Responding to the Threat of Agroterrorism: Specific Recommendations for the United States Department of Agriculture

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ESDP-2000-04
BCSIA-2000-29 **October 2000**

CITATION AND REPRODUCTION

This document appears as Discussion Paper 2000-29 of the Belfer Center for Science and International Affairs and as contribution ESDP-2000-04 of the Executive Session on Domestic Preparedness, a joint project of the Belfer Center and the Taubman Center for State and Local Government. Comments are welcome and may be directed to the author in care of the Executive Session on Domestic Session.

This paper may be cited as Anne Kohnen. "Responding to the Threat of Agroterrorism: Specific Recommendations for the United States Department of Agriculture." BCSIA Discussion Paper 2000-29, ESDP Discussion Paper ESDP-2000-04, John F. Kennedy School of Government, Harvard University, October 2000.

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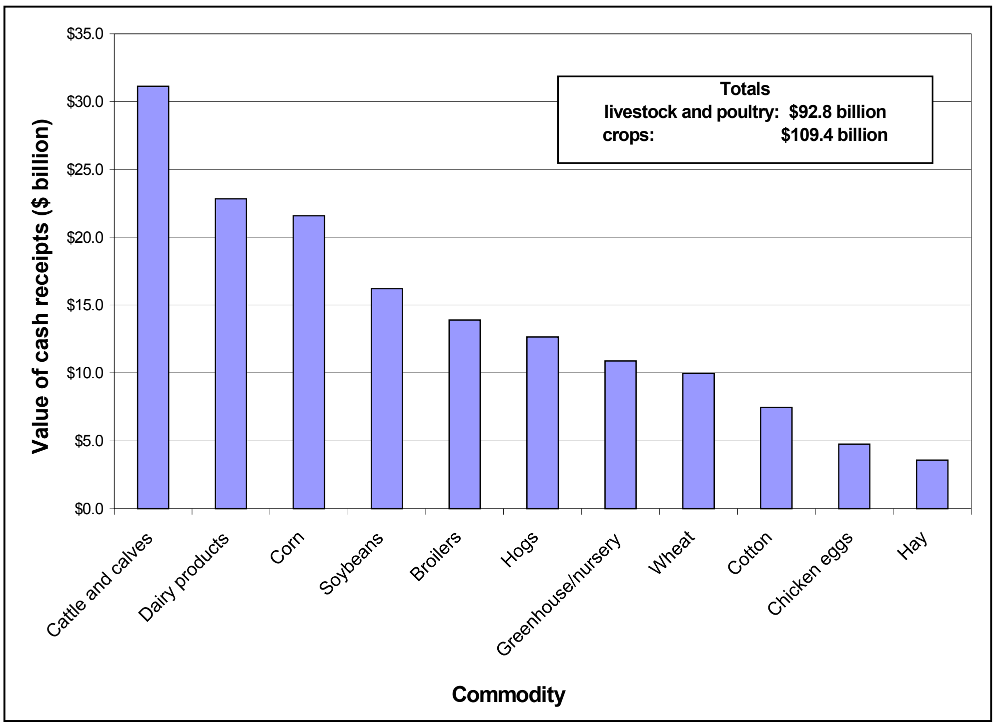
ACKNOWLEDGEMENTS

The author expresses special thanks go to the following people who contributed to this paper valuable information and expertise. From the USDA: Jerry Alanko, Dr. Bruce Carter, Dr. Tom Gomez, Dr. David Huxsoll, Dr. Steve Knight, Dr. Paul Kohnen, Dr. Marc Mattix, Dr. Norm Steele, Dr. Ian Stewart, Dr. Ty Vannieuwenhoven, Dr. Tom Walton, and Dr. Oliver Williams. From other agencies: Dr. Norm Schaad (USAMRIID), Dr. Tracee Treadwell (CDC). From the Kennedy School of Government: Dr. Richard Falkenrath, Greg Koblentz, Robyn Pangi, and Wendy Volkland.

The Executive Session on Domestic Preparedness is supported by Grant No. 1999-MU-CX-0008 awarded by the Office for State and Local Domestic Preparedness Support, Office of Justice Programs, U.S. Department of Justice. The Assistant Attorney General, Office of Justice Programs, coordinates the activities of the following program offices and bureaus: the Bureau of Justice Assistance, the Bureau of Justice Statistics, the National Institute of Justice, the Office of Juvenile Justice and Delinquency Prevention, and the Office for Victims of Crime. Points of view or opinions in this document are those of the author and do not necessarily represent the official position or policies of the U.S. Department of Justice.

The threat of biological weapons (BW) is usually associated with terrible outbreaks of human illness. Receiving substantially less attention from the media, however, is the fact that BW can also be used against agricultural targets as strategic economic weapons. Agriculture accounts for about 13 percent of the United States' annual gross domestic product.[1] In 1996 U.S. cash receipts for livestock, poultry, and crops totaled more than $200 billion.[2] An attack on agriculture could have enormous economic consequences.

Figure 1: Values of the Top 10 Agricultural Commodities, 1996.



Source: *Agriculture Fact Book 1998*, U.S. Department of Agriculture, Office of Communications, November 1998, pp. 43-44.

Americans enjoy some of the lowest food prices in the world, spending about 11 cents per dollar of disposable income compared to 50 or 60 cents per dollar in many other countries.[3] This is due in large

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[1] Floyd Horn and Roger Breeze, "Agriculture and Food Security," in Thomas Frazier and Drew Richardson, eds., *Food and Agricultural Security: Guarding Against Natural Threats and Terrorist Attacks Affecting Health, National Food Supplies, and Agricultural Economics*, Vol. 894 (New York: Annals of the New York Academy of Sciences, 1999), p. 11.

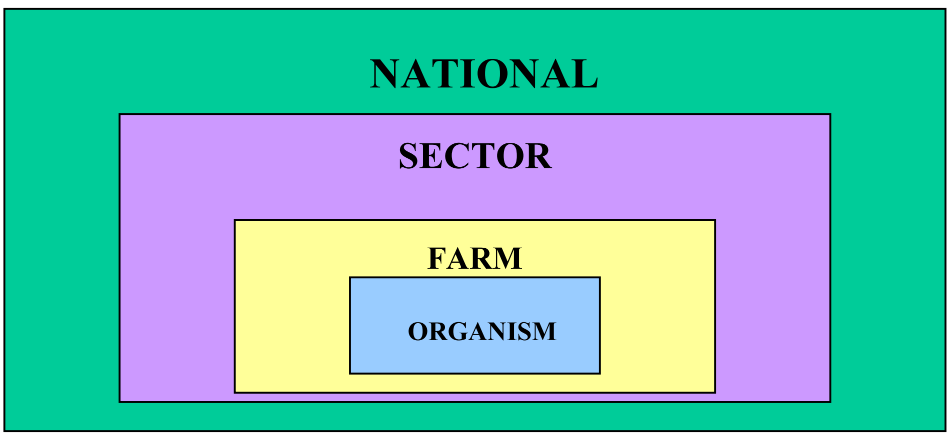
[2] *Agriculture Fact Book 1998*, U.S. Department of Agriculture, Office of Communications, November 1998, p. 43. Value of commodity cash receipts, 1996.

[3] The percentage of disposable income spent on food is decreasing. It was 13.8 percent in 1970, 13.4 percent in 1980, 11.6 percent in 1990, and 10.7 percent in 1996. *Ibid.*, p. 14. Also, Corrie Brown, "Agro-Terrorism: A Cause for Alarm," *Monitor*, Vol. 5, No. 1-2 (Winter-Spring 1999), p. 6.

part to the efficiency and the high health and quality standards that U.S. agriculture maintains, which keep production yields high and disease control costs low. The deliberate introduction of a pathogen—fungus, bacterium, virus, or insect pest—into U.S. livestock, poultry, or crops could cause a disease outbreak that would drive food prices up, halt valuable exports, and ultimately costs taxpayers billions of dollars in lost revenue and industry renewal costs.

For fiscal year (FY) 2000 more than $8 billion has been allocated to U.S. federal agencies for combating terrorism. The U.S. Department of Agriculture (USDA) will receive only 0.15% of that amount, about $12 million. The president's proposed budget for FY2001 more than triples the USDA's allocation to $41 million, which, if enacted, could significantly improve the agency's ability to defend against a terrorist attack on agriculture.[4] This paper suggests several ways that the USDA can to respond to this threat of "agroterrorism." The recommendations put forth are specifically intended to counter this threat, but they will also improve overall disease control capabilities, whether or not an attack occurs.

Figure 2: The four levels on which to counter the agroterrorist threat



The threat of an agroterrorist attack can be countered on four levels: (1) at the **organism** level, through animal or plant disease resistance; (2) at the **farm** level, through facility management techniques designed to prevent disease introduction or transmission; (3) at the agricultural **sector** level, through USDA disease detection and response procedures; and (4) at the **national** level, through policies designed to minimize the social and economic costs of a catastrophic disease outbreak.

[4] *Annual Report to Congress on Combating Terrorism: Including Defense against Weapons of Mass Destruction/ Domestic Preparedness and Critical Infrastructure Protection* (Washington, D.C.: Office of Management and Budget, 2000), p. 47.

The four levels presented here are not independent of one another. If crops themselves are resistant to disease, or if diseases or pests can be excluded at the farm level, there will be less chance that the USDA will have to respond to an outbreak. If disease/pest control is successful at the organism, farm, and sector levels, national recovery policies will not be necessary. The threat of agroterrorism cannot be fully countered on any one level. The four levels presented in this paper correspond to four prongs of a comprehensive strategy to counter agroterrorism.

This paper begins with a short background on past agricultural catastrophes, past BW programs targeting agriculture, and the feasibility of an agroterrorist attack. It then examines each of the four levels listed above, explaining the central concerns of each and making relevant recommendations for USDA action.

BACKGROUND

A disease that is introduced deliberately may be indistinguishable from one that is introduced inadvertently, or from one that arises naturally. An examination of past outbreaks gives some indication of the level of damage to expect from an agroterrorist attack. Beyond the damage lies the question of who would carry out such an attack and for what reasons. To address this broad topic, this section gives an overview of who has developed antiagriculture BW in the past, who has actually used BW against agriculture, the technical requirements for an agroterrorist attack, and some potential motivations.

Past Incidents of Large-Scale Disease Outbreaks

Natural outbreaks of diseases among plants and animals demonstrate the destructive potential of an agroterrorist attack. Historic examples show that the financial impact of an outbreak includes not only the cost of the lost agricultural products, but also the cost of the disrupted trade.

Foreign Animal Disease Incidents

The cost of recovering from serious disease outbreaks is much higher than just the cost of disposing of the infected animals. To effectively control the spread of disease, animals that might have been exposed must also be destroyed. In some cases this includes all of the animals within a geographic radius, as well as those that have been exposed through common transportation routes. Even so, the cost of slaughtering and disposing of this increased number of animals is only a fraction of the total cost of disease eradication, the greater part being that of disrupted production and trade. The following incidents are examples of this effect.

