Rapid Effective Trace-Back Capability Value in Reducing the Cost of a Foot and Mouth Disease Event

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Abstract:

This study evaluates how the availability of animal tracing affects the cost of a hypothetical Foot and Mouth Disease (FMD) outbreak in the Texas High Plains using alternative tracing scenarios. To accomplish this objective, the AusSpread epidemic disease spread model (Ward et al., 2006) is used to simulate a High Plains FMD outbreak under different animal tracing possibilities. A simple economic costing module (Elbakidze, 2008) is used to determine the savings in terms of animal disease mitigation costs from rapid, effective trace-back. The savings from increased traceability are then be compared to the cost of a functional National Animal Identification System (NAIS).

Initial results indicate that rapid, effective tracing reduces the overall cost of disease outbreaks and that the benefits per animal in terms of reduced cost of an outbreak more than outweigh the annualized cost per animal of implementing a NAIS. A value of time related to controlling an outbreak is estimated to have increased benefits from an identification system that incorporates a rapid response capability. We also find the level of benefits vary depending on the location of initial infection and whether or not welfare slaughter occurs.

Rapid Effective Trace-Back Capability Value in Reducing the Cost of a Foot and Mouth Disease Event[1]

The US National Animal Identification System (NAIS) has been the subject of debate for some time. The primary aim of NAIS would be the protection of the U.S. livestock herd from health threats and the reduction of outbreak related losses (USAHA). Specifically, if a disease outbreak were to occur − either from natural spread or intentional infection − rapid, effective tracing of potentially infected animals facilitated by a NAIS could reduce animals slaughtered and control costs. One of the long term goals of NAIS is to provide animal health officials with the capability to accurately identify all livestock and premises that have had direct contact with a reportable disease of concern within 48 hours after discovery of the disease (USDA-APHIS). Little is said as to why this is an optimal time window for tracing, but it implies that a time value of tracing exists. Most recently, livestock industry members have stated that the 48 hour window is not feasible under the current NAIS (Livestock Marketing Association), but no studies have been done in a case study context to determine the increased damages that occur due to later tracing. This study simulates the net time value of a rapid, effective trace back system, like NAIS, in the context of a highly contagious foreign animal disease, foot and mouth disease (FMD), in a concentrated feeding region, the Texas High Plains.

Currently, the U.S. depends on producers and livestock owners to identify sources of direct and indirect animal disease spread both downstream and upstream from their premises. Assuming implementation of a functioning NAIS system with full participation by producers, a system like NAIS would make the subsequent discovery of infected herds more rapid and reliable. In addition, producers would benefit from reduced false positive identification and potentially avoid unnecessary slaughter. Furthermore, the regionalization of the disease would be more reliable since the regions of the country that contain animal disease infection can quickly be identified. This should allow international markets for products from non-infected regions to re-open more quickly and reduce the time to regaining "disease free" status for the country[2]. Thus the ability,

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[2] We recognize that many other factors play a role in determining the extent of trade restrictions and the speed with which they are lifted in the event of an animal disease.

given a functioning NAIS is put in place, to trace infected and potentially infected animals would result in more rapid response and a smaller total outbreak related costs.

However, this system is not without costs. Before any significant benefits are derived from disease prevention, the costs of implementing, overseeing, maintaining, updating and improving the system are incurred (USAIP). During an outbreak, costs are incurred for using the system to track animals that may have been exposed to the disease. The substantial costs of implementing an animal tracing system such as the NAIS continue to be one of the biggest obstacles for producers to participate in the system (Elbakize). Producers have been reluctant to participate as the costs of participation reduce an already slim profit margin. It has been suggested that a mix of public and private funding be used to underwrite the system (USAIP). In addition, producers are concerned about potential liability that could arise due to the information available through the NAIS and some producers may be uncomfortable with the possibility of NAIS data becoming available to the Internal Revenue Service (Elbakidze). Other reasons for opposition to NAIS include: a further intrusion of government into private business, a belief that private enterprise can better implement a system, a belief that these decisions are not really a problem and a mandatory system would reduce price premiums.

