Economic Impact of Alternative FMD Emergency Vaccination Strategies in the Midwestern United States

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http://www.agmanager.info/livestock/marketing/AnimalHealth/FMD_Vaccination.pdf

Introduction

An outbreak of a highly contagious foreign animal disease (FAD) event in the United States would likely cause severe economic consequences. For example, in hypothetical foot-and-mouth disease (FMD) outbreaks originating from the proposed National Bio and Agro Defense Facility in Kansas, median losses were estimated at $115 billion (Pendell et al., 2015). With potential economic losses of this magnitude, animal health officials would employ intervention strategies to try to rapidly control and eradicate the disease.

One strategy that has been highly debated to control a potential FMD outbreak is emergency vaccination in conjunction with other disease management approaches. Emergency vaccination has been controversial for several reasons: 1) the ability to distinguish between vaccinated and infected animals, 2) delays in regaining lost export markets, 3) costs of vaccination, 4) uncertainty of the value of an emergency vaccination program, and 5) uncertainty of the availability of the specific type of vaccines needed for the strain of the virus.

Little is known about economic impacts of emergency FMD vaccination in the United States. Questions surrounding emergency vaccination include: What are the economic impacts of vaccinating and then depopulating the vaccinated animals vs. vaccinating and allowing the vaccinated animals to live? What are the economic implications of various capacity constraints (e.g., availability of personnel to administer vaccines, the number of infected herds prior to commencement of emergency vaccination program, etc.)? What are the economic impacts of creating varying sizes of vaccination zones?[1] This study was designed to address these types of questions by providing an economic assessment for animal health officials and policy makers concerning alternate FMD emergency vaccination strategies.
The purpose of the research summarized here was to estimate the economic impacts of alternative FMD emergency vaccination protocols in the United States. Specifically, changes in consumer welfare and returns to capital and management for producers are estimated and presented below.[2]

[1] A vaccination zone is a diameter around the infected herd where emergency vaccines are administered for all susceptible animals.
[2] For additional details of this study, see the published journal article by Schroeder et al. (2015).

Procedures:
To accomplish the objective, an epidemiological disease spread model as employed to determine the spread of an FMD outbreak under 15 alternate emergency vaccination scenarios (see Table 1 for scenario descriptions).[3] The disease study region was comprised of livestock in KS, NE, CO, SD, WY, northern OK, northern, NM, and the panhandle of TX. Output from the disease spread model were incorporated into a quarterly, multimarket partial equilibrium economic model of the United States agricultural sector. The economic modeling framework consisted of both vertical and horizontal linkages starting with livestock and crop production through to the final consumer, including international trade.

Results and Discussion:
The estimated 10th, 50th and 90th percentiles of disease duration, animals depopulated and animals vaccinated are presented in Figure 1, Figure 2 and Figure 3, respectively. The 50th and 90th percentiles for the no vaccination (NOVAC) scenario has the longest duration (nine quarters in length) and highest number of animals depopulated (17.4 and 18.1 million head, respectively) (Figure 1 and Figure 2). The scenarios that have the highest number of animals vaccinated are the two scenarios that have the largest vaccination capacity and vaccination zone (i.e., D50/10/50 and L50/10/50, respectively) (Figure 3). These scenarios also report the length of the outbreak for the 50th and 90th percentile at two and five quarters (Figure 1), respectively, while the total number of animals depopulated are about one and two million head, respectively (Figure 2).

The median cumulative losses to consumers and producers range from $55.5 to $187.8 billion (Figure 3). Additionally, government costs associated with an outbreak (euthanasia, indemnity payments, disposal costs, and cleaning and disinfecting) are estimated. The median government costs range from $1.1 to $11.5 billion.

We estimate the losses to producers and consumers at approximately $188 billion and $11 billion in costs to the government if movement control and depopulating infected herds with no emergency vaccination were implemented. If an aggressive emergency vaccination program with a 50 km vaccination zone and large vaccination rate at 22 days and 40 days were used, the median economic impacts are reduced significantly to $56 billion in losses to producers and consumers and $1.1 billion in costs to the government.

In the event of an FMD outbreak, implementing an emergency vaccination program could result in significant savings to producers, consumers and the government. In this study, there are two main drivers of economic impacts related to emergency vaccination, vaccination zone and vaccination trigger. The size of the vaccination zone appears to have larger impacts when compared to vaccination trigger. By increasing the size of the vaccination zone from 10 km to 50 km, median losses to producers and consumers are reduced by 48%. An additional 10% in savings is realized with increasing the vaccination capacity from five herds per day at day 22 and 10 herds per day at day 40 to 50 herds per day at day 22

[3] For additional details of the epidemiological disease spread model, see McReynolds et al. (2014).

and 80 herds per day at day 40. The higher vaccination capacity scenario would represent a situation in which producers would vaccinate their own herds.

