Viewpoint

Biological Terrorism Targeted at Agriculture: The Threat to US National Security

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The Midwest is reeling from an infestation of corn blight. Over 200 farms in Iowa alone have reported infections. Plant pathologists note that the pattern of infestation is inconsistent with a natural outbreak since the infections occurred in many places at once and were found in farms along major interstate highways. Scientists found that the infecting strain is identical to one found in Asia. Recently, this news station has received a letter from a group calling itself the Guardians of Gaia. They have claimed responsibility for the outbreaks and stated that they will continue to attack America's corn crops until farmers disavow the use of genetically modified 'franken-seed.' Already, several countries and food companies have turned to corn producers from other nations to avoid consumer backlash against the tainted produce. A USDA spokeswoman has claimed that corn blight is completely harmless to humans and consumers have nothing to worry about from eating infected corn. Furthermore, she stated that the actual damage to the crop has been minimal. However, the $20 billion a year corn-growing industry is already unable to sell its stores of corn….

This fictional scenario illustrates a current national security problem: several non-state actors have the ability to infect large swaths of US agriculture with pathogens that can cause severe economic disruption. Despite the severity of the threat, the US Congress has failed to provide adequate funding for countermeasures, and US agencies and agricultural industries have not taken the necessary steps to prevent agroterrorist attacks.

Last year, Congress appropriated $10 billion to combat terrorism, most of which was spent to prevent attacks using conventional weapons, the primary tool of terrorists today. One billion dollars of this allocation were specifically earmarked to thwart terrorism involving weapons of mass destruction such as biological weapons. Even though biological weapons that target agriculture are capable of massive economic damage on a national scale, the US Department of Agriculture (USDA) has not received the funds to combat terrorism that it requested out of this allotment. The USDA advanced two counter-terrorism proposals in the 2001 budget that totaled merely $15.9 million. However, the House of Representatives has approved only $2.9 million and the Senate only $3.6 million for these purposes.[1]

This financial neglect is mirrored by the limited attention given to anti-agriculture terrorism in US law and policy directives. Biological weapons that do not kill people are not included in the definition of "weapons of mass destruction" as stated in title 50, chapter 40 of the US Code (Defense Against Weapons of Mass Destruction Act). In fact, terrorism targeting crops or livestock is not mentioned in the unclassified portions of Presidential Decision Directives 39 or 62 (which both delineate policy on counter-terrorism) or, most surprisingly, Presidential Decision Directive 63, "Protecting America's Critical Infrastructure."

Response to a natural agricultural disease outbreak is coordinated by the Animal and Plant Health Inspection Service (APHIS), which would therefore also be responsible for managing the response to a biological attack on crops or livestock. Funding for this service, which is a branch of the USDA, has recently been diminished, thus reducing the number of plant and animal pathologists who can recognize and react to an outbreak of disease. A large-scale or multi-focal outbreak would likely overwhelm the response capability of this service, allowing for the catastrophic spread of disease.[2]

Agriculture is a major sector of the US economy whose protection should be given a high priority. The US agricultural sector accounts for 13 percent of the Gross Domestic Product and provides jobs for over 15 percent of Americans.[3] Exports of agricultural goods accounted for more than $50 billion dollars in 1998.[4] In addition to its economic significance, the agriculture sector also has special importance as a source of the nation's food supply.

Anti-agriculture biological terrorism may have received little attention because of a misconception that it is as difficult to obtain, weaponize, and disseminate agricultural pathogens as it is to take an anti-human biological weapon from bacteria to bomb. Biological agents that target people are extremely difficult to make into weapons that would kill more people than conventional explosives. Combined with the fact that only a subset of terrorists would want to kill thousands of people, this has led policymakers to conclude that such catastrophic terrorism is a "high-consequence, low-probability event."[5] However, a major act of agricultural terrorism, one that causes over a billion dollars in damage, could be produced by a series of limited infections triggered by pathogens delivered by simple methods. Furthermore, depending on the agent chosen, biological attacks against agriculture could appeal to politically motivated terrorists or criminal groups seeking financial gain, as well as to apocalyptic groups who seek to kill as many people as possible. A biological attack that targets agriculture, therefore, should be regarded as a "high-consequence, high-probability" event and receive the attention it deserves as a grave national security risk.

This viewpoint first outlines the relatively low technical barriers to obtaining non-human pathogens. It then argues that agricultural pathogens can be easily employed to harm animals and crops, causing major economic disruption. Next it reviews the types of terrorists most likely to be motivated to resort to agroterrorism. This viewpoint concludes that measures must be taken both to prevent and to mitigate agroterrorist attacks, and it offers several specific recommendations.

THE ABILITY OF TERRORISTS TO OBTAIN NON-HUMAN PATHOGENS[6]

Isolation from the Environment

To obtain a pathogen, a terrorist group could try to isolate the organism from the environment, order it from a biological collection or laboratory, or be given it by a state sponsor. To isolate a human pathogen from the environment would require a terrorist group to have at least a few members with expertise in microbiology. However, even a trained microbiologist has difficulty isolating the most highly pathogenic strains from nature and, once isolated, these strains often prove difficult to culture effectively while maintaining virulence. For example, Aum Shinrikyo, a well-funded and organized cult that released nerve gas on the subways of Tokyo, attempted to culture Ebola virus and *Bacillus anthracis* (the causative agent of anthrax) by collecting these agents from infected individuals and the environment, respectively. Both attempts failed to produce a weapon that caused any human deaths, despite the presence of several highly trained microbiologists in their group.[7]

The culturing of many animal and plant diseases from the environment is far easier. The former Soviet bioweapons scientist Ken Alibek has noted that the Soviets found anti-agriculture weapons easier to produce:

> In contrast to the sophisticated reactor techniques developed to produce anti-personnel biological weapons, anti-agricultural weapons were generally produced by more primitive

> methods. For the anti-crop fungal diseases, this involved basic surface cultivation techniques. For anti-livestock weapons, cultivation generally involved live-animal techniques. It is worth noting that both of these basic techniques could be easily adapted by terrorists.[8]

In fact, not only the Soviets but also the Iraqis used simple plant-surface culturing techniques to harvest anti-agricultural pathogens in the late 1980s.[9]

To culture a livestock or poultry pathogen, a terrorist would first have to find an outbreak of the disease he wished to isolate. The terrorist could then purchase an infected animal and, after modest processing, have a sample containing the pathogen. This sample could then be smuggled into this country and used to cultivate more pathogen.

The prospects for terrorist success can be gauged from a non-terrorist case, in which farmers in New Zealand sought to eradicate rabbits that were infesting their farms. It appears that the farmers had rabbit calicivirus smuggled into the country through one of the tightest airport/port biosecurity regimes in the world. Without using any special equipment, the farmers were able to culture the virus and then disseminate it by contaminating vegetables left out for the foraging rabbits.[10]

Plant pathogens could also be obtained with little technical difficulty. The terrorist would find an outbreak of a plant disease and purchase some infected plants. The terrorist would then smuggle the infected part of the plants or spores of the pathogen into the United States. To mass propagate the pathogen, little special equipment or expertise is required.

