Economic Benefits of using Genetic Selection to Reduce the Prevalence of Bovine Respiratory Disease Complex in Beef Feedlot Cattle

Bovine Respiratory Disease Complex Coordinated Agriculture Project

http://www.brdcomplex.org/

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BOVINE RESPIRATORY DISEASE COMPLEX

- Leading cause of death in dairy and beef cattle (NASS 2006)
- Despite use of vaccines and antimicrobials, morbidity and mortality rates have remained virtually unchanged in cattle over the past several decades (Miles 2009; Gagea et al. 2006)

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BOVINE RESPIRATORY DISEASE COMPLEX

- The average annual prevalence of BRDC was 16.2% over a 15 year period (USDA 2011)
- ~97% of feedlots with ≥ 1000 head of cattle have BRDC (USDA 2011)
- 60% of all harvested feedlot cattle have lung lesions from BRDC (Schneider et al 2009)

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ECONOMICS OF BRDC

- BRDC remains the most economically important disease of beef cattle, responsible for losses of over $800 million annually (Chirase & Greene 2001; Snowder et al. 2006; USDA 2001; Gagea et al. 2006)
- Approximately 350,000 feedlot cattle die annually in the US due to BRDC (USDA 2011)

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PROBLEM

Same level of morbidity and mortality from BRDC over the past 20 years despite utilizing:

- Best management practices
- Preventative vaccines
- Improved treatments

We need new approaches to reduce the incidence of BRDC in addition to our current approaches that are economically feasible!

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GENETICS

- There is increasing evidence that susceptibility to BRDC is at least partly under genetic control
- Differences in BRDC susceptibility has been found between cattle breeds and sire lines (Muggli-Cockett et al. 1992; Snowder et al. 2006; Maltecca et al. 2006)

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GENETICS

- Heritability estimates for susceptibility to BRDC have ranged from 0% to 26% in beef and dairy cattle (Snowder et al. 2005, 2006; Muggli-Cockett et al. 1992; Heringstad et al. 2008, Seabury et al. 2014, Neibergs et al. 2014)
- Studies in crossbred beef cattle identified loci associated with susceptibility to BRDC and cattle persistently infected with bovine viral diarrhea virus (Zanella et al. 2011)

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Animals & Phenotypes

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FEEDLOT STEERS

- Samples collected on 995 beef steers: 908 Angus, 18 Charolais, 25 Hereford, 44 Red Angus
- Cases and controls were housed in the same pens
- 497 were affected with BRDC, 498 were unaffected
- Animal health status defined by fever, cough, nasal discharge, eye discharge, and ear position or head tilt

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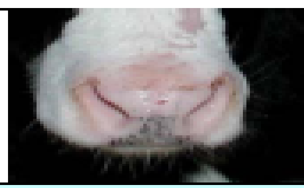
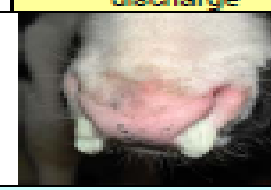
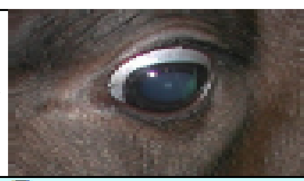
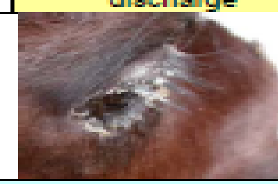
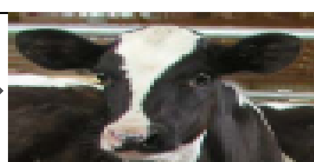
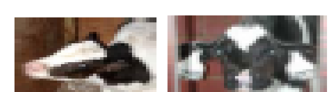
SCORING RESPIRATORY DISEASE

SCHOOL OF VETERINARY MEDICINE
University of Wisconsin-Madison

Calf Health Scoring Criteria			
0	1	2	3
Rectal temperature			
100-100.9	101-101.9	102-102.9	≥103
Cough			
None	Induce single cough	Induced repeated coughs or occasional spontaneous cough	Repeated spontaneous coughs
Nasal discharge			
Normal serous discharge	Small amount of unilateral cloudy discharge	Bilateral, cloudy or excessive mucus discharge	Copious bilateral mucopurulent discharge
			
Eye scores			
Normal	Small amount of ocular discharge	Moderate amount of bilateral discharge	Heavy ocular discharge
			
Ear scores			
Normal	Ear flick or head shake	Slight unilateral droop	Head tilt or bilateral droop
			

McGuirk SM. 2008. Disease management of dairy calves and heifers. Vet Clin NA: Food Anim Pract 24:139-153.

