

Agroterrorism in the U.S.: Key Security Challenge for the 21st Century

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ABSTRACT

Agriculture is one of the easiest sectors of the U.S. economy to disrupt, and its disruption could have catastrophic consequences for the U.S. and world economies. Agriculture in the U.S. accounts for 13% of the current Gross Domestic Product (GDP) and provides employment for 15% of the population. It produces high-quality, cheap, plentiful food for domestic consumption and accounts for more than \$50 billion in exports. The likelihood of terrorist acts interrupting the production, processing, and distribution of agricultural products is high: A number of different possible plant or animal pathogens could cause harm or loss of production, and even an act of agroterrorism that did not result in the destruction of foodstuffs or interruptions in the food supply could have a psychological impact. A number of recent unintentional events and epidemics have prompted the U.S. and other countries to provide resources to counteract contagious diseases and contain their impact, including increased funding to federal agencies that are responsible for protecting domestic agriculture. This article presents recommendations to protect agriculture, including changing the way agriculture is viewed on the federal level and increasing the resources to protect agriculture from terrorist attack.

VULNERABILITY TO THE THREAT

SINCE SEPTEMBER 11, THE WAY WE VIEW terrorist threats has changed drastically, and the U.S. government has taken on the task of seeking and destroying the means by which terrorists might try to launch future attacks. According to Harl, “The United States is still vulnerable to attack in several areas—(1) governance, (2) telecommunications, (3) transportation, (4) water supplies, (5) food production, (6) food processing and (7) food distribution.”¹ One industry in the U.S.—agriculture—is involved in half of these sectors. Agriculture is

the number one employer in the U.S.² (although relatively few people are employed in actual agricultural production). The U.S. agriculture system is the “most productive and efficient in the world, allowing Americans to spend less than 11 percent of disposable income on food, compared to the global average of 20 to 30 percent.”² As a part of the global economy, U.S. agriculture “contributes \$50 billion annually, making the farm sector the largest positive contributor to the national trade balance.”² Yet the agroterrorism threat remains underappreciated: “This point is further exemplified in a General Accounting Office (GAO) report on combating terrorism

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released just 9 days after 9/11. The report did not address threats to American agriculture, nor did it involve participation by the U.S. Department of Agriculture (USDA)."²

There are several reasons why the vulnerability of U.S. agriculture might not be appreciated. A recent RAND study notes, "Most Americans take it for granted that food is readily available and that their food is safe."³ A second reason that agriculture is "invisible" is that "modern agricultural practices in the United States, which are increasingly concentrated, have led to a dramatic reduction in the number of farms (2.2 million in 1998 compared to 6.3 million in 1929)."³ A third reason is that "technological innovation has resulted in fewer Americans being directly employed in agricultural production: farming accounted for 2.6 percent of the U.S. workforce in 1998 down from 23 percent in 1929."³

The vertical integration of agribusinesses—that is, the concentration of activities related to food production and distribution—also contributes to their susceptibility to attack. Figure 1 depicts a "hoof-to-plate" food supply chain, and Figure 2 shows a "seed-to-plate" scenario. All along the food chain there are opportunities for terrorists to introduce animal or plant pathogens. These opportunities, or "entry points" in the food chain, have varying levels of risk. For example, the average distance 1 pound of meat travels from farm to table in the U.S. is 1,000 miles,⁴ presenting a number of entry points located over a large geographical area. Some of these entry points are regulated or supervised by government agencies, but others are not—for example, stockyards, processing plants, and slaughterhouses are relatively open. In the live beef

market, 3 packers hold 72% of the market; in the pork market, 4 packers hold 57% of the market.⁵ Almost 70% of the beef cattle that are finished for slaughter in the U.S. are located in a 200-square-mile area.⁶ Four meat-packing centers process about 80% of the animals in the U.S. sent to slaughter.⁷

The management and trade of some crops also is vertical. Three agribusiness firms control approximately 82% of U.S. corn exports.⁸ Thus, agribusiness is concentrated both geographically and within the confines of several "mega-firms."

AGROTERRORISM DEFINED

For purposes of this discussion, we use the definition offered by Peter Chalk in testimony before the U.S. Senate Subcommittee on Oversight of Government Management, Restructuring, and the District of Columbia in 2001. He described agroterrorism as the deliberate introduction of a disease agent, either against livestock or into the food chain, for purposes of undermining stability and/or generating fear.⁹ Agroterrorism not only affects the animal or plant food chain that it attacks but the public confidence in the product as well. It has a psychological impact on the public's trust in government to provide adequate quality control over foodstuffs. And ultimately it could affect the trade of agricultural products with the rest of the world. This last item is no small consideration. According to Parker, "The exports of American agricultural products account for 15 percent of all global agriculture exports."² Thus, a major attack on U.S. agricul-

