Food Defense & Security in the age of ISIL

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Introduction

The food and agriculture sector is one of the United States’ 16 critical infrastructures, [1] supplying a safe, economical and abundant food supply to the consumer, as well as the warfighter. As a general rule, foods sourced in the United States or produced under conditions which meet U.S. pre-harvest and harvest regulatory standards pose little to no risks, beyond those already addressed and mitigated by food sector-specific screening tests and standard operating procedures for food handling and processing.

The United States has not known widespread hunger since the Great Depression (1929-1939), when, at its height, between 13 and 15 million people were unemployed. [2] Currently, the United States Department of Agriculture’s Food and Nutrition Service administers large-scale and comprehensive programs designed to prevent and mitigate hunger in the U.S. population. While these programs provide mechanisms for food support in time of need, they also could unintentionally enable vulnerability. The current generation of Americans is not accustomed to storing food for emergencies or finding alternate food sources should the food supply be disrupted on a large-scale or for an extended time. Complicating this, the food supplies on-hand in major U.S. cities are generally understood to be sufficient for only three days, although this does not take into account regionally warehoused supplies, which move quickly through normal distribution channels.

The southern United States is subject to seasonal hurricanes, ice storms and other large-scale weather events, so it is not uncommon to see emergency supplies moved into big-box stores in anticipation of major weather events. Depending on public concern, consumers may empty the shelves of staples such as bread, milk, baby formula, water and toilet paper during an intense flurry of short-term stockpiling. As weather emergencies worsen, transportation companies pull tractor-trailer trucks off the road to avoid damage as conditions deteriorate, disrupting the efficient system of food distribution.

This disruption is usually short-term if transportation systems remain intact and can be rapidly restored after a severe weather event. Private sector distribution resumes, providing consumers with necessary food supplies. In disasters like Hurricanes Katrina and Rita (2005), however, recovery of adequate food supplies was delayed because transportation infrastructure was seriously damaged.

The possibility of significant localized or regionalized shortages looms. At such times, cooperation among federal and state governments – along with the private sector, utilities, and non-government organizations – is vital for timely restoration of food and potable water supplies.
Intentional Contamination

Food and water supplies require protection from intentional adulteration caused by insider threats (such as disgruntled employees) or by organized terrorist groups such as the Islamic State of Iraq and the Levant, whose sympathizers or members could infiltrate companies in the food and agriculture sector.

Contamination of a single ingredient, such as wheat or eggs, could spread contamination into a wide variety of products, thereby magnifying the event’s scale. Loss of faith in the integrity of domestic food or water supplies would alarm the public and might cause civil unrest until an alternative safe supply can be identified, mobilized, delivered and accepted.

A secondary—but not insignificant—element in any intentional food or water contamination event would be the effect on “brand quality” or “brand confidence.” Food corporations work to create a brand that symbolizes quality and trust. When something damages or destroys that image, the economic effects on the company can be devastating.

Imagine a scenario where a staple like milk or bottled water is intentionally contaminated, which happened in China in 2008, when unscrupulous dairies used powdered melamine to disguise watered-down milk and infant formula. [2] This kind of economic devastation should be recognized in the “big-picture” context of the safe and secure food supply that is part of national security.

If the national food defense strategy fails to recognize farming as essential infrastructure, the immediate effect on the milk- and dairy-products market would be swift, perhaps even existential, because the company “brand” associated with such an attack could be put out of business.

In China, public trust was irrevocably shattered as consumers and the press considered the possibility that the milk supply as a whole—rather than just milk produced by one corporation—was contaminated and as they recognized the reality that no effective federal oversight existed. [3] In the U.S., the short- to medium-term effects would be that large quantities of milk and dairy products would be recalled and destroyed out of an abundance of caution. In a sufficiently large-scale event, overall supply would suffer. The cost of other foods would increase as companies compete for milk or milk products such as cheese, butter, and whey.

