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3/7/19
MMG 296

Bioterrorism Midterm Assignment – Biological Weapon Design

Motive and Objectives:

My bioterrorist inspiration came from our discussion, a class ago, about agroterrorism, which is defined as "the deliberate introduction of a disease agent, either against livestock or into the food chain for purposes of undermining stability and/or generating fear" (Oladosu and Rosa, 2013). Growing up in Vermont, I am very connected to where my food comes from as I have many friends who own and operate small farms and I have had the opportunity to work on multiple farms during the harvest season in the summer. I understand that it is idealist to think that everyone can have this relationship with their food, however as a member of the bioterrorist organization: *Live for Local*, our motive and ideology is to target large-scale, industrial agriculture with the purpose of inducing economic loss to hopefully cripple the global economy. This overarching motive has aided in the establishment of our four main objectives:

1. Decrease the supply of mass agricultural products
2. Due to decreases in supply; force consumers to spend more for non-local/large-scale industrialized agriculture products
3. Temporarily scare people away from buying targeted mass-agriculture products
4. Improve small business/local organic farming revenue.

To determine the potential for success – based on our given motive and objectives – I have looked at the results of previous attempts at agroterrorism. The main event repeated in the literature is the 2001 foot and mouth disease (FMD) outbreak in the UK which resulted in the slaughter of around 4 million cattle and an estimated cost of more than £5 billion to the UK economy. Additionally, a national election was postponed, the agricultural department was completely restructured and it was questioned whether British meat exports could ever recover to their pre-outbreak levels (Owens *et al*., 2002). Another example of the potential for agroterrorism and economic instability, this time based on a natural outbreak, is Avian influenza which struck the United States in 2015. The virus initially hit Minnesota, the nation's largest turkey producer, before migration of wild birds carried the virus south and into neighboring states. As a result of Avian influenza, 50 million birds, spread throughout 21 states, were sickened or killed and the total economic losses were estimated at $3.3 billion (Ramos, MacLachlan fi Melton, 2017).

Both of these outbreaks, natural and unnatural, signifies the potential social disruption and devastation that an agroterrorism event could have on large scale agriculture and the global economy.

Some additional, attractive qualities of agroterrorism, aside from its impact on the economy, are: (1) generally not hazardous to man and therefore decreases production risks, (2) require reduced technical and operational challenges, (3) vulnerable targets with low security, (4) concentration of monocrops and/or intensive rearing in a single location, (5) small number of disease cases can be devastating, and (6) difficulty distinguishing natural from unnatural outbreak (Owens *et al*., 2002).

<u>Selection of our Microbe:</u>

Seeing as we have established the ideology behind *Live for Local,* now all that's required is a pathogen – mascot, if you will – to support our motive and help achieve our objectives. The process of selecting a microbe began when I went on the Office International des ffipizooties/ ffipizootics (OIffi) website; OIffi is an organization which maintains and tracks animal diseases and outbreaks in member countries, and they are recognized by the World Trade Organization as the international agency for "setting animal health standards and for conducting international trade" (Bhushan *et al.,* 2013). On their site, the OIffi provides a dual-use chart which categories pathogens based on their modes of transmission and potential threat to socio-econimic or public health. The first disease listed is the notorious foot and mouth disease (**Table 1**), which I mentioned, led to the detrimental economic loss in the UK due to its impact on their cattle population.

Disease	Primary Modes of Transmission	Primary Animals Affected	Vaccine (use and availability in endemic areas)	Location	Affected humans
ψ Recent outbreaks in ffiurope, * Recent outbreaks					
Foot-and-mouth disease$^{\psi}$	Aerosols; direct or indirect contact (via human clothing, equipment, vehicles, or through milk or partially cooked meat)	Cloven-hoofed animals, esp. cattle and swine	Yes	Asia, Africa, Middle ffiast, South America*	Occasionally after very close contact, humans can develop mild symptoms

Table 1 – Our bioterrorist agent selected from List A, distributed by the OIffi (Bhushan *et al.,* 2013).

FMD has many bioterrorist advantages: (1) highly contagious, (2) transmitted by aerosol and direct or indirect contact, (3) doesn't pose a huge risk to humans, (4) ability to induce psychological fear in farmers, and (5) present across the globe. Additionally, even though FMD has a low mortality, it results in a high morbidity and includes symptoms such as abortion, anorexia, loss of milk production, and death of young animals due to myocarditis, all of which impact the production of meat and other animal products (OIffi, 2013).

Acquisition, Production, and Transmission of our Microbe:

FMD is a result of a viral infection caused by picornavirus, a group IV (+) ssRNA which means that the RNA can function both as a genome and as a messenger RNA that can be translated directly into protein in the host cell. Plus-strand RNA are simpler to synthesize due to this dual function-ability. However, another benefit of FMD, from an agroterrorist's perspective, is that it is endemic in almost all developing countries (**Figure 1**).

