CHAPTER 8

ESTIMATION OF THE OUTBREAK COST

Due to uncertainty about the dissemination rate and the large disparity from previously published simulations of FMD, seven scenarios reflecting different assumptions about dissemination rates and intervention policies were constructed. Scenarios 1 through 4 use high dissemination rates that reflect the information collected in the South Valley for this study, while scenarios 5 through 7 use the highest dissemination rates published in the literature—which are low by comparison.

All dissemination rates were allowed to change randomly up to 30% in any direction. The model was run one hundred times, and the means and variances for each scenario were calculated.

The seven scenarios are:

1. High dissemination rates, no depopulation of latent infections, and 90% of infectious herds eliminated each week.
2. High dissemination rates, 90% depopulation of latent infections starting in the third week, and 90% of infectious herds eliminated each week.
3. High dissemination rates, 95% depopulation of latent infections starting in the second half of second week, and 95% of infectious herds eliminated each week.
4. High dissemination rates, 95% depopulation of latent infections starting in the first half of second week, and 95% of infectious herds eliminated each week.
5. Low dissemination rates, no depopulation of latent infections, and 90% of infectious herds eliminated starting in the third week.
6. Low dissemination rates, 90% depopulation of latent infections starting in the first half of third week and 95% of infectious herds eliminated each week.
7. Low dissemination rates, no depopulation of latent infections, and 50% of infectious herds eliminated each week.

Table 3 shows results of the simulations in average numbers of herds destroyed or surviving. Scenario 1 represents the worst possible case considered in this study. However, it still is substantially more favorable than what is considered the most probable outcome in case of an outbreak. This is because the simulated depopulation is faster than could be expected with the limited financial resources presently available to respond to an animal health emergency. Initially the scenario 1 outbreak spreads slowly but explodes in the second half of the third week. By the end of the fourth week all susceptible herds have been infected, and depopulation ends in the first half of the sixth week. The standard deviation of the number of herds in all states at the end of the sixth week is 0.

In scenario 2, depopulation of 90% of all infectious and exposed herds starts at the beginning of the third week. The epidemic ends in the first half of the sixth week, and only 7.5% of the dairies, 7% of the feedlots, 8.7% of the commercial hog operations and 7.2% of the backyard operations survive the outbreak. The standard deviation is equal to 19% of the surviving herds. Even though elimination of infected herds proceeds faster than in scenario 1, the epidemic has the same duration because complete depopulation of latent infections requires an additional half week. If the efficiency in depopulation of latent and infectious herds increases to 95% from the beginning of the third week, about 13% of the herds survive. This scenario is not reported in Table 3.

In scenario 3, the intervention starts in the second half of the second week and the efficiency in depopulating latent infections and infectious herds is 95%. At the end of the epidemic 76% of the dairies, 73% of the feedlots, 74% of the commercial hog operations and 76% of the backyard operations survive the outbreak. The standard deviation is equal to 19% of the surviving herds.

Scenario 4 is similar to scenario 3 except that the intervention starts a half week earlier, during the first half of the second week. The outbreak has two peaks, at the beginning of weeks two and three, and 81.5% of the dairies, 80% of the feedlots, 82.7% of the commercial hog operations and 81.7% of the backyard operations survive the outbreak. The standard deviation is equal to 22% of the surviving herds.

Scenario 5 is similar to scenario 1 but with lower dissemination rates. The epidemic lasts 67 days and approximately 13% of the premises are not depopulated. The standard deviation is equal to 13% of the surviving herds.

In scenario 6, depopulation starts at the beginning of the third week, with 10% of latent and 5% of infectious herds remaining. Depopulation ends at the beginning of the sixth week, and by this time about 74% of the herds remain susceptible. The standard deviation is equal to 7.6% of surviving herds.

In scenario 7 the intervention starts in the first half of the third week and the efficiency in depopulating infectious herds is only 50%, but 10% of the latent infections become infectious. The outbreak ends after 77 days, and about 2.5% of the herds remain susceptible at the end of the epidemic. The standard deviation is equal to 4% of the surviving herds.

The simulations show that even when the dissemination rates are high, early intervention combined with high efficiency in identifying latent infections and depopulating can substantially reduce the magnitude of the epidemic. Increasing the efficiency of depopulating latent infections and infectious herds from 90 to 95% has only a minor impact; the key factor is the early beginning of depopulation.