Because of its high level of virulence, foot-and-mouth disease (FMD) is particularly expensive to eradicate, and it triggers immediate export restrictions. One example is the Canadian outbreak of FMD between 1951 and 1953. By most accounts this was not an overwhelmingly large outbreak. Only about 2,000 animals had to be destroyed, at a cost of about $2 million. Trade restrictions, however, decreased the value of Canadian livestock by $650 million, and the total economic impact due to international embargoes was about $2 billion.[5] Similarly, an outbreak of FMD in Italy in 1993 cost $11.5 million to eradicate, but the marketing disruption was more than ten times this amount, about $120 million.[6] In 1996 FMD broke out among swine in Taiwan. Nearly 4 million hogs had to be destroyed, and the long-term losses to swine-related industries are projected to reach $7 billion.[7]

Another foreign animal disease (FAD), highly pathogenic avian influenza (HPAI), struck Pennsylvania in 1983. About 17 million chickens had to be disposed of, and the cost of disease eradication reached $86 million.[8] The price of poultry increased as a result, which cost consumers another $548 million. The incident cost an additional $7 million in lost wages.[9]

To date there have been 180,729 reported cases of bovine spongiform encephalopathy (BSE),[10] also known as "mad cow disease", though the actual number of infected animals is estimated at about one million.[11] A total of 1.35 million head of cattle have been destroyed, at a cost to date of about $4.2 billion.[12]

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[5] Ty Vannieuwenhoven, "Animal Health Emergency Management System," presentation at the American College of Veterinarian Preventative Medicine (ACVPM) Board Review, April 28, 2000. These figures are in 1987 dollars.
[6] Ibid.
[7] Terrance M. Wilson and Carol Tuszynski, "Foot-and-Mouth Disease in Taiwan—1997 Overview" U.S. Animal Health Association, 1997 Committee Report—Committee on Epizootic Attack. Available at http://www.usaha.org/reports/taiwanfmd.html; and Corrie Brown, "Economic Considerations of Agricultural Diseases," in *Food and Agricultural Security,* Frazier and Richardson, p. 93.
[8] Bernice Wuethrich, "Playing Chicken with an Epidemic," *Science*, March 17, 1995, and Vannieuwenhoven, "Animal Health Emergency Management System"
[9] Vannieuwenhoven, "Animal Health Emergency Management System". These figures are in 1996 dollars.
[10] "Bovine Spongiform Encephalopathy," statistics web site maintained by the Office International des Epizooties, last updated October 17, 2000. Of these, 179,257 of the cases are from Britain, and the remaining 1,472 were reported from Belgium, Denmark, France, Ireland, Liechtenstein, Luxembourg, the Netherlands, Portugal, and Switzerland. Available at http://www.oie.int/eng/info/en_esbru.htm and http://www.oie.int/eng/info/en_esbmonde.htm.
[11] Frederick Murphy, "The Threat Posed by the Global Emergence of Livestock, Food-borne, and Zoonotic Pathogens," in *Food and Agricultural Security*, Frazier and Drew Richardson, p. 22.
[12] Brown, "Agro-Terrorism: A Cause for Alarm," p. 7.

Crop Disease Incidents

Throughout history, outbreaks of crop diseases have been associated with famine. Late blight of potatoes swept through Ireland in 1845, ruining the country's staple crop and helping to bring about the famine of 1845-46. Brown spot disease of rice contributed to the Bengal famine in India in 1942-43, in which nearly 2 million people died.[13] Developing countries, many of which depend on a single crop for food and have little money for food imports, are particularly vulnerable to widespread starvation when crop diseases break out. Given its wealth and diversity of food production, the U.S. does not face this risk, but it remains vulnerable to substantial financial losses.

For example, in 1970 leaf blight destroyed about $1 billion worth of corn in the United States.[14] More recently, fusarium head blight, also called scab of wheat and barley, has affected several successive harvests in the Dakotas, Minnesota, and Manitoba especially between 1993 and 1998. Abnormally wet weather probably contributed to this disease's spread over 10 million acres, which has cost an estimated $1 billion in lost production.[15]

Even a minor disease outbreak can have severe economic effects due to export restrictions. In 1996 a fungus disease called Karnal bunt was discovered in wheat seeds that had been grown in Arizona and shipped to other southwestern states. Following this discovery, more than fifty countries—including China, the largest importer of U.S. wheat—adopted phytosanitary trade restrictions against the U.S., which are regulations intended to keep foreign plant diseases or pests outside one's borders.[16] Because of the "highly credible, rapid, and effective control and clean-up of the states concerned," however, the importers accepted a quarantine area that included just the affected areas, which allowed international trade of wheat from other regions to continue.[17] Control and clean-up by the USDA's Animal and Plant Health Inspection Service (APHIS) cost an estimated $45 million, and the impact on exports was reduced to about $250 million, compared to the $6 billion total value of U.S. wheat exports.[18]

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[13] Paul Rogers, Simon Whitby, and Malcolm Dando, "Biological Warfare against Crops," *Scientific American*, (June 1999), p. 73.
[14] Ibid., p. 73.
[15] Edward Lotterman, "Scab: The Ninth District's Agricultural Plague of the '90s," *Fedgazette*, (November, 1998), p. 1.
[16] Bruce R. Beattie and Dan R. Biggerstaff, "Karnal Bunt: A Wimp of a Disease, but an Irresistible Political Opportunity," *Choices: The Magazine of Food, Farm, and Resource Issues*, (Second Quarter, 1999). Available online at http://www.aphis.usda.gov/karnalbunt/forum/forum-arizona.html.
[17] Horn and Breeze, "Agriculture and Food Security," p. 13.
[18] Ibid.

Antianimal and Anticrop Biological Weapons Programs

The deliberate introduction of disease is not a new idea. Militaries have targeted agriculture throughout history as a means of depriving the enemy of their food supply. Over the past century, several nations developed BW for use against agriculture, as described below.

Anti-Animal and Anti-Crop BW Research during World War II

During World War II several countries, including Germany, the United Kingdom, the United States, Canada, and Japan, had biological weapons programs that conducted research on antianimal and anticrop agents. Germany's program included defensive BW research on FMD, rinderpest, and potato beetles. Despite Adolf Hitler's prohibition of offensive BW research, German scientists investigated FMD as a potential offensive weapon.[19]

Meanwhile the British developed a retaliatory capability to be used if the Germans attacked with BW. They manufactured and stockpiled 5 million "cattle-cakes" laced with lethal doses of anthrax spores. These cakes were to be dropped on German grazing lands where they would be eaten by cattle. The destruction of German herds by anthrax infection was intended to be a serious economic blow to Germany's overstrained agriculture sector.[20]

The United States, in cooperation with Canada and Great Britain, investigated many animal and plant diseases during World War II. Anthrax, brucellosis, and glanders, which are both antipersonnel and antianimal agents, were all evaluated for mass production. Other primarily defensive work was done on rinderpest, Newcastle disease, and fowl plague.[21] In addition, several plant diseases were studied for their offensive potential, including late blight of potato, rice blast, brown spot of rice, rubber leaf blight, Southern blight, and wheat rusts.[22]

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[19] *Biological and Toxin Weapons: Research, Development, and Use from the Middle Ages to 1945*, Erhard Geissler and John Ellis van Courtland Moon, eds. (Oxford: Oxford University Press, Stockholm International Peace Research Institute [SIPRI], 1999), pp. 114-116.
[20] Ibid., p. 181.
[21] Ibid., p. 240.
[22] Ibid., p. 241.

The vulnerabilities that were targeted by the U.S. anticrop program were the Soviet wheat crop in the Ukraine and the rice crop in Asia.[23] The rice fungus diseases and Southern blight were pursued as a means of destroying Japan's rice and staple cereals crops, while the potato disease research was aimed at Germany's crops.[24]

Although Japan's massive World War II BW program was concerned primarily with human diseases, considerable research on crop diseases was done as well. The Japanese investigated fungi, bacteria, and nematodes—agents that affect grains and vegetables, particularly those found in Manchuria and Siberia.[25]

BW Programs since World War II

The United States, the Soviet Union, Great Britain, and Canada continued their BW programs after the war.[26] Between 1951 and 1969, the U.S. maintained stockpiles of three anticrop pathogens: stem rust of wheat (36,000 kg), stem rust of rye, and rice blast (900 kg).[27] Then in 1969 the U.S. renounced its BW program, though it continued defensive research. All four countries signed and ratified the Biological Weapons Convention (BWC) of 1972, which prohibits the acquisition and use of biological weapons. By 1975 the U.S. had destroyed its remaining BW stockpiles.[28]

Unlike the Western programs, the Soviet BW program did not end with BWC ratification. It grew during the 1970s and 1980s to include more than 30,000 scientists and workers, as well as seven production and two storage facilities.[29] The extensive program had an antiagriculture weapons branch, run by the ministry of agriculture. This agency developed anticrop agents including wheat rust, rice blast, and rye blast, and anti-animal agents including African swine fever, rinderpest, and foot-and-mouth disease.[30]

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[23] Simon Whitby and Paul Rogers, "Anti-crop Biological Warfare—Implications of the Iraqi and U.S. Programs", *Defense Analysis*, Vol. 13, No. 3, (1997), p. 312-313.
[24] Geissler and van Courtland Moon, p. 241.
[25] Ibid., p. 139.
[26] Richard A. Falkenrath, Robert D. Newman, and Bradley A. Thayer, *America's Achilles' Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack* (Cambridge, Mass.: MIT Press, 1998), p. 67. Also Tom Mangold and Jeff Goldberg, *Plague Wars* (New York: St. Martin's Press, 1999), p. 41.
[27] Whitby and Rogers, "Anti-crop Biological Warfare—Implications of the Iraqi and U.S. Programs," p. 310.
[28] Falkenrath, Newman, and Thayer, *America's Achilles' Heel*, p. 67.
[29] Mangold and Goldberg, *Plague Wars,* p. 65; and Ken Alibek, *Biohazard* (New York: Random House, 1999), pp. xii-xiii.
[30] Ken Alibek, "The Soviet Union's Anti-Agricultural Biological Weapons," in *Food and Agricultural Security*, Frazier and Richardson, p. 18.

Ken Alibek, a former high-level administrator of the Soviet BW program, claims that by 1990, however, the Soviet Union had abandoned its antiagricultural weapons program.[31]

Iraq is also known to have developed BW recently, including anticrop agents. Its research was primarily occupied with fungi that cause damaging diseases to cereal crops: rusts, blasts, and smuts. Iran's wheat crop is thought to be the target of these pathogens.[32] In 1985 and 1988 Iraq infected test wheat fields with wheat cover smut, demonstrating the efficacy of this fungus as a biological agent. Iraq claims to have destroyed the infected wheat in 1990.[33] Wheat cover smut results in a significant crop yield loss, and it produces the highly volatile trimethylamine gas, which can cause explosions in harvesters.[34]

Actual Use and Allegations of Use of BW against Agriculture

Despite the large amount of past research devoted to anticrop and antianimal agents, BW have rarely been used against agricultural targets. During World War I the Germans clandestinely inoculated horses and mules, being shipped from U.S. ports to the Allies, with anthrax and glanders, by swabbing the animals' muzzles with the infectious agents.[35] While these pathogens carried risks to humans as well as to the animals, no instances of human illness were recorded.[36] This was part of Germany's larger biological sabotage program in which they attempted to infect draft, cavalry, and military livestock between 1915 and 1918 in Romania, Spain, Norway, Argentina, and the U.S.[37]

Japan is alleged to have used animal and plant pathogens, including rinderpest and anthrax, against Russia and Mongolia in 1940.[38] This, however, seems to be the only actual use of BW against agriculture during World War II, despite the extensive research effort in several countries at that time.[39]
Nevertheless, there were numerous accusations of BW use. The potato beetle was a serious natural concern in Western Europe during World War II. Britain accused Germany of dropping small, cardboard bombs filled with Colorado beetles onto potato fields in southern England, including the Isle of Wight, in

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[31] Ibid., p. 19.
[32] Whitby and Rogers, "Anti-crop Biological Warfare—Implications of the Iraqi and U.S. Programs," p. 305.
[33] Raymond Zilinskas, "Iraq's Biological Warfare Program: The Past as Future?" in *Biological Weapons: Limiting the Threat*, Joshua Lederberg, ed., (Cambridge, Mass.: MIT Press, 1999), p. 139.
[34] Whitby and Rogers, "Anti-crop Biological Warfare—Implications of the Iraqi and U.S. Programs," p. 305.
[35] Stockholm International Peace Research Institute, *The Problem of Chemical and Biological Warfare,* Vol. 1*, The Rise of CB Weapons* (Stockholm: Almqvist and Wiksell, 1971), pp. 216-217.
[36] Geissler and van Courtland Moon, p. 35.
[37] Ibid., p. 59.
[38] SIPRI, *The Problem of Chemical and Biological Warfare,* p. 223.
[39] Geissler and van Courtland Moon, p. 121.

