NATIONAL IMPACTS OF CHANGES

IN LIVESTOCK DISEASE SURVEILLANCE

by

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Abstract

This research estimates the U.S. economic welfare effects of livestock disease surveillance. One type of surveillance considers livestock diseases already in the United States. Annual national economic welfare increases $1.4 billion on average compared with a Federal surveillance budget for endemic diseases of $300 million annually. Other surveillance deals with reducing the risk of foreign animal diseases entering and becoming established. The estimated annual gain to producers from surveillance for foreign animal diseases is $401 million dollars. Consumers experience additional benefits of $170 million annually. Total annual benefits are $571 million versus a foreign animal disease surveillance budget of $165 million.

Keywords: Livestock Disease, Surveillance, Economics

JEL Codes: Q10, Q17

National Impacts of Changes in Livestock Disease Surveillance

Introduction

Each year the U.S. Government spends funds to operate a system of animal disease surveillance. The National Animal Health Surveillance System (NAHSS) defines livestock disease surveillance "as the ongoing systematic collection, collation, analysis, and interpretation of data and dissemination of information to those who need to know so that action can be taken. The purposes of surveillance are rapid detection of introduced diseases and emerging issues, monitoring and providing actionable information for endemic diseases, and measuring regional prevalence of trade-significant diseases." In the United States, livestock disease surveillance occurs through several programs. For example, the National Animal Health Monitoring System (NAHMS) conducts periodic surveys of the individual livestock sectors. This information describes industry health and management practices. It also provides input to risk analyses determining disease introduction probabilities and helps define at-risk populations. In addition, surveillance is conducted in conjunction with on-going eradication and control programs. Finally, surveillance is directed at identifying diseases which might emerge in the United States whether originating from other countries or new forms of livestock diseases.

This research estimates the national gains and losses in economic welfare from the existence of livestock disease surveillance using a U.S. agricultural sector economic model combined with epidemiological results. Changes in variables and parameters associated with improved surveillance cause changes in market quantities and prices that generate differences in economic welfare. Two types of surveillance issues are considered. One type involves livestock diseases already in the United States. Improved surveillance in this context involves measures that reduce animal mortality, increase feed efficiency, and reduce veterinary expenses. The second type of surveillance analysis deals with reducing the risk of foreign animal diseases (FADs) entering the United States and becoming established.

Animal Disease Surveillance for Established Diseases

This section reports an analysis of the benefits of animal disease surveillance using survey results from the National Animal Health Monitoring System (NAHMS). Information obtained under NAHMS allows estimation of national producer reported percentages of cattle, swine, sheep and lambs lost to disease. Those survey estimates are inserted into a quarterly national agricultural sector economic model developed under the Program for Research of the Economics of Invasive Species Management (PREISM) to estimate the benefits of livestock disease surveillance (Paarlberg, Hillberg Seitzinger, Lee, and Mathews, Jr., 2008). The model is solved for 20 quarters to determine the percentage change in the endogenous variables for each quarter. The percent changes in the endogenous variables are applied to a baseline of forecasted quarterly data from January 2007 to December 2011 derived from the USDA May 2007 baseline.

Methodology

Livestock disease surveillance has several features to be considered in the scenarios. Foremost is the number of livestock by species and production type saved from disease. That information comes directly from the NAHMS reports. Reductions in morbidity should also be included in the analysis, however; the literature does not provide consistent estimates of livestock morbidity's impact. Therefore the shocks to supply introduced into the model are a lower bound of the impact of livestock disease surveillance on supply. Improved feed efficiency is considered. Both mortality and morbidity adversely affect feed efficiency. Improved surveillance means healthier animals which reduces veterinary costs. Finally, surveillance programs for endemic diseases enhances U.S. exports of livestock and livestock products by reassuring foreign trading partners that disease issues will be identified earlier. But, it is impossible to determine the extent that surveillance allows trade to continue so it is not included.

Animal losses from disease, except for broilers, are calculated from NAHMS reports for the years 1997 through 2002. The procedure is to take the reported losses and to determine the share lost due to disease. For example, in the year 2000, 10.0% of lambs born died or were lost. Of those lambs, producers reported 44.1% were killed by predators, 11.2% were weather related losses, and 0.7% stolen. The remaining 44.0% of lambs were lost to various diseases, so mortality in lambing due to disease is 4.4%. Table 1 reports the maximum percentage increases in the number of U.S. livestock by species and production type under the assumption that 10 percent of livestock disease mortality is eliminated by livestock disease surveillance in the United States.