Groups such as ISIL understand very well the potential psychological impact of contaminating food and water. In 2015, 45 ISIL members died in Mosul, Iraq, when unknown persons appear to have intentionally contaminated their iftar meal, the ceremonial end of the religious fast each evening during Ramadan. [4,5,6] To date, no publicly available information has revealed the exact nature of the event, although given the rapidity of the deaths it is likely that a rapid-acting toxic substance was involved rather than a foodborne pathogen.

ISIL leadership experienced firsthand how such an event instills fear and terror, possibly priming them to use poison to eliminate those considered enemies. Whether ISIL has the capability to deliver a major blow to U.S. food and water supplies is a discussion best reserved for other forums, but there is dear and openly available evidence indicating that ISIL recognizes the importance of critical infrastructures to the U.S. and would like to damage them significantly.

Defending the U.S. Food Supply

How should the United States address the full spectrum of potential threats to the food and water supply, whether of natural or terrorist origin? How does the U.S. defend the food supply?

Food defense is not just a “whole of government” issue, but rather a national problem, especially since the majority of players in this sector function outside of government. In other words, government assets and policies are important for protecting food and water, but the private sector and academia are also important and therefore must also be part of the solution.

In response to these needs, faculty in the Auburn University colleges of Agriculture, Engineering, and Veterinary Medicine have established a Food Defense Working Group [7] to leverage resources and address the full spectrum of needs. Working group members take a holistic approach, [8] from long experience recognizing the food and agriculture sector’s complexity. The group understands threats may come in many forms and from many directions and are convinced that practical, economically sound preparedness plans and solutions must be developed so that farms, ranches and companies in the food and agriculture sector remain profitable and viable. Their survival is fundamental to assuring that a safe, economical, robust and abundant food and water supply continues to remain available. The food and ag sector industry voice therefore must not be lost, since industry knows the intricacies of its daily operations far better than government.

In simple terms, food defense and food safety are two sides of the same coin, connected in that the lack of one element makes the other element more susceptible to intentional threats. Current U.S. Food and Drug Administration regulations call for companies to create and maintain food defense plans, [9] “Each covered facility is required to prepare and implement a food defense plan. This written plan must identify vulnerabilities and actionable process steps, mitigation strategies, and procedures for food defense monitoring, corrective actions and verification.”

Warfighters must be guaranteed a food supply at least as safe and reliable as that expected by the consumer. The Department of Defense has developed shelf-stable MREs (Meals Ready-to-Eat), which are supplied to warfighters for consumption of relatively short duration in situations where alternate and safe options of fresh food are unavailable. Difficulties have arisen and potential vulnerabilities have emerged when warfighters consume fresh or processed foods supplied by certified DoD vendors, which are frequently sourced, prepared and served by local contractual employees. Although the food is subject to the same inspection standards as in the United States, the presence of non-U.S. personnel in the food handling areas and the potential for intentional contamination cannot be discounted.

Robust strategies are therefore necessary to prevent food and water contamination by adversaries and must evolve as threats evolve. Here too, food corporations and experts outside of the Department of Defense can provide expertise and alternative views for developing strategies to deal with potential threats.

The Spectrum of Threats to the Food Supply

Threats to the food supply can take many forms, the majority of which do not originate
with terrorists or adversarial state actors. By far the biggest concern for food corporations is the adulteration that can result from the actions of a disgruntled employee working within the production and processing cycles. Since the food supply is the result of a highly complex system of systems, each with its own set of vulnerabilities, food defense must be comprehensive, starting with all the inputs (ingredients) and following through to the actual food product outputs, which are then transported to wholesalers, retailers and ultimately the consumer, whether civilian or military.

Common to all elements of the system is the human element, because if compromised by someone seeking revenge or economically motivated to do harm, the systems of protection can be circumvented and thereby compromised. A recent example, in June 2016, of a disgruntled employee occurred at the St. Cloud, Minnesota-based GNP Co., which was forced to recall 27 tons of chicken, under its Gold’n Plump and Just Bared Brands, when it was discovered that an employee had intentionally put sand and black soil in the company’s products. [10]

Remotely launched cyber-attacks are increasingly emergent as a persistent problem directed at food corporations. Industrial control systems used in food processing can be made to alter processes (e.g. cooking temperature) thereby compromising food safety, or else proprietary operation relational information can be extracted.