1943.[40] Germany itself was worried about the possibility of an enemy introducing the beetles into its fields. In 1944 there were reports of potato beetle outbreaks in northern Bavaria and Thuringia, and the Germans were quick to confirm these along with earlier outbreaks as enemy activity. Neither Britain nor the U.S., however, considered using potato beetles for BW purposes during World War II.[41]

Allegations of BW use continued during the Cold War. For example, Cuba has accused the U.S. of attacking the Cuban people, animals, and crops with biological agents twelve times during the period 1964-97. A recent report offers explanations for each episode, and concludes that each probably occurred naturally or was the result of human activity such as trade or travel.[42] Despite the various accusations, "biological weapons use by states since World War II [agricultural or otherwise] appears to be confined to a handful of state-directed assassinations employing biological agents and toxins."[43]

Likewise, agroterrorist attacks by nonstate actors have been rare; only one case of use and one case of threatened use have been documented. The first event was in 1952, when a group called the Mau Mau, a nationalist liberation movement originating with the Kikuyu tribe, used a plant toxin (African bush milk) to poison thirty-three steers at a Kenyan mission station, located in areas reserved for the tribe. This was believed to be part of a larger sabotage campaign against the British colonists and their livestock throughout Kenya.[44] The other case took place in the early 1980s when a group of Tamil militants threatened to spread foreign plant diseases among rubber and tea plantations in Sri Lanka, intending to cripple the Sinhalese-dominated government.[45] It is not clear which Tamil group initiated the threat, but because many such groups were supported in part by the Indian government, it is possible that the perpetrator was actually a state actor. (Until the evidence is confirmed, however, the incident will remain classified as a having been perpetrated by a nonstate actor.) These are the only well-documented instances of actual or threatened BW use against agriculture by nonstate actors during the 20th century.[46]

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[40] SIPRI, *The Problem of Chemical and Biological Warfare,* p. 223.
[41] Geissler and van Courtland Moon, p. 117.
[42] Raymond Zilinskas, "Cuban Allegations of Biological Warfare by the United States: Assessing the Evidence," *Critical Reviews in Microbiology*, Vol. 25, No. 5 (1999).
[43] Falkenrath, Newman, and Thayer, *America's Achilles' Heel*, p. 79.
[44] W. Seth Carus, "Bioterrorism and Biocrimes: the Illicit Use of Biological Agents in the 20th Century," working paper, (Washington, D.C.: Center for Counterproliferation Research, National Defense University, April 2000 revision), pp. 75-76.
[45] Carus, "Bioterrorism and Biocrimes: the Illicit Use of Biological Agents in the 20th Century," pp. 161-162.
[46] However, BW have been used by nonstate actors *in defense of* agriculture. When the New Zealand government ended its rabbit control program, sheep farmers were forced to shoulder the cost themselves. In 1997 several sheep farmers illegally released a rabbit pathogen onto their farms as a cheap and decisive way to control the rabbit population, which had been eating the grass designated for sheep. Rabbit calicivirus disease (RCD) killed many thousands of rabbits before it mutated into a nonlethal strain. The farmers' improper handling of the pathogen is

Feasibility of an Agroterrorist Attack

The threat of an agroterrorist event hinges on three factors: (1) a terrorist or terrorist group must have the technical ability to acquire and deploy a biological weapon; (2) the terrorist or terrorist group must be interested in sickening or killing animals or crops as a means to its goal; and (3) the terrorist or terrorist group must have the desire to do so using BW.[47]

Technical Requirements for Agroterrorism

Large-scale biological warfare requires significant technical expertise. It is much more difficult to carry out a successful large-scale, strategic BW attack than it is a single incident of sabotage. Agroterrorism is unique, however, because even a very small disease outbreak could prompt international export restrictions. The Karnal bunt of wheat incident demonstrates this possibility. In addition, some livestock and poultry viruses can travel great distances on their own; a perpetrator does not need to devise special dispersal devices. Thus the technical barriers to agroterrorism are lower than those to human-targeted bioterrorism. A perpetrator with a basic understanding of microbiology could simply visit an area where FMD occurs naturally, obtain diseased tissue, culture an infectious substance, and clandestinely infect American herds. A single act of sabotage like this would not require sophisticated knowledge or expertise.[48] Even a larger program of sabotage could use this method for multiple, simultaneous attacks.

Crop diseases, in general, do not travel airborne as fast or as far as animal diseases such as FMD. Plant pathogens are also highly sensitive to environmental factors such as temperature, humidity, and sunlight; even if a pathogen were released, it would not necessarily cause disease. Thus it would be technically very difficult to produce an agent that was guaranteed to cause disease. Spores would have to be protected from ultraviolet light, and the agent would have to be formulated to prevent clumping, allowing for airborne dispersal.[49] Nevertheless, mere exposure to a pathogen is, in some cases, grounds for export restrictions, so the technical barriers to deliberately spreading crop diseases are not necessarily relevant.

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suspected as the reason for the mutation, which has ironically given rise to an RCD-resistant rabbit population. Steve Goldstein, "Rabbit Response," *Philadelphia Inquirer Magazine*, February 13, 2000; and Carus, "Bioterrorism and Biocrimes: the Illicit Use of Biological Agents in the 20th Century," pp. 49-51.

[47] Falkenrath, Newman, and Thayer, *America's Achilles' Heel,* p. 169.

[48] Brown, "Agro-Terrorism: A Cause for Alarm," p. 7.

[49] Debora MacKenzie, "Run, Radish, Run," *New Scientist*, December 18, 1999, p. 38.

Motivations for Agroterrorism

Terrorists' motives vary widely. The perpetrator of an agroterrorist attack might be seeking revenge against a farmer. She may simply be trying to incite panic by causing a food scare. Maybe she belongs to a group whose ideology calls for the destruction of agricultural products. These are just a few of the possibilities. From the standpoint of the USDA, however, the most important motivations to consider are those that particular groups or individuals are known to hold. The two most common today are the profit motive and the anti-GMO (genetically modified organism) motive.

Potential for profit. Fluctuations in agribusiness can work to the benefit of different types of groups. These groups could be motivated to attack U.S. agriculture by the simple desire for monetary gain. Agricultural exports bring in billions of dollars each year. If U.S. exports were restricted as a result of disease, foreign agricultural producers would profit from their sudden gain in market share. Likewise on a local level, one producer could benefit from a (non-communicable) disease outbreak on a competing farm. Diseases that do not trigger nationwide trade restrictions could be maliciously introduced to allow one domestic producer to gain market share over another.

In another scenario, people who speculate on futures markets could profit from their knowledge of a pending change in U.S. prices. If trade restrictions were put on all U.S. pork as a result of disease outbreak, U.S. prices would drop and foreign pork prices would rise, both of which could benefit an informed speculator.

Destruction of animals or plants. There is a very real constituency today of people interested in damaging agricultural products: groups opposed to GMOs. Anti-GMO activists have attacked university and corporate research sites in at least eighteen incidents throughout seven states in the past year. According to one report, "Underground activists have trampled and sheared corn, uprooted sugar beets, [and] stripped the bark from experimental trees."[50] Anti-GMO groups have already shown their commitment to the destruction of certain crops. Although using BW does not align with a pro-natural foods ideology, it would take less effort and would have more widespread effects than doing physical damage to crops. If the ends justify the means, such groups may consider using BW to further their cause.

[50] James Cox, "Bio-crops Under Attack: Militants Destroy Test Plots of Genetically Modified Foods," *USA Today*, January 31, 2000.

Desire to Use BW against Agricultural Targets

Terrorists in the past have not successfully used BW against humans for a number of reasons, many of which are not relevant to BW use against agricultural targets. First, handling human pathogens is extremely dangerous; a terrorist puts himself in danger when he develops or disperses BW against humans. Animal and plant pathogens, however, do not usually affect humans (see below). Second, the psychological barrier against inflicting mass human casualties is lower when the target is animals or plants. Killing plants and animals is not generally considered to be as ethically objectionable as killing people.

Agricultural targets are "soft targets," or ones that maintain such a low level of security that a terrorist could carry out an attack unobserved. Biological agents are small, inexpensive, and nearly impossible to detect. A terrorist may choose to use BW against agriculture simply because it is the easiest and cheapest way to cause large-scale damage.

Agroterrorism is a multidimensional threat, involving a wide range of motives and perpetrators, and encompassing a wide range of actions, from single acts of sabotage to strategic wartime programs. So far the U.S. has not seen any acts of agroterrorism within its borders. The USDA, however, should take action now to bolster the nation's defenses against an incident. The following four sections describe each of the levels at which the USDA should aim its anti-agroterrorism efforts.

ORGANISM LEVEL: THE BIOLOGY OF DISEASE

A strong agricultural sector relies on the maintenance of good animal and plant health. Fungi, bacteria, and viruses cause diseases that can lower crop yields and sicken livestock and poultry. These three pathogen types present different hazards to different organisms. In most cases, a particular pathogen will cause a serious disease in only a single type of animal or crop. For example, rice blast is a fungus that infects only rice. Similarly, Newcastle disease is fatal only to poultry and other birds. The following section gives background information about a variety of pathogens, explains how plant and animal diseases are transmitted, and describes how infections can be reduced or prevented.

Livestock and Poultry Diseases

The diseases that pose the biggest threat to livestock and poultry are foreign animal diseases—those that are not currently found in the U.S. Many FADs have the ability to spread quickly because animals have not built up resistance to them and because they are readily transmitted. In addition, animals have become more disease prone over the years as a result of “increased stress levels brought about by intensive antibiotic and steroid treatment programs, as well as by husbandry changes designed to elevate the volume…and quality…of meat products.”[51] FADs require quarantine and immediate eradication efforts, and they can trigger export restrictions.

The Office International des Epizooties (OIE), also called the International Office of Epizootics or the World Organization for Animal Health, is an intergovernmental organization with 155 member countries. The World Trade Organization’s (WTO) “Agreement on the Application of Sanitary and Phytosanitary Measures” explicitly calls for the use of standards, guidelines, and recommendations developed under the auspices of the OIE.[52] Thus the WTO recognizes the OIE as the international body responsible for setting animal health standards on which international trade restrictions will be based.[53] The OIE maintains a list of “transmissible diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic or public health consequence and which are of major importance in the international trade of animals and animal products.”[54] These so-called List A diseases (see Appendix A) could severely damage the U.S. agricultural market, since an outbreak of one of these diseases is internationally recognized as grounds for export embargo.

[51] “First Annual Report to the President and the Congress of the Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction,” (Santa Monica, Calif.: RAND, December 15, 1999) p. 13.
[52] “International Standards,” Office International des Epizooties, available at http://www.oie.int/Norms/A_norms.htm.
[53] Alfonso Torres, “International Economic Considerations Concerning Agricultural Diseases and Human Health Costs of Zoonotic Diseases,” in *Food and Agricultural Security*, Frazier and Richardson, p. 80.
[54] “Definitions for List A and B Diseases,” Office International des Epizooties, available at http://www.oie.int/eng/maladies/en_classification.htm.

Table 1 summarizes basic information about List A diseases. BSE is not a List A disease, but it has been included for comparison because of the wide publicity it has received in recent years.

Table 1: OIE List A Diseases Affecting Primarily Cattle, Swine, or Poultry*

Disease	Primary Modes of Transmission	Primary Animals Affected	Vaccine available?	Location	Affect humans?
Foot-and-mouth disease	Airborne aerosols; direct or indirect contact (via human clothing, equipment, vehicles, or through milk or partially cooked meat)	Cloven-hoofed animals, esp. cattle and swine	Y	Asia, Africa, Middle East, South America	Occasionally after prolonged exposure, humans can develop mild symptoms.
Vesicular stomatitis	Direct contact (i.e. shared feed and water troughs, milking machines); insect vectors	Cattle, swine, horses	Y	U.S., Mexico, Canada, the Caribbean, Central and South America	During epidemics humans can get a version resembling flu
Swine Vesicular Disease	Ingestion of infected meat	Swine	N	Hong Kong, Japan, Europe	Occasionally causes flu-like illness
Rinderpest ("cattle plague")	Direct contact with any animal secretions; airborne droplets	Cattle, sheep, goats	Y	Africa, Middle East, Asia	N
Contagious bovine pleuro-pneumonia	Inhalation of droplets of infected animal secretions	Cattle	Y	Asia, Central Africa, Spain, Portugal	N
Lumpyskin disease	Insect vectors	Cattle	Y	Africa	N
Rift Valley fever	Insect vectors, esp. mosquitoes; direct contact with blood or tissue	Sheep, cattle	Y	Africa	Humans very susceptible; disease is sometimes fatal (human vaccine available)
Bluetongue	Insect vectors	Sheep, cattle	Y	U.S., Africa, Europe	N
Bovine spongiform encephelopathy ("mad cow disease")	Ingestion of foods containing infected meat and bone meal	Cattle	N	Primarily Great Britain, some cases in Western Europe	Suspected precursor to new variant Creutzfeldt-Jakob disease (fatal)
African Swine Fever	Insect vectors (ticks); ingestion of infected meat; direct contact; airborne aerosols within buildings	Swine	N	Africa, Iberian Peninsula, Sardinia	N
Classical Swine Fever (“hog cholera”)	Direct contact with animal secretions; indirect contact via shoes, clothing, equipment	Swine	Y	Africa, Asia, South and Central America, parts of Europe	N
Highly pathogenic avian influenza ("fowl plague")	Direct contact; airborne aerosols	Chickens, turkeys	Y	Worldwide	Usually rare, but 1997 Hong Kong epidemic killed six with influenza-like illness
Newcastle disease	Direct contact with animal secretions, esp. feces; contaminated feed, water, equipment, human clothing, etc.	Poultry, wild birds	Y	Worldwide	Occasionally causes transitory conjunctivitis after extensive exposure

*BSE is included here for comparison, though it is on List B. Also, three List A diseases are not included here because they do not primarily affect cattle, swine, or poultry: peste des petits ruminants and sheep/goat pox affect primarily sheep and goats; and African horse fever affects primarily horses.