DIAGNOSTICS AND GENOTYPING

- Diagnostics for Mycoplasma, *P. Multocida, M. Haemolytica, H. Somni*, bovine respiratory syncytial virus, bovine viral diarrhea virus, IBR (bovine herpes virus 1) completed
- DNA extracted, and genotyped for 778,000 SNPs

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FEEDLOT STEERS

- Data on lung and liver scores, yield grade, quality grade, and condemned carcasses were collected at harvest
- Treatment costs, initial weights, hot carcass weight, days on feed, collected for both cases and controls
- Pens were harvested as a group

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RESULTS

HEALTH SCORES

- Mean clinical score for cases was 8.04 ± 1.23
- Mean clinical score for controls was 2.06 ± 0.037
- 67.7% of cases had lung lesions
- 67.2% of controls had lung lesions
- Mortality for cases was 5.3% and 0.4% for controls

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DIAGNOSTIC SWAB RESULTS

Washington Animal Disease Diagnostic Lab

Pathogen	Feedlot Positive Cases	Feedlot Positive Controls	Odds Ratio	Odds Ratio 95% Confidence Interval	Odds Ratio P value
Arcanobacterium pyogenes	**3.4%**	**0.8%**	**4.35**	**1.41-17.89**	**0.0066**
Histophilus somni	**26.2%**	**12.7%**	**2.41**	**1.72-3.41**	**<0.0001**
Manheimia haemolytica	**38.2%**	**22.5%**	**2.11**	**1.59-2.82**	**<0.0001**
Pasteurella multocida	36.4%	36.1%	1.01	0.79-1.31	1.0 (*NS)
Mycoplasma spp.	**84.4%**	**77.9%**	**1.54**	**1.1-2.15**	**<0.0097**
Bovine corona virus	**17.4%**	**9.6%**	**2.08**	**1.4-3.11**	**0.0001**
Bovine respiratory syncytial virus	2.4%	0.8%	2.53	0.82-9.24	0.0881 (*NS)
Bovine viral diarrhea virus	**4.0%**	**1.6%**	**2.79**	**1.16-7.41**	**0.0125**
Bovine herpes virus	3.2%	1.6%	2.09	0.83-5.7	0.0995 (*NS)

*NS- not significant

HERITABILITY ESTIMATES

- Heritability estimates were obtained by GenABEL/GRAMMAR from relationship matrixes obtained from the genotypes of the BovineHD assay
- Heritability estimates were **17.7%** for BRDC as a case-control and **29.2%** for BRDC as a categorical trait

RATE OF GENETIC CHANGE

Factors	Case-Control	Health Score
BRDC prevalence (USDA 2011)	16.2%	16.2%
Estimated heritability	17.7%	29.2%
Accuracy of selection	0.42	0.54
Selection intensity	1.16	1.16
Additive genetic variance	0.15	0.19
Generation interval (years)	6	6
Rate of Genetic Change	**1.26%**	**2.08%**