The full article summarized here is available at:
http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9566077&fileId=S1074070814000054

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Table 1. Hypothetical Foot-and-Mouth Disease Outbreak Scenarios

Scenario Name	Vaccine Strategy[a]	Vaccination Capacity (herds, day 22, day 40)[b]	Vaccination Trigger (herds)[c]	Size of Vaccination Zone (Km)[d]
NOVAC	None	-	-	-
D5/10/10	V2D	5,10	10	10
L5/10/10	V2L	5,10	10	10
D1/10/10	Vfd2D	1,3	10	10
D5/10/50	V2D	5,10	10	50
L5/10/50	V2L	5,10	10	50
D1/10/50	Vfd2D	1,3	10	50
D5/100/10	V2D	5,10	100	10
L5/100/10	V2L	5,10	100	10
D5/100/50	V2D	5,10	100	50
L5/100/50	V2L	5,10	100	50
D50/10/10	V2D	50,80	10	10
L50/10/10	V2L	50,80	10	10
D50/10/50	V2D	50,80	10	50
L50/10/50	V2L	50,80	10	50

[a] Vaccine Strategy: vaccinate-to-die is denoted as V2D – all animals vaccinated are subsequently destroyed. Vaccinate-to-live denoted as V2L – vaccinated animals are not destroyed (only infected herds/animals destroyed). Vfd2D is when cattle in large feedlots (≥3000 head) are vaccinated, subsequently fed out for slaughter.

[b] Vaccination Capacity – number of herds vaccinated per day at 22 days and 40 days after first disease detection. For example, 5,10 refers to 5 herds per day at 22 days and 10 herds per day at 40 days.

[c] Vaccination Trigger – number of herds infected before the vaccination strategy is implemented.

[d] Size of Vaccination Zone – diameter of vaccination zone in kilometers around infected herds.

Source: Schroeder et al. (2015):
http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9566077&fileId=S1074070814000054

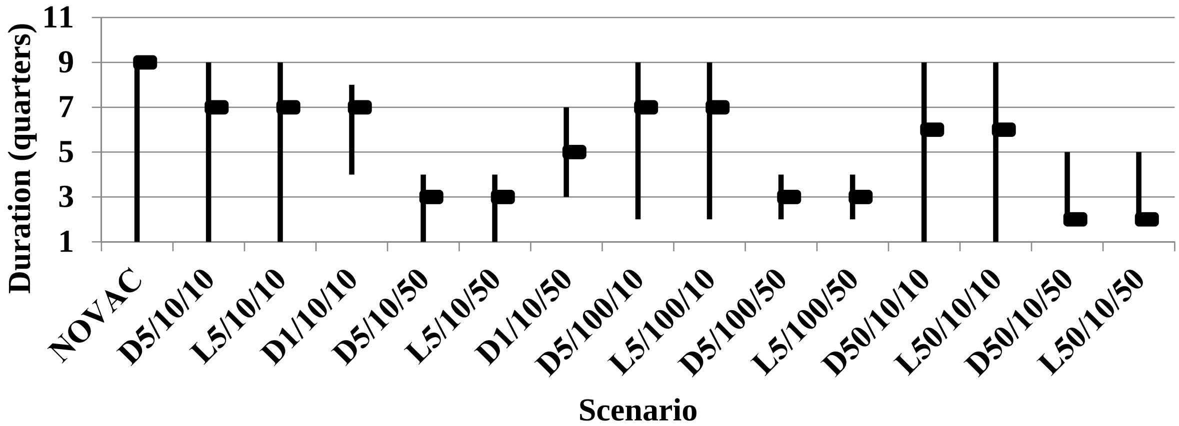

Figure 1. Duration of Outbreak by Scenario for 10th, 50th, and 90th Percentiles

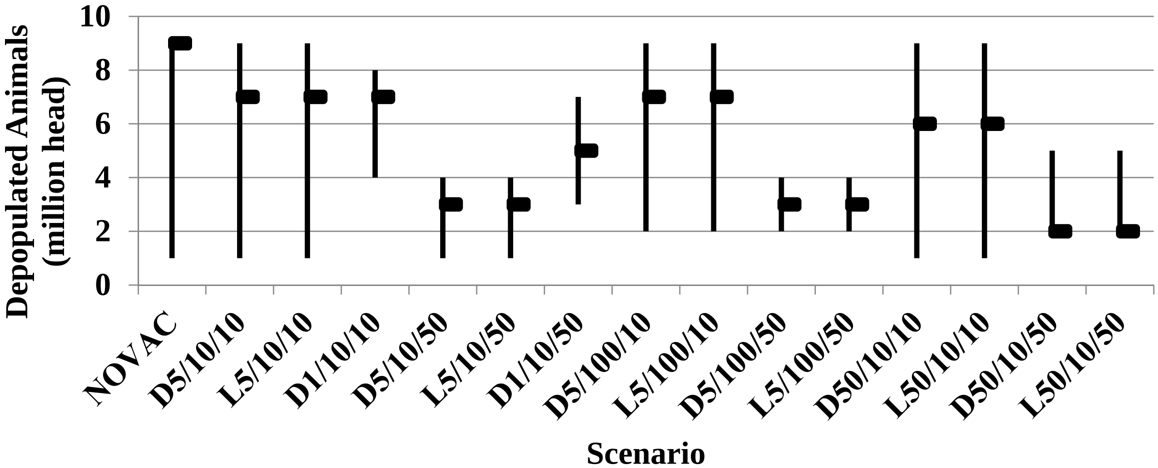

Figure 2. Total Number of Animals Depopulated by Scenario for 10th, 50th, and 90th Percentiles