In this study, the costs of a tracing system are compared to the benefits in terms of disease response control cost savings from rapid, effective tracing in the event of an outbreak of FMD. FMD is a highly contagious, vesicular disease that is recognized as being one of the greatest foreign animal disease threats to the U.S. livestock industry (USDA-APHIS). In an FMD outbreak scenario, control costs could amount to hundreds of thousands of dollars per day and the producers' losses grow exponentially until the disease is eradicated (USDA-APHIS). If a functional and effective NAIS is in place, animal health officials could use the system’s databases early in the response effort to identify all potentially infected premises and exposed animals in the surrounding area. Using that information, officials would be able to place movement restriction zone boundaries where most effective in slowing the spread of the disease and direct resources to the area most heavily infected. Also, combined efforts of private and state animal tracing databases could provide information on animals that have moved from infected zones (USDA-APHIS) thereby reducing the chance of secondary infection in other parts of the country.

Background

Several studies have dealt with the issue of animal diseases and traceability (Pendell, 2006, 2008; Pendell and Schroeder, 2007; Pendell et al., 2007); particularly, the effect of traceability success rates and the subsequent impact it would have on a hypothetical FMD outbreak. All three of those studies simulate an outbreak in southwest Kansas, and use the North American Animal Disease Spread Model (NAADSM) for the epidemiological model. These studies evaluated outbreaks initiated from three different premises (feedlot operation, beef cattle grazing operation, and swine operation). The costs of appraisal, cleaning and disinfection, euthanization, indemnity payments, and disposal are estimated for each outbreak (Pendell, 2006). The additional effectiveness in tracing associated with a functional NAIS was implemented by changing the success rate of finding the direct and indirect trace back animals that may be infected with FMD. Pendell used tracing levels of 90% ("high" level of success), 60% ("medium" level of success), and 30% ("low" level of success) in order to determine the impact that animal tracing can have after an outbreak is found. In the 2006 study, Pendell found average cost expenditures for a feedlot initiated outbreak increased as the trace back effectiveness declines. Results ranged from $196 million (high) to $402 million (medium) to $560 million (low). As the extent of animal identification in cattle increased, the number of animals culled was reduced as were the associated costs, and the length of the outbreak (by nearly two weeks). As the surveillance was increased, losses of consumer/producer welfare from the outbreak decreased approximately 60% (Pendell, 2006). In the 2008 study, results suggested that as animal tracing intensifies, the number of livestock lost to a FMD outbreak will decrease along with the FMD related costs (Pendell, 2008).

Elbakidze (2007) evaluated the effect of an animal identification system on traceability and subsequent isolation of potentially infected herds by minimizing expected losses to cattle producers, including the costs of lost production, suppressed demand in the cattle industry, lost export markets, indirect losses in related industries, and the costs of preventing and responding to an outbreak. A simplified economic-epidemic model was used to conduct sensitivity analyses of the benefits of investing in an animal tracing system. The results concluded that if the tracing process was efficient, then contact rates decreased, and the number of cattle lost also decreased. For instance, reducing the tracing time from four days to two days generated enough benefits to exceed the costs of an infectious disease outbreak (Elbakidze, 2007). This is assuming the tracing process is effective, and all direct and indirect contacts are found on the specific day considered (day 2,3,...8).

Although these studies examine closely the impact of more effective trace back, epidemic model limitations prevent the more extensive study of rapid, effective tracing. The model used by Pendell (NAADSM) contained limitations that restricted any other changes in animal tracing other than effectiveness. The model also assumed all disease spread and trace backs occurred within 24 hours of first detection and confined itself to minimize tracing forward only one level, which prevents itself from finding herds beyond one level and does not find the potential infected herds that infected the detected premise (Pendell). Elbakidze's epidemic model is a non-spatial Reed Frost model, that also contains limitations as to how tracing can be implemented. In this study only the lag between the date of infection and the discovery of infection in a herd can be set arbitrarily. It assumes all direct and indirect contacts are found simultaneously and instantaneously on the day of trace back. Elbakidze's model cannot examine the effect of an outbreak in a concentrated animal production region since the Reed-Frost formulation assumes uniform spread of herds and it cannot examine the impacts of tracing under alternative operation type initial infection points. This study will expand the prior literature of estimating the benefits of NAIS by considering, using a spatial epidemic model, the time value of tracing and the value of effective tracing under multiple outbreak initiation points. These benefits estimates will be compared to cost estimates of NAIS coming from the literature.