ECONOMICS

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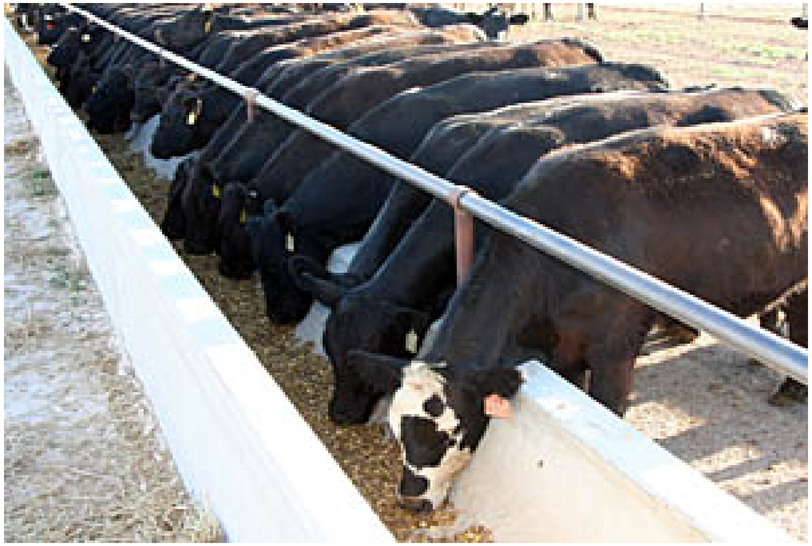
DAYS ON FEED

	Min	Max	Avg	SD	Count
Case	122	245	174.5	22.0	407
Control	112	259	175.1	22.2	475



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DAYS TO PULL DATE

	Min	Max	Avg	SD	Count
Case	3	189	67	53	407
Control	2	211	89	56	475

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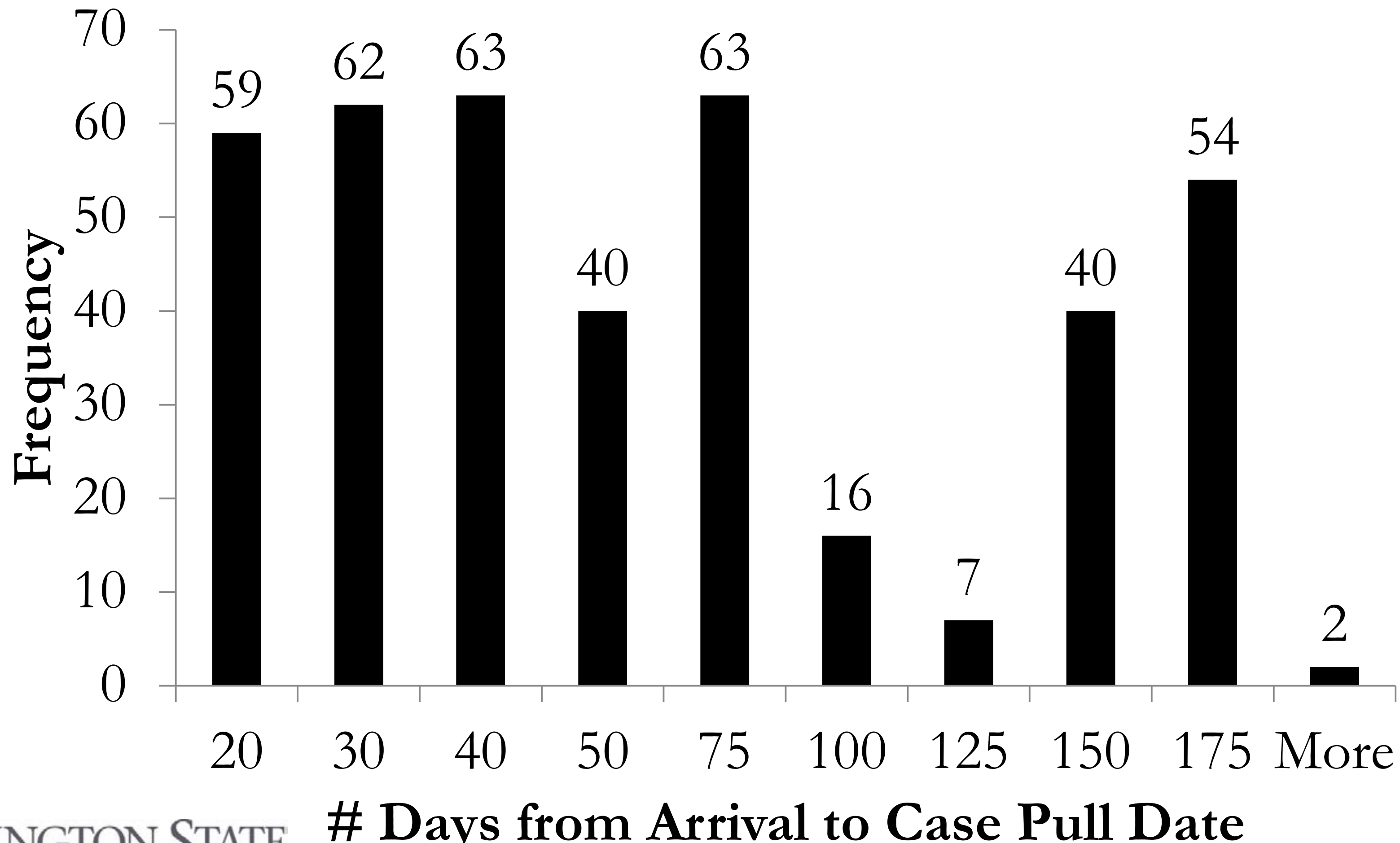
DAYS TO CASE PULL DATE