Because fewer livestock are lost to disease feed efficiency rises. Improved surveillance reduces livestock deaths and morbidity so that "lost" feed is recovered and reflected in reduced feed use per animal. The procedure determining the gain in national feed efficiency when mortality is reduced assumes that per animal feed efficiency does not change because of mortality. Livestock-feed balances give quantities of feed grains, wheat, soybean meal, and forages used for each type of animal that survives to market weight as well as for breeding animals at each stage of life. The NAHMS data gives the losses by life stage so scaling the number of surviving animals at the end of each stage yields a revised feed use value. Summing those revised values and comparing them to the per-animal feed use in the livestock-feed balances determines the change in national feed efficiency (Table 2).

Fewer animals lost to disease means reduced veterinary costs. Although these costs are not a large share of the cost of raising an animal, they affect the rental rate for capital and management. The revenue share allocated to veterinary costs for cattle, swine, and dairy cattle (milk) come from cost of production data for 2004 and 2005 given on the USDA/ERS website. The shares are 1.3% for swine, 3.8% for beef cattle, and 4.0% for milk (dairy cattle). The share for sheep/lambs is 2.8%, while the shares for poultry meat and eggs are 1 and 2 percent, respectively (Smathers et al. and Vukina).

Expectations of future returns to breeding animals by livestock growers are important to the adjustment pattern. Each scenario assumes naïve expectations for

returns to breeding animals where the expected future return during the current quarter is the observed return to a breeding animal last quarter.

Results

The annual impacts of reduced animal mortality resulting from livestock disease surveillance on returns to capital and management for producing sectors are given in Table 3. Society as a whole benefits from reduced animal mortality resulting from improved surveillance. If the 10 percent reduction in animal mortality is accompanied by improved feed efficiency and a 10 percent reduction in veterinary costs, the average annual gains to the United States are a net $1.4 billion. The aggregate U.S. economic welfare gain disguises shifts in economic welfare within the nation.

Among the producing sectors there are gainers and losers. For the meat industry returns to capital are $97.7 million greater on average annually. The increased returns to capital and management occur despite lower meat prices because the meat price declines are magnified in the animal prices. That is, animal prices fall further than do meat prices so the per unit returns to capital and management rise. The scenarios do not assume any expansion in kill capacity and more animals in the marketing chain cause pressure on that limited capacity. As a result the returns to animal growers fall when animal mortality is reduced. Returns to capital and management for beef cattle producers decline $147.2 million on average per year. Hog growers experience a decline in returns to capital and management of $316.5 million per year on average.

These effects spill over to other sectors. Crop producers lose $35.2 million annually on average due to the increased feed efficiency with the losses concentrated in coarse grains.

Dairy cattle and milk producers and processors increase total returns to capital and management of $259.8 million per year on average. Reduced cattle mortality and results in a slight increase in output. With an inelastic demand for milk, the output increase decreases price. The change in the rental rate for capital and management reflects lower feed costs and is slightly increased.

The changes in consumer welfare are driven by changes in prices paid by consumers. Prices fall for all final goods relative so consumer surplus increases. Over the five year period, average consumer surplus increases by $1.6 billion annually.

Other Factors

The model results suggest additional factors not explicitly considered. The scenarios hold the capital stock in meat industries constant while the results show returns to capital and management rising. Increased returns to capital and management could stimulate added investment by meatpacking and processing industries which would increase the meat supply and expand the derived demand for slaughter animals. The result would be lower meat prices with higher prices for animals and feedstuffs. The

increase in returns to capital and management in the meat sectors would be smaller, the decline in returns to capital and management for animal growers would be smaller, and the gains in economic welfare for consumers would be greater.

Another factor suggested by the model results is an adjustment in animal agriculture via exit. Exit of farmers and ranchers is a common response to improved technology. Reduced returns to capital and management could cause some marginal growers to exit. It is possible that the reduced sector returns identified by the model solutions are consistent with increased individual returns depending on the number of growers who exit.