Before 2003, full implementation costs of the U.S. Animal Identification Plan were estimated at over $500 million for the first six years of the program (Bailey, 2004). Another cost study completed by Sparks Companies Inc. (2002) estimated that the capital investment required to implement a source verification system for cattle would be approximately $140 million with an additional annual variable cost of about $108 million. Costs were also calculated for the NAIS for Texas for cow/calf operators and feedlots at $112 million dollars a year (Blasi et al., 2003). In an examination of two methods of tracing, the back and ear tag system was found to cost $72 and $84 million dollars respectively to track cattle to the former places of ownership (Disney et al., 2001).

The most recent USDA-APHIS (2009) analysis showed that the cost per cow ranged from a low of $2.53 per animal for the largest operation, to a high of $5.84 per head for the smallest operation. The overall costs for 90% NAIS participation, the minimal level deemed effective by APHIS would be $192.22 million dollars annually for all four primary animal species (cattle, swine, sheep, and poultry) while 100% participation was estimated at $228.27 million annually. Within the beef sector estimated costs are $4.91 per head for beef cattle operations, $.71 per head for backgrounder operation, $.51 per head for feedlots, $.23 for an auction market, and $.10 per head for packers. The average cost estimate per animal marketed throughout the cattle sector is $5.97 annually, with dairy cows averaging $6.21 annually (USDA-APHIS, 2009). These estimates will be used in our cost comparison.

Method

The study is conducted in an 8 county region in the Texas High Plains that contains the majority of Texas cattle feeding operations. The area covers over 7,900 square miles and consisted of 118 feedlots, 29 dairies, 88 swine farms, and 1,058 beef cattle premises in 2002 (USDA-NASS, 2003). This region was chosen for its concentration of livestock, specifically beef cattle, and its importance to state agriculture. Texas' largest agriculture revenue stems from the sale of beef cattle. The panhandle region has the most feedlot operations, and with nearly 6 million cattle on feed (Ward et al., 2007).

The primary data source for this study was the High Plains Project conducted by Ward et al. (2007). That study used surveys of High Plains operations' herd characteristics and animal movements to develop a High Plains implementation of AusSpread (Ward, et al., 2009). AusSpread, which is a stochastic, state transition susceptible-latent-infected-recovered (SLIR) model, was used to simulate scenarios for policy planning, vulnerability analysis and decision making. AusSpread uses probabilities to find farms with which the infected farm has had direct or indirect contact ("trace forward") and the source of infection ("trace back"). The model can trace forward and back one step at a time. Traced farms that are considered to have had a high chance of exposure to FMD are specified as dangerous contacts (dc) and are subject to active surveillance (Garner and Beckett, 2005). The effectiveness, sensitivity and specificity of tracing activities as well as the days required to trace dangerous contacts are the tracing parameters adjusted in the model. Effectiveness is the proportion of exposed farms identified in a 24 hour period. Sensitivity is defined as the proportion of those farms that are correctly identified as infected. Specificity allows the model to simulate farms that have been incorrectly found as infected premises, thus is inversely related to sensitivity. The days required to trace dangerous contacts is the time taken to collect and analyze information from the infected premises and identify high risk contacts in order to trace contacts forward and back from that premises. AusSpread will also allow variables such as the rate of disease spread through the population, the time period from infection until the initial detection of disease, and the ability and extent of resources for performing mitigations (Garner and Beckett, 2005). The simple economic model is a cost estimation based on work by Elbakidze. Cost categories included in the total control cost estimate are the costs of slaughter (appraisal, cleaning and disinfection, euthanization, disposal), indemnity payments, foregone income and surveillance are estimated for each outbreak. In addition it is assumed that additional feed will need to be brought into the region. If this feed were not brought into the region, additional slaughter for welfare reasons would occur.

The range of animal identification scenarios we will study relate to the ability to trace the path of infection and/or dangerous contacts after the first positive FMD case has been identified. By changing the tracing levels of these dangerous contacts, the model results show the benefits to rapid, effective tracing in the case study context. The base scenario is defined as a targeted disease outbreak response where the disease is detected 14 days after the first animal becomes sub-clinically infectious, all infected and dangerous contacts are slaughtered, surveillance of suspect herds occurs twice per week, no vaccination is utilized. Tracing parameters in the base scenario are that tracing occurs with 90% effectiveness, dangerous contacts are found in 48 hours, 95% specificity and 85% sensitivity.