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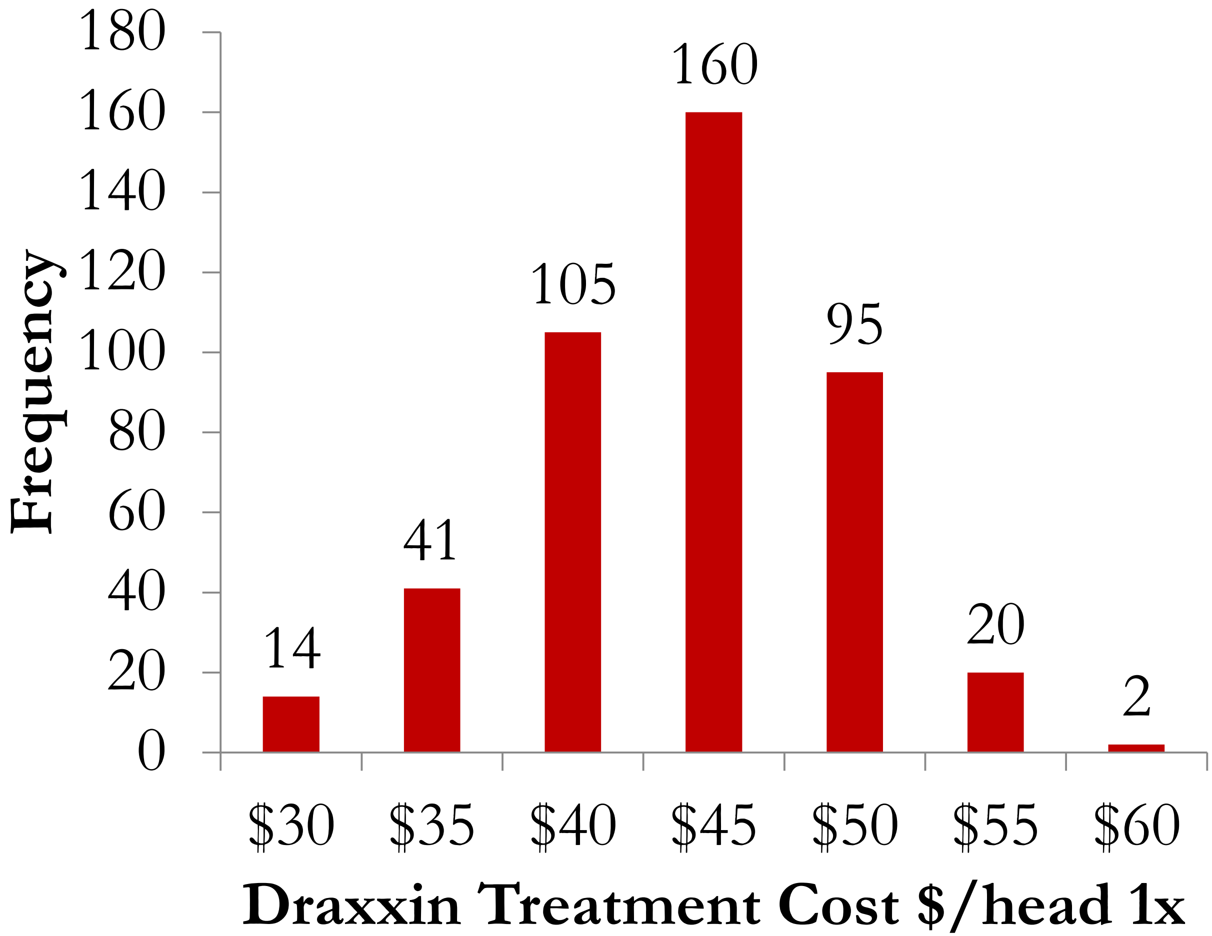
TREATMENT COST