Proprietary information theft has also become a huge problem for the food industry. In many cases these remote attacks are not the result of amateurs hacking into systems, but instead originate from adversarial foreign states, such as China and Russia, who seek to gain an unfair economic advantage for their food production and processing industries, without requiring investment in infrastructure or process development. Modern cyber-based food control systems must be sufficiently robust to achieve real-time detection of hacking and malware intrusion attempts. The systems must also assure that the resulting food product meets all requirements associated with regulatory food safety and nutrition compliance, including traceability (lot and processing date) — often even to point of origin — and consistent with all specification requirements as set by the food processing company or its customers.

### Food and Water Threat Agents

Food and water defense must consider a panoply of threat agents that could cause a loss of confidence in the food supply; these could actually cause the food supply to become unsafe should they be deployed in an actual event.

Planning by government agencies is often directed toward and concentrated on “high consequence, low probability” events such as the impact of botulinum toxin if introduced into the milk supply. However, the food industry is appropriately more concerned about “low consequence, high probability” events, which though localized still can have a profound effect on liability (e.g., contributing to the likelihood of personal injury lawsuits, as well as consumer perception of the brand quality and corporate image, both of which affect product marketability.

Food and water defense should consider the human element as the most important risk factor day-in and day-out. Insider threats, whether the result of disgruntled employees or actual adversaries or sympathizers of adversaries, are most likely not going to be sophisticated. Insiders are enabled by motivation, ID badge/card-key access and workshift-based opportunities, as well as their knowledge of specific vulnerabilities in their local food production processes and system controls or related to the water utility.

Disrupting the capability and opportunities available to an adversary (sophisticated or not) to intentionally contaminate food products and water seems an obvious first goal for a defense plan, but often may not be considered as a priority in the midst of day-to-day business operational requirements. This must quickly change since actions of a single employee are capable, given the right circumstances, to quickly bring a company to the brink of financial disaster.

### Chemical Agents

Common chemical agents are likely to be used by unsophisticated adversaries, whereas as highly concentrated odorless, tasteless and colorless chemical agents are more likely to be available to and utilized by agents of rogue states. Potential chemical agents include industrial chemicals, lubricants and cleaning agents, as well as those on the Environmental Protection Agency’s “List of Extremely Hazardous Substances and Their Threshold Planning Quantities.” [11] Any of these could cause death should they be introduced into the food supply, but due to qualities of pH, taste, etc., most of them are unlikely to be effective.

Industrial chemicals have caused population-level problems in the past. Of particular concern are those which are highly persistent, such as brominated flame retardants, [12] organophosphates, dioxin and PCBs, [13] all of which have been associated with food and animal feed contamination events.

From the perspective of concentrating on high probability events associated with ready access and availability, the food industry should be most focused on preventing accidental or intentional contamination of food products by industrial chemicals, lubricants and cleaning agents that are already present in food production and processing facilities.

### Biological Agents

Biological agents are likely to be beyond the capability of most unsophisticated adversaries. The Biological Weapons Convention is a legally binding treaty that outlaws biological arms. It was signed by 165 nations and has been in effect since 1975. Any time the presence of biological weapons is confirmed and proven intentional, the involvement of sophisticated and well-financed adversaries such as ISIS, or other rogue nation states is implied. If a nation state, the intentional use of biological weapons is addressed by the BWC treaty and is considered an act of war. Of prime concern in the investigation of a foodborne outbreak is the ability to discern what is unintentional contamination, versus that which is not.

The Centers of Disease Control and Prevention has described more than 250 different agents of foodborne disease, including algae, bacteria, molds and fungi, viruses, parasites and their related toxins. Naturally-occurring foodborne diseases caused by bacteria include botulism, brucellosis, infections caused by Campylobacter, Clostridium perfringens and *Escherichia coli*, Listeriosis, salmonellosis, shigellosis and vibriosis. [14,15] Each could be introduced in the food supply inadvertently through contamination or intentionally as criminal acts of terror or biological warfare.