Table 3: Simulation Results Herds Destroyed and Surviving In the South Valley

Scenario		Large Dairies	Small Dairies	Feedlots	Large Pigs	Backyard Pigs	Processing Plants	Duration (in days)
1	destroyed	175	441	15	23	1,001	27	35
	st.d.	0	0	0	0	0		
	survived	0	0	0	0	0		
	st.d	0	0	0	0	0		
2	destroyed	162	409	14	21	929	25	35
	st.d.	2.48	6.24	0.21	0.34	14.17		
	survived	13	32	1	2	72		
	st.d	2.48	6.24	0.21	0.33	14.15		
3	destroyed	42	106	4	6	241	6	35
	st.d	3	8	0	0	18		
	survived	133	335	11	17	760		
	st.d	3	8	0	0	18		
4	destroyed	32	80	3	4	183	5	35
	st.d	4	10	0	1	17		
	survived	143	361	12	19	818		
	st.d	4	10	0	1	22		
5	destroyed	151	381	13	20	866	23	67
	st.d	2	4	0	0	10		
	survived	24	60	2	3	135		
	st.d	2	4	0	0	10		
6	destroyed	45	114	4	6	260	7	35
	st.d	4	10	0	1	22		
	survived	130	327	11	17	741		
	st.d	4	10	0	1	22		
7	destroyed	170	430	15	23	975	26	72
	st.d	0	1	0	0	2		
	survived	4	11	0	0	25		
	st.d	0	1	0	0	2		

However, the opportunity for decisive intervention lasts only one week. If eradication starts in the third week of the outbreak, about 13% of the herds survive the epidemic compared to about 81% when eradication starts in the second week—assuming the same efficiency in depopulation.

Comparing scenarios 5, 6 and 7, it is clear that even with low dissemination rates, containment of the epidemic requires depopulation of dangerous contacts. An increase in the depopulation rate of infectious herds from 50% (scenario 7) to 90% (scenario 5, when latent infections are not removed) increases the proportion of surviving herds from about 2.2% to only about 13%. However, when latent infections are removed as well as a high proportion of infectious herds (scenario 6), the proportion of surviving herds increases to about 74%.

A key factor affecting the planning of eradication policies is the actual value of the dissemination rates. If the dissemination rates are low the stamping-out policy can be started later in the outbreak. If the dissemination rates are high—which is more likely—and depopulation starts late, the stamping-out policy may require depopulation of all herds in the affected region. In that case, ring vaccination combined with a slower depopulation rate may result in a lower economic loss. In any case, it is clear from the simulations that, regardless of the dissemination rates, a high degree of preparedness and timely availability of financial resources are necessary conditions for containment of the epidemic.

Costs of the outbreak

Table 4 shows the total C&D costs, including compensation for destroyed animals and materials, and the quarantine cost for the different scenarios. The figures result from multiplying the number of depopulated premises in each scenario by the C&D costs.

In this table and the following four there is an added second-phase scenario, designated as Scenario 8. All scenarios except this one are for the South Valley—Fresno, Kern, Kings and Tulare counties. Scenario 8, however, replicates scenario 1 (high dissemination rates, no depopulation of latent infections, and 90% of infectious herds eliminated each week) under the assumption that the outbreak affects the entire San Joaquin Valley and the Chino Valley.

Table 4: Cost of C&D, depopulation and quarantine (millions of $)

Scenario	Large Dairies	Small Dairies	Feedlots	Large Pig Operations	Backyard Operations	Processing Plants	Quarantine	Total Cost
1	542	361	218	4	32	11	260	1,428
2	502	335	204	4	30	10	260	1,345
3	130	87	58	1	8	3	258	545
4	99	66	44	1	6	2	258	476
5	468	312	189	3	28	9	311	1,320
6	139	93	58	1	8	3	258	560
7	527	352	218	4	32	10	319	1,462
8 (San Joaquin & Chino Valleys)	1,759	1,586	338	9	65	23	1,039	4,819

Table 5 shows the direct production losses caused by the outbreak. These are estimated as the average daily production in the region times the proportion of infected premises times the number of days the premises cannot sell their output. The calculations are based on the following assumptions: (1) the quarantines are lifted 120 days after depopulation of the last infected or exposed premise; (2) depopulated farms return to production 60 days after depopulation of the last infected or exposed premise; (3) the supply of animals outside the infected region is large enough to repopulate the quarantined premises in a short period of time, (4) the price of cattle remains at the levels prevailing before the outbreak; (5) dairies start selling milk immediately after the quarantines are lifted; (6) dairies that are not depopulated sell milk in the quarantine area without interruption at the same prices they received before the outbreak, (7) feedlots need 130 days after being repopulated to bring the animals to slaughter weight; and (8) hog facilities finish their animals in 40 days after the lifting of the quarantines.

Table 5: Direct production losses (in million dollars)

Scenario	Milk	Beef	Pork	Total
1	281	268	9	558
2	260	251	8	519
3	67	72	2	141
4	51	54	2	107
5	324	266	9	599
6	72	72	2	146
7	380	313	11	704
8 (San Joaquin & Chino Valleys)	710	746	12	1,468

The direct output losses induce additional losses that affect the entire state economy. These losses, shown in Table 6, were estimated as the direct output loss multiplied by the corresponding output multipliers from the IMPLAN model.