- Treated once with Draxxin
- 1.1 ml per 100 pounds
- $4.35/ml
- Average treatment cost per head $41.32



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ESTIMATED FINISHED WEIGHT

	Min	Max	Avg	SD	Count
Case	884	1,908	1,423	157	407
Control	1,052	1,844	1,443	150	452

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YIELD GRADE

Yield Grade	1	2	3	4	5	Total
Cases	36 (8)	162 (36)	199 (44)	49 (11)	2 (<1)	448
Control	37(8)	146 (30)	237 (49)	53 (11)	10 (2)	483

Numbers in ( ) are percent of total of either cases or controls

QUALITY GRADE

	Cases	Controls	χ^2	Significance
Prime	16 (3)	12 (3)	1.3	NS
Choice	240 (49)	286 (59)	8.1	0.005
Select	181 (37)	177 (36)	0	NS
No rolls	10 (2)	8 (2)	0.5	NS
Condemned	2 (<1)	0 (0)	NA	NS
Deads	26 (5)	2 (<1)	285.3	<0.0001
Railers	17 (3)	3 (<1)	64.6	<0.0001
Total	492	488		

Numbers in ( ) are percent of total of either cases or controls

MARBLING SCORES

P=0.009 (Prime+ through Choice Avg)

Quality	Case	Control	Significance
Prime+	0 (0)	0 (0)	NA
Prime Avg	0 (0)	1 (<1)	NS
Prime -	7 (2)	4 (1)	NS
Choice+	17 (4)	19 (4)	NS
Choice Avg	44 (10)	74 (15)	0.001
Choice-	179 (40)	200 (41)	NS
Select+	134 (30)	127 (26)	NS
Select -	49 (11)	44 (9)	NS
Standard+	7 (2)	4 (1)	NS
Standard-	12 (3)	10 (2)	NS
	449	483	

FEEDLOT COST OF BRDC

- Average loss in carcass value (and death loss) was $162.78, the cost of a single Draxxin treatment was $41.32, average feeder purchase price lost (of those that died) across all cases was $49.87
- **$253.97 was the total cost per BRDC affected animal**
- If CAB premiums were included, the cost would be higher

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POTENTIAL GAINS

- In 2013, 9,131,500 heifers and 16,003,400 steers were harvested from US feedlots with >1000 head of cattle
- 4,071,854 feedlot cattle were estimated to be affected with BRDC with a 16.2% prevalence rate
- When feeder purchase costs are included, the cost of BRDC was **$253.97 per affected animal or $1,034,128,760 in 2013**

This is a conservative estimate

POTENTIAL GAINS

With the estimated rate of genetic gain for selection for BRDC at 1.26% (case-control) and 2.08%, **between $13-$21.5 million could have been saved in the feedlot sector through selection in 2013**

ADDITIONAL BEEF POPULATIONS TO BE ANALYZED

- Commercial feedlot in Washington state has collected more than 850/1000 additional samples which will be genotyped and analyzed
- Commercial feedlot in Alberta, Canada is beginning the collection of the last set of 1000 animals, to be completed by spring

INDUSTRY TRANSLATION

- Finish analysis on remaining 2 feedlots and compare results obtained for each feedlot and as a composite of all three
- Provide current markers to industry to use for selection
- Secure additional funding to identify causal variants that will be more accurate over time, across breeds and provide for the opportunity to improve prevention and treatment for the disease through a better understanding of the pathogenesis of the disease

ACKNOWLEDGEMENTS

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