Some of the most damaging crop pests have been insects accidentally introduced from foreign lands into the United States. Smuggling in and rearing insects could thus be another tactic, which again is not technically difficult, that terrorists might attempt.

Obtaining Pathogens from Laboratories or Collections

There are fewer controls monitoring the possession of microorganisms that infect only plants or livestock than those that can sicken or kill humans. To prevent terrorists from acquiring harmful biological agents from microbe libraries, laboratories must first register with the Centers for Disease Control before they are permitted to obtain any of the 24 human pathogens that have the "potential to pose a severe threat to public health and safety."[11] Importantly, no plant pathogens or pathogens that infect only lower animals are on this prohibited list. To obtain these non-human pathogens, a lab must instead obtain a permit from the USDA.

To determine if USDA guidelines were being followed for the transfer of plant pathogens, I corresponded with 17 laboratories working with plant pathogens that could be used by terrorists. When asked, a third of the research labs contacted stated that they would require no paperwork to send viable samples of their plant pathogens inside the same state. All labs required a USDA permit for the transfer of plant pathogens out of state. However, none of the labs stated that they would contact anyone in law enforcement about the request (as would be done for the request of a human pathogen) or do any further checking if the permit seemed in order.[12]

However, laboratory strains of plant and animal pathogens are often not as virulent as those found in nature. Furthermore, the most infectious foreign animal diseases, such as foot-and-mouth disease virus (FMDv) and the Rinderpest virus, are studied in the United States only at the Plum Island Animal Disease Center.[13] Therefore these animal pathogens could not be shipped to anywhere in the United States by a laboratory or cell bank. Since the most dangerous animal and plant pathogens would be easier to isolate from the environment, well-informed terrorists are unlikely to try to obtain anti-agricultural agents by mail order.

Obtaining Pathogens from State Sponsors

Enemies of the United States may turn to biological weapons that target agriculture as a means of prosecuting a "shadow" war. Several countries are suspected to possess anti-agriculture biological weapons. In the 1950s and 1960s, the United States stockpiled weapons meant to destroy the staple crops of foreign nations, such as potatoes, soybeans, sugar beets, cotton, wheat, and rice.[14] In the 1980s, Iraq researched wheat cover smut and camel pox for use as weapons.[15] Also in the 1980s, the Soviet Union weaponized wheat and rye blasts, wheat rust, African Swine Fever, Rinderpest, and FMDv.[16]

Any country whose agents commit acts of agroterrorism against the United States might believe it could evade attribution for the act. It is difficult to unambiguously attribute an agricultural disease outbreak

to a biological attack as opposed to a natural occurrence. For a biological attack involving human pathogens, there are two potential indicators that a disease outbreak resulted from deliberate attack: the kinetics of the outbreak and the route of infection. Explosive outbreaks, in which hundreds of people all become ill at once, or outbreaks that occur simultaneously at geographically scattered areas are unlikely to occur in natural, person-to-person spread of a disease. A second indication is a prevalence of respiratory infections, because mass-casualty biological weapons rely on the victims inhaling the pathogen. For example, the few cases of anthrax infection that have occurred in the United States have almost all been cutaneous.[17] If cases of inhalation anthrax were to show up at hospitals, a biological attack would be highly suspect.

Biological attacks on agriculture have fewer indications to distinguish them from natural outbreaks. Although anti-agricultural biological terrorism could also cause explosive or multi-focal outbreaks, these infections would occur through the pathogen's natural route of entry into the host. A group looking to disguise an attack as a natural outbreak would have its agents spread the pathogen over a single area near a port of entry into the country, thereby mimicking the pattern of a natural outbreak. How could the USDA distinguish between an insect invader that came accidentally aboard wooden packing material from China (as did the Asian longhorned beetle[18]) from insects intentionally placed there by terrorists or foreign agents?

Unambiguous attribution of a lethal biological attack would have severe military consequences for the state sponsor. For example, the United States threatened "overwhelming" and "devastating" retaliation against Iraq if it used chemical or biological weapons in the Gulf War.[19] The consequences for a state sponsoring conventional terrorism have been far less grave. In response to a particularly bold series of conventional attacks, the Reagan administration decided to retaliate with limited air-strikes against Libya in Operation El Dorado Canyon.[20] The question arises as to what kind of retribution would be appropriate against a state sponsor of anti-agriculture biological terrorism. Since the primary damage would be economic and few deaths would occur as the result of such a terrorist action, a full-scale war or nuclear retaliation would likely be deemed excessive. A state sponsor could undertake a campaign to weaken its adversary economically, yet not have to fear the destruction of its own regime as a result of being caught in the act of agricultural sabotage.

THE ABILITY OF TERRORISTS TO TURN AGRICULTURAL PATHOGENS INTO WEAPONS

The successful cultivation of a pathogenic organism is neither the last nor the most difficult step in producing a weapon capable of killing people outside its immediate area of release. Liquid cultures of bacteria or viruses are not easily dispersed to create aerosols that stay suspended in air and lodge in the lungs. Also, most human pathogens lose virulence quickly when kept in a liquid suspension.[21] In order to make an efficient weapon, the agent must be dried into a powder, a process that requires milling and drying, thereby necessitating the use of equipment that must be operated by an expert machinist. Even though the Iraqis possessed the milling and drying equipment necessary to produce dried anthrax, they were apparently unable to solve technical and safety problems associated with the dried agent and so loaded their bombs with a wet suspension of *Bacillus anthracis*.[22]

Unlike biological weapons that target people, terrorists can choose among several plant or animal pathogens that need to come in contact with only the surface of the target host to cause infection—no special process to weaponize the agent is required. When using pathogenic fungi of plants, one need not worry about creating a respirable aerosol; by simply spreading the agent over the target hosts, several infections can be induced. Cattle can be infected by FMDv simply by coming in contact with the clothes of a contaminated herdsman; thus, major outbreaks can even be caused by accident.[23] Therefore, a terrorist group need not include a machinist to get a usable biological weapon that targets crops or livestock. A knowledgeable individual could do severe damage to agriculture with a pathogen obtained from the environment of a foreign country.

States have primarily developed biological weapons that are lethal to humans but that do not spread easily from one person to another. Non-communicable pathogens have been chosen to prevent contagion from the target country back to the state that delivered the weapon.[24] Terrorists, however, could use biological agents that are highly communicable among their non-human targets. Using communicable agents, a terrorist

could cause a widespread contagion from small, localized, initial infectious foci.

After an initial infection is established, many plant and animal disease agents can spread by the wind to geographically separated areas. For example, wind-borne FMDv could spread throughout an entire cattle-raising region from one centrally located infected farm.

Furthermore, organisms can be chosen with incubation periods that would disguise the presence of a pathogen until the animal has been introduced to other, uninfected animals. Some diseases can be carried in an asymptomatic host, making identification of the disease before it enters a large herd difficult.[25] Also, certain pathogens can establish infections in wild animals, creating a reservoir of virus that will continue to infect domesticated animals and make eradication of the disease from the country extremely difficult.

