

US food safety under siege?

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When it comes to the prospect of an aggroterrorist attack—the use of biological agents against crops, livestock, poultry and fish—US agriculture has rolled out the welcome mat. Integration and consolidation in the industry widen the potential impact of any single attack. Internationalization of the food chain offers limitless possibilities for human consumption contagions, as well as economic and political instabilities. To combat and anticipate potential attacks to the US food chain, greater effort should be placed on designing new disease-resistant varieties of plants and livestock on the basis of genomic information. Stricter regulations and enforcement capabilities should be introduced not only at our borders but at the point of origin where food is grown, procured or processed for domestic consumption within the United States. At the same time, the United States must develop a comprehensive preparedness and prevention strategy of international proportions in close coordination with our trading partners and the private sector.



The foot and mouth disease outbreak in the UK in 2001 devastated agriculture

Changes in food production and regulation

The US strategy of protection for the food system, as mapped out in the Homeland Security Presidential Directive/ HSPD-9 of January 30, 2004, presupposes that in striving to protect production, processing, food storage and delivery systems within US territory, a credible line of defense will be created to protect the food chain and encourage a thriving agricultural economy. In fact, US agriculture has undergone dramatic change. For crops, 'farm to fork' no longer is confined to a regionally based agricultural system, but now encompasses a highly integrated and consolidated global undertaking. For livestock, 'hoof to home' now takes on a new meaning that includes a high concentration of production, specialization of

calf operations, long distance shipping and massive feedlots averaging thousands of head marketed per facility¹, for both domestic and international consumption². These commercial developments have resulted in previously unimaginable production and handling efficiencies in domestic and export markets³.

In 2001, over 70% of processed food in the United States was purchased from other countries, representing almost 30% of final gross product⁴. Fifteen of the top 25 food and beverage companies in the global market are US owned, accounting for about 10% of the global market. US multinational companies account for roughly 6.5% (ref. 5). With greater consolidation on a global scale, interaffiliate trades account for an increasing portion of the value of the food chain. Like other nations, the United States is moving from self-sufficiency to an increasing dependence on other countries for its food supply.

At the same time, the US regulatory infrastructure for food safety is still a work in progress

and is hobbled by overdependence on the private sector and underdependence on international cooperation. Whether it is a matter of detection, surveillance or information flow, the US government is currently dependent on the private sector for cooperation and support. To share information, government and industry have established the Food and Agriculture Information Sharing and Analysis Center (ISAC; Washington, DC, USA), which includes key industry association representatives, especially from the processed food and feed sectors.

The Bioterrorism Act of 2002 sets up tracking mechanisms whose effectiveness depends on industry self-reporting. New food import regulations issued by the US Food and Drug Administration (FDA; Rockville, MD, USA) now require prior notification of eight hours for goods arriving by ship, four hours by rail or air and two hours by road. This dependence on the private sector is burdensome for companies and both insufficient and unreliable for ensuring

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Table 1 Selected biological pathogens that could be used in an agro-terror attack on the United States

Disease	Target/vector	Agent
Animal diseases		
Foot-and-mouth disease	Livestock	Foot-and-mouth virus
African swine fever	Pigs	African swine fever virus
Plant disease		
Stem rust for cereals	Oat, barley, wheat	<i>Puccinia</i> spp. (fungus)
Southern corn leaf blight	Corn	<i>Bipolaris maydis</i> (fungus)
Rice blast	Rice	<i>Pyricularia grisea</i> (fungus)
Potato blight	Potato	<i>Phytophthora infestans</i> (fungus)
Citrus canker	Citrus	<i>Xanthomonas axonopodis</i> pv. <i>citri</i> (bacterium)
Zoonoses		
Brucellosis	Livestock	<i>Brucella melitensis</i> (bacterium)
Japanese encephalitis	Mosquitoes	Japanese encephalitis virus (flavivirus)
Cutaneous anthrax	Livestock	<i>Bacillus anthracis</i> (bacterium)

ing the public's food safety concerns.

Current regulations have evolved since last December, after a reality check of the US government's enforcement capabilities along with industry's feedback and support. The initial regulations failed on both counts and the prospects for the latest regulations remain uncertain. FDA and the Customs & Border Protection Agency (Washington, DC, USA) still have not adequately funded the enforcement infrastructure nor trained personnel to ensure statistically random, uniform inspections under the new prenotification time frames⁶. Industry is called upon to fill the breach but is still relatively unprepared, with insufficient resource commitment to comply fully with the latest regulations.

There remains a remarkable lack of consultation, joint surveillance and shared research with trading partners worldwide. Whether grits or pasta, the US diet still thrives on an international food supply chain. Similarly, food protection and terrorist prevention have to be internationalized, particularly given the advances that continental-wide Europe and Japan have achieved in this regard.

The threats

Although no precedent exists for an agro-terrorist attack on the food chain, the dire consequences of natural outbreaks provide a glimpse of the potential damage that could be wrought. The scale of the foot-and-mouth disease (FMD) outbreaks in Taiwan in 1997 (ref. 7) and in the UK in 2001 (ref. 8) or the bovine spongiform encephalopathy (BSE) epidemic in the United Kingdom from 1996 to 2002 was more devastating than previous

epidemics because of the size and structure of modern agricultural production. Taiwan was forced to slaughter more than 8 million pigs and suspend its exports. In the United Kingdom, 4.2 million animals were destroyed in 2001 and 2002, with devastating economic consequences. The cost to Taiwan, a major supplier to Japan, was estimated to be over \$20 billion. In the United Kingdom, direct compensation payments alone amounted to approximately \$9.6 billion⁸. Because of two major outbreaks of BSE, the United Kingdom slaughtered approximately 5.8 million head of cattle (30 months or older), with an impact of up to \$8 billion for the 2000–2001 occurrence alone^{9,10}. The 2003 Dutch outbreak of H7N7, a very pathogenic strain of avian influenza virus, resulted in the necessary culling of over 28 million birds out of a total of 100 million. These numbers pale in comparison to the estimates for a terrorist-induced pathogen release at the heart of the international food chain. The range is astonishing, from almost \$7 billion due to a contagion of Asiatic citrus canker on Florida's citrus fruit alone to \$27 billion in trade losses for FMD^{11,12}.