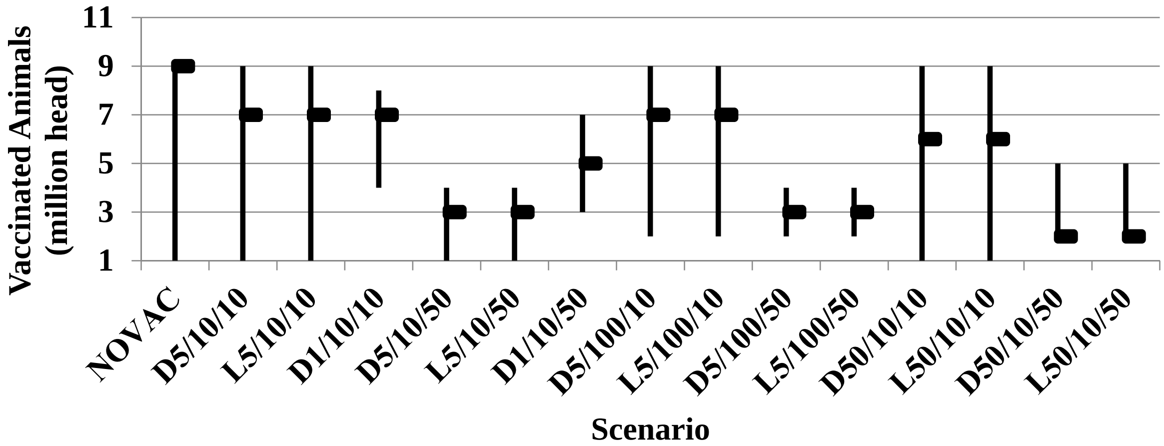

Figure 3. Total Number of Animals Vaccinated by Scenario for 10th, 50th, and 90th Percentiles

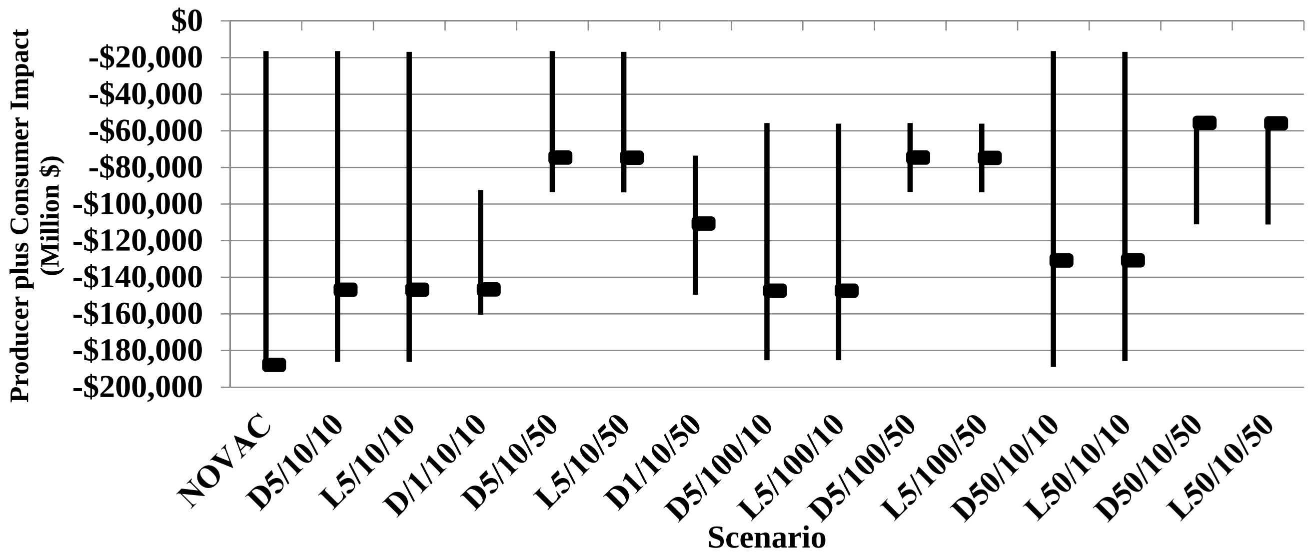

Figure 4. Estimated 10th, 50th, and 90th Percentile Confidence Intervals of Total Consumer Surplus Plus Producer Returns to Capital and Management Impacts (See Table 1 for Disease Management Scenarios Defined).

Source: Schroeder et al. (2015)
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