THE ABILITY OF TERRORISTS TO EMPLOY ANTI-AGRICULTURAL PATHOGENS

Once a terrorist group obtains an anti-agricultural weapon, the challenge remains to disseminate it widely enough to damage an industry that occupies much of the land in the country's interior. Crops require expanses of land to grow, and consequently are grown over thousands of square miles. The modern animal farm, however, is a huge operation with often several hundred thousand animals in one location. These two extremes of target concentration require that a terrorist use markedly different techniques for targeting crops versus targeting livestock or poultry. In both cases, however, it would be possible for terrorists to cause disease outbreaks that have major economic consequences. Terrorists also confront few disincentives against employing anti-agricultural weapons, which also increases the likelihood of their use.

Targeting Animals Raised in Large Herds

The trend in animal farming is to consolidate herds onto larger farms to reduce overhead. If current trends continue, by 2002 the 40 largest pig producers will provide 90 percent of pigs to the US market and by 2010 the largest 30 feedlots will generate 50 percent of the finished cattle. A typical poultry farm will have from 250 thousand to several million birds.[26] Four meat packers process about 80 percent of the animals sent to slaughter.[27] This concentration of animals, combined with the communicability of livestock diseases, suggests that a handful of attacks could cause widespread devastation to an important sector of the US economy.

Another factor that facilitates the spread of an animal disease is that animals and animal products are often moved to many locations in a short period of time. It is common practice in several states to send diseased animals to the Midwest for slaughter.[28] Furthermore, newborn pigs are routinely raised on a nursery farm and then moved to a breeding or growing farm as they mature. These farms are often located in different states, allowing for widespread dispersal of an infectious agent.[29] In a feedlot of 500 thousand cattle, about 3,000 cattle a day are sent to slaughter, where they mix with cattle from other locations. More troubling still, several hundred animals are sent to other feedlots each day, potentially spreading contagion.[30] New animals are supposed to be quarantined; however, many farms do not follow this practice.[31]

Targeting Crops Grown Over Vast Areas

Since crops are grown over wider areas than animals, contaminating a significant portion of any particular crop is problematic. In the 1950s and 1960s, the US doctrine for using anti-crop weapons was to create several foci of infections distributed over a wide area, not to carpet every plant with agent.[32] US planners expected the microbes would spread on the wind to the uninfected portions of the crop. Terrorists could imitate this approach simply by driving to multiple fields and distributing infected plant material or insects as they pass by. Alternatively, terrorists could also attempt to trigger infections in multiple locations by contaminating products that are distributed widely from a few central stockpiles.

The Ability of Attacks to Cause Economic Harm

Agricultural pandemics can lead to economic losses of immense proportions. In 1983, an outbreak of highly pathogenic avian influenza in Pennsylvania cost farmers $86 million in control and cleanup, and increased the price of poultry and eggs to consumers by a third.[33] The 1997 FMDv outbreak in Taiwan decimated the country's pork industry, causing $7 billion in damage.[34] The well-publicized outbreak of mad-cow disease in Great Britain cost the country $4.2 billion in depopulation costs alone.[35]

Even limited infectious outbreaks can cause significant economic losses. To protect their local agriculture,

foreign countries will enact trade embargoes to prevent infected animals and plants from entering their country. These trade restrictions will be enacted even if an infection is limited to a small area or a few animals. In 1951 to 1952, a small outbreak of FMDv occurred in Canada. The disease only infected 2,000 animals and cost only $2 million (1987 dollars) for disinfection and carcass removal. Although the infection was very limited, trade embargoes placed on Canadian meat cost the farmers $2 billion (1987 dollars) in lost revenues.[36] Karnal bunt (*Tilletia indica),* a minor pathogen of wheat, caused large-scale economic disruption during a limited outbreak. In 1996, the fungus was found in wheat seeds grown in the Southwest, a discovery that led other countries to severely curtail the import of American wheat. Although the actual extent of the infections was limited, the total impact on wheat exports was estimated to be roughly $250 million.[37] These examples demonstrate that a biological attack on agriculture need not be massive; the mere presence of a pathogen can have economically devastating consequences.[38]

Additionally, consumers will turn away from a product that is considered potentially tainted. Consider the case of Chilean grapes supposedly laced with cyanide in 1989. Although no one fell ill as a result of the alleged poisoning and the FDA found no conclusive evidence of the poison in any grapes, consumers refused to buy all types of Chilean fruit. The suspected poisoning caused an estimated $210 million loss in profit and damaged the relationship between the United States and Chile.[39] Although many agricultural pathogens are harmless to people, the visceral fear of poison and disease can scare consumers into purchasing what they consider "safer" products.[40]

If a terrorist group were to use a zoonotic agent, an agent that can harm people as well as animals, the consumer reaction would be even stronger. If the terrorists wished to cause no fatalities, they could inform the authorities of the incident before the animal products reached the human food chain. By providing proof that they contaminated several animals in one herd, and claiming that they had contaminated unnamed others, the terrorists could create an economic disaster for the meat or dairy industry.

Weakness of Deterrents against Employing Anti-Agricultural Biological Weapons

A weapon that is easy to acquire and use may still pose an unlikely threat if the prospects of employing it are so horrible that terrorists refuse to disseminate it. The enormity of using biological weapons that can kill thousands increases the likelihood of dissention within a group that plans to employ them. Many terrorist plots have been foiled by conspirators who succumbed to an attack of conscience and informed on their partners.[41] A biological attack on agriculture may have no human casualties and is therefore less likely to prompt members of the terrorist cell to sabotage the attack. Furthermore, if the terrorists are not using zoonotic organisms, they need not worry about becoming casualties of their own weapons.

The fact that the consequences for using a weapon of mass destruction against agriculture are less severe than using one that will inflict mass human casualties allows terrorists who do not wish to sacrifice themselves to employ them. The law of the United States illustrates the dichotomy of retribution visited upon terrorists who use biological weapons that target people versus those that target crops. Section 2332a of title 18 of the US Code states that a person who uses or attempts to use "a weapon of mass destruction shall be imprisoned for any term of years or for life, *and if death results,* shall be punished by death, or by imprisonment for any term of years or for life" (emphasis added). Therefore, terrorists using biological weapons that target plants or livestock but not people would not have to worry about paying the ultimate price for their actions. It is important to note that anti-agriculture weapons are defined as weapons of mass destruction in the criminal code (title 18 of the US Code), but as stated before, not in the Defense Against Weapons of Mass Destruction Act (title 50, chapter 40). Furthermore, it has been pointed out that section 2332 applies to an agroterrorist incident only if the agent were used against a person or property of the United States.[42] Importantly, section 177 of title 18 prohibits the stockpiling, acquisition, or possession of an agricultural weapon. Since possession of a biological weapon is required in order to use a biological weapon, agroterrorists who employ such a weapon could be found in violation of section 177 instead and still be imprisoned for a term of years.

If section 2332 cannot be stretched to fit the agroterrorist crime, the terrorists would be charged under section 43 of title 18. This section states that anyone who causes economic damage in excess of $10,000 to an animal enterprise by causing the loss of animals or property without harming a person can be jailed for up to only one year. Under the terms of this section, the terrorists would also have to pay the appropriate financial restitution.[43]

THE TERRORISTS WHO MAY RESORT TO AGROTERRORISM

The fact that biological weapons that target agriculture are relatively simple to acquire, weaponize, and use does not necessarily mean that terrorists will use these exotic weapons instead of conventional explosives. The weapons and tactics chosen by terrorist groups tend to change as the group becomes more convinced of its own rhetoric. Terrorists often begin with non-violent forms of protest, graduate to the destruction of property, and then to violent action.[44] A terrorist group could incorporate non-violent anti-agriculture terrorism in the increasing spiral of criminal activity.