The first set of alternative scenarios varies the days until dangerous contacts are found. They examine day by day the time until dangerous contacts are traced for 4, 6 and 10 days as opposed to the assumption of tracing within 48 hours (baseline). This represents double the 48 hour tracing window that is the goal of the NAIS system, triple the tracing window, and an outer limit of 10 days. The second set of alternative scenarios reduces the effectiveness of tracing from the baseline of 90% trace in 24 hours to only 30% trace in 24 hours.

Results and Discussion:

For each set of scenarios, two different types of initial infection locations were considered: commercial feedlot, and a sale barn. Although, for the effectiveness of tracing a large beef cattle grazing operation index herd was also considered. The purpose of examining different infection locations is to determine if animal identification may be more important for some spread paths than others. Results will be broken out by the type of infection point.

Commercial Feedlot Infection Point:
Rapid, effective tracing reduces the disease outcomes for outbreaks starting in company owned feedlots. The median slaughter is increased when tracing occurs within 10 days, and the number of animals placed under movement restrictions increases for 4, 6 and 10 days. If tracing does not occur until 10 days, head slaughtered increases by 7% and animals placed under movement restrictions increases by almost 50%. If a decrease in the success of tracing to 30% from 90% occurs, slaughter and the number of animals under movement restrictions increases also. Furthermore, distribution of animals slaughtered or placed under movement restrictions shifts right, indicating that the worst possible outcome has increased compared to scenarios with rapid, effective tracing. Results are reported in table 1.

Table 1: Commercial Feedlot Infection Point Epidemic Results

Scenario	Median	% Change from Base	Min	Max
Animals Slaughtered				
Baseline (2 Day)	91,600		67,785	206,565
4 Day Trace	90,600	↓1%	66,896	240,277
6 Day Trace	91,600	0%	67,883	267,676
10 Day Trace	97,600	↑7%	67,306	361,611
30% Efficiency	94,900	↑4%	68,080	344,800
Herds Slaughtered				
Baseline	49		17	177
4 Day Trace	54	↑10%	19	121
6 Day Trace	52	↑6%	21	143
10 Day Trace	61	↑24%	20	175
30% Efficiency	57	↑16%	19	170
Animals Placed Under Movement Restrictions				
Baseline	30,000		7	279,272
4 Day Trace	48,000	↑59%	2	234,292
6 Day Trace	40,000	↑33%	2	334,797
10 Day Trace	45,000	↑50%	216	323,143
30% Efficiency	44,000	↑49%	2	354,567

The mitigation cost of the disease outbreak is also reduced under rapid, effective tracing. For all of the longer times to tracing the total mitigation cost of the disease outbreak, assuming feed is brought into the region, is increased 0.4%, 2% and 9% respectively. If tracing does not occur until day 10, a significant increase in the total mitigation cost results across disease mitigation cost categories. Furthermore, if tracing only occurs with 30% effectiveness, a significant increase in total mitigation cost occurs across the different mitigation cost categories increasing total disease mitigation costs by almost 20%. Results for disease mitigation costs are broken down in table 2. Differences are at times small; however, this is not totally unexpected since little movement occurs forward from feedlots. Rather the benefits to tracing arise from the ability to trace movements of animals before they enter the feedlot.

Table 2: Commercial Feedlot Infection Point Disease Mitigation Costs ($)

Scenario	Median	% Change from Base	Min	Max
Indemnity Payments				
Baseline (2 Day)	$77.2 M		$57.0 M	$187 M
4 Day Trace	$77.0 M	↓0.3%	$56.6 M	$230 M
6 Day Trace	$77.0 M	↓0.3%	$57.4 M	$226 M
10 Day Trace	$84.0 M	↑9%	$56.2 M	$313 M
30% Efficiency	$80.5 M	↑4%	$57.6 M	$310 M
Cost of Slaughter				
Baseline	$1.77 M		$1.26 M	$4.3 M
4 Day Trace	$1.78 M	↑0.6%	$1.31 M	$4.6 M
6 Day Trace	$1.83 M	↑3%	$1.27 M	$5.1 M
10 Day Trace	$1.95 M	↑10%	$1.26 M	$6.9 M
30% Efficiency	$2.05 M	↑16%	$1.40 M	$7.2 M
Forgone Income				
Baseline	$1.91 M		$1.34 M	$17.58 M
4 Day Trace	$1.97 M	↑3%	$1.32 M	$18.70 M
6 Day Trace	$1.93 M	↑1%	$1.35 M	$14.21 M
10 Day Trace	$2.23 M	↑17%	$1.32 M	$12.97 M
30% Efficiency	$2.06 M	↑8%	$1.35 M	$20.99 M
Cost of Surveillance				
Baseline	$101,900		$24,200	$187,050
4 Day Trace	$107,750	↑6%	$22,000	$211,700
6 Day Trace	$103,150	↑1%	$29,600	$294,650
10 Day Trace	$128,375	↑26%	$34,800	$292,500
30% Efficiency	$114,650	↑13%	$26,250	$264,750
Total Cost of Disease Mitigation Assuming Feed Can Be Brought In				
Baseline	$80.2 M		$58.4 M	$195.2 M
4 Day Trace	$80.5 M	↑0.4%	$59.0 M	$250.8 M
6 Day Trace	$82.2 M	↑2%	$58.7 M	$238.0 M
10 Day Trace	$87.1 M	↑9%	$58.5 M	$326.4 M
30% Efficiency	$95.3 M	↑19%	$61.2 M	$320.5 M

