for each calf, and the respective mean weight increases were calculated.

— = Not applicable. *Value is significantly ($P < 0.05$) less than the corresponding value for the BVDV test–negative calves.

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"Vaccinate the PI's out of the herd"

- Vaccine induced MD
- Delayed onset postvaccinal mucosal disease
- Recognized very early in vaccine evaluation (cBVDV was used)
- How many PI's will you remove?
- It is possible to create MD with heterologous vaccine, but not so efficient
- 1a PI will develop MD due to 1a cBVDV vaccine, 1b PI's probably will just mount an antibody response
- My guess: <25% of the PI's will succumb to MD following vaccination with MLV cBVDV vaccine

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Examples: 13 PI's, 3 MD cases

- At processing, animals received the following: unique individual animal identification tag; a modified-live infectious bovine rhinotracheitis virus (IBRV) and BVDV (both type I and type II viruses) vaccine;
- Death occurred prior to harvest in 8/13 (61.5%) PI animals: 3 were diagnosed with mucosal disease, 1 was diagnosed with peritonitis, and 4 were diagnosed with BRD.

Booker et al. Can Vet J 2008;49:253–260

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Example 2: 10 PI's none died

- all cattle received a modified-live virus vaccine against BVDV,
- Ear notches from 10 of 5,041 (0.2%) calves yielded positive results for BVDV
- No MD cases

O'Connor et al. American Journal of Veterinary Research (2005) 66, 2130-2134

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Ongoing BVDV research in Calgary

There are 3 BVDV researchers left in Canada (as far as I know)

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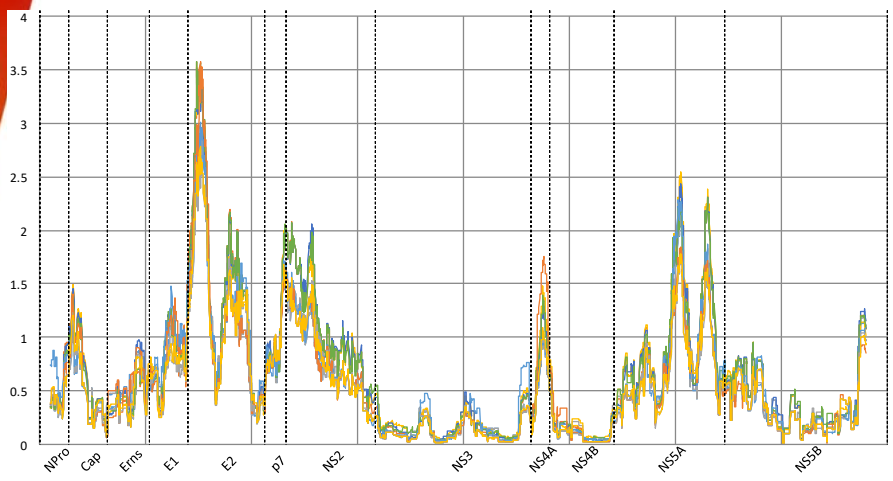
Diversity of BVDV 1a at amino acid level



Chernick *et al.*

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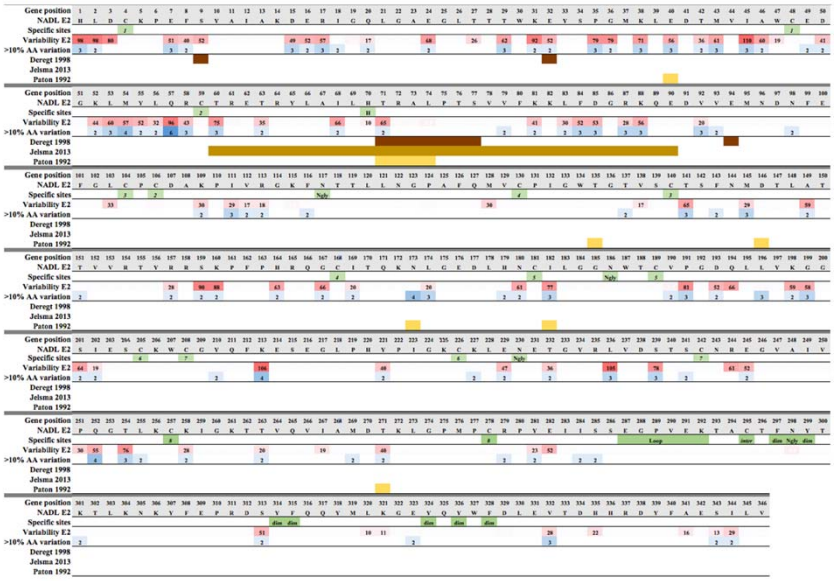
Where are the epitopes…exact