Sources: Bradford Smith, *Large Animal Internal Medicine* (St. Louis, MO: Mosby, 1996), pp. 799-821, pp. 1010-1011, pp. 1246-1248; Frederick Murphy, E. Paul Gibbs, Marian Horzinek, and Michael Studdert, *Veterinary Virology* (San Diego, Calif.: Academic Press, 1999), pp. 295-298, pp. 419-468, pp. 522-568; and OIE web site, http://www.oie.int/eng/maladies/en_fiches.htm.

Transmission of Livestock and Poultry Diseases

All but one of the List A diseases are viruses,[55] yet they are transmitted in different ways. Most viruses can be transmitted through direct contact. Some can be spread through the air over great distances in aerosol form. Others, such as bluetongue and African swine fever, are spread by "vectors"—other organisms capable of transmitting diseases—such as ticks and mosquitoes. There are three primary transmission modes of these animal diseases.

1. Airborne Transmission Mode of Animal Diseases. Foot-and-mouth disease, avian influenza, and Newcastle disease all can spread via airborne aerosols over long distances. In 1981, three days after an outbreak of FMD in Brittany, France, single cases appeared across the English Channel on the Isle of Wight. Prevailing wind patterns corroborate the hypothesis that the virus traveled a distance of 175 miles as an airborne aerosol.[56] Airborne diseases are extremely difficult to contain and thus would present an enormous challenge to emergency responders in the event of an outbreak. These diseases can also be transmitted by direct contact.

2. Direct Transmission Mode of Animal Diseases. Diseases such as rinderpest, vesicular stomatitis, hog cholera, and African swine fever can be spread by direct contact among animals, as well as by contact with contaminated objects. For example, feed troughs, water troughs, and milking machines that are used by an infected animal can transmit a virus to other animals. In addition, these viruses can travel on people's clothes, shoes, and equipment. This presents the necessity of biosecurity measures—keeping animal facilities clean and restricting human and vehicle traffic around animals. (See below for further discussion.)

3. Vector Transmission Mode of Animal Diseases. As mentioned, some diseases are transmitted by insect vectors. A tick or a mosquito contracts a disease from one animal and transmits it to another through a subsequent bite. In these cases disease control depends on insect control. Many developing

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[55] Contagious bovine pleuropneumonia is caused by mycoplasma.
[56] Frederick Murphy, E. Paul Gibbs, Marian Horzinek, and Michael Studdert, *Veterinary Virology* (San Diego, Calif.: Academic Press, 1999), p. 527.

countries cannot afford insecticides, so diseases tend to persist. Rift Valley fever, which recently broke out on the border of Yemen and Saudi Arabia killing more than one hundred people,[57] is an example of an animal disease that is transmitted by insect vectors (mosquitoes). (It is also transmitted by direct contact.)

Vaccination of Livestock and Poultry

Vaccines exist for most of the List A diseases, though they are not generally used except to control an emerging outbreak.[58] Once a disease has been eradicated from a country or region, the expensive and labor-intensive procedure of vaccinating animals is discontinued.

Vaccines can keep animals from acquiring diseases, but in most cases they do not keep animals from being carriers. A cow vaccinated against FMD can carry the disease in her throat tissues for two and a half years after exposure.[59] Also, a vaccinated animal cannot be distinguished from an infected one; the titers are the same. FAD vaccines are typically used only to stop an epidemic. Then, to eradicate the pathogen completely, both infected and vaccinated animals have to be destroyed.[60]

If there were a FAD outbreak, infected and exposed animals would have to be quarantined, and others in surrounding areas would have to be vaccinated immediately to prevent further spread of the disease. If FMD were introduced into this country, many thousands of animals would have to be vaccinated immediately. For this reason, it is important that vaccines are available to USDA emergency responders. A vaccine shortage could allow a small outbreak to become an epidemic.

> ***Recommendation**: The USDA should be ready to supply vaccines for all List A diseases in case of an outbreak.*

[57] "Rift Valley Fever – Saudi Arabia and Yemen," Pro-MED Mail post No. 20000925.1652. Available in Pro-MED Mail archives at http://www.promedmail.org. Rift Valley fever is a List A disease of sheep and cattle that is extremely dangerous to humans as well.
[58] Telephone conversation with staff veterinarian Dr. Ian Stewart, USDA:APHIS:VS:Emergency Programs, March 27, 2000.
[59] "Foot-and-Mouth Disease: Sources of Outbreaks and Hazard Categorization of Modes of Virus Transmission," USDA APHIS Veterinary Services, December 1994, p. 2.
[60] Telephone conversation with Dr. Stewart.

Currently the only List A disease for which the USDA has vaccine available is FMD.[61] It also does not currently have a means of procuring vaccines for other List A diseases.[62] Maintaining stockpiles of vaccines is very expensive, so a better preparation method would be to have one or more pharmaceutical manufacturers ready to produce List A vaccines when needed. This requires up-to-date vaccine research so the USDA could give manufacturers the right formulation for the disease strain of concern. Also, the USDA should establish formal agreements with manufacturers to ensure prompt action when needed.

Crop Diseases and Pests

Most crop diseases do not kill plants outright. Instead they produce failed harvests by drastically reducing the quality and quantity of a plant's output. Unlike animals, plants do not have immune systems that actively seek out and destroy pathogens. They have different kinds of protective mechanisms, one of which is their cell walls, which are made primarily of cellulose and lignin. These rigid barriers are impervious to many pathogens, particularly viruses.[63] Whereas viruses present the greatest agroterrorist threat to animals, fungi present the biggest threat to crops. The three anticrop agents developed by the United States in the 1960s were all fungi: wheat rust, corn smut, and rice blast.

If a fungus were introduced under the right conditions, "the spores…[could be] spread for great distances by the wind and establish centers for further spread once they infect a plant. Because of infection, subsequent spread normally occurs in a series of waves, the frequency of which depends on the incubation period of the particular fungus."[64]

Just as the WTO looks to the OIE for animal export guidelines, it recognizes the International Plant Protection Convention (IPPC) as the source of international standards for the phytosanitary measures affecting trade.[65] The IPCC has 111 member countries, each of which submits its own phytosanitary restrictions—the pathogens to which imported plants and plant products must not have been exposed—according to the standards set by the IPPC and the country's specific vulnerabilities. There is no analog of List A for crop diseases, given that every country sets its own import requirements. There are,

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[61] Telephone conversation with Dr. Bruce Carter, USDA Center for Veterinary Biologics (Ames, Iowa), March 28, 2000.
[62] Ibid. Dr. Carter, however, is working on the task of finding manufacturers of List A disease vaccines.
[63] Telephone conversation with Dr. Paul Kohnen, USDA ARS plant pathologist.
[64] J. H.Rothschild, *Tomorrow's Weapons: Chemical and Biological* (New York: McGraw-Hill, 1964), p. 24.
[65] "International Plant Protection Convention," available at http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/PQ/En/IPPCe.htm.

however, diseases that are particularly worrisome due to their ease of transmission, high level of impact on harvests, ability to infect staple cereals, and historical consideration for offensive weapons use. Table 2 shows some of these pathogens.

Table 2: Crop Diseases of Particular Agroterrorist Concern

Crop Affected	Pathogen Type	Pathogen	Disease	Primary Mode of Transmission
Cereals (wheat, barley, rye)	Fungus	*Puccinia graminis**	Stem rust of wheat	Airborne spores
	Fungus	*Puccinia glumarum**	Stripe rust of cereals	Airborne spores
	Fungus	*Erysiphe graminis*	Powdery mildew of cereals	Airborne spores
Corn	Bacteria	*Pseudomonas alboprecipitans*	Corn blight	Waterborne cells
Rice	Fungus	*Pyricularia oryzae**	Rice blast	Airborne spores
	Bacteria	*Xanthomonas oryzae*	Rice blight	Waterborne cells
	Fungus	*Helminthosporium oryzae*	Rice brown-spot disease	Airborne spores
Potato	Fungus	*Phytophthora infestans*	Late blight of potato	Airborne spores

*Recommended for export control by the Australia Group, an international consortium that recommends items and pathogens for export control to limit chemical and biological weapons proliferation.

Source: Charles Piller and Keith Yamamoto, *Gene Wars* (New York: Beech Tree, 1988), pp.246-247.

Transmission of Crop Diseases

Plant pathogens are transmitted by wind, water, or vectors such as insects. They are also heavily dependent on environmental factors such as temperature, humidity, rainfall, and sunlight. Due to this heavy dependence on external factors, the introduction of a pathogen does not necessarily result in widespread infection. *Phytophthora infestans*, the fungus responsible for late blight of potatoes, existed in Ireland long before the 1845 blight that destroyed the Irish potato crop. It was the unique weather conditions that year, however, that allowed the fungus to reproduce and spread so quickly. There are three primary transmission modes of crop diseases.

1. Airborne Transmission of Plant Diseases: Fungi. The life cycle of fungi includes the production of dry spores, which are dispersed on the wind. "Spores…traveling on the wind can attain altitudes as high as 10 km and distances of over 1000 km down range of their origin."[66]

Once a fungus has infected an area, it is extremely difficult to eliminate all of the spores. Fungicides can help, but fungi can persist in other hosts, allowing the disease to continue infecting plants for long periods of time. Chestnut blight, caused by a fungus introduced originally from Asia, has virtually eliminated the American chestnut tree from the U.S. by this mechanism.[67]

2. Plant Disease Transmission via Insect Vectors: Viruses. As mentioned earlier, plant cell walls are impervious to viruses, which can develop and reproduce only by invading a host cell and taking over its metabolism. The only way a plant can be infected with a virus is if the virus is introduced through a broken cell wall. Insects such as aphids are often virus carriers. When an aphid feeds on a leaf, it pierces cell walls and inadvertently transmits the virus.

Although viruses can be extremely damaging to crops, their ability to spread is limited by insect movement. Generally, viruses do not have the ability to spread as far as fungi can. Virus control depends heavily upon insect control and the use of virus-resistant crop strains. Currently crop viruses are untreatable.

3. Waterborne Transmission of Plant Diseases: Bacteria. Bacteria require moisture for transmission. They cannot be transmitted on the wind, but they often travel via wind-driven rain. Splashing rainwater can transmit bacteria from plant to plant, and irrigation runoff can spread bacteria over entire fields. Insects can transmit bacteria as well. Like viruses, bacteria can cause serious plant diseases, but they cannot generally spread over vast areas as fungi can.

Pathogen Resistance in Crops

Crops can be made resistant to many diseases through genetic selection and mass production of resistant strains. Many commercial seed companies sell hybrids that are resistant to specific pathogens. Today

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[66] Eric Taylor, *Lethal Mists* (Commack, NY: Nova Science, 1999), p. 160.
[67] William Purves, Gordon Orians, and H. Craig Heller, *Life:The Science of Biology* (Sunderland, Mass.: Sinauer Associates, 1995), p. 1178.

wheat rust is controlled by the use of resistant wheat strains. Seed companies must find a new strain each year to keep up with the rapid evolution of the rust fungus.[68]

Other forms of pathogen resistance include herbicides, to eliminate weeds, and pesticides, to control insect pests. Virus-resistant plant varieties reduce the need for insect control as a means of stopping virus transmission. Insects, however, can do serious direct damage to crops, and infestations of particular insects can prompt export restrictions. The Mediterranean fruit fly, commonly known as the Medfly, lays its eggs on many types of fruit on which the larvae later feed. If the Medfly became established in the U.S., the USDA estimates that it would cost $1.5 billion per year in lost production and export restrictions.[69] The introduction of a foreign pest is another potential agroterrorist threat.