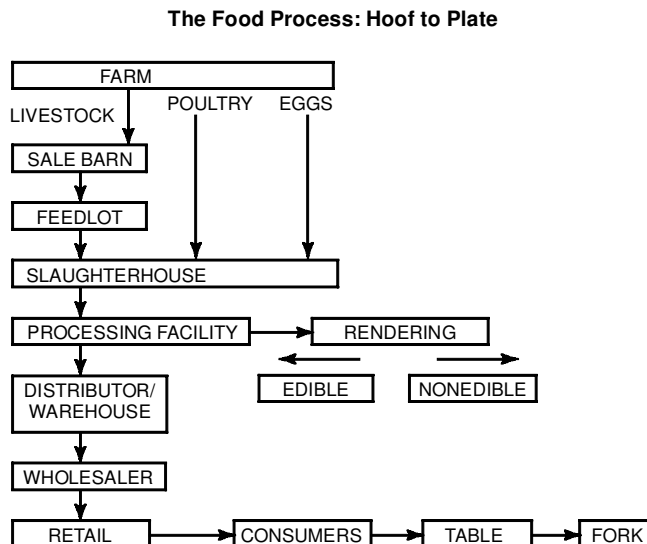


FIGURE 1. FOOD SUPPLY CHAIN⁴⁵ (ANIMAL).

The Food Process: Seed to Plate

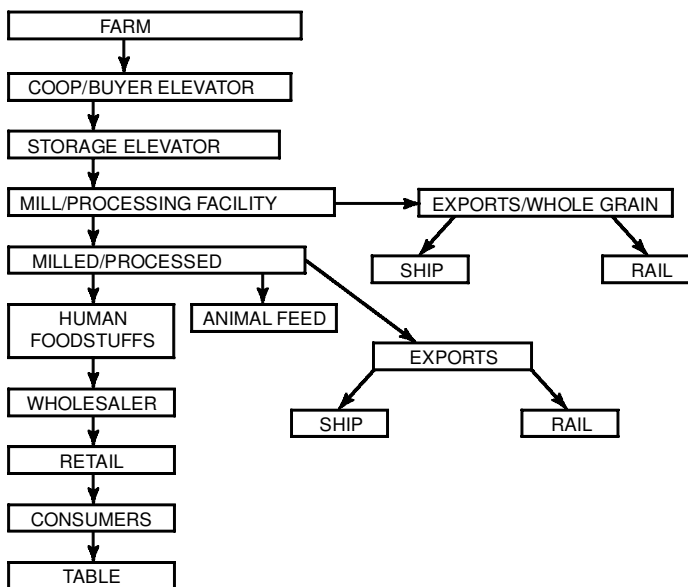


FIGURE 2. FOOD SUPPLY CHAIN (CROP).

ture might affect exports, pricing, and eventually the confidence of our global partners in American foodstuffs. Purposeful attacks may even be mistaken for naturally occurring epidemics or outbreaks, thus allowing a terrorist group to strike without having the attack attributed to them and to create terror and disruption without causing the deaths of large numbers of people.²

Currently, agroterrorism is not defined as a weapon of mass destruction (WMD) under federal law. Agroterrorism, as determined by the federal government, is a part of bioterrorism under the Agroterrorism Prevention Act of 2001 and the Agricultural Bioterrorism Protection Act of 2002.⁷ Casagrande notes, “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 U.S. Code (Defense Against Weapons of Mass Destruction Act).”⁷ Agroterrorism under current law is a felony; however, actions to infect the food supply do not meet the current WMD standard. “In fact, terrorism targeting crops or livestock is not mentioned in the unclassified portions of Presidential Decision Directives (PDD) 39 or 62 (which both delineate policy on counter-terrorism.)”⁷ Agriculture also was not originally included in PDD 63, which identifies the critical infrastructures within the U.S. that are deemed vulnerable to terrorist attack.³ As Parker notes, “Agriculture is a critical infrastructure. It constitutes one-sixth of gross domestic product (GDP)—over a trillion dollars a year.”² The exclusion of agriculture from these important policy documents demonstrates that agroterrorism has not been

on the minds of U.S. policymakers. Classifying agroterrorism as a WMD might raise its profile and ensure that agroterrorists are punished with appropriate penalties.

Pathogens—Animal

Pathogens cause diseases that may affect animals, plants, or humans. The mere fact that a pathogen might affect multiple sectors of the agriculture system can cause disruption, which can occur anywhere along the food supply chain. Agroterrorism can involve pathogens that cause zoonotic diseases—that is, diseases that can be transmitted from animals to humans.¹⁰ However, zoonotics do not generally affect humans in the same way they do animals.