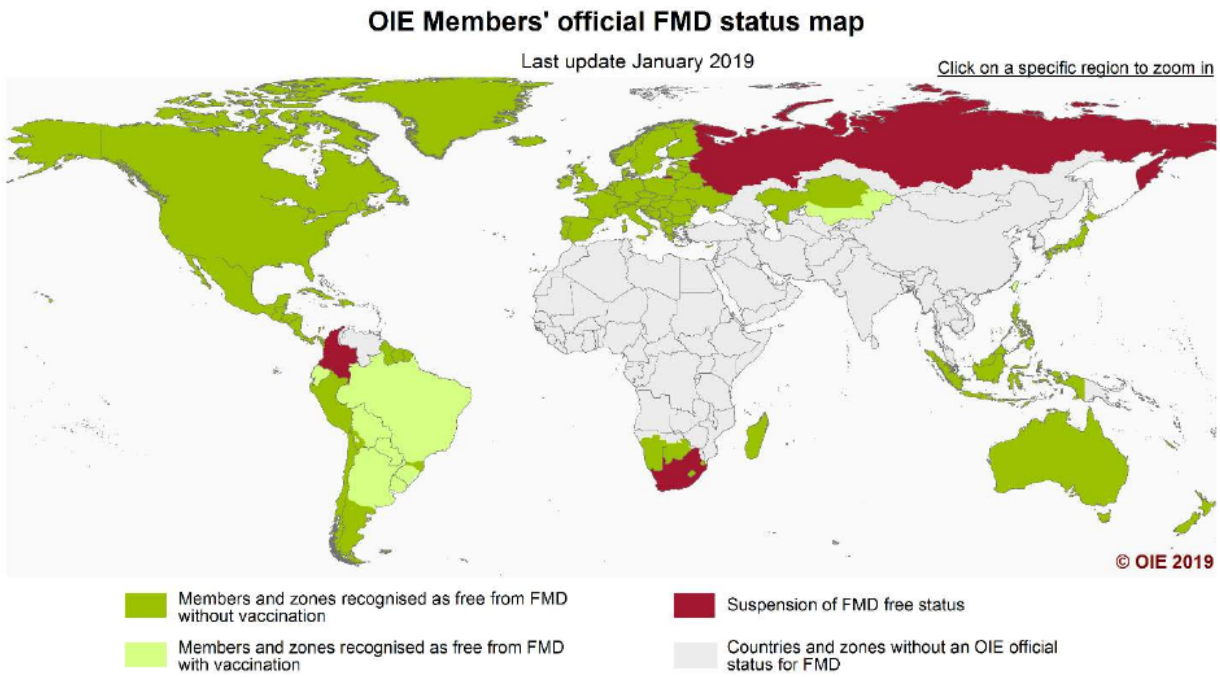

Figure 1 – The presence and risk of FMD in countries across the globe (OIffi, 2019).

The widespread nature of FMD allows for ease of acquisition of the virus. Due to global concern about foot and mouth disease as a highly contagious and potentially economically devastating disease, there are many dual-use laboratory and field tests that our group could exploit in order to acquire the virus. Laboratory-based tests, which involve isolation of the virus or demonstration of the FMDV antigen, include enzyme-linked immunosorbent assay (ffiLISA) and isolation techniques combined with reverse transcriptase PCR (RT-PCR). However, the challenge with laboratory techniques is that they often require “availability of a dedicated laboratory facility, highly trained laboratory personnel, and multiple sample handling or preparation” as well as “virus isolation requires a cell culture facility” and the test takes 4 to 6 days for completion (Oem *et al.*, 2009). A seemingly easier method for our skill-level and time-frame is a lateral flow assay (LFA) which is “based on a monoclonal antibody (MAb 70-17) and was developed for the detection of foot-and-mouth disease virus (FMDV) under nonlaboratory conditions” (Oem *et al.*, 2009).