Effects of Livestock, Poultry, and Crop Diseases on Humans

Some of the animal viruses discussed above are zoonotics, meaning that they are transferable among different species. The term is frequently used to describe diseases that move from animals to humans. Zoonotics, however, do not generally affect humans in the same way they do animals. For example, foot-and-mouth disease, vesicular stomatitis, and Newcastle disease can be transmitted to humans, but the resulting illness is mild and not considered dangerous to human health. (See Table 1 for the effects of List A diseases on humans.)

Nevertheless, a few of the pathogens discussed in this chapter have been known to seriously harm humans. Six people died in Hong Kong in 1997-98 as a result of the highly pathogenic avian influenza outbreak.[70] Also, a link is suspected between human ingestion of BSE-infected beef products and seventy-four cases of new variant Creutzfeldt-Jakob disease (nvCJD),[71] a fatal neurological disorder.[72]

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[68] Ibid., p. 536. Resistant strains of wheat are different from genetically modified strains of wheat. Resistant strains occur naturally. When a strain is found that resists a particular disease, it is selected and propagated. GMOs do not occur naturally. They are engineered to have advantageous properties, and they often incorporate genes from other species.

[69] "The Mediterranean Fruit Fly," USDA:APHIS:Plant Protection and Quarantine fact sheet, May 1999. Available at http://www.aphis.usda.gov:80/oa/pubs/fsmedfly.html

[70] Murphy et al., *Veterinary Virology*, p. 467.

[71] Murphy, "The Threat Posed by the Global Emergence of Livestock, Food-borne, and Zoonotic Pathogens," p. 23; and "CJD (New Variant) - UK: Update, June 2000," Pro-MED Mail post No. 20000707.1126, July 7, 2000. Available in Pro-MED Mail archives at http://www.promedmail.org.

[72] Improper rendering procedures are considered to be the cause of the widespread BSE outbreak. These have been changed, so no further infections are expected. For more information, see below.

Although the threat of agroterrorism is primarily an economic concern, the emergence of new zoonotics, such as the recent Nipah virus in Malaysia and West Nile virus in New York City, raises serious human health considerations as well.

Crop diseases are not generally considered a public health threat in the U.S., both because so few plant pathogens are toxic to humans, and because strict regulatory processes prevent diseased or contaminated products from reaching the market.

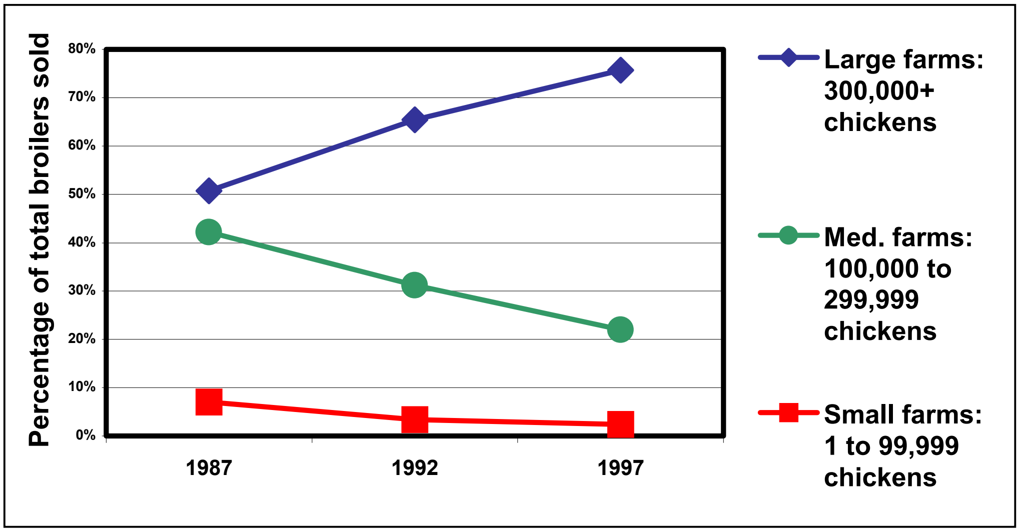
FARM LEVEL: THE STRUCTURE OF U.S. AGRICULTURE AND THE SPREAD OF DISEASE

Trends in the agricultural sector toward more intensive farming of both animals and crops have helped keep food prices low in America, but these practices have also increased the risk of catastrophic disease and pest outbreaks. Farmers, themselves, can decrease the risk of disease or pest introduction through facility management techniques that increase farm biosecurity.

Intensive Farming Conditions

Five of the top ten agricultural commodities come from animals that are raised in highly concentrated conditions: cattle, dairy products, broilers, hogs, and eggs. Figure 3 demonstrates the increase in intensive farming practices for broilers.

Figure 3: Broiler Production by Farm Size (chickens sold/yr), 1987-97



Source: *USDA 1997 Census of Agriculture*, Vol. 1, U.S. Summary Data, Table 20. Available at http://www.nass.usda.gov/census/census97/volume1/us-51/toc97.htm.

Figure 3 shows that in 1987 about 50 percent of the broilers sold each year came from large farms (those that sold 300,000 per year). Ten years later, 75 percent came from these farms. Only nine farms produce 59 percent of the nation's broiler inventory.[73] Likewise, the number of large hog and cattle herds has increased. Just 2 percent of the nation's feedlots supply three quarters of its cattle.[74] The increased density of animals per farm heightens the epidemiological risk: one infected animal can expose several thousand others.

Intensive farming is efficient; it allows farmers to raise more animals with fewer resources. The trend toward larger farms is unlikely to change, so this epidemiological risk must be countered in other ways.

Farm Biosecurity to Prevent Disease Introduction

A livestock producer can reduce the epidemiological risk by increasing biosecurity measures at his facilities. New animals should be isolated from the rest of the herd for several days to let potential symptoms appear. Currently most cattle diseases are introduced through the purchase of infected

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[73] *USDA 1997 Census of Agriculture*, Vol. 1, U.S. Summary Data, Table 20. Available at http://www.nass.usda.gov/census/census97/volume1/us-51/toc97.htm.

animals.[75] Vehicles and people should be kept away from livestock buildings because they could introduce or transmit diseases.[76]

Not all farms adhere to these general guidelines. A survey of 252 farms that raise hens for egg production, some with more than 200,000 egg layers, found that almost one-third of the sites allow nonbusiness visitors into the laying houses.[77] More than 85 percent of dairy farms do not isolate new cows from the rest of the herd for any period of time.[78]

> ***Recommendation*: The USDA should establish a Biosecurity Training Program to educate farmers on biosecurity best practices.**

A Biosecurity Training Program could entail a wide variety of activities such as educational mailings, presentations at local Farm Bureau meetings, and workshops at state and local levels. Biosecurity is in any farmer's interest. Heightened biosecurity will not only reduce the chance that a terrorist could introduce a disease into farm facilities, but will also reduce the spread of naturally occurring diseases and pests. This program would help counter the threat of agroterrorism at the front line: on the farm.

Crop Biosecurity to Prevent Disease/Pest Spread

Just as a high concentration of animals increases the risk of widespread disease, a high density of identical crops increases the risk of diseases or pests. The larger the available area for pathogen or pest infestation, the more successful the infestation will be. Vast areas of crop monocultures—fields planted with identical crops—and very simple crop rotations have increased susceptibility to pests.[79]

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[74] "Agriculture Department Heightens Counterterrorism Activities," *CBW Chronicle*, February 2000. Published by the Stimson Center, and available online at http://www.stimson.org.
[75] Smith, *Large Animal Internal Medicine,* p. 1648.
[76] Richard Battaglia and Vernon Mayrose, *Handbook of Livestock Management Techniques* (New York: Macmillan, 1981), p. 527.
[77] "Highlights of Layers '99 Study Results: Part II Biosecurity," USDA:APHIS:VS, January 2000. Available at http://www.aphis.usda.gov/vs/ceah/cahm/cahm-act.htm.
[78] "Biosecurity Practices of U.S. Dairy Herds," USDA, June 17, 1996. Available at http://www.aphis.usda.gov/vs/ceah/cahm/cahm-act.htm.
[79] Miguel A. Altieri, "Ecological Impacts of Industrial Agriculture and the Possibilities for Truly Sustainable Farming," *Monthly Review*, July/August 1998.

Planting crops that can resist pests and pathogens does not solve the whole problem. "History has repeatedly shown that a huge area planted with a single variety is very vulnerable to a new matching strain of a pathogen or insect pest."[80] This "matching" phenomenon is commonly observed in the evolution of island ecosystems. As the area planted with identical crops gets larger, the endemic pest population gets larger because there is greater opportunity for establishment. Even pathogens and pests that do not normally affect the crop can mutate into forms that will take advantage of the abundance. "An eventual proliferation of new parasitic species and strains, including pathogens, is the ages-old outcome of selective pressures when the host population is artificially increased."[81]

Rotating crops and planting a diverse range of plant varieties are often cited as ways to counter this disease and pest risk.[82] These methods, however, undermine the economy-of-scale benefits of monoculture. In addition, biosecurity measures such as the suggestions for animal disease control are unrealistic for crops. It would be virtually impossible to restrict people from getting close enough to crops to release or transmit a pathogen. Nevertheless it is important that farmers address the inherent risks of monoculture planting.

> ***Recommendation**: The Biosecurity Training Program should extend to crop farmers in order to educate them on the risks of monoculture planting and suggest appropriate means of avoiding long-term harm.*

Biosecure farm management practices protect farmers from losses to disease, and can reduce the need for pesticides, decreasing farmers' expenses. The more that farmers can do themselves to guard against diseases and pests, the lower the chance of an outbreak, whether natural or deliberate, local or catastrophic.

SECTOR LEVEL: USDA DISEASE DETECTION AND RESPONSE

The Animal and Plant Health Inspection Service, a division within the USDA, is responsible for protecting U.S. agriculture from diseases and pests. To do this, APHIS engages in a wide range of disease/pest detection and response activities. The enormous amount of human travel around the world, however, is making it harder to keep exotic diseases outside the U.S. Furthermore, as human resources

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[80] Ibid., p. 66.
[81] Martin Weitzman, "Economic Profitability Versus Ecological Entropy," draft paper presented at the Harvard University Seminar in Environmental Economics and Policy, Cambridge, Mass., February 23, 2000, p. 2.
[82] MacKenzie, p. 40.

decline at the USDA,[83] new strategies for detecting and eradicating diseases are needed. There are several technologies that can pick up where human surveillance leaves off, but these must be refined and deployed.

Disease Surveillance, Detection, and Diagnostic Capabilities

With many FADs, time is critical. The faster a disease can be detected and diagnosed, the sooner it can be controlled. This is especially important given the frequent travel of livestock among production facilities. Investment in developing new technologies and in upgrading laboratory facilities can increase the agricultural sector's level of preparedness for outbreaks.

Disease Surveillance and Detection

U.S. agriculture relies upon ground surveillance for disease reporting. The greater the number of human monitors, and the better trained they are to recognize diseases, the better the chance that serious diseases do not become widespread outbreaks.

Government budget cutbacks over the last decade have decreased the number of plant pathologists and field veterinarians. There have been reductions in staffing in government and at colleges of agriculture, and extension or applied research positions have been de-emphasized. "The U.S. is vulnerable to acts of bioterrorism due in part to a declining number of plant pathologists who can identify agents of plant disease."[84] Similarly, the number of field veterinarians has decreased substantially, and many are not well trained to recognize foreign diseases.[85] Surveillance is the first line of defense against a disease outbreak, whether natural or deliberate, and limited resources compromise this defense. Given the decreasing number of human surveyors, new technologies should be harnessed to maintain adequate surveillance.

> ***<u>Recommendation</u>: The USDA should increase funding for disease detection and surveillance technologies, such as linked human and animal disease databases and satellite surveillance.***

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[83] *Agriculture Fact Book, 1998*, p. 66. The number of people working at the USDA was 110,754 in 1995, 108,620 in 1995, and 99,866 (projected) in 1998.
[84] R. L. Forster, "Ground Surveillance," abstract of lecture given at the American Phytopathology Society Annual Symposium, Montreal, Canada, August 10, 1999. Available at http://www.scisoc.org/feature/BioSecurity/abstracts.htm.
[85] Brown, "Agro-Terrorism: A Cause for Alarm," p. 8.