As CDC stipulates, “When two or more peo-
The Spectrum of Food & Water Threat Agents Summary

Chemical Agents
- Industrial chemicals
  - Brominated flame retardants
- Organophosphates
- Dioxin
- PCBs
- Lubricants
- Cleaning agents
- Chemicals on the Environmental Protection Agency’s “List of Extremely Hazardous Substances and Their Threshold Planning Quantities”

Biological Agents
- Examples of Foodborne Disease Agents
  - Algae
  - Bacteria
  - Molds and fungi
  - Viruses
  - Parasites and their related toxins.
- Foodborne Diseases Caused by bacteria
  - Botulism
  - Brucellosis
  - Infections Caused by Campylobacter
  - Clostridium Perfringens & Escherichia coli (E. coli)
  - Listeriosis
  - Salmonellosis
  - Shigelllosis & vibriosis

Toxins
- Bacteria
- Fungi & Algae
  - Aflatoxins on crops (B1, B2, G1, G2)
  - Aflatoxins in milk (M1 and M2)
- Plants
- Seafood Related
  - Cyanobacteria
  - Tetrodotoxin
- Eukaryotic animals
  - Shellfish
- Reptiles
- Industrial chemicals
- Pharmaceutical
- Food-preservation chemicals
- Processes
  - Grilling
  - Fermentation

*Continued on page 22

ple get the same illness from the same contaminated food or drink, the event is called a foodborne disease outbreak.” [16] In 2015, the CDC monitored 17-40 potential food poisoning or related clusters each week, and investigated more than 195 multistate foodborne outbreak clusters, which led to the identification of confirmed or suspected vehicles of transmission and subsequent recalls of chicken, pork, sprouts, cheese, ice cream, nut butter, cucumbers and raw frozen tuna food products. [16]

As of 2016, multistate foodborne outbreaks in the U.S. due to naturally occurring bacterial contaminants have included alfalfa sprouts (Salmonella Reading and Salmonella Abony), [17] flour (E. coli 0121 and 026), [18] frozen vegetables (Listeria monocytogenes), [19] raw milk (Listeria monocytogenes), [20] pistachios (Salmonella montevideo), [21] alfalfa sprouts (E. coli O157; Salmonella muenchen and Kentucky), [22,23] shake and meal products (Salmonella virchow) [24] and packaged salads (Listeria monocytogenes). [25]

A Closer Look at Select Bacterial Toxins

Depending on the specific food item and the time, temperature, pressure, additive, salinity and amount of water used during processing, most bacteria are killed during cooking and processing, including select agents such as Clostridium botulinum and Bacillus anthracis and their associated toxins.

Some particularly hardy thermophilic and psychrophilic bacteria are able to survive processing and may subsequently replicate in foods. Time-temperature-pressure charts constitute essential food science technical knowledge and are the basis for food industry based “Good Manufacturing Practices,” including “use by” dates and holding temperature requirements (refrigeration/freezing) for foods such as milk, uncooked meat and eggs. Shelf-stable ultra-pasteurized milk and packaged meals are sterile as produced; however, they do not remain so once opened. Shelf-stable items must be promptly used, refrigerated or frozen to retard bacterial growth and preserve product wholesomeness, similar to any conventional product.

A good example is Staphylococcal enterotoxin B, or SEB, which is among the most common form of food-poisoning due to post-market bacterial contamination. SEB causes numerous cases of household and institutional food poisoning, usually attributable to unsafe household food handling practices (leaving foods out on the counter at room temperature) by the food preparer or other household consumer. All of the examples above illustrate how a bacterially contaminated food product can be widely dispersed across the country or even the world, causing a disease outbreak over a large geographical distance or population.

In some cases, naturally occurring events may be difficult to discern from those caused intentionally, since the latter may be purposefully masked, may be locally targeted rather than widespread and may not involve unusual pathogens, thus mimicking naturally occurring foodborne disease events. Future efforts for monitoring and protecting the modern food supply will necessitate development of faster methods for detection and identification of bacterial pathogens.

