

Economics and Homeland Security Strategies: Issues regarding Carcass Disposal in Design of Animal Disease Defense Systems

This research was supported by the Texas A&M University based National Center for Foreign Animal and Zoonotic Disease Defense (FAZDD) that was established by the Department of Homeland Security. However, views expressed are those of the authors and do not necessarily represent those of the FAZDD. All remaining errors are the authors.

(Extended Abstract)

New Yorkers, Washingtonians, Americans in general, and the whole world were shocked and terrified at the terrorist attack on the World Trade Center and the Pentagon on September 11th, 2001. Americans do not feel safe and peace as they did before September 11th despite the enormously increase in expenditures on homeland security and national defense. Today in an effort to bolster confidence and protect the nation the Department of Homeland Security is identifying vulnerabilities and evolving strategies for protection. Agricultural food supply is one identified vulnerable area, and with the food supply component of the economy animal disease defense is one of the major concerns.

When there is an animal disease outbreak such as foot and mouth disease (FMD)¹, it is crucial to have an effective and rapid mechanism to control the disease spread and minimize the cost in terms of livestock losses, negative economic impacts, public health hazards, and adverse environmental impacts. In the case of FMD outbreaks, the basic disease control mechanism is slaughter of all infected animals along with numerous susceptible animals in near proximity to infected animals. For example in managing the 2003 FMD outbreak in the United Kingdom 4,220,000 animals were slaughtered including 582,000 cattle, 3,487,000 sheep, 146,000 pigs, 3,000 goats, 1,000 deer.² Such a large number of animals created a large carcass disposal issue with potential associated problems of air and water contamination, odor, long term suitability of land use near disposal sites, disposal costs etc. This raises an economic issue that will be addressed in this paper that involves the design of a disease management system in the face of a potential deliberate or accidental FMD outbreak including carcass disposal considerations.

The set of alternatives that may be employed in addressing the carcass disposal problem includes a number of pre and post outbreak options. Namely to minimize potential environmental impacts disposal facilities can be pre located that if available would facilitate environmentally improved methods of carcass disposal (see a review of disposal technologies, including burial, incineration, composting, rendering, lactic acid fermentation, alkaline hydrolysis, and anaerobic digestion in the recent Carcass disposal

¹ FMD is an infectious disease affecting cloven-hoofed animals such as cattle, sheep, pigs, goats and deer. It spreads through air, transport vehicles, artificial insemination, milk related transmission, direct contact, and by wildlife such as birds, dogs, cats, and rodents. An additional complication with FMD is that the infected animals don't show the signs of the disease for a couple of weeks but they are contagious.

² <http://www.defra.gov.uk/footandmouth/cases/statistics/generalstats.htm>.

review done for USDA). However such facilities can be expensive while also having limited capacity and may be difficult to justify given the magnitude of the threat. One can also employ strategies to reduce the rate of slaughter so the needed rate of carcass disposal can be reduced which in turn reduce the immediate severity of the carcass disposal problem and the needed facilities to handle disposal. Vaccination of potentially infected animals in one of these strategies. Normally, vaccination is not considered as a disease option due to the two complications (Elbakidze, 2004): (a) Standard tests cannot distinguish vaccinated from infected animals³ and today vaccinated animals would need to be slaughtered anyhow to maintain a countries "disease free" status. (b) Vaccination is not perfect with some vaccinated animals potentially still carrying the FMD virus and being contagious which reduces the FMD management effectiveness relative to immediate slaughter.. However vaccination does help manage FMD spread and lessens the flow of slaughtered animals

Hence the vaccination possibility in conjunction with the carcass disposal and disease management problem raises an economic problem. Namely, carcass disposal generates a tremendous operational concern in the face of which society would try to minimize the loss from both disease management, facility investment cost and the adverse external costs induced by carcass disposal processes. In the face of such a problem buying time may be a valuable option. Consider the following simplified problem statement: suppose we can dispose all infected and susceptibly infected animals within a day at an extremely high cost, or with a couple days at a relative low cost. Disease management policy should consider whether it is better to have a mechanism to delay slaughter and disposal while controlling disease spread in at reasonable level.

This setting leads naturally to the following questions: Is it technically feasible and economically needed to slaughter all infected and susceptibly infected animals? If not, what are other choices we could have? In this study, we examine vaccination as an alternative option to implicitly increase disease eradication capacity in the time domain while controlling the disease spread and lowering the carcass disposal cost.

We address this issue modeling vaccination as a put option to buy time and, thereby cutting down carcass disposal cost. We present the model in a dynamic setting considering both a two-period and multiple-period games. In each game, we minimize the potential loss by choosing the optimal amount of animals to be slaughtered and vaccinated in each period, given the operation cost and capacity of carcass disposal. The amount of animals at risk to be either slaughtered or vaccinated in a period consists of both vaccinated animals in the previous period and newly vulnerable/infected animals. Our preliminary results show that vaccination is an option to extend the carcass disposal capacity in temporary dimension and lower the disposal cost. We summarize our preliminary results as follows:

³ www.economists.com, 2003.

- (a) If the rate of disease spread is very fast because of the natural traits of virus, climate conditions, etc, it is optimal to slaughter and dispose to the full capacity, or even build new capacity, in the early period.
- (b) The lower the marginal vaccination cost, and/or the lower the marginal cost of slaughter and disposal, the higher the value of vaccination in terms of its role in reducing the cost. Therefore, we slaughter relatively less and vaccinate relatively more in the early periods.
- (c) Option value of vaccination matters on the optimal mix of slaughter and vaccination. We refer the option value as a value of having vaccination as an option, or a value of delaying slaughter and disposal. The higher the option value, the less amount of infected and susceptible infected animals will be slaughtered and disposed in the early periods. Furthermore, in the multiple-period game, we find that we can achieve a steady state when the option value is greater than the disease spread rate.

Reference:

Elbakidze Levan (2004). Agricultural Bio-Security as an Economic Problem: An Investigation for the Case of Foot and Mouth Disease. *PhD Thesis*, Department of Agricultural Economics, Texas A&M University, 2004.

Carcass Disposal: A Comprehensive Review. Prepared by the National Agricultural Bio-security Center Consortium at Kansas State University, Carcass Disposal Working Group for the USDA Animal & Plant Health Inspection Service per Cooperative Agreement 02-1001-0355-CA, 2004. The entire report is available at <http://fss.k-state.edu/research/books/carcassdispfiles/Carcass%20Disposal.html>.