The level of violence a terrorist group will rise to varies depending on the motivation of the group. Therefore, the goals of a terrorist group will affect the likelihood that they will resort to anti-agriculture biological weapons as opposed to conventional weaponry. Groups with political, religious, and criminal motivations, or fanatically devoted to a single issue, all might turn to agroterrorism.

Terrorists with Political Goals

Violent groups with political goals will find it difficult to attract as much attention, create as much economic chaos, and suffer as few consequences by employing any other type of weapon. Many terrorists want autonomy for a disenfranchised ethnic group, the release of prisoners sympathetic to their cause, or a change in what they view as an oppressive government. To effect these changes, these groups need the support of the population. The use of indiscriminate violence, however, tends to harden the resolve of the populace to fight against those causing the bloodshed instead of against the terrorists intended targets. Furthermore, terrorists with a political goal often rely on sympathetic individuals for logistical support, financial assistance, and new recruits. These resources may become scarce as the citizenry grows weary of the terrorists' violent tactics. To better sway their audience, many terrorist groups have turned to causing economic damage, often in addition to limited, violent action, to achieve their political goal. In fact, the RAND Corporation proposes that terrorists will "...continue to destroy things and kill people, but their principal strategy may move toward the non-lethal end of the spectrum where command and control nodes and vulnerable infrastructures provide rich sets of targets."[45]

Paul Rogers of Bradford University has reported that several terrorist groups have changed from the deliberate injury of people to the destruction of property and the disruption of commerce as their method of choice.[46] He writes that, in the 1990s, the Provisional IRA (PIRA) attempted to keep civilian casualties to a minimum in their bombing campaigns in London's central business districts. These actions lie in stark contrast to the older tactics of the PIRA that killed over 2,000 civilians and military personnel in the IRA's 30-year history of terror. Rogers cites several reasons for the change in strategy: the British casualties did not lead to war-weariness among the English populace or a conciliatory response from the British government, and the PIRA's tactics incited counter-insurgency actions and reprisal bombings from Loyalists. Furthermore, in possible response to the violence, the nationalist community began supporting the Social Democratic Labour Party instead of Sinn Fein, which had close ties to the PIRA. Starting in 1992, the PIRA began a bombing campaign that targeted economic nodes, such as highway overpasses and empty shopping areas, instead of people. This campaign had a direct financial cost in terms of rebuilding destroyed buildings, equipment, and roads, and an indirect cost in terms of insurance recovery and loss of business and tourism to the area. Rogers attributes the British government's willingness to risk dealing with Sinn Fein in 1994 to the damage incurred by this economic terrorism.

Other terrorists also turned to economic destruction to effect a change. For example, in 1979, Palestinian terrorists poisoned Israeli oranges to sabotage the Israeli economy.[47] Even terrorists who seek to kill with bombing attacks often target tourists in hopes of doing economic damage. Such is the case with Islamic militants in Egypt and the ETA in Spain, who, in addition to murdering government officials, have killed many tourists.[48] Furthermore, terrorists could target a crop in which the

target country takes particular pride, such as Spanish olives or French wine-grapes.

Terrorists have also resorted to cyberterrorism to inflict economic damage on their targets. Through the destruction or infiltration of computer networks and web-pages, cyberterrorists have caused hundreds of millions of dollars in damage yet have killed no one. This economic means of targeting perceived enemies is on the rise.[49] Similar motivations might therefore produce attacks on agriculture intended to cause economic harm.

Anti-agricultural weapons can also satisfy a political terrorist's goal of publicity. Even though no casualties may result from a terrorist attack directed at agriculture, there would be enormous media attention to a confirmed attack involving a weapon of mass destruction. The novelty of an attack with biological weapons would cause the story to dominate the headlines for many weeks. Biological weapons targeted at agriculture might be the ideal weapon to allow a terrorist group to gain the attention of a large population without killing a large number of people. When a bomb kills a handful of victims, this atrocity only really affects those who are killed or maimed and their relatives and friends. The rest of the country looks on with pity for the victims and anger at the attackers, but is otherwise unaffected. As seen with the avian influenza outbreak in the 1980s, an agricultural disease outbreak could raise the price of meat or produce, thereby affecting everyone in the country. The widespread effect of an attack on agriculture, combined with the relative mildness of a zero-casualty action, could increase the public outcry to meet the demands of the terrorists.

States hostile to the United States may turn to biological weapons that target agriculture as a means of practicing asymmetric warfare. Covert delivery of state-made biological weapons could cripple the agrochemical industry of a rival nation. Although retribution would be likely if the sponsor-state was unambiguously revealed, nuclear or similar "overwhelming and devastating" reprisal would not be likely in a case where few deaths occurred.

Terrorists with Religious Motivations

Many terrorist groups are not fettered by the same constraints that shape the tactics of terrorists with political goals. These groups have no political agenda that would suffer because of public backlash against violent attacks. Such groups may be found among the American Christian identity/patriot movement, eschatologists who are seeking to foment the apocalypse, and sects or cults motivated by religious ideals that encourage violent reprisal against those who impede their goals. These groups may attempt to use biological weapons to kill people on a massive scale. It is fortunate, therefore, that religious motivation is behind only a minority, albeit a growing one, of terrorist attacks.[50]

These groups could attempt to inflict mass casualties using a zoonotic agent by infecting animals that would later enter the human food chain. However, these agents are not as easy to culture and disseminate as are FMDv and plant pathogens. Furthermore, the incubation time of these pathogens must be timed so that the animal does not show symptoms that would prevent the animal products from coming to market.

By attacking a nation that relies on one staple crop to feed the majority of its population, terrorists can cause widespread famine in a developing nation. The damage done by famine can far outweigh the casualties inflicted by conventional or even non-conventional weapons. The attraction of fanatical religious groups to this type of biological weapon is the almost biblical scale of the consequences. It should be noted, however, that the US food supply is diverse and plentiful enough that this type of attack would not plunge the US population into starvation. These groups would therefore use anti-agricultural weapons against the United States to cause economic devastation as part of a larger campaign.

Although American patriot/Christian identity groups have recruited supporters from rural areas where farming is the mainstay of the economy, these terrorists may turn to a biological attack against agriculture because advocacy of this type of attack is found in *The Turner Diaries*, the fictional account of a revolution from which Timothy McVeigh and other militiamen have taken inspiration. In this book, the militia is frustrated with the apathy with which mainstream, white America is greeting the militia's revolution against the American government. To shock Americans out of their apathy, the book records that the militiamen "began appealing to things they can understand, fear and hunger. We will take food off their tables and empty their refrigerators…."[51]

Criminals

Agricultural weapons will be pursued not only by those who have ideological or theological goals, but also those groups whose concerns are more pragmatic and mercenary. Dr. Horn, administrator of the Agricultural Research Service, testified that anti-agriculture weapons could be used by the greedy to manipulate the commodity and futures markets.[52] By using pathogens that affect only one type of organism, these attacks could occur without inducing losses in other types of plants or livestock. For example, blackmailers might try to extort money from a target company by threatening to unleash a pathogen on the industry's crops or livestock. Or, agricultural pests might be used by foreign agricultural concerns to gain a competitive edge.[53] In addition, people with a grudge could use anti-agriculture weapons to get revenge for a perceived wrong. For example, a group of individuals who lost loved-ones to lung cancer might target the tobacco crop. In all the above cases, the moral barrier to the criminal act is reduced because no people would be injured in the attacks.