Toxins

Toxins capable of causing disease originate from many sources, including bacteria, fungi, algae, plants, eukaryotic animals such as shellfish and reptiles, as well as industrial chemicals, pharmaceuticals, food-preservation chemicals and processes such as grilling and fermentation. The use of toxins to cause foodborne disease strongly implies criminal intent. There is general agreement among experts that use of certain purified and concentrated toxins connotes a level of sophistication not generally associated with lone terrorists or ordinary criminals, rather than with disgruntled employees. Rather, such events instead suggest well-funded adversaries who are unusually knowledgeable and well-equipped. If the involvement of a nation state in such an event is proven, it may be considered an act of war.

Among the toxins produced by fungi and algae the most important are the aflatoxins (B1, B2, G1, G2), produced by Aspergillus fungi). The United Nations Food and Agricultural Organization estimates that globally, 25 percent of crops are affected by mycotoxins, among which aflatoxins are the most problematic.

Aflatoxins occur on a wide variety of crops (corn, tree nuts and peanuts, cottonseed, figs and spices) in the field prior to harvest, and extensive post-harvest contamination may occur if conditions of storage are not sufficiently dry. Aflatoxin M1 and M2 are
toxic metabolites found in milk and dairy products of cows that ate grain that had aflatoxin contamination. Because aflatoxins are hepatotoxic and carcinogenic to humans and animals, the FDA has established “action level” thresholds of 5 ppb for M1 and M2 in milk and 20 ppb for aflatoxins in other human foods and animal feeds. Detection of a violative level of aflatoxin requires removal of the affected commodity lot from commerce. [26]

Seafood-related toxins are produced by various species of marine and freshwater algae and cyanobacteria (blue green algae), which are then concentrated by filter-feeding shellfish, including clams and oysters. Human exposure is primarily controlled by state health department regulatory closure of affected shellfish beds, with enforcement by state and federal fishery authorities. Tetrodotoxin [27] is a highly bioactive neurotoxin produced by marine bacteria in the Vibrionaceae family, which concentrates in the liver and gonads of certain species of Puffer Fish (“fugu” sushi), Globe Fish and Toadfish (order Tetraodontiformes), as well as some amphibian, octopus and shellfish species. These species are not commercially fished in U.S. waters or legally imported, and therefore are not of prime concern to the U.S. food industry, but do occasionally appear as smuggled goods, and therefore could theoretically enter the food supply in limited quantities.

Radiological Material

Although highly unlikely, radioactive materials, particularly those more commonly available or associated with other industrial processes (such as radiation sources for diagnostic imaging and X-ray inspection of pipeline welds) could be used to contaminate animal feeds or food stuffs. Delivery of those materials associated with other industrial processes would be exceedingly difficult and likely detectable. Such actions would require that a motivated criminal or radicalized individual with some level of technical knowledge gain access to a food processing plant in order to contaminate milk, meat, eggs, produce, or access to animal feeds on-farm or at a feed mill during commercial processing. Less problematic materials on the other hand could be delivered by less sophisticated adversaries. One example:

Gas lantern mantles contain thorium to produce incandescence when lantern fuel is burned on the mantle. Although only thorium is initially present on the mantle, the thorium daughters build up, some over a period of weeks and some over a period of years, and significant quantities of these daughters are present when the mantle is used. Some of these daughters are released when the lantern fuel is burned on the mantle. [28]

If potential threats to the food and water supplies were to emerge through U.S. or allied intelligence efforts, and deemed plausible, appropriate federal and state authorities working with industry experts could recommend or even require that radiation monitors be installed where foodstuffs enter and exit the processing plant, or water is sent to the consumer. Incidents involving radioactive materials are addressed according to the requirements of the Nuclear/Radiological Incident Annex of the U.S. National Response Framework. Multi-agency experts on the NRF Advisory Team for Environment, Food and Health would be convened to assess the incident and make response and mitigation recommendations based on the specific event.