Large Beef Cattle Grazing Operation Infection Point:

For infections starting in large beef grazing operations, there is little movement of animals coming into the operation with the exception of replacement breeding stock. Rather, the tracing of animals going forward through the supply chain will be critical since animals can move over large distances and change hands several times as they move into feeding operations.

A limited number of scenarios were run for an outbreak starting in a large beef cattle grazing operation, but results indicate benefits to rapid, effective tracing in terms of reducing epidemic results. A reduction in the success of tracing to 30% from 90% increases the severity of the disease outbreak on the average. In particular, the number of animals placed under movement restrictions increases by 17%. This could have serious implications for local economies. Also appears to worsen considerably the right tail of the distribution for animals slaughtered. Results are given in table 3.

Table 3: Large Beef Grazing Infection Point Epidemic Results

Scenario	Mean	% Change from Base	Min	Max
Animals Slaughtered				
Baseline (2 Day)	6,291		947	69,559
30% Efficiency	6,585	↑5%	954	69,805
Herds Slaughtered				
Baseline	9		2	26
30% Efficiency	10	↑ 11 %	2	67
Animals Placed Under Movement Restrictions				
Baseline	8,100		1	288,803
30% Efficiency	9,500	↑17 %	2	288,802

Under less effective tracing, the total costs of disease mitigation when feed can be brought into the movement restriction zone are increased by 20% if tracing occurs in 48 hours. In particular, the costs associated with the animals placed under movement restrictions take a large jump. This is connected to the results presented in table 3 showing the increase in animals placed under movement restrictions as the efficiency of tracing declines to 30%. Another important aspect is the probability of an extreme outcome. As with the epidemic results, the right tail of the distribution of results appears to worsen with less effective tracing. Results for disease mitigation costs when infection starts in a large beef grazing operation are given in table 4.

Table 4: Large Beef Grazing Infection Point Disease Mitigation Costs

Scenario	Mean	% Change from Base	Min	Max
Indemnity Payments				
Baseline (90%)	$4.7 M		$765,059	$61.9 M
30% Efficiency	$5.5 M	↑17%	$765,098	$62.1 M
Cost of Slaughter				
Baseline	$153,000		$ 32,475	$1.3 M
30% Efficiency	$183,000	↑19%	$ 32,475	$1.3 M
Forgone Income				
Baseline	$147,000		$ 18,889	$2.9 M
30% Efficiency	$166,000	↑13 %	$ 18,889	$2.9 M
Cost of Surveillance				
Baseline	$11,000		$6,675	$29,275
30% Efficiency	$27,000	↑145%	$8,925	$107,100
Total Cost of Disease Mitigation Assuming Feed Can Be Brought In				
Baseline	$5.0 M		$ 804,398	$ 63.7M
30% Efficiency	$6.0 M	↑20%	$ 806,498	$ 64.8M

Sale Barn Infection Point:

When an FMD outbreak begins in a sale barn it is assumed the disease will linger in the facilities for a week affecting animals present on the sale day for the week of initial infection and the sale day for the next week. Overall, rapid, effective tracing reduces the impacts infections starting in sale barns. Compared to the base of tracing in 48 hours, 4, 6 and 10 day tracing increases the animals slaughtered by 49%, 91% and 69% respectively. Results for animals placed under movement restrictions is mixed, with a decrease of 22% for 6 days. This could be related somewhat to the large number of animals in the region slaughtered compared to other days. Less successful tracing at 30% as opposed to 90% caused an increase in the number of animals slaughtered (59%) but reduced the numbers of animals placed under movement restrictions (27%). Results are reported in table 5.