Some diseases affect both people and animals, while others are species-exclusive. The Office International des Epizooties (OIE) classifies as list A pathogens: foot-and-mouth disease (FMD), Bluetongue, Rift Valley fever, bovine spongiform encephalopathy (BSE, or “mad cow disease”), and avian influenza. These include pathogens rarely seen in the U.S., but they could potentially pose a national security risk because of their high mortality rates, easy dissemination, and high degree of contagion and their potential to cause public fear and social disruption. These pathogens also require special action for American public health and preparedness,¹¹ because many of the diseases are not endemic to the U.S., so many health care and agricultural inspection officials cannot properly identify symptoms.

List B pathogens as categorized by the OIE are: brucellosis, salmonella, glanders, ricin toxin, typhus fever, viral encephalitis, and staphylococcal enterotoxin B.¹¹ These diseases are moderately easy to disseminate and result in moderate morbidity rates and low mortality rates. They also require specific enhancements of the Center for Disease Control and Prevention's (CDC) diagnostic capacity and enhanced disease surveillance.¹¹ This includes increasing CDC's capacity to diagnose all List A, B, and C diseases. It also includes concentrating surveillance efforts on both List A and List B diseases. These are easier to disseminate and may provide an agroterrorist a more accessible pathogen to use.

One such pathogen is foot-and-mouth disease. It is the most contagious animal disease known, with nearly 100% of exposed animals becoming infected.¹² The most recent and widely publicized FMD epidemic occurred in the UK in 2001, with the direct cost being from \$2–3 billion for the culling and destruction of more than 3 million animals.¹³ Losses totaled over \$6 billion, not including losses due to imposed trade barriers¹⁴ and damage to the tourism industry, which accounted for another \$5 billion.¹⁰

The last outbreak of FMD in the U.S. was in 1929.¹² The threat of FMD "is the agricultural equivalent of a threat to use smallpox on a human population, with the difference that FMD is more readily available than is smallpox."⁶ Controlling outbreaks of FMD is one of the keys to U.S. dominance of meat markets and production to the tune of over \$50 billion annually.⁴

It is interesting to note that the U.S. has not had an outbreak of FMD since the advent of television. Roger Breeze, associate director of the USDA's Agriculture Research Service, stated that "no visual point of reference has been available to prepare the public for the consequences of containing such an occurrence."¹⁵ The massive slaughter of animals required for the containment of such a pathogen would be, at the least, a public relations challenge.

Even the rumor of disease can produce sudden, damaging consequences to the market economy. In 2001, inside a sale barn in Kansas, a veterinarian noticed that some cattle had lesions on their tongues—a symptom of foot-and-mouth disease. The vet didn't suspect foot-and-mouth disease, but he notified state and federal authorities anyway.¹⁶ Once this incident was broadcast, the cattle futures market plummeted. It turned out that the cattle had been fed rough hay that contained thorns, which had caused the lesions. The cattle industry lost an estimated \$50 million because of this incident—and this was just a rumor of disease.

Recently, an outbreak of FMD was reported in Russia: "The Itar-Tass News Agency reported that cattle in the city of Blagoveshchensk in far eastern Russia were found

to have foot-and-mouth disease. A state of emergency was introduced in six districts of the Amur region."¹⁷ Officials there have already slaughtered 1,000 head of cattle bred at a local settlement farm, where the disease was detected on April 15, 2004. The vastness of a country cannot protect it from outbreaks of these animal pathogens, although it may slow down the spread of such a pathogen.

Another type of pathogenic outbreak occurred in 1983–84 and again in 2002: The U.S. poultry industry suffered both times through a particularly virulent strain of avian influenza. In the earlier instance, the eradication of the disease cost \$63 million and contributed to a nearly \$350-million rise in the prices of turkey, chicken, and eggs.¹⁸ Without government intervention and eradication of whole flocks to stem the outbreak, it is estimated that the final cost of the epidemic could have reached \$5.6 billion.¹⁹ In 2002, avian flu cost producers from \$130–140 million.²⁰ In Texas in February 2004 another outbreak of avian flu was reported. "This highly pathogenic H5N2 strain was last seen in the U.S. during the 1983–84 outbreak in Pennsylvania and Virginia."²¹ Russia, the European Union, South Korea, and Mexico all stopped or banned imports of poultry products after the announcement from Gonzales, Texas.²¹

Recently, a dairy cow in Moses Lake, Washington, tested positive for BSE. The cow in question was not detected by routine surveillance, but as Dave Louthan, the slaughterer on the scene, stated, by a "fluke."²² The cow's temperature could not be taken because the slaughterer thought it was going to trample the other cows in the trailer. Louthan stated, "Mad cows aren't downers [cattle that are on the ground], they're up and they're crazy."²² Louthan killed "the cow . . . outside and that is the only reason it was tested. The plant's testing program called for sampling cows killed outside only."²³ The discovery prompted Japan to halt all beef imports from the U.S. Currently, the Creekstone Farms Premium Beef of Arkansas City, Kansas, has threatened to sue the USDA to obtain permission to test every animal at its slaughterhouse for BSE,²⁴ so that it can resume beef trading with Japan. Japan, which is the largest market for U.S. beef, "is now pressing for the U.S. to test all 35 million cattle that are slaughtered each year."²⁴ This has a significant impact on the U.S. beef industry and the entire U.S. agricultural export trade surplus. The issue is no longer about one cow at one plant found to have mad cow disease.