The Advisory Team includes representatives from EPA, the Department of Agriculture, the Food and Drug Administration (USDA), the Food and Drug Administration (FDA), the Centers for Disease Control (CDC) and Prevention, and other federal agencies. The advisory team develops coordinated advice and recommendations on environmental, food, health, and animal health matters for the Incident Command/Unified Command (IC/IU, DHS, the Joint Federal Office (JFO) Unified Coordination Group, the coordinating agency, and/or State, tribal, and local governments, as appropriate. [29]

Physical Hazards

There is a higher probability for the use of physical hazards to intentionally adulterate food, because this is attainable by all ranges of adversaries, including those with marginal capabilities. Physical hazards primarily bring to bear economic effects (costs of recall, etc.) rather than serious public health risks. Physical hazards have been intentionally introduced during food processing, but also unintentionally, usually as a result of equipment or process failures, carelessness or by accident.

Potential contaminants include metal, plastic, paper, insects, rocks and dirt to name but a few. Because of the ubiquitous nature of insects, rocks and soil at the source farms, their introduction is generally avoided through rigorous process engineering, intensive maintenance schedules for equipment, and employee training. Most food industry processes also include highly sensitive metal detectors at the end of the production lines, which immediately identify any metallic contamination and remove the affected items.

Thus, actual ingestion of such materials is quite rare, but does on occasion occur, and may cause physical damage (mouth cuts, damage to teeth, esophageal or intestinal abrasion or other injury). If swallowed, medical monitoring and appropriate intervention may be required. These materials are most frequently used by disgruntled employees—who have both opportunity and access—to halt production and cause a costly business disruption. A recent example of intentional contamination involved a disgruntled employee who added dirt and sand to poultry products. [10] The financial impact of such events may be significant; large quantities of affected food have to be recalled, damage to the corporate brand is possible, and liability exposure may be significant if members of the public experience actual physical injury or illness from these exposures.

Antibiotic and Pharmaceutical Residues

The availability and use of antibiotics and other pharmaceuticals in animal production over the last century has—along with the many benefits to animal health and food safety—also created the potential for animal-source foods—meat, milk, eggs, fish and shellfish—to contain significant residues of these substances.

Beginning in the 1980s, the public health and food safety regulatory agencies of the United States, European Union countries and other developed nations have engaged in active discussion and consensus-building with regard to the use of antimicrobials in food animal production and aquaculture. In 2012, the U.S. Food and Drug Administration published Guidance for Industry #209, which established the principle of “judicious use” of antimicrobials, and called for limiting the uses of medically important antibiotics in food-producing animals to only those that are necessary to assure the health of the animals.
Beginning in January 2017, any herd-level medication delivered in feed or water must be under the direction of a licensed veterinarian, and requires a new type of prescription, the Veterinary Feed Directive. The USDA Food Safety Inspection Service and the FDA work together closely to establish safe thresholds for antibiotic residues and meat, milk and dairy products, eggs and seafood; both agencies also operate extensive food safety surveillance and laboratory testing programs. The USDA’s Food Animal Residue Avoidance and Depletion program provides real-time technical information to the U.S. food animal production veterinarians responsible for issuing VFDs and overseeing the judicious use veterinary pharmaceuticals in food animals.

The FARAD website [30] maintains the list of drugs which are not legal for use in U.S. food–producing animals due to their known potential for harmful effects to consumers, as well as web-based on-line access to professional decision-making tools to assist food animal production veterinarians in making appropriate post-treatment withdrawal intervals for meat, milk and eggs. These consumer protection measures also serve to protect and limit the liability exposure of U.S. farmers, veterinarians, and food industry corporations.

Although both accidental and intentional introduction of antibiotics in the food supply has occurred in the past, the development of rigorous domestic detection programs, regulatory oversight, and inventory accountability programs is lessening the possibility of widespread contamination of the food supply by antibiotics. That said, increasing amounts of the U.S. food supply originate in foreign countries which do not have the same standards of accountability. This has on multiple occasions resulted in seizure and destruction of substantial amounts of imported food, deemed unfit for human consumption either because of the presence of drugs not legal for use in the U.S. or because of the presence of drug residues above the allowable thresholds.