Another factor emerging from the supply control literature involves the time frame of the analysis. This model is quarterly and solved over 20 quarters so demands for outputs and inputs have a tendency to be inelastic or have low elasticity. It is possible that longer-run adjustments would result in more elastic demand response that could alter the economic welfare impacts (Paarlberg, 1964). Short-run declines in economic welfare for livestock producers could turn into longer-run benefits if demand elasticities rise.

Surveillance and Foreign Animal Diseases

Livestock disease surveillance also reduces the risk of diseases not presently in the United States animal herd from entering and becoming established. Efforts to detect FAD events in the United States include field investigations, disease-specific surveillance programs, and diagnostic laboratory surveillance. This section uses the U.S. agricultural sector model to estimate the economic effects of increased efforts to reduce the risk of entry and establishment of foot and mouth disease (FMD) and classical swine fever (CSF) and highly pathogenic avian influenza (HPAI).

Methodology

The methodology used combines simulation results from the U.S. agricultural sector model with risk assessment research. The U.S. agricultural sector model used in the previous section gives changes in economic welfare in the event of outbreaks of the three diseases considered compared to a base period. The base period used consists of the first quarter 2007 through the fourth quarter of 2011. The risk assessment analyses identify the likelihood of disease exposure to a U.S. animal.

There are three sources of economic impacts from entry of a foreign animal disease. One source is the loss of animals via depopulation and inventory adjustment. Simulations with the North American Animal Disease Spread Model (NAADSM) and observed outbreaks in other nations suggest that most outbreaks in developed countries depopulate small numbers of animals compared to the national herd and most outbreaks are brief. For these scenarios animal losses of 3 percent are assumed for all species and occur in only quarter 1. Nevertheless, there remain dynamic effects from the depopulation as breeding inventories and future market animals are reduced. Changes in returns to livestock production induce secondary producer response. The scenarios

assume naïve expectations for returns to breeding animals where the return observed in the previous quarter is expected to persist.

A second source is the loss of export sales which generate large national impacts. The analysis includes the export losses resulting from an outbreak. For FMD, U.S. exports of beef, beef cattle, pork, swine, milk, lamb and sheep meat, lambs and sheep, and dairy cattle would be embargoed, and in the CSF outbreak, U.S. exports of pork and swine are blocked. Each scenario assumes these exports are reduced by 80% in quarter 1, by 40% in quarter 2, and by 10% in quarter 3 for FMD and CSF outbreaks based on recent outbreak durations in Europe. Exports fully recover in quarter 4. For HPAI, estimates of trade responses by U.S. trading partners by the Foreign Agricultural Service of the U.S. Department of Agriculture are used (Paarlberg, Hillberg Seitzinger, and Lee). U.S. poultry meat exports were estimated to decline by 89% in quarter 1, 65.3% in quarter 2, 16.1% in quarter 3, and 11.9% in quarter 4 in the event of an outbreak lasting less than one quarter.

The third source is the response of U.S. consumers to a disease outbreak. For the diseases considered, while only HPAI can be transmitted to humans, some consumers are assumed to respond adversely. For FMD demand reductions occur for beef, pork, and lamb meat. For CSF only pork demand is affected, while for HPAI only poultry meat and egg demands are reduced. The percent demand reductions are the same across scenarios and are based on observed reductions due to HPAI in Western Europe. The assumption is that 4% of U.S. consumers drop out of the respective meat markets in quarter 1. Demand recovers some in quarter 2 with only a 2% demand reduction. By quarter 3, demand is 0.5 percent lower.

Obtaining the risk of disease entry and establishment proved difficult. There are detailed discussions of the ways in which a foreign animal disease might enter the United States (USDA/APHIS, 2001; National Agricultural Biosecurity Center Consortium, 2004). While these reports provide detailed information on pathways, epidemiology, and treatment/handling of risks, they avoid explicitly stating a quantitative risk. An earlier study examines feeding of household waste (garbage feeding) that is a major pathway for disease introduction and does estimate the annual probabilities of U.S. hogs being fed infected material (USDA/APHIS, 1995). A number of scenarios are evaluated for household waste and for waste from legally imported food products. Household waste scenarios consider the days from initial processing to exposure to the U.S. hog, transit time. The scenarios also vary the percent of the waste free of disease. Scenarios for waste from legally imported food vary confidence intervals and the proportion not adequately processed.