Economic warfare might be employed by drug traffickers as revenge for the actions taken by the United States to winnow down the drug traffickers' profits. Drug-lords have sponsored terrorism in the past: the attack on the Colombian Supreme Court in 1984 was perpetrated in response to Colombia's willingness to extradite drug traffickers to the United States.[54] Another incentive for these "narco-terrorists" to use anti-crop weapons is the proposed US effort to weaponize plant pathogens that attack narcotic-producing crops.[55] It is likely that drug cartels would want the capability to "retaliate in kind" in response to an American attack on narcotic crops. These criminal groups undoubtedly have the chemical laboratories, financial resources, and smuggling ability to sponsor an effective attack on US agriculture.

Radical Ecologists and Animal Rights Groups

Certain ecoterrorists might find biological weapons particularly attractive. These groups have voiced goals from an end to deforestation by the lumber and paper industries to the cessation the genetic engineering of "frankenfoods." The most radical of these groups work toward the destruction of all agriculture because they believe it is a perversion of the natural order. Various ecoterrorist groups have claimed responsibility for firebombings of university and biotechnology labs, vandalism of logging equipment, dynamiting of electrical plants, attempted sabotage of nuclear power plants, slaughter of cattle, and the destruction of whole fields of genetically engineered crops.[56] These groups have bombed, ransacked, and burned various USDA facilities.[57] In fact, terrorists espousing environmental issues and animal rights were the most active terrorists in the United States in the 1990s.[58] Furthermore, the radical ecoterrorist group RISE, who espoused killing nearly all humanity with biological weapons, was one of the few terrorist organizations to actually acquire human pathogens in the hope of creating a weapon.[59]

Ecoterrorists could use biological agents to cripple the production of a crop such as corn, which is predominately produced from genetically modified seed in the United States. Alternatively, a group could use a smaller scale dissemination to spread the disease only in the test fields of a biotechnology company or among experimental livestock. Ecoterrorists would be attracted to biological weapons in particular because of the irony of using nature to reverse the depredations of mankind. Furthermore, many of these groups espouse a policy of nonviolence, and biological agents targeted at agriculture could accomplish their goals without the death of any humans. In contrast to acts of mayhem by groups seeking to force a country into a particular plan of action, a biological attack against agriculture is a means *and* an end for many ecoterrorists. Biological agents could allow ecoterrorists to devastate genetically engineered crops, remove livestock from pristine grassland, or economically ruin a fertilizer manufacturer. In fact, animal rights terrorists have used chemical poisons in the past to cause financial damage to specific industries. The British Animal Liberation Front allegedly poisoned candy bars, turkeys, and eggs to protest various crimes against animals. To avoid human casualties, this animal rights group issued warnings about the attacks.[60] Also, the only possible incident of bioterrorism directed against agriculture allegedly came from an ecoterrorist group. The rapid spread of the Mediterranean fruit fly in California in 1989 was allegedly caused by a group called the Breeders, who stated that they spread the insects to protest agricultural practices.[61]

MEASURES TO PREVENT AND MITIGATE ANTI-AGRICULTURAL ATTACKS

The above analysis indicates that nationalist/separatists, criminals, fringe ecologists, hostile nations, and the

fanatically religious all have motivations to resort to agricultural weapons. Furthermore, anti-agriculture weapons are relatively easy to obtain and employ, and an attack on agriculture can inflict grave economic damage. Agricultural terrorism thus cannot be thought of as either a "low-probability" or a "low-consequence" incident.

This analysis suggests that the current state of funding for agricultural disease control and detection is inadequate. More funding needs to be appropriated to the USDA and its Animal and Plant Health Inspection Service. Further measures are also needed to stop terrorist from obtaining and employing these anti-crop and livestock weapons. Finally, because prevention may fail, more steps must be taken to recognize and respond quickly to an agricultural disease outbreak.

Preventing Acquisition of Anti-Crop and Anti-Livestock Biological Weapons

Even though terrorists are unlikely to request anti-agricultural pathogens from laboratories or cell banks, a few easy steps should be taken to prevent this method of acquisition. The paperwork requirements for obtaining plant or livestock pathogens should be as stringent as those currently in use for obtaining human pathogens. Furthermore, any request for an agricultural pathogen should be reported to the USDA, which can in the case of a suspicious-looking request notify the FBI to investigate the solicitor further. These steps could help identify and stop terrorists before they actually obtain pathogens from other sources.

Terrorists may look to state sponsors to provide them with anti-agricultural biological weapons. Many policymakers have suggested that the Biological Weapons Convention needs to be strengthened to include no-notice site inspections of suspected biological weapon facilities to make the acquisition and stockpiling of biological weaponry more difficult.[62] No-notice inspections would make a proliferating state take extra measures to disguise their anti-agricultural biological weapons program. However, because agricultural weapons require little to no weaponization to employ, it may be impossible to determine if a stock of agricultural pathogen is for offensive or peaceful purposes.

Terrorists could also gain access to valuable expertise through a proliferating state's unemployed weapon scientists. To prevent this eventuality from occurring, the USDA is a sponsor of the Freedom Support Act, which employs former Soviet scientists, engaging them in peaceful research.[63] This program is valuable because it adds incentives for veteran BW designers to stay home, instead of potentially being recruited to work for terrorists, and it should continue to be funded.

One way to make it more difficult for terrorists to obtain agricultural pathogens from the environment is to make these pathogens more rare. This can be accomplished by having APHIS teams respond to outbreaks of animal and plant diseases throughout the world. By having the outbreaks controlled more quickly, the windows of opportunity for terrorists to acquire pathogens would be narrowed. In addition to having obvious humanitarian benefits, these missions could provide APHIS teams with the experience they need to diagnose and control foreign animal and crop diseases that they have not seen in the United States. Furthermore, the United States should assist and help fund foreign efforts to eradicate disease. Currently, the European Community is sponsoring the Pan African Rinderpest Eradication Campaign to expunge this devastating disease from the planet by 2010.[64] As more pathogens are removed from the planet, the terrorists' arsenal shrinks.

The ability of APHIS's Plant Protection and Quarantine staff to detect agricultural products and pathogens that are smuggled into the country must be improved. This service often finds itself overwhelmed by the sheer volume of traffic entering the country.[65] Any improvement in the ability of this service to prevent the entry of pathogens into this country will increase the barrier to terrorists obtaining this type of weapon.