### Heavy Metals

Heavy metals – which include arsenic, beryllium, lead, cadmium, hexavalent chromium, copper, cobalt, iron, and mercury [34] – are not a major concern for the food processing industry. Human exposure is usually the result of community environmental health hazards associated with permitted industrial process discharges into waterways upstream of municipal water intakes, mining leachate which has contaminated groundwater (superficial aquifers) as well as surface water, or exposure to other hazardous waste in the environment. If ingested, these metals can be absorbed and become persistent toxins when the body concentrates and stores them. Infants and children are particularly susceptible to ingestion of heavy metals due to their highly active metabolism during normal periods of rapid growth. Depending on the dose and duration of such exposures, they may suffer long-term medical sequelae or even death. An important exception to the above statements is lead. The CDC estimates that at least 4 million U.S. households, ...have children living in them that are being exposed to high levels of lead. There are approximately half a million U.S. children ages 1-5 with blood lead levels above 5 micrograms per deciliter (μg/dL), the reference level at which CDC recommends public health actions be initiated. [35]

Childhood exposure to sources of lead in the U.S. environment has been steadily de-
Municipal drinking water systems, such as those recently affected in Flint, Michigan may be a significant source of childhood exposure to lead, mainly due to deteriorating and poorly maintained legacy water distribution systems, which contain lead solder joints and even on occasion lead pipes. [36,37] Water from these contaminated municipal systems could theoretically contaminate foodstuffs which might use the water as part of the food process. The food processing industry is aware of the potential threat of lead contamination and proactively monitors lead levels in supply water.

Many other municipal systems across the United States are similarly aged as the Flint, Michigan municipal water system, therefore similar problems of potable water contamination are highly likely in the future, and an abundance of caution is justified. There is an ongoing discussion among food corporations as to whether heavy metal monitoring of water supplies should be increased in frequency.

**Future Terrorism in Context**

A recent article by the STRATFOR Intelligence Group [38] reflecting on the 15th anniversary of the 9/11 attack is helpful to frame the context for forecasting probabilities of future attacks by terrorists on the food supply. As was stated earlier, the most pressing problem for the food and agricultural industries is insider threats, which most frequently are due to disgruntled employees wishing to cause economic harm on their employer. Next most likely to occur are criminal incidents, where there is an economic motive. This leaves the last category of concern – the actual attack by terrorists or adversarial nation states on the food supply. An article published by STRATFOR on Sept. 8, 2016, [39] reminds that, “Sophisticated Tradecraft is Not Dead…Before the 9/11 attacks, al Qaeda had amassed an impressive array of terrorist planners, trainers and training camps.” To be sure, in the wake of 9/11, the United States and its allies were relentless in tracking down, killing and capturing many of the individuals responsible for the planning and execution of the attack, including Osama bin Laden.

This does not mean, however, that sophisticated tradecraft is dead, or that groups and individuals cannot develop and use it in future attacks. The poor preparation and delivery exhibited by most jihadists today cannot be allowed to lull security forces into complacency, only to be caught off guard by advanced operatives tomorrow. Amateur jihadists frequently stumble into FBI sting operations, but professional terrorists are not as easy to snare. More important, tradecraft was neither the only nor the primary reason that 9/11 attackers were so successful… The critical component of the 9/11 attack was the perpetrator’s conceptualization and planning…Mohammed (Khalid Sheikh Mohammed – the 9/11 attack planner) adopted an outside-the-box strategy. He decided to use an improvised weapons system that was part of the United States’ infrastructure – air transportation – to attack the nation itself. [39]

He was successfully able to do this because he had a deep and detailed understanding on how this critical infrastructure worked.

If a major attack were to successfully occur on the food, agriculture or water infrastructures, it will likely be found that the adversaries responsible have that same detailed knowledge of the organization and operational functionality of the things being targeted, as did those responsible for 9/11. The most efficient way for this knowledge to be gained by the adversary is to place people inside the systems to do reconnaissance and elucidate the exploitable weaknesses. Assume that those adversarial pathfinders are already here.