During a drill conducted in February 2003 called Silent Prairie, it was demonstrated that an outbreak "would not be a local event."¹¹ Federal government leaders, including a number of members of Congress, participated in the exercise. Some results were not unexpected: "Any kind of foreign animal disease (FAD), if it took only five days

to detect, would be all over the country.”²⁵ Subsequent to the drill, it was found that there were other agricultural issues that affect the second- and third-order effects of an outbreak of a foreign animal disease, including the stoppage of agricultural imports and exports and the complete halt of commerce within the U.S. Given that “no U.S. city has more than a seven-day food supply on hand,”²⁵ food supplies could actually run out.

Pathogens—Plant

Some prevailing plant pathogens include Karnal bunt, wheat smut, rice blast, and brown stripe mildew, which is a corn pathogen. Many of these pathogens not only reduce crop yields but also infect the harvested crops. These diseases can taint wheat before it is processed into flour. Crop pathogens are even harder to detect than animal disease because of the longer incubation periods and the difficulty in correctly identifying the specific pathogen. Small amounts of pathogen can infect large areas of cropland, and natural outbreaks of these diseases occur often. The total cost of these crop diseases to the U.S. economy, including all outbreaks of naturally occurring plant diseases, is estimated to be in excess of \$30 billion per year.²⁶

In 1996, Karnal bunt, a fungus disease, was discovered in wheat seeds that had been grown in Arizona and shipped to other southwestern states. Following this discovery, 50 countries adopted phytosanitary trade restrictions against the U.S. “Sanitary measures are those related to human or animal health, and phytosanitary (SPS) measures deal with plant health.”²⁷ These measures are part of the World Trade Organization (WTO) actions to improve commerce and establish a standard of export and import requirements. “The major objectives of the SPS Agreement are two: 1. protect and improve the current human health, animal health, and phytosanitary situation of all member countries [and] 2. protect the members from arbitrary or unjustifiable discrimination due to different sanitary and phytosanitary standards.”²⁷ The eventual cost of control and cleanup of the Karnal bunt fungus outbreak was an estimated \$45 million, and exports were reduced by \$250 million of the \$6 billion total value of U.S. wheat exports.¹⁰ This is even more significant considering that half of all wheat produced in the U.S. is exported.

Some of these plant and animal pathogens have been weaponized in the past. The U.S. even had a biological program that began in 1943 and was terminated in 1969 by executive order. “The anti-plant agents in the program were the fungi that cause wheat rust and rice blast.”²⁸ The U.S. then ratified the Biological and Toxin Weapons Convention (BWC) in March 1975 and since then has pressed to ensure compliance by all signatories. “In

2001, the Bush administration rejected an effort by other signatories to conclude a protocol that would provide verification measures.”²⁸ This was due to the fact that the U.S. is still conducting an “active biodefense program”²⁸ according to BWC provisions, including prophylactic, protective, or other peaceful purposes.

As part of the Soviet Union, Russia had the largest biological warfare program in the world; it included Ebola, yellow fever, rinderpest, wheat stem rust, and blast.²⁹ The Bush administration has expressed concern over whether Russia is in compliance with the Biological Warfare Convention of 1972 and about the security and status of the weapons program Russia inherited from the Soviet Union. Another cause for alarm was seen during the 1980s, when Iraq developed and used wheat smut, a grain pathogen, to infect Iran’s food supply³⁰ during the Iran–Iraq war of 1980 to 1988. Wheat cover smut results in significant crop yield loss and produces highly volatile trimethylamine gas that can cause harvesters to explode.¹⁰ Iraq claims to have destroyed the infected wheat in the 1990s.¹⁰

CURRENT RESOURCES

Shortages of food, decreased confidence in the food supply, and economic upheaval are all possible after-effects of an animal or plant pathogen outbreak. Attacks on the \$193-billion U.S. crop and livestock industry¹⁰ would have catastrophic consequences when the probable ripple effects are taken into account. In FY2000, more than \$8 billion was allocated to U.S. federal agencies for combating terrorism; of that amount, the USDA received only \$12 million, or 0.15%.¹⁰ FY2003 funding included \$5.9 billion to defend against bioterrorism,³¹ of which \$328 million was allocated to fight agricultural bioterrorism.³² The budget for the biological countermeasures of the Department of Homeland Security Research and Development increased from \$285 million in FY2004 to \$407 million in FY2005.³³ The National Institutes of Health (NIH) budget increased 2.6% to \$28.6 billion for FY2005, with \$1.7 billion for bioterrorism research.³⁴ However, in neither case is there a mention of agricultural bioterrorism or agroterrorism.