Several patterns can be observed. First, the probability of exposure to CSF exceeds that for FMD. Second, the probability of exposure through feeding of household waste exceeds that of exposure through feeding of legally imported food. Third, shorter transit time raises the probability of exposure. Finally, as the share of the product free of the disease or the share adequately processed increases, the probability of exposure falls.

Obtaining a risk assessment for HPAI proved impossible so this study makes estimates based on observed outbreaks in North America. From 1924 to 2004 there were five outbreaks of HPAI in North America for an annual probability of 6.25% (USDA/APHIS). That probability is similar to the median values generated for FMD and CSF. Given the current global situation with the H5N1 virus outbreaks in Asia, the base probability is set at 7.5% with a range of 3.18% to 14.54%.

The risk estimates and the economic welfare determined from the U.S. agricultural sector model give the expected return to capital and management and the expected consumer surplus by sector. This is accomplished by multiplying the solution in the event of an outbreak by the probability of an outbreak and then multiplying 1 minus the probability of an outbreak by the no outbreak results. Adding these values give the expected value. Comparing the expected welfares across different probability distributions shows how changes in livestock disease surveillance for foreign animal diseases affect expected welfare.

Results

The initial set of results assumes separate disease outbreaks of FMD, CSF, and HPAI occur in the first quarter of 2007. For these disease outbreaks, exports and demands for the respective meats drop for the first three quarters of that year. Dynamic effects persist with the largest effects in the early quarters. Poultry adjust quickly. Swine show a longer response with cattle having the longest response. Crops also show lagged production adjustment.

As prices fall returns to capital and management fall or show small increases while consumer surplus for many final goods rises (Tables 4 and 5). For the FMD scenario, the United States as a whole experiences a decline in returns to capital and management of $940 million with most of the impact occurring in the initial quarters. The largest declines in returns to capital and management occur for the meats directly affected by the export restrictions. The impacts of the FMD outbreak on returns to animal agriculture are mixed for several reasons. One reason is that demand shocks are felt indirectly. Live animal exports are small so the loss has little impact. The animals are directly affected by depopulation which is a supply reduction and puts some offsetting upward pressure on prices. Reduced feeding lowers prices for feedstuffs which affect returns to livestock producers.

Allowing producers to react via inventory adjustment and the speed of adjustment affect the estimated returns. Initially animal prices and returns to capital and management fall, but rise above the baseline in later quarters as demand recovers, but the dynamic effects of the animal losses persist. For beef cattle, the adjustment is slow enough that returns over the 5-year simulation period are $564 million greater. For dairy, returns $27 million greater. Swine adjust more quickly and the initial losses are larger because pork exports are a larger share of production. Returns to capital and management for hog growers over the 5 years fall $229 million. Sheep and lamb growers lose $14 million.

The largest spillover effects occur for poultry meat. Returns to capital and management for poultry meat increase $146 million. As prices for other meats fall in quarter 1, consumers substitute for poultry meat so poultry meat's price weakens to remain competitive. The falling price lowers the return to capital. As other meat prices recover and rise above the baseline so too does the poultry meat price. Also reduced feed demand contributes to improved returns to poultry growers. Egg returns show a similar, but smaller change.

Feed demand falls and this lowers prices for coarse grains, soybeans, and forage. Returns over the years 2007-2011 fall $166 million for coarse grains and $3 million for soybeans. Forage crops experience a loss of $390 million. Food crops, wheat and rice, experience little loss in demand so returns rise slightly.

The economic welfare of consumers is measured by consumer surplus. Consumers divide into those whose demand is unaffected and those consumers who stop consuming red meats. Consumer surplus rises for many goods because prices are lower. The largest price declines occur for beef and pork in quarter 1 so these commodities generate the largest consumer surplus increases for those consumers who continue to eat beef and pork. Yet, 4 percent of consumers are assumed to curtail purchases in quarter 1 and they experience a large reduction in consumer surplus. Over the entire period consumer surplus for beef falls $3.3 billion and pork consumer surplus is $382 million lower. There is also a gain in consumer surplus for poultry meat because its price falls via substitution effects. Total U.S. consumer surplus increases $52 million so losses for red meats are balanced by gains for other commodities.