These two detection/surveillance technologies are discussed below.

1. Linked Human and Animal Disease Databases. Good surveillance requires good intelligence. One innovative project called the Montana Plan has devised a partnership between human and veterinary health services. This web-based database contains records of both human and animal diseases, collected from a variety of traditional sources (i.e., state public health agencies) and nontraditional sources (i.e., Fish and Wildlife departments, poison control bureaus). It is a regional repository of information, covering Montana, the Dakotas, and Idaho, that could help diagnose emerging zoonotic diseases.[86] For example, if such a database had been available during the summer of 1999 in New York City, state epidemiologists would have been able to link the thousands of crow deaths with the mysterious human outbreak of West Nile virus.

Funding is needed for the computer equipment and for the manpower to set up the database infrastructure. In addition, the USDA should take a leading role in promoting this project and educating people on its wide-ranging benefits. One reason the Montana Plan has been so successful is that organizations voluntarily make entries into the database. Each recognizes the value of having a complete record that it can access at will.[87] By providing the funding and leadership, the USDA can help start multiple regional databases, which would then continue on their own momentum.

2. Satellite Tracking Systems. The USDA's Agricultural Research Service (ARS), in conjunction with four private companies, is developing a satellite-based system for remotely sensing crop distress. By combining various field measurements such as reflectance with Global Positioning System information, the system can pinpoint problems within fields. For example, the imaging system can detect a faulty irrigation system, an insect infestation, or other problems that cause visible changes in plants.[88] This type of early-warning system can alert farmers to problems in time to take action.

Disease Diagnosis

A fast diagnosis is critical in the case of a disease such as FMD, which can spread hundreds of miles during the time lag between when the disease is noticed and when a national lab confirms it. Currently

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[86] Telephone conversation with Dr. Marc Mattix, veterinary pathologist for Montana state diagnostic laboratory, May 18, 2000.
[87] Ibid.
[88] Kathryn Stelljes, Don Comis, Marcia Wood, and Dawn Lyons-Johnson, "From Sky to Earth ...Researchers Capture "Ground Truth," *Agricultural Research*, March 1999, p. 5.

there are no rapid screening tests for FADs. State labs do not routinely check for FADs because these diseases are so rare, and in some cases they do not have the resources to diagnose particular FADs. These samples have to be sent to a national lab. As a result, it could take several days for a FAD to be diagnosed.[89]

> ***<u>Recommendation</u>: The USDA should increase funding to ARS or to private contractors for the development of rapid FAD diagnostic technologies. These screening tests should be made available at state levels.***

Rapid diagnostic tools can be used directly on animals and do not require additional lab analysis. These "pen-side" diagnostic tests can tell immediately if an animal has the antibodies to the disease in question. A farmer or local veterinarian could use multiple pen-side diagnostics to determine which disease was the culprit. For example, FMD is often mistaken for vesicular stomatitis, which does not spread nearly as rapidly. By using a few of these diagnostic tests, a veterinarian could pinpoint the actual disease quickly. The second diagnostic, a differential test kit, could be used to tell whether or not an animal had already been vaccinated against the disease in question. (The presence of antibodies could mean either that the animal is infected or that it has been vaccinated, and veterinarians need to know which is the actual case.) Both of these technologies would be extremely useful for fast diagnosis and disease containment.

Plum Island: Biosafety Level 4

The place where rapid diagnostic tools would be developed is the Plum Island Animal Disease Center, located off the northeastern tip of Long Island, New York. Plum Island is currently doing research on FMD and African swine fever, and it develops vaccines for a variety of FADs.[90] It has added 1 million doses of FMD vaccine to the North American FMD Vaccine Bank. It also conducts research on ways to facilitate imports and exports through appropriate meat processing techniques.[91]

By law, Plum Island is the only laboratory in the country that can do research on certain highly infectious animal diseases such as FMD. Currently Plum Island is certified as a Biosafety Level 3 (BL3) lab. Typically, diseases that are lethal to humans and have no known human vaccine are handled in a BL4 lab, which offers the highest level of safety to humans. The BL4 labs in the U.S., however, such as the ones at

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[89] Telephone conversation with Dr. Ty Vannieuwenhoven, May 10, 2000.
[90] "Plum Island Animal Disease Center: Selected Scientific Accomplishments," available at http://www.ars.usda.gov/plum/accomplish.htm.
[91] Ibid.

the National Institutes of Health in Bethesda, Maryland, and at the Centers for Disease Control in Atlanta, Georgia, are designed for the study of human diseases only. The U.S. has no BL4 facilities for the study of farm animals, even though animal diseases such as West Nile virus and Nipah virus can be fatal to humans.[92]

> ***<u>Recommendation</u>: Funds should be allocated to upgrade the Plum Island Animal Disease Center to Biosafety Level 4.***

New infectious diseases are appearing in animals worldwide, and some of these diseases are proving hazardous to humans. In Malaysia the Nipah virus, which emerged among swine in 1998, has claimed more than one hundred human lives.[93] During the summer of 1999 in New York City, seven people died from West Nile virus, which first appeared among birds in the area.[94] Researchers are already working on West Nile virus at Plum Island.[95] To develop new diagnostic technologies and vaccines, which will benefit the entire agriculture sector, researchers need a safe facility to work in. Upgrading the facility to BL4 will allow them to study dangerous zoonotics under appropriately safe conditions.

USDA Disease Response Procedures and Capabilities

The USDA has extensive procedures in place for dealing with disease outbreaks among plants and animals. These emergency procedures begin at the local level and expand to include national labs and administration if the situation is sufficiently serious.

If the USDA knew that a disease outbreak was not natural but deliberate, emergency response personnel would have to treat the area as a crime scene, working closely with the Federal Bureau of Investigation (FBI).[96] The USDA is unlikely to know this, however, because the outbreak would only become apparent

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[92] "Expanded Research Scope Under Consideration for Plum Island," available at http://www.ars.usda.gov/plum/bsl4.htm.
[93] "Nipah Virus—Malaysia: Official Report," Pro-MED Mail post No. 990606113005, June 6, 1999. Available in Pro-MED archive at http://www.promedmail.org.
[94] "Expanded Research Scope Under Consideration for Plum Island."
[95] Telephone conversation with Ty Vannieuvenhoven, May 12, 2000.
[96] One successful incident of this type happened recently in Montana. According to Dr. Marc Mattix, there was an anthrax outbreak, which they decided to treat as a possible crime scene. County law enforcement and FBI personnel conducted an investigation alongside the animal health responders. It was eventually determined that the outbreak was not deliberate. Dr. Mattix believes that the coordination between the various government agencies in this situation worked well.

several days or even weeks after someone released the pathogen. Even if the USDA knew that it was deliberate, they would still have to contain the outbreak. Thus the USDA's ability to handle a bioterrorist attack on agriculture hinges on its ability to handle natural outbreaks of disease.

Current Emergency Management Procedures

Disease outbreaks among plants or animals fall under the auspices of APHIS, a division of the USDA's Marketing and Regulatory Programs (see Appendix B for an organizational chart). Within APHIS, animal disease outbreaks are handled by Veterinary Services (VS), while plant disease outbreaks are handled by Plant Protection and Quarantine (PPQ). Procedures differ between the two, so they are addressed separately below.

1. Emergency Procedure for Animal Disease Outbreaks. Within thirty-six hours of a serious disease outbreak, a national USDA team can be mobilized to handle the situation. The following is a summary of what would happen if a FAD broke out:[97]

1) A farmer notices a sick animal, or a herd manager of a large production operation notices a higher mortality rate than normal or unique symptoms in a group of animals and calls the local or corporate veterinarian. This recognition could also begin at a port, sale barn, or other place of animal concentration.

2) The veterinarian either makes a diagnosis of a domestic disease or suspects something abnormal based on clinical signs or epidemiology.

3) If abnormal, the veterinarian will notify a representative of the state veterinarian or APHIS area veterinarian in charge, who will begin the investigation.

4) Within twenty-four hours, a foreign animal disease diagnostician (FADD) visits the premises and begins an investigation. The FADD may be a state or federal veterinary medical officer. The FADD works with the labs to describe the situation and takes the appropriate samples to confirm the disease.

5) The Early Response Team (ERT) may be called within twenty-four hours to characterize an unconfirmed or emerging disease or to describe the pathogenesis and epidemiology of

[97] This sequence of events was provided by Dr. Ty Vannieuwenhoven, APHIS Emergency Programs Staff.

the disease. The ERT makes recommendations that may lead to either a return to routine control and surveillance measures or an escalation of response.

6) If a disease is confirmed, local and State resources are used to contain, control and eradicate the disease if possible. If those resources are exceeded or the state requests assistance, the Regional Emergency Animal Disease Eradication Organization (READEO) is activated to integrate with the state's response. The READEO's role is to give additional technical support, coordinate national communication, and manage national consequences and federal response resources.

2. Emergency Procedure for Plant Disease Outbreaks. PPQ's Invasive Species and Plant Management (ISPM) section is responsible for plant disease control and eradication.[98] Plant protection includes guarding against foreign diseases as well as against pests, which can transmit diseases or do direct damage to crops. Below is an outline of the events following a plant disease outbreak.

1) A grower recognizes a problem with his crops and contacts his local plant health expert, often a plant pathologist associated with a university. Under most circumstances, the grower can simply send a sample of the diseased plant into a local agricultural lab and get a diagnosis. PPQ allows forty-eight hours from initial report of a disease to confirmation by a qualified taxonomist.[99]

2) If the lab recognizes the disease as being particularly serious, it will notify the state plant health authority.

3) If the disease is one for which emergency procedures already exist, then the plan is put into action by the ISPM personnel, regional Rapid Response Teams (RRTs), regional and state personnel, and industry groups.

4) An RRT can be at the infection site within forty-eight hours; the members of this team are prepared to take emergency quarantine action if necessary.[100]

5) If the pest is a new one, PPQ calls upon the New Pest Advisory Group to assess the significance of the pest and to determine a response plan.[101] This process takes at most

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[98] *Emergency Programs Manual*, USDA:APHIS Plant Protection and Quarantine, June 1996, p. 15; and telephone conversation with Dr. Steve Knight, APHIS PPQ, May 17, 2000.
[99] *Emergency Programs Manual*, p. 237.
[100] Ibid., p. 98.
[101] Ibid., p. 30.

> twenty-one days for pests that are not considered critical, or significantly less for a major pest that is likely to spread quickly and that may have significant economic or other effects.[102]

Although plant diseases do not usually spread as rapidly as animal diseases do, PPQ has procedures in place to control outbreaks very quickly.

Supplemental Human Resources for Emergency Response

APHIS's emergency response capabilities could be overwhelmed by a deliberate disease introduction, especially if an attack occurred in multiple locations and/or with multiple pathogens. Resource cutbacks in Veterinary Services, both within the U.S. and abroad, raise the possibility that there may not be sufficient qualified staff to respond effectively to an outbreak.[103] Emergency response capabilities need to have some type of "surge" capacity.[104]

Conveniently, there are many people throughout the country with the expertise needed in the event of an emergency: local accredited veterinarians. A four-country review of the U.S. animal health emergency management system suggests that the USDA should make a formal, cooperative arrangement with the American Veterinary Medical Association so that accredited veterinarians could be called upon to assist in the event of a widespread emergency.[105]

> ***<u>Recommendation</u>*: *The USDA should establish a contingency network of accredited veterinarians in case of a catastrophic outbreak.***

Almost all practicing veterinarians in the U.S. have been accredited by the USDA, a distinction that includes some training (though limited) in FADs.[106] These veterinarians are located nationwide, and they are likely to be the first responders in any FAD outbreak. With some additional FAD training, possibly

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[102] Ibid., p. 243.
[103] *Quadrilateral Review of the United States Animal Health Emergency Management System,* USDA, 1996, p. 28. This was an independent review of U.S. AHEM by Australia, Canada, New Zealand, and the U.S.
[104] Horn and Breeze, "Agriculture and Food Security," p. 15.
[105] *Quadrilateral Review of the United States Animal Health Emergency Management System*, p. 28.
[106] Phone conversation with Dr. Ian Stewart, USDA: APHIS Emergency Programs veterinarian, March 28, 2000. Although accreditation includes some FAD training, there is no requirement for "refresher" courses. For some vets it has been twenty or more years since their FAD training. If accredited vets are to be enlisted in emergency response, they will probably need additional training.

through Plum Island's current training course for veterinarians,[107] local accredited vets could become a valuable contingency resource.