But is this enough? Spending approximately \$2 billion to protect only parts of an agriculture industry that in 2004 has assets in excess of \$1.1 trillion (after accounting for farm debt)³⁵ may not be enough. In simple terms, that is roughly \$2 spent per \$1,000 of agricultural assets—including farms, processing plants, stockyards, grocery stores, and ports—to protect them from attack. However, the new budget does provide funds for hiring more people and for additional training to protect the nation’s food supply. The FY2004 budget will fund 7,680

food safety inspectors, provide specialized training, and strengthen surveillance programs.³⁶ It is yet to be seen if funding additional inspectors will increase the current level of 2–3% inspection of fresh produce entering the U.S.³⁷

One major change that will help mitigate the risk of an outbreak is that part of the USDA's Animal and Plant Health Inspection Service (APHIS) is being shifted to the Department of Homeland Security.³⁷ Generally, the Food and Drug Administration (FDA) inspects fruits and vegetables and the USDA inspects meat and poultry.

Another strategic asset that is available for containment, mitigation, and consequence management is the Technical Escort Units (TEU) supplied by the U.S. Army Explosive Ordnance Disposal. These units, among other things, escort presidential candidates, but they also are available to help contain and provide consequence management for biological agents. The U.S. Army Veterinarians inspect food for the U.S. Army, but they could also assist the USDA, the Animal Plant and Health Inspection Service (APHIS), and customs agents covering ports of entry into the U.S. The Federal Emergency Management Agency (FEMA) is the federal executive agent that provides mitigation and consequence management primarily for natural disasters. This agency could provide integration of current operations in the case of an agroterrorist attack. The Northern Command (NORTHCOM) is a new Department of Defense (DoD) combatant command. Legislation since 9/11 incorporates some of the functions of these agencies but does not provide for sharing of intelligence among all organizations. Current legislation also does not give the U.S. a comprehensive and feasible plan to contain and manage the consequences of agroterrorism or adequately protect agriculture as a strategic asset.

RECOMMENDATIONS

The challenges posed by the prospect of agroterrorism reach across a number of disciplines and across federal, state, and local agencies and include programs focused on food chain protection, surveillance, consumer education, and sharing of intelligence. Also of high importance are the U.S. Farm Bill, agribusiness, research grants, risk management, and enforcement of the Clayton Act.

Sharing information

The U.S. must share information and intelligence up and down government hierarchy chains, as well as across previously separated government agencies, to prevent agroterrorism. This will help in detecting unusual activities and may even produce information that is of no conse-

quence to some agencies but can help protect agricultural resources. For example, a recent report notes two examples of surveillance systems: "FoodNET, which the U.S. Department of Agriculture uses to track food-borne illness, and CDC's Behavioral Risk Factor Surveillance System, a phone survey which gathers data on behaviors that lead to chronic disease." These systems gather information but do not link together to share information with each other or with other health and environmental databases.³⁸

The consolidation of some agencies and functions under the Department of Homeland Security is one way that information can be shared across agencies. However, intelligence-sharing should occur among the USDA, APHIS, the Food Safety Inspection Service (FSIS), the FDA, CDC, the U.S. Customs Service, the Immigration and Naturalization Service (INS), and other government agencies. One way to share information would be to combine the inspection arms of the USDA and the FDA. This would allow better coverage of all food inspection results and increase response times to food pathogen outbreaks.

Change law and enforce the Clayton Act

The Defense Against Weapons of Mass Destruction Act (Title 50, chapter 40, of the U.S. Code) must be amended to include agroterrorism as a weapon of mass destruction. Equating agroterrorism to a chemical or nuclear attack would demonstrate to the public how serious an agroterrorist attack would be to the U.S. The danger is not only the destruction of meat and other foodstuffs but the great impact that disruption of the food supply would have on the economy and the psychological effect it would have on the public. The new law must also treat agroterrorists like those who commit "conventional" acts of terrorism.