It should be noted that title 18, chapter 10 of the US Code prohibits the acquisition, stockpiling, transfer, or development of anti-agricultural biological weapons. However, this law does not apply if the pathogen is for peaceful purposes. As stated above, since little or no weaponization is required to make agricultural pathogens into a weapon, it is difficult to tell whether pathogens are retained for peaceful or illegal purposes. Furthermore, a highly contagious animal virus that is mishandled by someone with no terrorist intent could accidentally cause severe disruption of agricultural commerce. If the purpose of the agent were immaterial, and the only exception to title 18, chapter 10 were organizations that had USDA permits for the retention of pathogens, then both the legal loopholes and potential for

accidental dissemination would be curtailed. In fact, this suggestion has been made by several policymakers in order to more easily prevent unlicensed groups from obtaining human pathogens.[66]

The cost of these steps to prevent terrorists from acquiring anti-crop and anti-livestock weapons is minimal, and many of these measures have other desirable effects. Biological weapons inspections and weapon scientist retraining would also help uncover covert biological antipersonnel weapons and prevent the spread of weapon expertise. APHIS's assistance in helping mitigate disease outbreaks in other countries not only has a humanitarian benefit, but also provides training in exotic pathogen control in case of a natural disease outbreak of a foreign pathogen. Increased border security makes it more difficult for naturally occurring pests to accidentally enter the United States.

Preventing Use of Anti-Agriculture Biological Weapons

Terrorists may attempt to contaminate centrally held stocks of agricultural products that are later dispersed over wide areas. Both farms and companies that supply them with agrochemicals should make it more difficult for criminals to gain access to these goods. Locks and tamper-evident seals that are checked before the products are dispensed would ensure that warehoused agrochemicals are safe before being given to animals or spread on fields. In order to protect interstate commerce, Congress should mandate that any agricultural product that is stored in one location and then parceled out to more than one state be safeguarded by tamper-evident seals.

Terrorists may also attempt to introduce livestock pathogens to animals that will later be moved elsewhere. Although it is already part of current biosecurity protocols, farms should always quarantine animals arriving to their farms from other locations. Also, farms should not let outsiders have access to their herds. If a farm wishes to show part of a herd for sale or auction, this portion should be kept separate from the rest of the herd and quarantined after the showing is done. If these simple measures were followed, terrorists would have to transport the agents themselves to locations they wanted to attack, thereby increasing the chances of being apprehended. The use of both strict quarantine procedure and tamper-evident seals, though inconvenient, has a minimal cost. The cost of these safeguards should be absorbed by the agricultural companies, as these measures allow the companies to better protect their own herds and crops and ensure a safer product to their consumers.

The United States should take steps to facilitate lawsuits filed by corporations and farmers who suffer losses at the hands of terrorists. If blame were unambiguously attributed, lawsuits could be brought against individual sponsors or the political branches of the guilty terrorist group. Already a few such lawsuits have been settled successfully: the Klinghoffer family won a suit against the PLO for their role in the hijacking of the *Achille Lauro*, for example.[67] Due to the potentially enormous financial costs of a biological attack, a successful compensatory lawsuit could spell financial ruin for a radical political movement. By threatening the existence of the very movement itself, this measure could have a larger deterrent effect on a terrorist group than the incarceration of a few of their agents.

Mitigating the Effects of a Biological Attack on Agriculture

The sheer size and expanse of the American agriculture industry, combined with the simplicity of obtaining, weaponizing, and using anti-agricultural agents and the diversity of terrorist groups who could be interested in employing these agents, make any combination of deterrence and prevention unlikely to be fail-safe. Therefore, more steps should be taken to limit the damage incurred if terrorists do successfully deploy a biological agent against agriculture.

Several of the following proposals will take significant investment at the federal level. However, all of these suggestions would also help mitigate the consequences of the more common case of natural disease outbreaks. Funding for these proposals could become available by first fixing an inconsistency in the law. As stated before, biological weapons that sicken plants and animals (other than humans) are not considered weapons of mass destruction under the Defense Against Weapons of Mass Destruction Act (title 50, chapter 40) but are defined as such under the Criminal Code (title 18). In the Defense Against Weapons of Mass Destruction Act, specific proposals for homeland defense against chemical, biological, and nuclear weapons are delineated, and funding for the proposals is allocated. Proper inclusion of anti-agriculture biological agents in the Defense Against Weap-

ons of Mass Destruction Act could provide a framework for funding allocation for the following proposals.

Just as surveillance of the patterns of human disease can help law enforcement recognize and react to a terrorist attack involving biological weapons targeting our population, enhanced surveillance of agricultural disease would help stem the spread of plant and animal pathogens. An outbreak caused by a terrorist attack could be explosive, and the time it takes for the state agencies to notice and report a disease to APHIS could prevent effective disease management. APHIS should create monitoring teams that patrol farms for disease. These teams should use antibody-mediated, real-time diagnostic tests for the presence of plant pathogens on crops, and PCR-based assays for the detection of viruses in livestock hosts. These tests could detect diseases before symptoms became visible or before the diseases were communicable to other animals and plants. Furthermore, the sooner the infected herd is quarantined or the infected crop is destroyed, the less likely the pathogen would spread to other areas. Alternatively, farms and feedlots could provide samples on a regular basis to regional labs where the tests can be done as the samples are received.

Furthermore, computer models, which calculate possible geographical ranges of plant disease, could guide these patrolling teams, insofar as which pathogen should be tested for and in which regions they should test for it.[68] These models use information about weather patterns and pathogen temperature-and-moisture-tolerance to determine areas where plant pathogens could live. By creating models for the most dangerous anti-crop pathogens, the APHIS teams could save time and resources by testing for diseases only where they are likely to spread.

The USDA should fund more research directed at pathogen genome sequencing and finding new vaccines and antibiotics. At the present time, there is no vaccine that provides protection against all families of FMD viruses.[69] Several veterinary laboratories have reported the increasing presence of antibiotic-resistant bacteria. However, by unlocking the genetic makeup of the most dangerous agricultural pests, we can gain insight into new strategies to prevent catastrophic outbreaks. Researchers in Brazil have already sequenced the genome of citrus variegated chlorosis (*X. fastidiosa*).[70] Various strains of this bacteria cause disease in a variety of agriculturally important plants, such as alfalfa, grapes, coffee, and stone fruits. This one sequencing project demonstrates how research can be the first step in the prevention of several plant diseases.

The creation of vaccine and antibiotic stockpiles has been proposed to provide treatment to the masses of people who would be exposed to pathogens in a biological terrorist attack. The same strategy would hold for veterinary vaccines, insecticides, antibiotics, and antifungals that would be useful in stopping the spread of pathogens to uninfected sectors of agriculture. The USDA currently has vaccine and antibiotic stockpiles, but these are not sufficient should regular practices not contain an outbreak, such as would be the case in a multifocal terrorist attack.[71] Similarly, it would be wise for private agricultural corporations and farming concerns (or the companies that insure them) to create their own caches of drugs until federal stockpiles can be increased.