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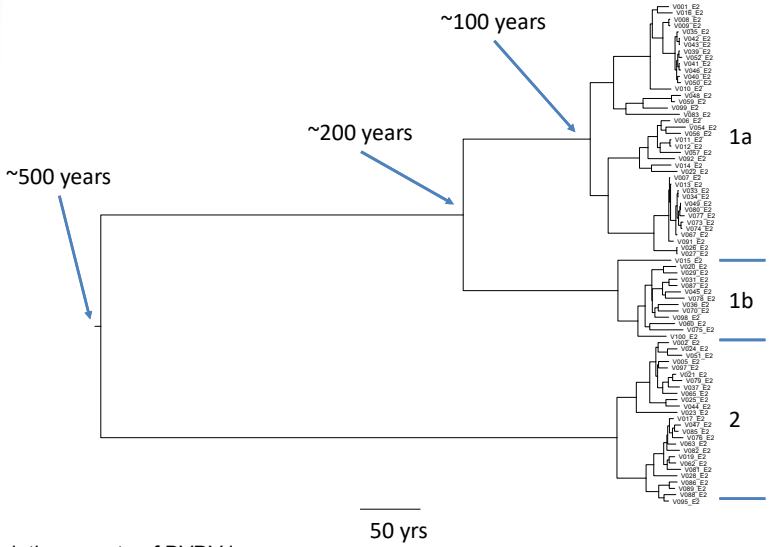
BVDV Phylogeny (E2)



The evolutionary rate of BVDV is 1.4×10^{-3} AA substitutions per site per year

Chernick et al. Virology 509 (2017) 232–238

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BVDV Subgenotypes 2008-2011

Cattle breeds 2011

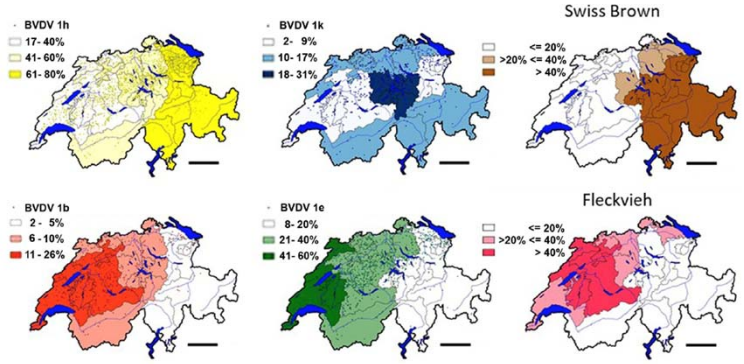

Fig 2. Distribution of the main subgenotypes of BVDV-1 and of Swiss Brown and Fleckvieh cattle.

Stalder et al. PLoS ONE 13(12): e0207604.

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SAVE THE DATE:
16-17-18 JUNE 2020

CALGARY, AB

8th BVDV SYMPOSIUM COMBINED WITH THE UCVM BEEF CATTLE CONFERENCE

Questions?

'BVDV,
is there a limit to our tolerance?'

The virus, BVD pathogenesis
and a pathway to eradiation.

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