Table 5: Sale Barn Infection Point Epidemic Results

Scenario	Median	% Change from Base	Min	Max
Animals Slaughtered				
Baseline	6,415		35	163,881
4 Day Trace	9,559	↑49%	49	147,059
6 Day Trace	12,223	↑91%	194	133,886
10 Day Trace	10,846	↑69%	58	150,995
30% Efficiency	10,199	↑59%	44	148,801
Herds Slaughtered				
Baseline	31		5	113
4 Day Trace	33	↑7%	5	112
6 Day Trace	36	↑16%	5	99
10 Day Trace	35	↑13%	5	120
30% Efficiency	31	0%	5	104
Animals Placed Under Movement Restrictions				
Baseline	23,383		2	169,189
4 Day Trace	24,513	↑5%	2	245,189
6 Day Trace	18,267	↓22%	2	166,349
10 Day Trace	24,828	↑6%	2	213,990
30% Efficiency	17,051	↓27%	2	148,340

There is a benefit to tracing in 2 days as opposed to 4, 6 or 10 days for reducing the total disease mitigation cost. There is a 35% increase in total cost assuming feed can be brought in for 30% efficiency as opposed to 90% efficiency in tracing. The largest individual cost category, indemnity payments, shows significant increases when tracing cannot occur in the 48 hour time period, and when it is not as effective. Results for the total disease mitigation cost when an outbreak starts at a sale barn are given in table 6.

Table 6: Sale Barn Infection Point Disease Mitigation Cost

Scenario	Median	% Change from Base	Min	Max
Indemnity Payments				
Baseline (2 Day)	$4.7 M		$23,460	$137 M
4 Day Trace	$7.7 M	↑64%	$ 34,223	$124 M
6 Day Trace	$9.3 M	↑98%	$15,586	$113 M
10 Day Trace	$8.7 M	↑85%	$ 41,142	$127 M
30% Efficiency	$8.2 M	↑ 74%	$ 30,379	$128 M
Cost of Slaughter				
Baseline	$311,000		$ 28,826	$3.7 M
4 Day Trace	$357,000	↑15%	$ 28,826	$3.2 M
6 Day Trace	$458,000	↑47%	$29,701	$2.8 M
10 Day Trace	$369,000	↑19%	$ 20,200	$2.9 M
30% Efficiency	$379,000	↑22%	$ 28,826	$3.1 M
Forgone Income				
Baseline	$126,000		$ 645	$3.2 M
4 Day Trace	$198,500	↑58%	$ 922	$4.1 M
6 Day Trace	$230,000	↑83%	$3,841	$7.8 M
10 Day Trace	$220,000	↑75%	$ 1100	$3.0 M
30% Efficiency	$211,000	↑67%	$ 823	$4.4 M
Cost of Surveillance				
Baseline	$80,437		$20,375	$300,150
4 Day Trace	$89,925	↑12%	$19,750	$209,300
6 Day Trace	$89,587	↑11%	$19,150	$181,150
10 Day Trace	$89,400	↑11%	$20,200	$240,750
30% Efficiency	$82,287	↑ 2%	$24,150	$215,125
Total Cost of Disease Mitigation Assuming Feed Can Be Brought In				
Baseline	$6.9 M		$90,312	$141 M
4 Day Trace	$9.2 M	↑33%	$132,157	$128 M
6 Day Trace	$11.4 M	↑65%	$399,922	$116 M
10 Day Trace	$10.7 M	↑55%	$182,549	$134 M
30% Efficiency	$9.3 M	↑35%	$107,980	$132 M

The Time Value of Rapid, Effective Tracing Capability

Using the annualized average cost per animal from the APHIS costing analysis, a comparison can be made as to the median savings from rapid, effective tracing in the High Plains of Texas. Under current tracing it may be closer to the 10 day mark to trace rather than the 48 hours expected and tracing may not reach the 90% effectiveness that would be hoped for. First, the control cost per animal under rapid, effective tracing (baseline) is calculated. Then for 4, 6, or 10 days tracing and 30% effectiveness the change in the cost per animal from the baseline is calculated, where the number of animal slaughtered will increase significantly if feed cannot be brought into animals within the movement restriction zone.