APHIS should be strengthened. APHIS is adequately funded to rapidly respond to both animal and plant disease outbreaks, but their current capabilities would be overwhelmed by a large, multi-focal outbreak, or several major disease outbreaks at once (which terrorists may try to trigger to overwhelm the responders).[72] Funding to APHIS should be increased to create larger Early Response Teams, three-member teams that can respond to a disease outbreak in 24 hours, and more Regional Emergency Animal Disease Eradication Organizations (READEO), who direct and assist in disinfection, vaccine administration, animal culling, and other duties.[73] If more READEO teams were created, several of these teams could be deployed abroad to help combat foreign disease outbreaks. The patrolling teams proposed above can be mobilized to assist READEO teams when outbreaks are found.

To help combat an explosive outbreak, APHIS should create a reserve network of veterinary and plant pathologists, chosen from academia and industry, that it can mobilize in the case of a massive outbreak.[74] A reserve network reduces the cost of having hundreds of underused pathologists when disease outbreaks are rare.

One of the most devastating effects of even a small-scale outbreak is trade embargoes placed on the affected crop. Soon after an outbreak is confirmed, APHIS must rigorously determine the extent of the disease and delineate boundaries of infected and uninfected areas. By preventing the introduction of disease into the areas declared uninfected, economic losses can be diminished

by the resumption of trade from areas assured to be unaffected by the pathogens.[75]

The USDA should create a program to educate farmers on how to recognize and react to foreign diseases and pests. Since some farms do not follow the appropriate biosecurity measures, more education is needed about the importance of proper biosecurity technique.

Also, private industry and agriculture should prepare public relations campaigns to restore public confidence in their products after a disease outbreak.[76] Each industry can tailor advertisements in advance to address the concerns that would be caused by diseases that would likely befall their crops. These efforts could help avert economic losses on the scale of the Chilean Fruit scare in the case of terrorist actions, or following natural outbreaks such as the Karnal Bunt infestation.

Terrorists have the motivation and technology to cripple a vital section of the American economy. More funding must be appropriated and changes to laws must be made to prevent a financial disaster. Through judicious application of the recommendations above, the United States can limit the damage done and reduce the usefulness of this powerful, yet often overlooked, class of weapons of mass destruction.

[1] Official from Office of Budget and Program Analysis, USDA (name withheld by request), telephone conversation with author August 7, 2000.
[2] John B. Adams, "The Role of National Animal Health Emergency Planning," *Annals of the New York Academy of Sciences* 894 (1999), pp. 73-75.
[3] Floyd P. Horn and Roger G. Breeze "Agriculture and Food Security," *Annals of the New York Academy of Sciences* 894 (1999), pp. 9-17.
[4] Terrance M. Wilson, Linda Logan-Henfrey, Richard Weller, and Barry Kellman, "A Review of Agroterrorism, Biological Crimes, and Biological Warfare Targeting Animal Agriculture," in C. Brown and C.A. Bolin, eds., *Emerging Animal Diseases* (Washington, DC: American Society of Microbiologists, forthcoming), prepublication copy provided by the authors.
[5] Richard A. Falkenrath, Robert D. Newman, and Bradley A. Thayer, *America's Achilles' Heel* (Cambridge, MA: MIT Press, 1998), passim.
[6] Editor's note: In consultation with the author, certain details about how to acquire and spread non-human pathogens, as well as citations to certain sources that contain these details, have been omitted from the following sections of this viewpoint, in order not to inadvertently provide potentially useful operational information to any parties who might misuse such information.
[7] David E. Kaplan, "Aum Shinrikyo," in Jonathan B. Tucker, ed., *Toxic Terror* (Cambridge, MA: MIT Press, 2000), pp. 207-226.
[8] Kenneth Alibek, "The Soviet Union's Anti-agricultural Biological Weapons," *Annals of the New York Academy of Sciences* 894 (1999), pp. 18-19.
[9] Raymond A. Zilinskas, "Iraq's Biological Weapons," *Journal of the American Medical Association* 278 (August 6, 1997), p. 419.
[10] This example provided by Wilson et al., "A Review of Agroterrorism," p. 6.
[11] Anti-terrorism and Effective Death Penalty Act of 1996, April 24, 1996.
[12] Two principal investigators reported that the USDA papers could easily be forged by criminals wanting to acquire the pathogens illegally.
[13] Veterinary Services, "The Foreign Animal Disease Diagnostic Laboratory at Plum Island Animal Disease Center," United States Department of Agriculture Animal and Plant Health Inspection Service Fact-sheet (December 1992), <http://www.aphis.usda.gov/oa/pubs/fsfadlab.html>.
[14] Much of the information about the history of agricultural biological weapons was taken from Paul Rogers, Simon Whitby, and Malcolm Dando, "Biological Warfare against Crops," *Scientific American* 280 (June 1999), pp. 62-67.
[15] Zilinskas, "Iraq's Biological Weapons," p. 419.
[16] Alibek, "The Soviet Union's Anti-agriculture Biological Weapons," pp. 18-19.
[17] Jeanne Guillemin, *Anthrax* (Berkeley: University of California Press, 1999), pp. 4-5.
[18] "Asian Longhorned Beetle," United States Department of Agriculture Animal and Plant Health Inspection Service Fact-sheet (September 1998), <http://www.aphis.usda.gov/oa/pubs/fsalb.pdf>.
[19] The full text of this threat can be found in: US DOD, Office of the Secretary of Defense, *Conduct of the Persian Gulf War, Final Report to Congress* (Washington, DC: US Government Printing Office, April 1992).
[20] Walter Laqueur, *The New Terrorism* (New York: Oxford University Press), p. 170.
[21] Zilinskas, "Iraq's Biological Weapons," p. 421.
[22] Ibid.
[23] Veterinary Services, "Foot-and-Mouth Disease," United States Department of Agriculture Animal and Plant Health Inspection Service Fact-sheet (July 1998), <http://www.aphis.usda.gov/oa/pubs/fsfmd.html>.
[24] The Soviet Union weaponized smallpox (a highly contagious virus), but the weapon would have been used only in the case of a total war. In a war of mutual destruction, accidental casualties in your own populace from the disease release would hardly matter. "Biological Weapons in the Former Soviet Union: an Interview with Dr. Kenneth Alibek," *The Nonproliferation Review* 6 (Spring-Summer 1999), p. 6. Japan weaponized, and reportedly intended to use, *Yersinia pestis*, the causative agent of plague, in World War II. Fleas carrying plague would have been dropped onto islands to deny the use of these islands to the United States. Hal Gold, *Unit 731 Testimony* (Tokyo: Yenbooks, 1996), pp. 86-88.
[25] Michael V. Dunn, "The Threat of Bioterrorism to US Agriculture" *Annals of the New York Academy of Sciences* 894 (1999), pp. 184-188.
[26] Ibid.
[27] Wilson et al., "A Review of Agroterrorism."
[28] Ibid.
[29] Beth Lautner, "Industry Concerns and Partnerships to Address Emerging Issues," *Annals of the New York Academy of Sciences* 894 (1999), pp. 76-79.
[30] Dunn, "The Threat of Bioterrorism," pp. 184-188.
[31] Wilson et al., "A Review of Agroterrorism."
[32] Rogers et al., "Biological Warfare against Crops," pp. 65-66.
[33] Lautner, "Industry Concerns," pp. 76-79; Veterinary Services, "APHIS's Role in Animal Health and Trade," United States Department of Agriculture Animal and Plant Health Inspection Service Fact-sheet (August 1998), <http://www.aphis.usda.gov/oa/pubs/fsprotect.html>.
[34] Corrie Brown, "Economic Considerations of Agricultural Diseases," *Annals of the New York Academy of Sciences* 894 (1999), pp. 92-94.
[35] Ibid., pp. 92-94.
[36] Lautner, "Industry Concerns," pp. 76-79.
[37] Anne Kohnen, "Responding to the Threat of Agroterroism," Master's Thesis, Harvard University, April 2000.
[38] Deen, "Trends in American Agriculture," p. 165.
[39] Philip J. Hilts, "Don't Eat Grapes, FDA Warns," *Washington Post*, March 14, 1989, p. A1; Eugene Robinson, "Chile's Grape Growers Rage Against U.S. Ban," *Washington Post*, March 16, 1989, p. A1; "Chile Celebrates Lifting of Fruit Ban," *Washington Post*, March 18, 1989, p. A22; and Reuters, "Bomb in Chile Said Linked to Embargo," *Washington Post*, April 8, 1989, p. A13.