As noted earlier, vertical integration causes the food chain to be an easier target for agroterrorism. Currently the "country faces very high and rapidly increasing levels of concentration in both industries supplying farms and in those buying farm products."³⁹ Over the past two decades, a number of acquisitions and mergers have taken place in agricultural companies, but the efficiencies derived from these mergers are partially offset by the increased risk of attack they engender. The concentration of these food activities increases the vulnerability of the entire national agricultural network. The Clayton Act, which concerns the social, political, and economic implications of high concentration, monopoly, and massive mergers, needs to be enforced.

Designate lead federal agency

Within the federal government there needs to be a lead agency for food safety or consequence management. The

FDA and USDA currently conduct most of the food inspections, and FEMA has an Emergency Support Function (ESF #11) for food, with the USDA as the responsible agent. There needs to be a closer relationship among these three agencies to adequately provide for food security and the mitigation and consequence management of any pathogen outbreak. This team could also have ties to the Department of Homeland Security and other agencies and could function in time of crisis as the command and control conduit for information to the lead government agencies responding to the threat.

Increase vigilance and public awareness

A constant information campaign directed at the American public about how the food supply is being protected is required. The public will support additional spending to protect agricultural resources if they are informed on how that money is spent. The size and scope of agriculture both as a business and as the industry that feeds the U.S. population requires additional resources to adequately protect and preserve it. Protecting current U.S. agricultural assets of \$1.1 trillion with roughly \$2 billion in resources is not sufficient.

Improving current monitoring systems would help increase public awareness. Funding of additional inspectors and border guards is important, but the education and training of all agricultural stakeholders is imperative. Public awareness could be increased through the Cooperative Extension Agents, who are already in place throughout the nation, supported by land grant universities. Farmers and consumers should have information about food safety that is up to date and accurate.

Leverage technology

The technology of early detection is key to prevention and preparedness. "Agriculture lags far behind the medical field in the development and use of new and emerging technology, such as nanotechnology, rapid and inexpensive diagnostic tools and availability of robust databases."⁴⁰ Inexpensive methods of tagging and sampling foodstuffs for quality testing are essential technological innovations. For example, data tags or microchips could be attached to containers or even inserted into the foodstuffs. This would allow the origin, transportation, warehousing, and transient points to be recorded for use in determining if foodstuffs were contaminated. The ability to pinpoint accurately the origin of grains or animals could greatly enhance containment measures. Currently, domestic pets can be given implants the size of a grain of rice to help in animal control and to prevent loss. This technology could be used today in meat- and milk-producing animals in conjunction with passive interrogators. Interrogators could be used at stockyards and slaughter-

houses to collect data and safeguard domestic meat sources. A national system to locate any cow, pig, or chicken in the U.S. within 48 hours is years away, although the current Secretary of Agriculture has promised to speed development.⁴¹ Commercial off-the-shelf systems exist today that would not need development but would require management of the information and determining federal and state roles.

Increase biodiversity

We should work to decrease current crop disease costs, which are more than \$17.5 million a year, accounting for 17% of the total cost of production in developing countries.⁴² One way to increase biodiversity is gene sequencing of the pathogens themselves, and one area of particular opportunity is plant pathogens. By increasing biodiversity the U.S. can develop disease-resistant cultivars of food grains and crops. Increasing biodiversity also would allow for research into human disease treatments and cures. Research could increase the knowledge of plant pathogen sequenced genomes. Currently, fewer than 6% of the microbial genomes that are sequenced are plant pathogens.⁴³ By understanding the microbial genomes, we can better defend against plant pathogens through earlier detection, designing crops with inherent resistance, and identifying genes that allow crops to contract and spread disease.

In Homeland Security Presidential Directive 9: Defense of United States Agriculture and Food, a National Veterinary Stockpile for vaccines is mandated.⁴⁴ However, by establishing a National Strategic Reserve of cultivars, the U.S. could preserve genetic material and increase biodiversity. A repository of both plant and animal genome sequencing could help in development of disease-resistant crops and disease-resistant livestock.

Enhance veterinarian education

Most veterinary college curricula do not emphasize foreign animal diseases. Thus, few state and local veterinarians possess the necessary expertise to deal with List A pathogens.⁴ In addition, more veterinarians—especially large-animal veterinarians—are needed nationwide to provide adequate preparedness.⁴ List A pathogens and zoonotic diseases are primarily found in large-animal species, but only 751 veterinarians in the American Veterinary Medical Association deal exclusively with bovines, with another 3,000 who are "mixed large-animal" veterinarians.⁴ More veterinarians who are well educated on List A and B and zoonotic pathogens would be helpful with detection and prevention efforts. Federal grant money directed at educating more veterinarians is a start in solving this problem.

CONCLUSION

Today U.S. agriculture and agricultural products are vulnerable to terrorists, and an act of agroterrorism would affect both the U.S. and world economies. Such an attack could undermine consumer confidence in the government's ability to regulate and maintain the nation's food supply, and the safety of a nation's food supply is a matter of great psychological, social, political, and economic importance. We can take steps to prevent agroterrorism by sharing information among government agencies, educating more veterinarians, strengthening laws, increasing public awareness, and increasing research to find new ways to combat this threat.