NATIONAL LEVEL: POLICIES FOR ECONOMIC RECOVERY

The effects of an agroterrorist attack would extend beyond the agricultural sector. Americans nationwide could suffer from higher food prices, as well as from the psychological effects of a food scare. As a federal agency, the USDA has the opportunity to expand its scope of influence to include national strategies for countering the social and economic threat of agroterrorism.

Public Opinion

Export restrictions aside, the loss of domestic sales due to an agroterrorist attack depends to a large degree on the public's reaction to an outbreak. If people perceive a personal health risk, they will stop buying the risky product, even if the animal/crop disease poses no threat to human health, or even if there are no diseased products on the market. It is the *perception* of risk, not necessarily the actual risk, that can drive financial losses exponentially higher than necessary.

Example: BSE and the British Campaign to Restore Public Confidence

Bovine spongiform encephalopathy (BSE) is thought to have been present in British cattle at low levels since the eighteenth century. It is not communicable, has an incubation period lasting several years, and has been inherited at low frequency by succeeding generations of cattle. BSE is also thought to be associated with scrapie, a sheep disease.[108]

The BSE story began in about 1980, when a change in British rendering procedures left sheep carcasses with the scrapie agent still active. Cattle were then fed meat and bone meal made from the infected sheep, causing the cattle's brain and nervous system tissues to become infected. These cattle were then rendered after slaughter, only to be fed back to other cattle in the form of meat and bone meal, causing an explosive growth in the number of BSE infections.[109]

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[107] Phone conversation with Dr. David Huxsoll, Director of Plum Island. Plum Island currently conducts FAD training courses, but the frequency may have to be increased to accommodate additional vets.

[108] Paul Brown and Raymond Bradley, "1755 and All That: A Historical Primer of Transmissible Spongiform Encephalopathy," *British Medical Journal*, December 19-December 26, 1998.

After the March 1996 announcement of a probable link between consumption of BSE-infected meat and a lethal human neurological disease, new variant Creutzfeldt-Jakob disease, confidence in British beef plummeted. The industry once valued at an estimated $880 million per year suddenly became worthless.[110]

But two years after the outbreak, beef sales rose to 93 percent of the pre-1996 levels. This was due in large part to an extensive public relations campaign waged by Britain's Meat and Livestock Commission (MLC).[111] The MLC set up a strategy group that included senior MLC officials as well as representatives from advertising agencies. The campaign emphasized messages such as the beef industry's improved hygiene and quality standards. It was closely tied into the government efforts at controlling BSE, so advertising agencies were kept abreast of government initiatives. This aggressive campaign has been successful in restoring confidence in British beef.[112]

USDA Preparedness to Restore Public Confidence in U.S. Agricultural Products

If U.S. agricultural exports are curtailed, it will be critical for the U.S. to maximize its domestic sales. An effective public relations campaign could help bring sales back up after a food scare.

> ***<u>Recommendation</u>: The USDA should prepare a contingency public relations campaign to restore/promote confidence in U.S. agricultural products.***

The USDA can prepare itself for an agroterrorist event by planning a campaign, to (1) communicate to the public what actions the USDA is taking to protect public health, and (2) restore confidence in the untainted products. Its message should be clear and informative, communicating specific information regarding what happened, which items have been affected, what the USDA has done to quarantine the affected products, and what is being done to ensure quality among the remaining products.

It is important that these efforts are not wasted if there are no disease outbreaks, deliberate or otherwise. Whatever advertisements or announcements the USDA makes should be sufficiently generic that they could be used as educational materials to promote confidence in U.S. goods. For example, they could

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109 Ibid. Also Frederick Murphy, "The Threat Posed by the Global Emergence of Livestock, Food-borne, and Zoonotic Pathogens," pp.22-23.

110 Brown, "Agro-Terrorism: A Cause for Alarm," p. 7.

111 Robert Gray, "Mad Cows and English PR Men," *Marketing*, April 16, 1998.

112 Ibid.

explain what the USDA does on a regular basis to protect public health and ensure product quality. Specific announcements about an outbreak should be planned but not created in advance.

Budget Planning for Disease Outbreaks

When a disease outbreak is so serious that it hinders interstate and foreign trade, the secretary of agriculture can declare an "extraordinary emergency" and seize, quarantine, and dispose of affected or exposed animals as he deems necessary or appropriate.[113] Owners of those animals are then eligible for fair market value compensation of the animals they lost, though not for the revenue lost due to the imposed quarantine or the lost production time.[114] The same is true for farmers whose crops contract serious diseases or pests.[115] But an extraordinary emergency will be declared only if "adequate measures are not being taken by the State or other jurisdiction."[116] Thus federal involvement depends upon how much has been done already at the state level. Given that states' abilities to deal with disease outbreaks vary, the need for federal involvement will differ in each situation. This blurred division between state and federal responsibilities makes federal budgeting for disease eradication difficult.

If the amount of money needed for disease eradication and compensation is very high, extraordinary emergencies are funded by ad hoc congressional legislation. An emergency supplemental appropriation is passed in this case, which is not subject to the balanced budget amendment. The USDA's Farm Services Agency (FSA) usually coordinates the compensation programs.[117] Otherwise the money comes from within the USDA, often from FSA but sometimes from another part of the agency that happens to have the necessary resources.[118]

> ***Recommendation*: The USDA should establish a contingency budget to fund disease eradication efforts and compensation costs.**

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113 "Livestock and Poultry—Diseases," Public Law 87-518, July 2, 1962.
114 Ibid.; and written comments from Dr. Ty Vannieuwenhoven.
115 The cities of New York and Chicago are receiving $1.4 million and $450,000 respectively for tree removal costs accrued during recent efforts to eradicate the Asian longhorned Beetle. "Glickman Announces Additional $5.5 Million to Combat Asian Longhorned Beetle, Reimburse Chicago and New York for Tree Removal Costs," USDA press release, March 12, 1999. Growers affected by the outbreak of Karnal bunt of wheat are also eligible for compensation. "Final Karnal Bunt Compensation Rule for 1996-97," USDA:APHIA:PPQ press release, June 9, 1998.
116 "Livestock and Poultry—Diseases."
117 Phone conversation with Jerry Alanko, Farms Services Agency, March 28, 2000.
118 Telephone conversation with Dr. Steve Knight, APHIS PPQ, May 23, 2000.

By having funds readily available, the USDA can avoid the delay of procuring money by an ad hoc process. This preparation will enable the USDA to begin disease eradication efforts sooner, and to compensate farmers quickly, which will speed national agricultural recovery times.

Surge capacity for the budget should also be considered. In the event of an agroterrorist event, disease eradication and compensation costs could reach into the billions of dollars. Preparedness for an extreme emergency should take into consideration how enough money can be secured on short notice and how it can be administered quickly and efficiently.

> ***Recommendation:* The USDA should devise a strategy for obtaining very large amounts of money as preparation for a major disease outbreak and eradication effort.**

This is not to say that surge capacity should be included in the contingency budget suggested above. It would, however, be useful to have a plan for procuring and distributing sums upward of $10 billion on short notice. This is a rough estimate, taking into account the values of the agricultural commodities that appear in Table 3.

Table 3: Total Values of Agricultural Commodities

Commodity	**1996 Value of Cash Receipts ($U.S. billion)**
Cattle and Calves	$ 31.1
Dairy products	$ 22.8
Broilers	$ 13.9
Hogs	$ 12.6
Corn	$ 21.6
Wheat	$ 9.9
Rice	$ 1.6

Source: *Agriculture Fact Book, 1998*, pp. 43-44.

Assuming that an agroterrorist attack would affect one commodity for one year, that export restrictions would be imposed for that year, and that little of the commodity could be sold on the domestic market for that year, $10 billion seems to be an appropriate starting point. Probably the worst-case scenario would be an outbreak of foot-and-mouth disease, which affects both cattle and swine. The commodities together represent about $65 billion worth of lost value to U.S. producers, (cattle, dairy products, and hogs).[119]

The U.S. is not in danger of lacking the funds to eradicate disease or to compensate farmers. In the event of a catastrophic disease incident, however, enormous amounts of money will have to be transferred very quickly. Having a contingency plan for a surge in the budget will help the USDA to recover quickly from either a natural or deliberate catastrophe.

CONCLUSION

Biological weapons are not just a threat to human health. A terrorist armed with animal or plant pathogens also threatens the livestock, poultry, and crops of the agricultural sector, a vital part of the U.S. economy. The fact that a single, determined individual or small group could bring all U.S. beef or wheat exports to a halt underscores the need for increased defense against this threat.

U.S. agriculture is particularly vulnerable to foreign diseases, to which domestic animals and plants have not built up a natural resistance. In addition, with crops and animals concentrated in fewer production facilities, and with the frequent transportation of animals among these facilities, a single pathogen introduction could cause very widespread infection. The USDA maintains disease detection and response capabilities, but its resources may be overwhelmed by a deliberate attack, especially if the attack involves a foreign disease and/or several simultaneous outbreaks. An outbreak of a foreign disease could prompt the international community to impose export restrictions on U.S. agricultural goods, resulting in severe financial losses for U.S. producers. The public reaction to an agroterrorist attack may further amplify these financial losses, if food safety concerns prompt voluntary boycotts of domestic agricultural products.

This report suggests that the USDA take action on four levels to reduce the possibility of an agroterrorist attack, as well as to minimize the negative consequences of such an attack.

1. **Organism Level**. The USDA should be ready to supply vaccines for all List A foreign animal diseases.

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[119] By comparison, the 1989 savings and loan bailout has cost about $165 billion. Sean Paige and Timothy W Maier, "Savings-and-Loan Bailout: The Bills Keep Coming," *Insight on the News*, Jun 7, 1999, p.45. Nevertheless the government has not been crippled by this enormous burden. An agricultural disaster would be expensive but probably would not surpass that price. The U.S. can handle massive financial burdens, but would benefit from careful attention to financing options.

2. **Farm Level**. The USDA should set up a Biosecurity Training Program to counter the threat of diseases and pests at the farm level.
3. **Sector Level**. The USDA should invest more resources in disease detection, surveillance, and diagnostic technologies. Examples include creating linked animal-human disease databases, developing more rapid diagnostic tests for FADs, upgrading Plum Island to BL4, and establishing a contingency network of veterinarians.
4. **National Level**. The USDA should be ready to deal with the public reaction to a serious food scare, and it should have the budgetary means to proceed with fast and efficient disease recovery.

The challenge of domestic preparedness is to anticipate the threat and counter it *before* an incident occurs. An examination of the U.S. agricultural system brings to light several opportunities for defending against terrorist attack, while simultaneously improving overall animal and plant health. With a heightened awareness of the threat and with additional resources, the USDA can effectively protect agriculture, one of America's critical infrastructures.

List of Acronyms

APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
BL3	Biosafety Level 3
BSE	Bovine spongiform encephalopathy
BW	Biological weapons
BWC	Biological Weapons Convention (of 1972)
ERT	Early Response Team (for animal disease outbreaks)
FAD	Foreign animal disease
FADD	Foreign animal disease diagnostician
FMD	Foot-and-mouth disease
FSA	Farm Services Agency
GMO	Genetically modified organism
HPAI	Highly pathogenic avian influenza
IPPC	International Plant Protection Convention
ISPM	Invasive Species and Plant Management
MLC	Meat and Livestock Commission (Britain)
nvCJD	new variant Creutzfeldt-Jakob disease
OIE	Office International des Epizooties (International Office of Zoonotics)
PPQ	Plant Protection and Quarantine
READEO	Regional Emergency Animal Disease Eradication Organization
RRT	Rapid Response Team (for plant disease outbreaks)
USDA	United States Department of Agriculture
VS	Veterinary Services
WTO	World Trade Organization

Appendix A: International Office of Zoonotics Lists A and B Diseases

List A Diseases:

Transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socioeconomic or public health consequence, and which are of major importance in the international trade of animals and animal products.

List B Diseases:

Transmissible diseases that are considered to be of socioeconomic and/or public health importance within countries and which are significant in the international trade of animals and animal products.