[40] Jessica Stern, *The Ultimate Terrorists* (Cambridge, MA: Harvard University Press, 1999), pp. 34-39.
[41] For example, see Dan Barry, "Police Break Up Suspected Bomb Plot in Brooklyn," *New York Times*, August 1, 1997, p. A4. In this case, the confidant of two terrorists, who planned to detonate suicide pipe bombs in the New York subway, informed the police of the plot just hours before it was implemented.
[42] Wilson et al., "A Review of Agroterrorism."
[43] Ibid.
[44] Bruce Hoffman, *Inside Terrorism* (New York: Columbia University Press, 1998), p. 177.
[45] Ian O. Lesser, Bruce Hoffman, John Arquilla, David Ronfeldt, and Michele Zanini, *Countering the New Terrorism* (Santa Monica, CA: RAND, 1999), pp. 71-72.
[46] Paul Rogers, "Political Violence and Economic Targeting—Aspects of Provisional IRA Strategy 1992-1997," unpublished manuscript given to the author.
[47] Hoffman, *Inside Terrorism*, p. 178.
[48] Laqueur, *The New Terrorism*.
[49] Information about cyberterrorist attacks and trends is from Lacqueur, *The New Terrorism*, pp. 74-78.
[50] Lesser et al., *Countering the New Terrorism*, figure 2, p. 16. Religiously motivated attacks accounted for a low of two out of 64 events in 1980 to a high of 26 out of 56 in 1995.
[51] Andrew McDonald, *The Turner Diaries*. This quote was cited by Lacqueur, *The New Terrorism*, p. 114.
[52] US Senate, Armed Services Committee, Emerging Threats and Capabilities Subcommittee, October 27, 1999.
[53] Robert P. Kadlec, "Biological Weapons for Waging Economic Warfare," *Airpower*, <http://www.airpower.maxwell.af.mil/airchronicles/ battle/ chp10.html>.
[54] Laqueur, *The New Terrorism*, p. 215.
[55] Jim Robbins, "Drug War Awaits Attack of Killer Fungus," *New York Times*, July 18, 2000, p. C1; Paul Rogers, Simon Whitby, and Malcom Dando, "Silver Bullet or Poison Chalice: The Biowar against Drugs," *Scientific American* (June 1999), p. 75. Notably, the United States' proposal does not violate the Biological Weapons Convention because these weapons would be used for peaceful purposes and not in armed conflict.
[56] Brad Knickerbocker, "Concerns Rise as Ecoterrorists Expand Aim: Biotech Research and Fur Farms are the Latest Targets of Fringe Groups on the Far Left," *Christian Science Monitor*, April 3, 2000, p. 3; Laqueur, *The New Terrorism*, pp. 199-204.
[57] Horn and Breeze, "Agriculture and Food Security," pp. 9-17.
[58] Philip B. Heymann, *Terrorism and America* (Cambridge, MA: MIT Press, 1998), p. 1.
[59] Importantly, the members of RISE lacked the engineering skill required to make biological weapons from solutions of pathogen or the understanding of the yield of these weapons. For more on RISE, see W. Seth Carus, "R.I.S.E.," in Jonathan B. Tucker, ed., *Toxic Terror* (Cambridge, MA: MIT Press, 2000), pp. 55-70.
[60] Stern, *The Ultimate Terrorists*, pp. 65-66.
[61] More information can be obtained on the Breeders at the Canadian Intelligence Security Agency's website at <http://www.csis-scrs.gc.ca/eng/ miscdocs/purve.html> or from Reuters, "Officials Advertise to Contact Mystery Group Claiming Medfly Release," *Los Angeles Times*, February 10, 1990, p. A13. Importantly, this allegation was never proven, and it is unclear to this day whether the medfly infestation was a natural occurrence.
[62] See for example Robert Kadlec, Allan Zelicoff, and Ann Vrtis, "Biological Weapons Control: Prospects and Implications for the Future," *Journal of the American Medical Association* 275 (August 6, 1997), pp. 351-356.
[63] Horn and Breeze, "Agriculture and Food Security," pp. 9-17.
[64] Alfonso Torres, "International Economic Considerations Concerning Agricultural Diseases and Human Health Costs of Zoonotic Diseases," *Annals of the New York Academy of Sciences* 894 (1999), pp. 80-82.
[65] Wilson et al., "A Review of Agroterrorism."
[66] Ibid., p. 15.
[67] The RAND Corporation suggested this measure to increase the economic consequences for those groups sponsoring terrorism in *Countering the New Terrorism.*
[68] Ron Sequeira, "Safeguarding Production Agriculture and Natural Ecosystems against Biological Terrorism," *Annals of the New York Academy of Sciences* 894 (1999), pp. 48-67.
[69] Peter L. Nara, "The Status and Role of Vaccines in the US Food Animal Industry," *Annals of the New York Academy of Sciences* 894 (1999), pp. 206-217.
[70] The *Xylella fastidiosa* Consortium of the Organization for Nucleotide Sequencing Analysis, "The Genome Sequence of the Plant Pathogen *Xylella fastidiosa*," *Science* 406, July 13, 2000.
[71] Nara, "The Status and Role of Vaccines in the US Food Animal Industry."
[72] Adams, "National Animal Health Emergency Planning," pp. 73-75.
[73] Veterinary Services, "APHIS' Role in Animal Health and Trade."
[74] This suggestion for a reserve network comes from Kohnen, "Responding to the Threat of Agroterroism."
[75] Ann H. Seitzinger, Kenneth W. Forsythe, Jr., and Mary L. Mandell, "Regionalization's Potential in Mitigating Trade Losses Related to Livestock Disease Entry," *Annals of the New York Academy of Sciences* 894 (1999), pp. 95-99.
[76] Kohnen ("Responding to the Threat of Agroterrorism") suggests that the USDA should be responsible for a public relations campaign in the aftermath of an attack. However, the sheer variety of products that the USDA oversees would make any preparation in advance of an attack on any particular foodstuff hopelessly complex. Also, promoting goods has always been the purview of the private sector; federal government involvement in the promotion of certain effected products would be in violation of fair trade.