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REFERENCES

1. Harl NE. U.S. agriculture, food production is threatened by bioterrorism attacks. *Ag Lender* April 2002:1. Available at: <http://www.econ.iastate.edu/faculty/harl/USAgThreatened.pdf>. Accessed April 21, 2004.
2. Parker HS. *Agricultural Bioterrorism: A Federal Strategy to Meet the Threat*. Washington, DC: Institute for National Strategic Studies, National Defense University, McNair Paper 65; 2002:x.
3. Chalk P. *Hitting America's Soft Underbelly: The Potential Threat of Deliberate Biological Attacks Against the U.S. Agricultural and Food Industry*. Santa Monica, Calif: RAND National Defense Research Institute; 2004:33.
4. Gilmore Commission Report. *Forging America's New Normalcy: Securing our Homeland, Protecting our Liberty*. Arlington, Va: RAND Corp; 2003:chap 7.
5. Allison R. Representing farmers in hard financial times. *In Motion* May 3, 1999:1. Available at: <http://www.inmotionmagazine.com/repre.html>. Accessed February 4, 2004.
6. Pate J, Cameron G. *Covert Biological Weapons Attacks Against Agricultural Targets: Assessing the Impact against U.S. Agriculture*. ESDP-2001-05. Washington, DC: Belfer Center for Science and International Affairs; August 2001:19.
7. Casagrande R. Viewpoint: Biological terrorism targeted at agriculture: The threat to U.S. national security. *The Non-proliferation Review* Fall-Winter 2000; 3:96.
8. Oates B. Family farmers from mid-Missouri and Mexico hold fair trade picnic and roundtable. *In Motion* July 12, 2003:2. Available at: <http://www.inmotionmagazine.com/ra03/picnic.html>. Accessed February 4, 2004.
9. Hearings Before the Senate Subcommittee on Oversight of Government Management, Restructuring and the District of Columbia, 107th Cong. 1st Sess (2001) (testimony of Peter Chalk on Terrorism, Infrastructure Protection, and the U.S. Food and Agricultural Sector, p. 2).
10. Kohnen A. Responding to the Threat of Agroterrorism: Specific Recommendations for the United States Department of Agriculture. BSCIA Discussion Paper 2000-29, ESDP-2000-04. Cambridge, Mass: Harvard University, John F. Kennedy School of Government; October 2000:20.
11. Centers for Disease Control and Prevention. *Bioterrorism agents/diseases*. Available at: <http://www.bt.cdc.gov/Agent/agentlist.asp>. Accessed February 24, 2003.
12. Agroterrorism: Facing the threat. *Farm Bureau News* October 22, 2001;80(19). Available at: <http://www.fb.com/fbn/html/agriculturalterrorism.html>. Accessed September 19, 2002.
13. Lessons from an epidemic. *Nature* June 28, 2001;411:977.
14. Jayarao B, Wolfgang D, Tewari D. Agroterrorism: A potential threat to U.S. animal agriculture. *Herd Health Memo*. University Park, Penn: Pennsylvania State University, Cooperative Education, College of Agricultural Sciences; December 2001:2.
15. Chalk P. The U.S. agricultural sector: A new target for terrorism? *Jane's Intelligence Review* February 9, 2001:6.
16. Gips MA. The first link in the food chain. *Security Management Online* February 2003:1. Available at: <http://www.securitymanagement.com/library/001379.html>. Accessed May 9, 2003.
17. Bagel A. Russia declares foot-and-mouth emergency. *Daily News* April 21, 2004:1. Available at: <http://www.meetingplace.com/DailyNews/pop.asp?ID=12235>. Accessed April 21, 2004.
18. Knowles T. Law enforcement's role in defending against bio-terrorism threats to America's livestock industry. *Journal of Homeland Security* December 2002:8. Available at: <http://www.homelandsecurity.org/journal/articles/display-Article.asp?article=81>. Accessed May 12, 2004.
19. Brown C. Agro-terrorism: A cause for alarm. *The Monitor* Winter-Spring 1999;5(1-2):6.
20. Virginia Farm Bureau Federation. Valley poultry growers pleased with indemnification. *Farm Bureau News and Features* August 8, 2002:1. Available at: http://www.vafb.com/news/2002/aug/080802_1.htm. Accessed August 20, 2002.
21. Deadly strain of avian flu in Texas. *Journal of the American Veterinary Medical Association News [JAVMA News]* April 1, 2004:1. Available at: <http://www.avma.org/onlnews/javma/apr04/040401c.asp>. Accessed April 15, 2004.
22. McNeil DG Jr. Cow killer's "big mouth." *Kansas City Star* February 8, 2004:A4.
23. Personal email reply from Dave Louthan, February 10, 2004 [maddddcow@hotmail.com].
24. Quaid L. Fight looms on cattle tests. *Kansas City Star* April 10, 2004:C1.
25. Manning A. Federal drill to test preparedness for foot-and-mouth "agroterrorism." *USA Today* February 10, 2003:1.

