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Paratuberculosis in Swiss dairy cattle: Potential Control Strategies and Cost-Benefit Analysis

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Introduction

Materials and Methods

Paratuberculosis (PTB) or Johne's disease

Mycobacterium avium subsp. paratuberculosis (MAP)



worldwide distribution



chronic enteritis; primarily in ruminants

reduced animals' performance \rightarrow high economic losses

Objectives

- to develop potential control strategies suitable for Switzerland
- to estimate the effectiveness of potential control strategies on reducing the between-herd prevalence
- to estimate the costs and benefits associated with different control scenarios

Potential Control Strategies for Switzerland



Potential control programs for Switzerland: Development of **two different** control strategy with **different scenarios of participation rate**

Scenario 1 = Mandatory control program (all herds of Switzerland are involved) Scenario 2 = Voluntary control program with no incentives (expected low participation rate) Scenario 3 = Voluntary control program with incentives (expected higher participation rate) → Stochastic simulation model over a ten-year period with a starting prevalence of 3.6%



Cost-Benefit and Goal seek Analysis of control programs

Effectiveness of Potential Control Strategies

Both control strategies effectively reduce the between-herd prevalence with high participation rates, as seen in scenario 1 (mandatory participation) and scenario 3 (high participation rate due to incentives). However, low participation rates, as in scenario 2, are not effective in reducing the between-herd prevalence. After a ten-year period, the between herd prevalence decreases in control program 1 to a median of 0.08% (90% central range, CR: 0.04% - 0.17%) for scenario 1, to a median of 2.96% (90% CR: 2.82% - 3.13%) for scenario 2 and to a median of 1.39% (90% CR: 1.28% - 1.57%) for scenario 3. After a ten-year period, the between herd prevalence decreases in control program 2 to a median of 0.32% (90% central range, CR: 0.08% - 1.19%) for scenario 1, to a median of 3.43% (90% CR: 3.11% - 3.85%) for scenario 2 and to a median of 2.24% (90% CR: 1.83% - 2.87%) for scenario 3.

Between-herd Prevalence over 10 years











Cost-Benefit Analysis of Potential Control Strategies

With the current low between-herd prevalence of 3.6% and within-herd prevalence of 4.9% in Switzerland, both control strategies are not economically beneficial over a ten-year period. The figures below show the minimum between- and within-herd prevalence required for the control strategies to become beneficial after a ten-year period under the mandatory control scenario. A Benefit-Cost Ratio (BCR) greater than 1 indicates a beneficial outcome.

Control Strategy 1 using Sock Swab for herd screening										Control Strategy 2 using serum ELISA						
	5%	0.08	0.16	0.24	0.33	0.41	0.49	0.57	0.65	0.73	0.81	5%	0.06	0.12	0.18	0.2
ierd prevalence	10%	0.15	0.3	0.45	0.6	0.75	0.9	1.05	1.2	1.35	1.5	10% 15% 20% 25% 30% 35% 40% 45% 50%	0.12	0.24	0.35	0.4
	15%	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89	2.1		0.17	0.34	0.5	0.0
	20%	0.26	0.52	0.79	1.05	1.31	1.57	1.83	2.1	2.35	2.62		0.22	0.43	0.64	0.8
	25%	0.31	0.61	0.92	1.23	1.54	1.84	2.15	2.46	2.76	3.07		0.26	0.52	0.77	1.0
	30%	0.35	0.7	1.04	1.39	1.74	2.08	2.43	2.78	3.13	3.47		0.31	0.6	0.89	1.3
Ļ	35%	0.38	0.77	1.15	1.53	1.92	2.3	2.68	3.07	3.45	3.83		0.34	0.68	0.99	1.2
vee	40%	0.41	0.83	1.25	1.66	2.08	2.49	2.91	3.32	3.74	4.16		0.38	0.75	1.09	1
betv	45%	0.45	0.89	1.33	1.78	2.22	2.67	3.11	3.56	4	4.45		0.42	0.81	1.19	1.
ц	50%	0.47	0.94	1.41	1.88	2.35	2.83	3.3	3.77	4.24	4.71		0.45	0.87	1.27	1.6
		5%	10%	15%	20%	25%	30%	35%	40%	45%	50%		5%	10%	15%	20

Control Strategy 2 using serum ELISA for herd screening with a risk-based approach

5%	0.06	0.12	0.18	0.24	0.3	0.36	0.42	0.47	0.53	0.58
10%	0.12	0.24	0.35	0.46	0.57	0.68	0.78	0.89	0.99	1.08
15%	0.17	0.34	0.5	0.66	0.82	0.97	1.11	1.25	1.39	1.53
20%	0.22	0.43	0.64	0.84	1.04	1.22	1.41	1.58	1.76	1.92
25%	0.26	0.52	0.77	1.01	1.24	1.46	1.67	1.88	2.08	2.28
30%	0.31	0.6	0.89	1.16	1.42	1.67	1.91	2.15	2.38	2.59
35%	0.34	0.68	0.99	1.26	1.59	1.87	2.13	2.39	2.64	2.88
40%	0.38	0.75	1.09	1.3	1.74	2.05	2.34	2.62	2.88	3.14
45%	0.42	0.81	1.19	1.54	1.88	2.21	2.52	2.82	3.1	3.38
50%	0.45	0.87	1.27	1.65	2.02	2.36	2.69	3.01	3.31	3.6
	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%

within-herd prevalence

within-herd prevalence

Benefit-Cost Ratio after 10 years at different between- and within-herd prevalence levels.

Conclusions

Simulations have shown that both control programs effectively reduce between-herd prevalence when participation rates are high, whereas low participation rates have only a minor impact on prevalence reduction. However, none of the epidemiologically efficient scenarios are economically beneficial given the current low within- and between-herd prevalence in Switzerland. For the current situation in Switzerland, we propose testing all animals in herds with previously reported PTB cases using a serum ELISA, confirming positive results with PCR, and removing PCR-positive animals from the herd. Additionally, an individual farm risk assessment should be conducted for these herds. With this approach, a BCR greater than 1 can be achieved after ten years at the current prevalence levels in Switzerland.



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