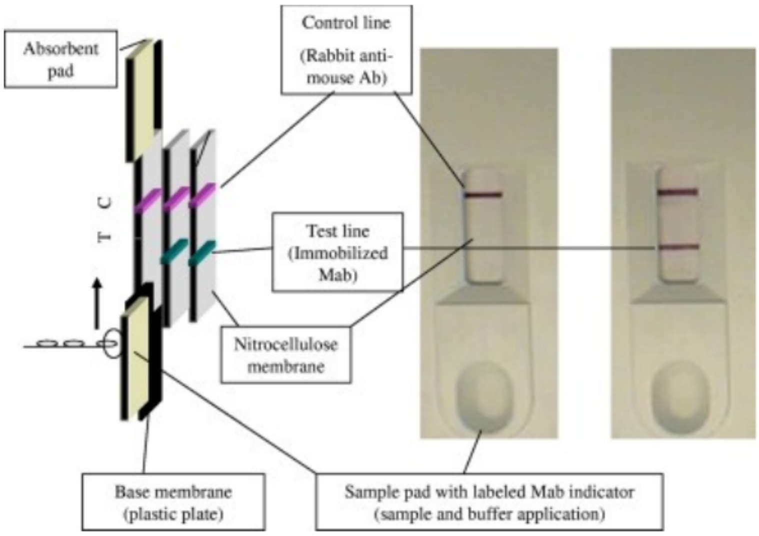

Figure 2 – A Lateral Flow Assay (LFA) used for the detection of foot and mouth disease. There are two tests, the one on the left is negative and only has a control line present, while the right test is positive due to the presence of the test line.

The use of a LFA (**Figure** 2) will allow *Live for Local* to detect the virus through the cow’s milk, blood/scabs, or other bodily fluids while simultaneously ensuring successful acquisition of the virus. There are seven serotypes of the virus: O, A, C, SAT 1, SAT 2, SAT 3, and Asia 1. However, due to our choice of identification technique, LFA, we will only be able to identify type O, A, Asia 1, and C, yet, their rate of detection is almost comparable to that of an ffiLISA (Oem *et al.*, 2009). Out of these four serotypes, our goal is to acquire multiple types as we are not attempting to weaponize our pathogen but instead hope to deter, but not eliminate the use of vaccines (as they will be additional industry expense). "Infection with one serotype does not confer immunity against another" (OIffi, 2017).

Once acquired, we will incubate the virus in a small herd of pigs, as they are the best amplifiers of the virus (Knight-Jones and Rushton, 2013). Following viral amplification, samples of the virus will be collected and buffered at a pH between 6 and 9, in order to maintain viability, and placed in containers which allow aerosolization of the virus (OIffi, 2013). Our anticipated time of attack is to hit the mid-United States, in particular many livestock farms in Texas and up through Kanas and Nebraska, during the summer. These three states are the highest producers of cattle accounting for over 27% of the U.S. production (USDA and NASS, 2017). Cattle are the most susceptible to FMD and once infectious, after 3 – 5 days, they have been estimated to have the potential to infect over 70 other cattle within a susceptible herd (Knight-Jones and Rushton, 2013). If all goes to plan, the potential for economic devastation is inevitable.

<u>ffixpected Outcomes of Bioweapons Use</u>:

Economic Outcomes:

With our pathogen set on course, having been released up the mid-United States, *Live for Local* has plans to disperse throughout the country, and I anticipate fleeing back to Vermont. As long as no one saw us carrying out the attack and my group hasn't self-sabotaged, I think our chances of laying low, directly following, will result in a successful escape.

In order to understand the potential response and outcome of our attack, I think it's best to review a previous outbreak of the disease while comparing and contrasting the environment in which they both occur. Let’s recap on the 2001 outbreak in the UK, as this case presents most similar.

On February 19th, 2001, a veterinary inspector, undertaking routine inspections, identified vesicular lesions, which are a characteristic symptom of foot and mouth disease, on 27 sows and one boar. A laboratory test was used to confirm this disease and on February 20th, the MAFF released a statement preventing the “movement” of all susceptible livestock in an effort to trace back the initial case of infection. However, by the time this was discovered, “foot and mouth disease had spread through the movement of pigs and people and local airborne spread”. By March 2nd, the disease had spread across 40 locations and an estimated 25,000 animals had been killed. Following, the United States sent a group of veterinarians to help “clean” infected premises, however as FMD continued to spread, the initial five days required to investigate suspected farms, decreased to three and eventually only 24 hours! The disease continued to spread, despite all prevention efforts, and “on March 23rd, to fight the spread of FMD, ffiuropean Union veterinarians in Brussels agreed to limited emergency vaccination in the Netherlands…this overturned the 15-year ffi.U. policy of prohibiting vaccination for FMD”. On June 12th, the spread had slowed; but, only after resulting in the death of over 3,281,000 animals spread throughout 1,736 locations and disrupting the schedule of the general election (USDA).

In the United States, agriculture accounts for nearly 13% of the current Gross Domestic Product (GDP) and employs about 15% of the population. Additionally, it produces high-quality, inexpensive food for domestic consumption and over $50 billion in exports (Cupp, Walker, and Hillison, 2004). Due to the industry’s size and variations in the spread of the disease, calculating the economic impact of FMD is extremely difficult, however some scientists have simulated total output losses of between $37 – 228 billion with $23 – 61 billion making up the agricultural and food manufacturing sectors alone. Some of the factors that were involved in their determination of the economic impact include: (1) production losses (2), constraints on/reduction in exportation, (3) domestic demand, (4) shifts in consumer preference, and (5) government expenditure on remediation services (Olasosu, Rose, and Lee, 2013).