26. Pimental D, Lach L, Zuniga R, Morrison D. Environmental and economic costs of nonindigenous species in the United States. *BioScience* 2000;50:53–65.
27. Iacovone L. *Analysis and Impact of Sanitary and Phytosanitary Measures* [paper based on master's thesis]. Sussex, England: Sussex University; 2002. Available at: <http://www.cid.harvard.edu/cidtrade/Papers/iacovone.pdf>. Accessed April 20, 2004.
28. *What Are the Global Threats from Weapons of Mass Destruction?* Washington, DC: Nuclear Threat Initiative; 2003. Available at: http://www.nti.org/e_research/profiles/USA/index.html. Accessed April 13, 2004.
29. Biological Weapons Convention. Washington, DC: Council for a Livable World; 2002. Available at: http://64.177.207.201/pages/16_111.html. Accessed April 19, 2004.
30. Chemical and Biological Weapons Non-Proliferation Project. *Iraqi Weapons of Mass Destruction*. Washington, DC: Henry L. Stimson Center; March 2003:1.
31. Miller B. Study urges focus on terrorism with high fatalities, cost. *Washington Post* April 29, 2002:A3.
32. Borenstein S. U.S. agriculture at risk of bioterrorism, scientists warn. *Philadelphia Inquirer* September 20, 2002.
33. *DHS R&D Wins Big Increase in FY2005 Budget*. Washington, DC: AAAS; 2004. Available at: <http://www.aaas.org/spp/frd/dhs05p.pdf>.
34. *Bush administration FY 2005 budget limits increases for health programs*. Available at: <http://www.bumc.bu.edu/Departments/PageMain.asp?DepartmentID=38&Page=8901>. Accessed April 19, 2004.
35. *U.S. Agricultural Sector Indicators*. Washington, DC: USDA Economic Research Service; 2004:71. Available at: <http://www.ers.usda.gov/publications/waob041/waob2001e.pdf>. Accessed April 19, 2004.
36. Harrison A. *USDA News Release: President Bush to Propose Record-Level Funding for USDA Food Safety Programs*. Washington, DC: USDA Office of Communications, Release No. 0021.03, 23, January 2003:1.
37. Manning A, Weise E. Who is minding the USA's food store? *USA Today* January 26, 2004:1. Available at: <http://www.spnnetwork.com/mii/2004/040139.htm>. Accessed April 23, 2004.
38. *Animal-borne Epidemics Out of Control: Threatening the Nation's Health*. Washington, DC: Trust for America's Health; August 2003:7. Available at: <http://healthyamericans.org/reports/files/Animalreport.pdf>. Accessed May 12, 2004.
39. Carstensen PC. Market Concentration and Agriculture: Equally Harmful to Producers and Consumers. Paper presented at the conference Visions for the Millennium, Structural Changes Facing Livestock & Grain Markets in the 21st century, May 9–10, 2003, Kansas City, MO. Available at: <http://www.usda.gov/gipsa/psp/issues/millennium/carstensen.htm>. Accessed November 18, 2003.
40. Vidaver AK. Agroterrorism: Security through prevention and preparedness. *CoFarm*, Coalition on Funding Agricultural Research Missions, Department of Plant Pathology, University of Nebraska-Lincoln, p. 1.
41. Livestock tracking under development. *Kansas City Star* February 8, 2004:A4.
42. Wheelis M, Casagrande R, Madden LV. Biological attack on agriculture: Low-tech, high impact bioterrorism. *Bio-science* July 2002;52(7):573.
43. Sherwood JL. Briefing on crop biosecurity—Are we prepared? *CoFarm*, Coalition on Funding Agricultural Research Missions, Department of Plant Pathology, University of Georgia, p. 2.
44. Homeland Security Presidential Directive 9: Defense of United States Agriculture and Food. January 30, 2004. Available at: <http://www.whitehouse.gov/news/releases/2004/02/20040203-2.html>. Accessed February 6, 2004.
45. USDA Protecting America's Meat, Poultry and Egg Products, A Report to the Secretary on the Food Security Initiatives of the Food Safety and Inspection Service (FSIS). January 31, 2003, p. 2. Available at: <http://www.fsis.usda.gov/oa/topics/FoodSecReport.pdf>. Accessed November 20, 2003.

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