The export restrictions in the event of CSF and HPAI outbreaks are more focused. This means the total changes in U.S. economic welfare are smaller and concentrated. In the CSF scenario, the pork processing sector loses $800 million over five years while swine growers lose $255 million. These losses are largely front-loaded. For the CSF outbreak, the total decline in returns to capital and management in U.S. agriculture and agribusiness is $886 million. Consumers in the United States benefit $158 million from lower prices. Again consumers separate into two groups. Consumers who continue to eat pork gain while those who reduce pork consumption suffer a welfare loss. The gain in economic welfare to consumers who continue to eat pork is less than the loss to consumers scared to eat pork.

For HPAI, the poultry meat sector loses $489 million. The decline in returns for the entire United States is $262 million. Consumer surplus is $1.2 billion lower. A gain in consumer surplus of $158 million occurs for poultry meat as the benefits of a lower price exceed the losses of fearful consumers. For eggs the opposite happens. The total loss to egg consumers is $2.3 billion. Milk products, pork, beef, and lamb meat also generate benefits for consumers as prices for those products decline along with the lower poultry meat price.

Expected economic welfare measures incorporate the risk of an animal being exposed to FMD, CSF, or HPAI. The expected economic welfare for U.S. producers and consumers is compared to that when there is no outbreak (base observed values) and when an outbreak is certain. Tables 6 and 7 report the values for FMD. Values for CSF and HPAI are similar. As probabilities of exposure rise, expected returns to U.S. agriculture and agribusinesses and expected consumer surplus converge toward the values obtained when a disease outbreak is certain. When the probabilities of disease exposure fall, economic welfare outcomes move toward the no disease values.

Although the analysis treats each disease as unique, there could be compounding effects. That is, improved surveillance could lower exposure risks for all of the diseases at the same time. The results reported treat the cases as separable, but that is not necessarily the situation. Therefore, the results are examined to determine the value of having a surveillance program for all three foreign animal diseases in place. This value is estimated by comparing the expected economic welfare estimates at the median with the expected economic welfare when an outbreak is certain. This comparison shows $401 million dollars in estimated annual gains to producer returns to capital and management from the existence of a livestock disease surveillance program for the three foreign animal diseases (Table 8).

Aggregating the median expected consumer surplus estimates and comparing to the value for consumer surplus when an outbreak is certain shows additional benefits of $170 million annually (Table 8). Combining the producer and consumer gains yields program benefits of $571 million annually, compared to estimated program costs of approximately $165 million for Fiscal Year 2006.

If improvements in surveillance increase the share of product imported that is uninfected, there are additional gains in returns to capital and management. In the case of household garbage as an FMD source, if the share of product uninfected rises from 75% to 85% from improved surveillance at the port of entry, then median expected returns from 2007-2011 are $25 million higher. If the uninfected share rises to 95%, median returns are another $22 million greater. For feeding legal food product imports, the risks are considerably lower, so the gain from improved surveillance is lower as well. Consider FMD, if increased surveillance lowers the proportion of food not adequately process from 0.00035 to 0.00023, the gain in median expected returns to capital and management from 2007-2011 is $2 million.

Another way to consider these results is to argue that increased surveillance shifts the probability distribution downward. In the scenario where the FMD exposure source is household waste, the transit time is 14 days, and the share of product uninfected is 75%, the median probability is 6.68%. If improved surveillance lowers the median probability to that of the 25th percentile, 3.17%, the expected returns to capital for U.S. agriculture and agribusiness would be $33 million greater. Converted to a per unit gain in expected returns shows that cutting the exposure probability for FMD by 1% generates a $9.5 million gain over the five year period.

The magnitudes of gains are disease specific in the analysis and reflect the economic welfare impacts of the disease as well as the size of the risk reduction. For the situation where household garbage is the source of CSF, improving the share of product uninfected from 75% to 85% and then to 95% generates gains in expected returns of $37 million and $39 million. The one percent risk reduction for CSF gives an $8.8 million gain in expected returns over the five year period. These gains are lower than those for FMD in the similar scenarios even though the reduction in exposure probability is greater for CSF because the economic impacts of CSF are smaller.