The time value of tracing can be stated simply as the reduction in control costs of the outbreak as tracing occurs more rapidly. For an outbreak starting in a commercial feedlot, a reduction in costs of disease mitigation per animal is realized for detection at 2 days as opposed to 6 or 10 days. Assuming feed can be brought into the region, the cost of disease mitigation with rapid, effective tracing per animal slaughtered is a cost of $875/animal. This cost increases by $13, $21, and $16 for 4, 6 and 10 days trace respectively. Should the effectiveness of tracing be reduced to 30%, the cost per animal increases by $3/animal when feed can be brought into the region. This indicates that, although the results in reducing some cost categories is mixed, there is a positive time value of rapid, effective tracing. In order to compare this to the cost of investment in a NAIS ($0.51 for feedlots) the expected loss from an FMD outbreak in any given year is calculated under rapid, effective tracing and compared to the cost incurred in any given year. The problem is that the probability of an FMD incident in any year is unknown. If an FMD outbreak were to occur this year with probability one and a functional rapid, effective NAIS system could be in place the expected loss could be reduced through animal tracing to $12.49 per animal. However, as the probability of an outbreak declines the expected loss reduction would also decline.

For outbreaks starting in large beef grazing operations, the increase to 90% effectiveness as compared to 30% tracing effectiveness has mixed results. If tracing were to occur in 48 hours at 90% effectiveness of tracing, the cost of disease mitigation per head is $930/animal, assuming feed can be brought in. Under less effective tracing, the additional cost per animal is $3/animal assuming feed can be brought in. Thus, in beef grazing operations there is a positive value of more effective tracing.

Sale yards have a considerable amount of variability in how large a disease outbreak may be, and results for the value of tracing are mixed. However, in general a reduction is realized for detection at 2 days as opposed to 4, 6 or 10 days. Assuming feed can be brought into the region, the cost of disease mitigation with rapid, effective tracing per animal slaughtered (baseline) is a cost of $960/animal. When tracing occurs at 4, 6 or 10 days the cost per animal decreases as opposed to 2 days if feed can be brought in. Similarly, when tracing is only 30% effective cost per animal of the disease outbreak decreases.

Conclusions and Implications:

This study has attempted to address what benefits of rapid, effective animal tracing might be possible in terms of reducing the disease mitigation costs of a FMD outbreak in the Texas High Plains. Results indicate that rapid, effective tracing reduces the overall cost of disease mitigation for outbreaks starting in different types of operations. The question then becomes whether or not the benefits derived from tracing outweigh the cost of implementing it. Results indicate the benefits per animal in terms of reduced cost of disease mitigation in the event of an outbreak more than outweigh the cost per animal of implementing a national animal identification system particularly for feedlots, however the level of benefits will vary depending on the location of initial infection and whether or not welfare slaughter occurs.

Two main issues have been identified for a NAIS: first, how the liability will be shared in a system such as the NAIS and second, how the costs of implementing animal ID will be allocated (Bailey and Slade, 2004). The benefits from such a system seem to outweigh the additional cost, making implementation a priority. These two issues should be addressed or the system should be made mandatory if these benefits are to be realized in the event of an animal disease outbreak.

This study is limited in several aspects. First, the cost of disease mitigation is only a small part of the overall cost of a disease outbreak. Basing results simply on these costs is most likely underestimating the benefits to tracing. The economic analysis should be expanded to include the use of a sectoral model capturing price effects and changes in national welfare from the simulated outbreak. An additional consideration not taken into account here is the benefits the NAIS system would have in speeding the time to recovery and reducing national trade losses from the outbreak. Expanding the economic analysis would allow a more complete picture of the benefits of the system.

In addition, the potential benefits of an animal identification system are not limited to its application in a foreign animal disease outbreak. It could be used for multiple diseases, both those currently endemic in the US and other exotic diseases. Consumer confidence in the event of a meat recall or animal disease outbreak could be increased by reducing uncertainty about the meat source. A tracing system could also improve the marketability of U.S. products in countries where the availability of a full history from farm gate to plate yields a price premium. Other potential benefits include: contributing to producer gains from improved genetics, carcass quality, herd certification, and premium prices for specific products. Although these benefits are recognized, the focus of this study is on the value of rapid, effective tracing in the event of a highly contagious foreign animal disease outbreak.

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