Table 6: Direct, indirect and induced output losses in California (in million dollars)

Scenario	Milk	Beef	Pork	Total
1	455	518	17	990
2	421	484	15	920
3	109	138	4	251
4	83	104	3	190
5	525	513	18	1,056
6	117	138	4	259
7	615	603	21	1,239
8 (San Joaquin & Chino Valleys)	1,150	1,439	24	2,613

In addition to the output losses, a FMD outbreak would trigger trade losses to both California and the U.S.; given the difficulties in estimating the beef exports originating in California, only the losses for the U.S. were estimated. These losses, shown in Table 7, are the result of restrictions imposed by the major current U.S. customers, forcing the U.S. to sell its animal products in markets willing to accept them.

Table 7: Trade losses (in million dollars)

Scenario	Beef	Milk	Pork	Skins	Total
1	2,992	703	843	1,560	6,098
2	2,992	703	844	1,562	6,101
3	2,992	703	846	1,566	6,107
4	2,992	703	845	1,564	6,104
5	3,108	730	847	1,568	6,253
6	2,992	703	848	1,570	6,113
7	3,126	734	849	1,572	6,282
8 (San Joaquin & Chino Valleys)	2,992	703	843	1,560	6,098

It is assumed that the products subject to trade restrictions are sold in the FMD-endemic market where prices are 50% lower than in the FMD-free market. Since most of the exports subject to restrictions are currently shipped to Japan and Korea, which do not recognize the regionalization principle, the outbreak would affect not only exports originating in California but all U.S. exports. The model assumed that the restrictions are lifted two years after depopulation of the last infected or exposed herd, and that U.S. exporters can regain the market share in the FMD-free market immediately. This is a very optimistic scenario because it assumes that the C&D efforts would be 100% effective in eliminating the virus from all infected premises, and that other exporters would not permanently capture a portion of the U.S. share of the FMD-free market.

The trade losses arise exclusively from a lower export price. It is assumed that exporters in other states are able to maintain the volume of exports they shipped before the outbreak. This assumption is very unlikely, but follows the basic assumption that the outbreak is restricted to the South Valley. It is also assumed that California does not export any pork meat, and that trade restrictions on pork meat are applied only by Japan and Korea.

The total cost due to the FMD outbreak in California is equal to the direct, indirect and induced output losses, plus the cost of C&D and enforcing the quarantine, plus the losses due to trade restrictions. Table 8 shows the total cost of the outbreak, including the effect on all meats, skins and dairy products originating in any state in the U.S. If the dissemination rates are high, a half week delay in the start of depopulation increases the loss by $132 million (compare scenarios 3 and 4, column 7). A delay of seven days increases the loss by $1,754 million (scenarios 1 and 4, column 7). If the outbreak spreads to the entire San Joaquin Valley and the Chino Valley, the loss increases by $6,770 million over even the most optimistic of the South Valley scenarios (scenarios 4 and 8, column 7)

Even in the most optimistic case (scenario 4), public animal health services would need $475 million during weeks two to six of the epidemic to eradicate the outbreak. However, under present legisla-

Table 8: Total cost (in million dollars)

Scenario	C&D	Quarantine	Direct, Indirect and Induced Output Lost			Trade from California	Total (with Cal. trade)	Trade from U.S.	Total (with U.S. trade)
			Dairy	Beef	Pork				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	1,169	260	455	518	17	1,871	4,289	6,098	8,516
2	1,084	260	421	484	15	1,871	4,135	6,101	8,365
3	287	258	109	138	4	1,871	2,667	6,107	6,903
4	217	258	83	104	3	1,871	2,535	6,104	6,768
5	1,010	311	525	513	18	1,969	4,345	6,253	8,630
6	303	258	117	138	4	1,871	2,692	6,113	6,934
7	1,143	319	615	603	21	1,984	4,686	6,282	8,983
8 (San Joaquin . Chino & Valleys)	3,781	1,039	1,150	1,439	24	1,871	9,305	6,098	13,531

tion only $12 million would be immediately available, and appropriation of additional resources would require legislative intervention which could delay the start of eradication more than one week. In this same scenario, eradication of the outbreak would require depopulation and disposal of 149,000 cows and 2,183 pigs in the first two weeks of the eradication campaign. Past experiences—in Italy and Taiwan, for example—indicate that this is almost impossible. The simulations suggest that the most probable outcome in the case of a FMD outbreak would be a rapid spread over California and other states with large livestock industries. Therefore, the estimates in Table 8 including Scenario 8 must be considered as the lower bound of the true cost of an outbreak.

It also must be noted that the cost estimates are based on very optimistic assumptions about:

- The efficiency of the eradication policy, in particular the feasibility of imposing a 100% efficient quarantine and achieving 100% efficiency in C&D of depopulated premises.
- The containment of the outbreak in California.
- The time frame in which the markets return to a situation similar to the one prevailing before the outbreak.