Such effects are noticeable for HPAI. The observed probability of a U.S. outbreak is 7.5%. The low probability is assumed to be 3.18%. That reduction in risk generates $12 million in higher expected returns to capital and management from 2007-2011, which for each 1% reduction in the risk translates into a gain of $2.8 million over the five year period. For only these three diseases combined then, each additional 1 percent reduction beyond the median in the risk posed to the U.S. livestock population translates into $21.1 million in gains to capital and management in the livestock and feed industries over the five year period, or $4.2 million annual.

Conclusion

This research considers the economic welfare changes arising from livestock disease surveillance. One part examines the impact of reduced animal mortality for diseases already present in the United States. The second part considers the effect surveillance for foreign animal diseases has on economic welfare.

Part one uses NAHMS results to examine reduced animal mortality, increased feed efficiency, and decreased veterinary expenses as surveillance improves. The United States as a whole benefits from surveillance for endemic livestock diseases. Annual national economic welfare rises by an estimated $1.4 billion on average. This compares favorably with estimated program costs of approximately $300 million annually.

In the second part, the impact of surveillance for foreign animal diseases is evaluated by considering reduced probabilities of exposure to FMD, CSF, and HPAI. The existence of a livestock disease surveillance program raises the expected returns to capital and management for U.S. agriculture and agribusiness and increases consumer surplus. Combining the producer and consumer gains yields program benefits of $571 million annually, compared to estimated program costs of approximately $165 million for Fiscal Year 2006. Across the three diseases, further one percent reductions in the risk posed to the U.S. livestock and feed sectors results in additional $4.2 million increases in returns to capital and management annually.

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Table 1. Percent increases in U.S. livestock numbers by species and production type due to livestock disease surveillance

Species	Production Type	Percent Increase
Beef Cattle		
	Finish	0.14
	Background, Late	0.12
	Background, Early	0.12
	Weaning	0.25
	Calf Crop	0.21
	Cows and Replacements	0.12
Swine		
	Finish	0.27
	Grower, Early	0.26
	Pig Crop	0.36
	Breeding Inventory	0.27
Dairy Cattle		
	Cows	0.42
	Replacements	0.19
Lambs and Sheep		
	Finish	0.22
	Grower	0.27
	Background	0.27
	Lamb Crop	0.44
	Ewes and Replacements	0.34
Broilers*		0.05
Layers		1.46

Source: Calculated from NAHMS reports and *NCSU Cooperative Extension Service

Table 2. Gains in feed use per animal due to livestock disease surveillance

Species	Feed	Percent Improvement
Cattle	Feed Grains	0.211
	Forage	0.283
	Wheat	0.245
	Soybean Meal	0.222
Swine	Feed Grains	0.355
	Wheat	0.363
	Soybean Meal	0.382
Dairy Cattle	Feed Grains	4.870
	Forage	0.692
	Wheat	0.488
	Soybean Meal	0.487
Lambs/Sheep	Feed Grains	0.309
	Forage	0.412
	Soybean Meal[a]	0.350
Poultry meat	Soybean Meal	0.494
	Wheat	0.480
	Feed Grains	0.474
Eggs	Soybean Meal	1.400
	Wheat	1.300
	Feed Grains	1.300

[a] Ewes only.

Source: Calculated from livestock-feed balances and the values in Table 1.

Table 3. Annual change in returns to capital and management due to reduced mortality from livestock disease surveillance

	Year					Annual
	2007	2008	2009	2010	2011	Average
Sector						
			Million dollars			
Meat Processing	97.8	54.4	111.5	112.7	112.0	97.7
Eggs and Layers	3.0	2.7	0.6	-0.6	-2.4	0.7
Dairy Cattle and Milk	270.0	262.9	259.4	257.9	248.9	259.8
Beef Cattle	-39.3	-149.6	-147.1	-198.6	-201.2	-147.2
Swine	-150.8	-279.4	-344.0	-391.1	-417.2	-316.5
Lambs and Sheep	-0.1	-.05	-1.0	-0.8	-0.5	-0.6
Crops	-52.2	-35.1	-36.2	-23.9	-28.8	-35.2
Soybean Processing	-6.6	8.0	20.7	14.4	16.2	10.5
Total Welfare Producers	121.8	-136.5	-136.2	-230.1	-273.0	-130.8