Additional vulnerabilities, present in the agriculture sector, that make an outbreak somewhat inevitable include: (1) increases in globalization – global food trading and transportation of animals, (2) concentration and intensive farming, (3) increasing herd sizes, (4) inaccurate and inappropriate diagnostic training, (5) lack of security and surveillance, and (6) increased disease susceptibility due to over and misuse of antibiotics, dehorning, hormonal injections, and other farming practices (Haralampos *et al.*, 2013 and Parker, 2000).

Psychological and Social Outcomes:

"Beyond immediate economic and political impact, such attacks could also elicit fear and anxiety among the public" (Parker, 2000). While our motivation for agroterrorism is predominantly focused on economics, there is an aspect of social disruption, imbedded in our third and fourth objectives, that we are hoping to achieve. Additionally, the more chaos and psychological fear, propagated by farmers, society, big agriculture, and others combatting our attack, the more conversation about consumer health becomes publicized which could polarize the debate and lead to distrust in government and large corporation, which could be beneficial to our cause. To conclude, a report released in 2015 from the Blue Ribbon Study Panel on Biodefense said "the United States is underprepared for biological threats… and while biological events may be inevitable, their level of impact on our country is not" (Bodin, 2017).

ffixpected Counter-Measures:

As budding agroterrorists, it is important for us to understand the potential counter-measures which would occur as a response to an/our attack. While there have not been any previously successful agroterrorism attacks in the United States, we have explored some of the response mechanisms employed by those combatting the naturally caused FMD outbreak that hit the UK in 2001, and while I imagine much of the response would be similar, if an outbreak of that magnitude were to occur in the U.S., we are also almost two decades ahead of that time. To bring us back to the present, and explore the prevention, detection, and response mechanisms used to combat an agroterrorism attack in the U.S., the Congressional Research Service and USDA has put out audit reports to help fill in the gaps.

“In an outbreak damage is proportional to the time it takes to first detect the disease”, therefore detection is the first step in controlling a disease outbreak (Monke, 2007). Large animal veterinarians play the most prominent role in the detection process and requires them to be competent in disease surveillance and outbreak control with the authority to enforce potential movement restrictions. The Animal and Plant Health Inspection Service (APHIS), within the past 10 years, has recognized and initiated effects to increase training for veterinarians in the U.S. who have not been exposed to foreign animal diseases due to their successful eradication in the U.S. Also important to note; that in response to recent, widespread outbreaks such as Avian influenza in the U.S., many states have initiated simulations to test and improve their detection and response protocols following an agroterrorism attack.

Following the detection of an outbreak in the United States, the Secretary of Agriculture has the authority to:

1. Stop imports of animals and animal products into the U.S. from suspected countries (7 U.S.C. 8303);
2. Stop animal exports (7 U.S.C. 8304) and interstate transport of diseased or suspected animals (7 U.S.C. 8305);
3. Seize, quarantine, and dispose of infected livestock to prevent dissemination of the disease (7 U.S.C. 8306);

4. Compensate owners for the fair market value of animals destroyed by the Secretary’s orders (7 U.S.C. 8306(d)); and
5. Transfer the necessary funding from USDA’s Commodity Credit Corporation (CCC) to cover costs of eradication, quarantine, and compensation programs (7 U.S.C. 8316).

Citation: Monke, J. (2007, March 12). *Agroterrorism: Threats and Preparedness*(Rep.).

Depending on the extent to which the disease had spread, would determine the best mechanisms for control; vaccines are used on mass scale in China, India, and Africa to combat FMD outbreaks, however due to the recognition of the United States as FMD free without vaccination (**Figure 1**), this would likely be avoided as an initial strategy as veterinarians would be unable to determine if the presence of FMD antibodies in an animal were due to infection or vaccination. “Of all lines of defense, mass eradication is the most politically sensitive and difficult”, with environmentalists, farmers, and groups opposed to mass slaughter protesting its presence as a control method, however it has been the primary method of disease elimination during both the 2001 FMD outbreak in the UK and the 2015 Avian influenza outbreak in the United States (Monke, 2007 and Ramos, MacLachlan ﬁ Melton, 2017).

Conclusion:

A successful bioterrorist is driven by a motive, often based in generating psychological fear, economic or political instability, and/or social disruption. As an agroterrorist organization, *Live for Local*, has selected foot and mouth disease (FMD) as our pathogen of choice, due to the results of previous outbreaks, such as the 2001 UK FMD epidemic, which correspond to our motive of debilitating the economy and disrupting domestic confidence in government, while boosting the sales of local, small scale agriculture. To ensure well rounded planning, this paper also focused on our expected outcomes and the public and government response.

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