LIST A Diseases

Foot and mouth disease	Bluetongue
Vesicular stomatitis	Sheep pox and goat pox
Swine vesicular disease	African horse sickness
Rinderpest	African swine fever
Peste des petits ruminants	Classical swine fever
Contagious bovine pleuropneumonia	Highly pathogenic avian influenza
Lumpy skin disease	Newcastle disease
Rift Valley fever	

LIST B Diseases

List B Multiple Species diseases

Anthrax	Q Fever
Aujeszky's disease	Rabies
Echinococcosis/hydatidosis	Paratuberculosis
Heartwater	New World screwworm (Cochliomyia hominivorax)
Leptospirosis	Old World screwworm (Chrysomya bezziana)

List B Cattle diseases

Bovine anaplasmosis	Haemorrhagic septicaemia
Bovine babesiosis	Infectious bovine rhinotracheitis / infectious pustular vulvovaginitis
Bovine brucellosis	Theileriosis
Bovine genital campylobacteriosis	Trichomonosis
Bovine tuberculosis	Trypanosomosis (tsetse-borne)
Bovine cysticercosis	Malignant catarrhal fever
Dermatophilosis	Bovine spongiform encephalopathy
Enzootic bovine leukosis	

List B Swine diseases

Atrophic rhinitis of swine	Trichinellosis
Porcine cysticercosis	Enterovirus encephalomyelitis
Porcine brucellosis	Porcine reproductive and respiratory syndrome
Transmissible gastroenteritis	

List B Avian diseases

Avian infectious bronchitis	Fowl typhoid
Avian infectious laryngotracheitis	Infectious bursal disease (Gumboro disease)
Avian tuberculosis	Marek's disease
Duck virus hepatitis	Avian mycoplasmosis (M. gallisepticum)
Duck virus enteritis	Avian chlamydiosis
Fowl cholera	Pullorum disease
Fowl pox	

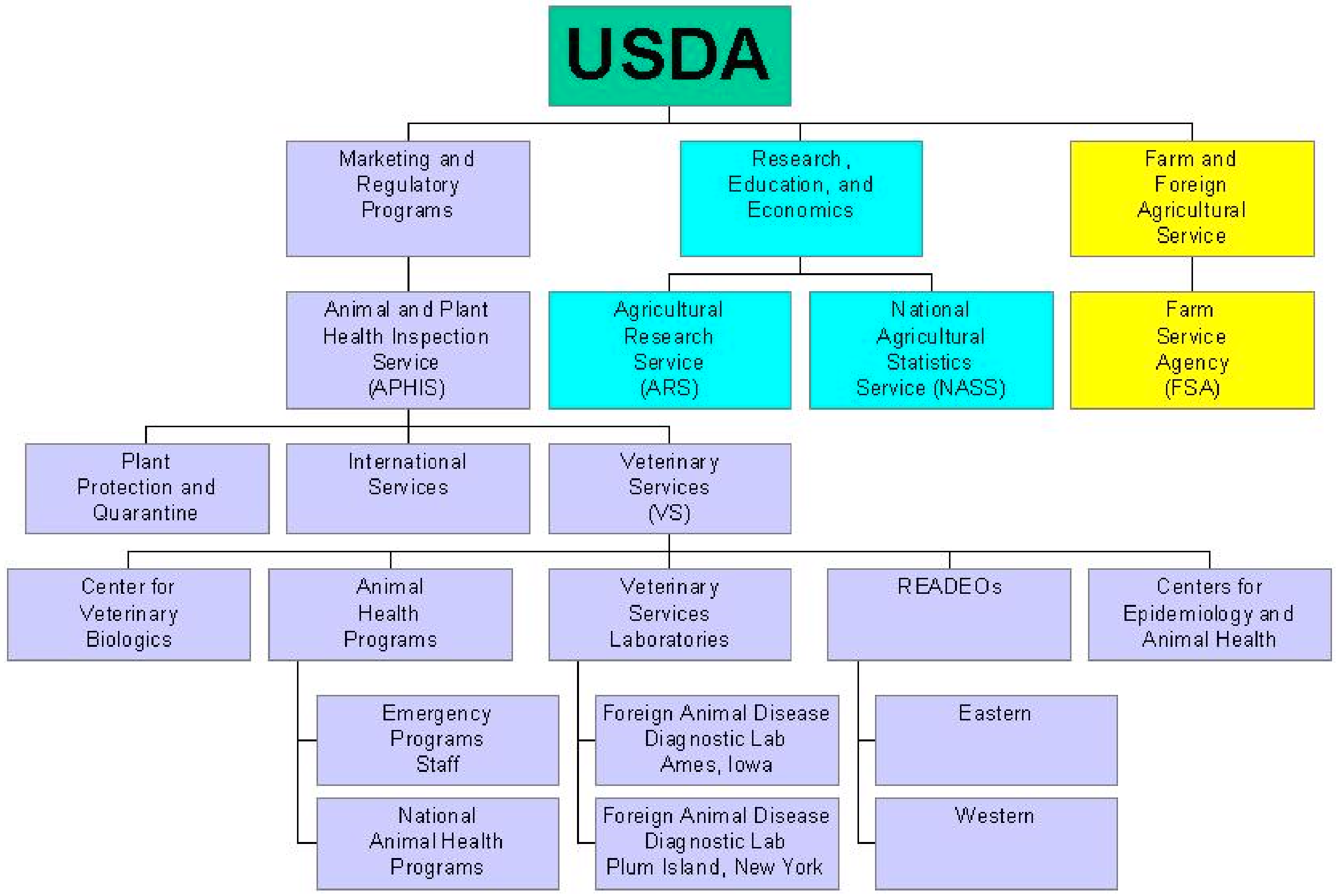
List B categories not listed here: equine diseases, sheep and goat diseases, fish diseases, crustacean diseases, Lagomorph diseases, mollusc diseases, bee diseases, and other diseases

Sources:

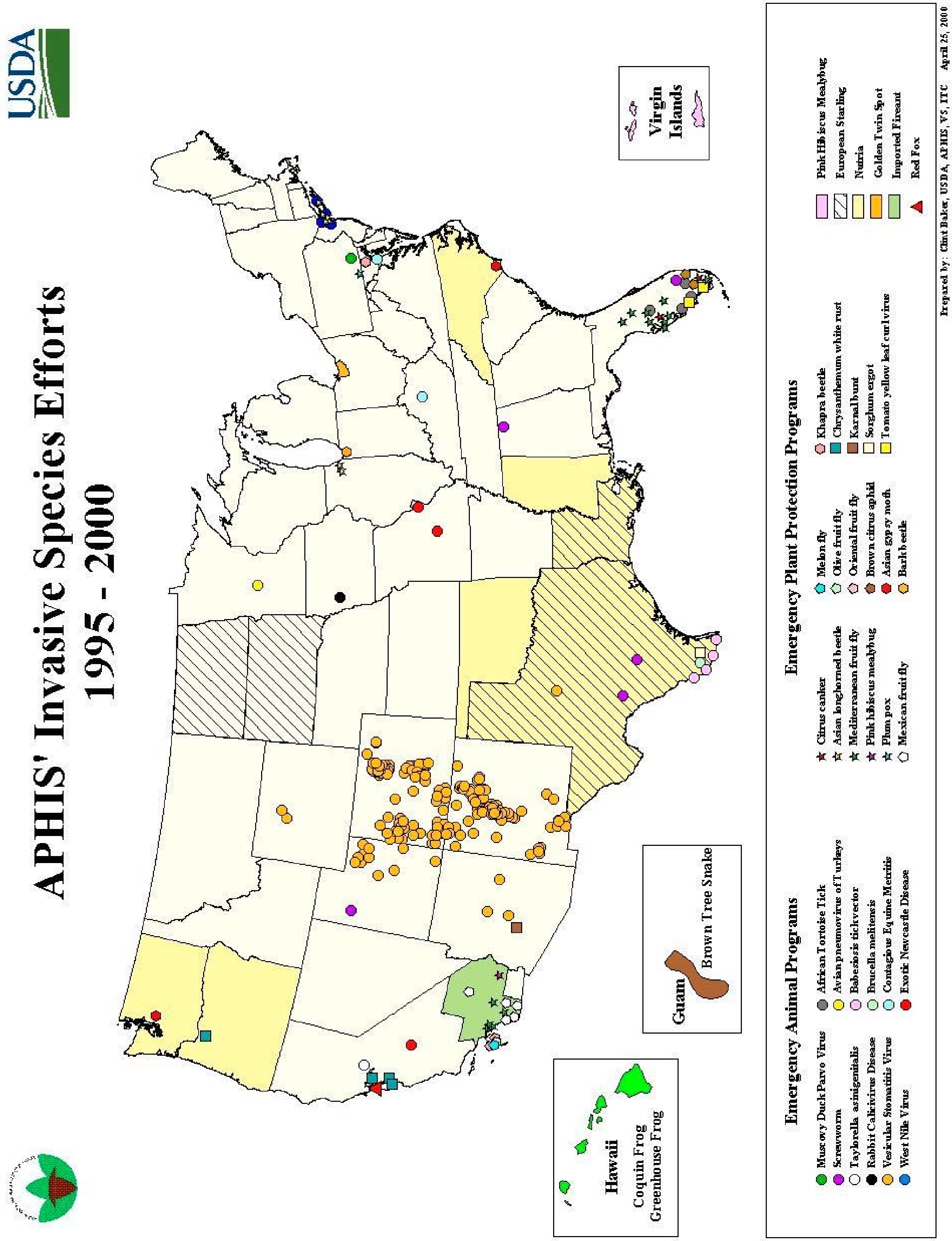
Definitions of List A and B diseases can be found on the OIE web site at http://www.oie.int/eng/maladies/en_classification.htm.

Disease lists can be found on the OIE web site at http://www.oie.int/eng/maladies/en_fiches.htm.

Appendix B: USDA Organization Chart



This organization chart shows the relationships between the departments mentioned in this report.
Note: It does not show every department in the USDA.


APHIS' Invasive Species Efforts
1995 - 2000
USDA
Virgin Islands
Guam
Brown Tree Snake
Hawaii
Coquin Frog
Greenhouse Frog
Emergency Animal Programs
Muscovy Duck Parvo Virus
Screwworm
Taylorella asinigenitalis
Rabbit Calicivirus Disease
Vesicular Stomatitis Virus
West Nile Virus
African Tortoise Tick
Avian pneumovirus of Turkeys
Babesiosis tick vector
Brucella melitensis
Contagious Equine Metritis
Exotic Newcastle Disease
Emergency Plant Protection Programs
Citrus canker
Asian longhorned beetle
Mediterranean fruit fly
Pink hibiscus mealybug
Plum pox
Mexican fruit fly
Melon fly
Olive fruit fly
Oriental fruit fly
Brown citrus aphid
Asian gypsy moth
Bark beetle
Khapra beetle
Chrysanthemum white rust
Karnal bunt
Sorghum ergot
Tomato yellow leaf curl virus
Pink Hibiscus Mealybug
European Starling
Nutria
Golden Twin Spot
Imported Fireant
Red Fox
Prepared by: Clint Baker, USDA, APHIS, VS, ITC April 25, 2000

EXECUTIVE SESSION ON DOMESTIC PREPAREDNESS

JOHN F. KENNEDY SCHOOL OF GOVERNMENT
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The John F. Kennedy School of Government and the U.S. Department of Justice have created the Executive Session on Domestic Preparedness to focus on understanding and improving U.S. preparedness for domestic terrorism. The Executive Session is a joint project of the Kennedy School's Belfer Center for Science and International Affairs and Taubman Center for State and Local Government.

The Executive Session convenes a multi-disciplinary task force of leading practitioners from state and local agencies, senior officials from federal agencies, and academic specialists from Harvard University. The members bring to the Executive Session extensive policy expertise and operational experience in a wide range of fields - emergency management, law enforcement, national security, law, fire protection, the National Guard, public health, emergency medicine, and elected office - that play important roles in an effective domestic preparedness program. The project combines faculty research, analysis of current policy issues, field investigations, and case studies of past terrorist incidents and analogous emergency situations. The Executive Session is expected to meet six times over its three-year term.

Through its research, publications, and the professional activities of its members, the Executive Session intends to become a major resource for federal, state, and local government officials, congressional committees, and others interested in preparation for a coordinated response to acts of domestic terrorism.

***For more information on the Executive Session on Domestic Preparedness, please contact*:**

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