As stated earlier, the human element is always the most important factor in defeating a strident and thinking adversary. Amateurs are frequently easy to catch, but a well-funded, technically proficient adversary or group of adversaries will not be. If the United States food and water supplies are to remain safe, expenditure of effort will have to increase in the coming months and years. Food and water have from the beginning always been highly effective weapons of war. Government alone or government and the military will not be adequate to the task to be faced, for our adversaries understand well how both work. In the future, the food, agriculture and water industries will have to work as equal partners with government and the military.

In reality, the expertise on food, agriculture and water does not reside in Washington, but rather in the industries and the people that actually put food on the table and water in the taps. A significant requirement for assuring the continuation of a safe, abundant uninterrupted food supply is to better share warning intelligence with the people in the infrastructure that actually need it. Accompanying this requirement is the need for government to seek out expertise in the industry and – most importantly – listen to what they have to say.

The Auburn University Food Systems Institute Food Defense Working Group collaborates with the food industry, state and federal regulatory and law enforcement agencies such as the Federal Bureau of Investigation, the Department of Homeland Security, the Department of Health and Human Services (Centers for Disease Control and Prevention and the Food and Drug Administration), and the U.S. Department of Agriculture’s Food Safety Inspection Service to develop methods and strategies to prevent and detect potential food-related terrorist events.
1. The Department of Homeland Security (DHS) is responsible for protecting sectors designated as “Critical Infrastructures,” which are described by DHS as “…[S]ector Critical Infrastructures, systems, and networks whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national pandemic health or safety, or any combination thereof.” U.S. Department of Homeland Security. (2015, October 27). Critical Infrastructure Sectors. Retrieved from https://www.dhs.gov/critical-infrastructure-sectors (accessed October 30, 2016).


17. “Brominated flame retardants (BFRs) are mixtures of man-made chemicals that are added to a wide variety of products to make them less flammable. They are used commonly in plastics, textiles and electrical/electronic equipment.” There are five groups of BFRs: Polybrominated diphenyl ethers (PBDEs) – Used in the manufacture of plastics, textiles, electronic casings, circuitry Hexabromocyclododecane (HBCDs) – Used as a component of thermal insulation in the building industry Tetrabromobisphenol A (TBBPA) and other chemics. Used in the manufacture of printed circuit boards, thermoplastics (mainly in TVs) Polybrominated biphenyls (PCBs) – Used in the fire or consumer appliances, textiles, plastic foams Other brominated flame retardants. Brominated Flame Retardants. Europe: a problem for the future. Retrieved from https://www.efsa.europa.eu/en/topics/topic/bfr (accessed October 30, 2016).

18. Dioxins and polychlorinated biphenyls (PCBs) are chemicals that persist in the environment and accumulate in the food chain. Dioxin refers to two groups of compounds Polychlorinated dibenzo-p-dioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs). Dioxins have no technological or other use, but are generated in a number of thermal and industrial processes as unwanted and often toxic by-products. In contrast to dioxins, PCBs had widespread use in numerous industrial applications, and were produced in large quantities for several decades with an estimated total world production of 1.2-1.5 million tons, until they were banned in most countries by the 1980s.” Dioxins and PCBs. European Food Safety Authority. Retrieved from http://www.efsa.europa.eu/en/topics/topic/dioxin (accessed October 30, 2016).


36. Recent comprehensive studies looking at lead contamination of drinking water are lacking. CDC’s most recent is: Lead in Drinking Water and Human Blood Lead Levels in the United States, Mary Jean Brown, Sc.D. and Stephen Margolis, Ph.D. Morbidity and Mortality Weekly Report (MMWR), Supplements, August 10, 2012 / 61(04):1-9. Lead is unlikely to be present in source water unless a specific source of contamination exists. However, lead has long been used in the plumbing materials and solder that are in contact with drinking water as it is transported from its source to homes. Lead leaches into tap water through the corrosion of plumbing materials that contain lead. The greater the concentration of lead in drinking water and the greater amount of lead-contaminated drinking water consumed, the greater the exposure to lead. In children, lead in drinking water has been associated both with BLLs >10 µg/dL (40.41) as well as levels that are higher than the U.S. GM level for children (1.4 µg/dL) but are <10 µg/dL. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/su6104a1.htm_%cif=%su6104a1_w (accessed October 30, 2016).


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