Table 4. Returns to capital and management in selected U.S. agricultural and agribusiness sectors, 2007-2011

	Value 2007-2011 Baseline			
Commodity	Base	FMD	CSF	HPAI
	-- million 2007 dollars --			
Beef	4099	3756	4060	4059
Beef Cattle	25368	25932	25481	25483
Pork	21052	20234	20252	21011
Swine	12729	12500	12474	12747
Lamb/Sheep Meat	152	163	173	173
Lamb/Sheep	321	307	314	314
Milk	8636	8663	8701	8749
Poultry Meat	8665	8811	8684	8176
Eggs	-1821	-1808	-1815	-1854
Coarse Grains	77693	77527	77656	77651
Wheat	13118	13229	13127	13141
Soybeans	37610	37607	37609	37608
Rice	4603	4610	4604	4605
Soy Crushing	7661	7805	7707	7761
Forage	107654	107264	107627	107654
Total	327540	326600	326654	327278

Table 5. U.S. consumer surplus for selected goods, 2007-2011

Commodity	Value 2007-2011 Baseline			
	Base	FMD	CSF	HPAI
	-- million 2007 dollars –			
Beef	265569	262282	265558	265636
Pork	134864	134482	134369	134908
Lamb/Sheep Meat	6931	6882	6931	6932
Milk	653564	655300	653924	654078
Poultry Meat	78180	78555	78277	78338
Eggs	416416	416621	416442	414120
Coarse Grains	233649	234240	233760	233788
Wheat	70037	70881	70105	70197
Rice	13815	13829	13816	13818
Soybean Oil	6114	6119	6115	6118
Total	1879139	1879191	1879297	1877933

Table 6. U.S. economic welfare, 2007-2011: Food and Mouth Disease from household waste

	billion dollars			
Days Transit	14	14	14	3
Uninfected Share	75%	85%	95%	85%
Returns to Capital and Management for U.S. Agriculture and Agribusiness				
Expected Returns:				
25th Percentile	327.510	327.522	327.534	327.505
50th Percentile	327.477	327.502	327.527	326.459
75th Percentile	327.418	327.464	327.514	327.382
100th Percentile	326.680	326.815	327.175	326.603
Outbreak Certain	326.600			
No Outbreak	327.540			
Consumer Surplus				
Expected:				
25th Percentile	1879.141	1879.140	1879.139	1879.141
50th Percentile	1879.142	1879.141	1879.140	1879.144
75th Percentile	1879.146	1879.143	1879.140	1879.148
100th Percentile	1879.187	1879.179	1879.159	1879.191
Outbreak Certain	1879.191			
No Outbreak	1879.139			

Table 7. U.S. economic welfare, 2007-2011: Food and Mouth Disease from legally imported food waste

billion dollars			
Confidence Interval	95%	99%	--
Proportion not adequately processed	0.00023	0.00035	0.0001
Returns to Capital and Management for U.S. Agriculture and Agribusiness			
Expected Returns:			
25th Percentile	327.538	327.537	327.539
50th Percentile	327.536	327.534	327.538
75th Percentile	327.533	327.529	327.537
100th Percentile	326.425	326.371	327.488
Outbreak Certain	326.600		
No Outbreak	327.540		
Consumer Surplus			
Expected:			
25th Percentile	1879.139	1879.139	1879.139
50th Percentile	1879.139	1879.139	1879.139
75th Percentile	1879.139	1879.140	1879.139
100th Percentile	1879.145	1879.148	1879.142
Outbreak Certain	1879.191		
No Outbreak	1879.139		

Table 8: Average Annual Changes in US Economic Welfare Due to Livestock Disease Surveillance, 2007-2011: Aggregation Across FMD, CSF, and HPAI

	Returns to Management and Capital	Consumer Surplus
	-- million dollars –	
Risk Reduction Achieved:		
100^{th} to 50^{th} Percentile	401	170
100^{th} to 75^{th} Percentile	365	157
75^{th} to 50^{th} Percentile	35	13
75^{th} to 25^{th} Percentile	57	20