An array of pathogens could be introduced easily and effectively with assurance of widespread health, economic and political impacts (see **Table 1**). For livestock, the prime candidates are FMD and African swine fever (ASF). FMD is particularly attractive from a terrorist standpoint because it is a highly contagious viral infection with a morbidity rate of 100% in cattle. ASF is equally effective¹³.

Next on the list are the zoonotic diseases, which offer a different strategy: using animals to infect humans. Brucellosis, though not fatal,

results in chronic disease; some paramyxoviruses can be passed through direct contact with animals and feature a mortality rate in humans of 36%; certain arboviruses, such as Japanese encephalitis virus, which is spread by insect vectors, and cutaneous forms of anthrax could be readily introduced in the United States. Animal hides, an import item to the US, are a common carrier of anthrax spores that can be readily inhaled and prove fatal for humans.

When it comes to crop pathogens, the list is equally long and ominous: stem rust for cereals and wheat, southern corn leaf blight, rice blast, potato blight, citrus canker and several nonspecific plant pathogens. Although not transmittable to humans, these pathogens would cut a wide and devastating swath in crop production.

It takes relatively few dollars and little imagination to introduce these deadly pathogens. Just like a crop duster or even hand spray pumps, aerosol would be an effective means to introduce the crop pathogen of choice on plants. A terrorist could also rely on cross border winds or water systems to carry a harmful pathogen from another country into the United States. For animals, the options could be somewhat more imaginative, such as dusting a turkey's feathers with a pathogen agent and then filling small bomblets with the feathers to explode over a targeted area, mushrooming contamination as the feathers drift with the wind to such likely targets as a high density avian population.

Economic and political impact

Any agro-terrorist attack on the food chain would create marked economic instability and losses due to dislocational, trade and health effects. Every bushel of wheat, corn or soybeans (all staple food and feed items) in addition to beef carcasses and pork bellies, has a futures contract written in Chicago and on other exchanges in Europe, Asia and Latin America. These contracts are all written on margin positions, meaning that the financial losses on unfulfilled contracts would be a multiple of the contract itself. Apart from stocks, losses could be incurred as a result of the following: loss of business for freight-forwarding companies, cancellations of ocean freight, rail and truck hauls; insurance claims on cargoes; and abrogation of contracts up and down the food chain.

With only a partial and untested 'Bioshield' system in place, one likely scenario is that US politicians would adopt a unilateral response to what is an international problem in the face of a bioterrorist attack. Whether it's cross-border winds or the globalization of our food chain, the fact remains that much of our own vulner-

ability rests with imported pathogens. The US cannot seal off its territory from these pathogens. By attempting to do so, the government would make matters worse in the absence of uniform international security and surveillance systems.

The appropriate counter-terrorist response requires a global security system for sharing research, findings and coordinating strategies with trading partners where the United States sources and sells much of its food. Present policies risk the kind of economic repercussions experienced with Japan in the aftermath of the three-day soybean embargo imposed by the United States in 1973, which became a major *shoku* in Japan's economic history. Concern over food security, rooted in the soybean embargo, inspired the first and ultimate line of defense in Japan's resistance to liberalizing international trade rules for the agricultural sector.

Counterattacks

The first priority to combat these threats is to invest in the creation of pathogen-resistant crops through genetic engineering. The National Plant Genome Initiative (Washington, DC, USA) is an international collaboration between academia and the private sector to build a plant genome research infrastructure¹⁴ targeted at sequencing model plant species and therefore identifying genes associated with disease resistance. Together with information concerning large-animal genomes—the cattle genome is anticipated soon—genomic information can be applied to develop new strains of plants and livestock resistant to animal and plant pathogens likely to be used by terrorists. The US Department of Agriculture's (Washington, DC, USA) newly sponsored research centers and other joint government and private sector initiatives inside and out-

side the United States could also contribute to the search for resistant strains of livestock. In addition, short-term virus testing and monitoring measures can be adopted to address the problem of increased susceptibility of livestock to disease due to changes in cattle feeding and meatpacking. The discovery earlier in 2004 of a BSE-infected Holstein cow in the United States demonstrated that the monitoring and surveillance system in place is insufficient for rapid detection purposes.

There is also an immediate need for a stronger set of regulations that feature comprehensive coordination of research, detection and surveillance on both national and international fronts. Private industry partners in this undertaking must be treated equitably and fairly with a greater effort to broaden industry representation. The easiest step that can be taken to strengthen US defenses is to initiate and fund an intensive personnel training program to meet CBPA (Customs and Border Protection Agency) and FDA's ambitious program benchmarks for field operations, including port inspections, staffing and personal training, and industry registrations. We still lack uniform and consistent enforcement standards for industry and government agencies. Although that is the 15-year goal of the Automated Commercial Environment (ACE) run by the US Customs, nothing in place can accommodate different information and reporting systems in both the government and the private sector.

Longer term measures should include accelerated research programs and an integration and internationalization of policy planning and enforcement. Although the target is to create a practical system of defense for the US food chain, new endeavors to foil terrorists also can result in a broader international system of preparedness. Lifting the siege is the first step

to defeating the aggressors.

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