HISTORICAL PERSPECTIVE ON AGROTERRORISM:
LESSONS LEARNED FROM 1945 TO 2012

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This article presents a historical perspective on agroterrorism cases from 1945 until 2012. The threat groups and perpetrators associated with bio- and agroterrorism are clustered into several groups: apocalyptic sects, lone wolves, political groups, and religious groups. We used open-source information, and 4 biological agroterrorism cases are described: (1) in 1952, Mau Mau poisoned cattle in Kenya by using a plant toxin from the African milk bush plant; (2) in 1985, the USDA claimed that Mexican contract workers were involved in deliberately spreading screwworm (Cochliomyia hominivorax) among livestock; (3) in 2000, Palestinian media reported that Israeli settlers released sewer water into Palestinian agricultural fields; and (4) in 2011, a person was sentenced to prison after threatening US and UK livestock with the deliberate spread of foot-and-mouth disease virus. All 4 cases can be assigned to political groups. These cases have not attracted much attention in literature nor in the public media, and the credibility of the sources of information varies. We concluded that agroterrorism has not been a problem during the period studied. Lessons learned from the few cases have generated awareness about the fact that nontypical biological weapons and non–high-risk agents, such as African milk bush, screwworm, and sewer water, have been used by attackers to influence local decision makers. This review will be useful in improving future preparedness planning and developing countermeasures.

BIological warfare and bioterrorism through the ages have been well documented in historical literature.1-3 Deliberate misuse of biological agents poses a threat not only to public health, but also to the agricultural sector and the food chain, which need to be considered in terms of preparedness against bioterrorist incidents.4 The complex global food trade and risks associated with livestock transport present vulnerabilities that may have undesirable animal and public health implications.4 The outbreaks of foot-and-mouth disease (FMD) in the United Kingdom in 2001 and in Taiwan from 1997-1999 have shown the enormous consequences even a natural outbreak can have for a country.5-7 Most of the world’s population gets its caloric requirements from plant-based foods such as wheat, rice, and maize, but many nations lack the capacity to feed their population. To
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compensate, they depend on international aid and trade in plants and plant products.\(^8\) Relatively few cases of agroterrorism have occurred in the past, but it is important to study these few incidents to better understand the modus operandi and motivations that different actors may have for using biological agents against the agricultural sector. To better understand agroterrorism, an integrated behavioral framework for analyzing terrorism is needed.\(^9\) In addition, improved knowledge about terrorist motives and behavior will lead to better countermeasures and strategies.\(^10-12\)

By conducting a historical study of agroterrorism, it is possible to improve preparedness for future incidents. In this article, examples from historical events are examined to see how biological agents or weapons have been intended for agrarian sabotage. This historical study of agroterrorism will be used to analyze changes through time and show a pattern for future trends regarding agricultural terrorism—one of the least studied types of terrorism.\(^13,14\)

Biological warfare has been used for centuries to sabotage and weaken the enemy.\(^15,16\) This has been and still is a kind of terrorism that could potentially be used by various actors with different agendas. Examples are terrorist groups such as apocalyptic sects, lone wolves, and political and religious groups.\(^17\)

Several countries have had offensive biological weapons programs: Canada (1939-1969), France (1922-1928, 1934-1940, and 1947-1972),\(^18\) Japan (1930-1945),\(^19\) Germany (1923-1945), the United Kingdom (1940-1964), the Soviet Union (1928-1992), Iraq (1974-1991), South Africa (1981-1995), Hungary (1936-1944\(^20\) and 1945-1989), and the United States (1942-1969), to name just a few.\(^21\) During World War I, Germany tried to attack draft horses using biological agents like Bacillus anthracis (anthrax) and Burkholderia mallei (glanders), and between the World Wars, both Germany and France studied agricultural pathogens such as rinderpest virus, Phytophthora infestans (causing late blight), Puccinia spp. (causing wheat rust), and several beetle pests.\(^22\) These efforts continued, and although no biological agents were used during World War II by Germany, the UK produced 5 million cattle cattles with B. anthracis spores to be dropped on Germany. The early period of biological warfare agent development in the UK was characterized primarily by developing antianimal and anticrop agents.\(^23\)

During this time Japan also put considerable resources into the development and production of biological weapons and used them against China.\(^24\) Various agroterrorism agents and diseases have been studied or weaponized in Russia (1935-1992), including African swine fever virus, avian influenza virus, B. anthracis, Brucella spp. (causing brucellosis), Burkholderia mallei, Chlamydophila psittaci (causing psittacosis), FMD virus, Mycoplasma mycoides mycoides (causing contagious bovine pleuropneumonia), Newcastle disease virus, Orf virus (causing contagious ecthyma in sheep), rinderpest virus, Venezuelan equine encephalitis virus, and vesicular stomatitis virus, as well as the plant pathogenic viruses brown grass mosaic virus, potato virus Y, tobacco mosaic virus, wheat and barley streak mosaic virus, and the fungi Magnaporthe grisea (causing rice and rye blast), Puccinia sorghi (causing maize rust), and Puccinia graminis (causing wheat stem rust).

In the US the following biological agroterrorism agents have been studied or weaponized from 1943 to 1969: avian influenza virus (causing fowl plague), B. anthracis, Brucella spp., B. mallei, Chlamydophila psittaci, eastern, Venezuelan, and western equine encephalitis virus, FMD virus, Newcastle disease virus, and rinderpest virus as well as Phytophthora infestans and the causative agents of wheat blast, wheat stem rust, rice blast, and rice brown spot disease. In Iraq, aflatoxins and the causative agents of cover smut/bunt of wheat have been studied or weaponized.\(^24,25\) After World War II, the research on plant pathogen and anticrop weapons continued in several countries.\(^26\)

Today, there are many lists of similar agents, like the Australia Group lists for export control, the US list\(^27\) and the US CDC bioterrorism select agent list for human pathogens,\(^28\) and the USDA/APHIS list of animal and plant pathogens.\(^29\) Although the development of biological weapons is prohibited in most countries, and 166 countries have signed and ratified the Biological and Toxin Weapons Convention of 1972,\(^30\) today there are still a few countries around the world engaged in research on biological weapons for offensive use. There is little or no open-source information about these countries regarding the status of research and development of biological weapons or what their biological warfare potential is at the present time. Countries mentioned in this connection are Syria, Iran, and North Korea. Furthermore, there is no information about what has happened to the bioweapons or know-how that Russia (as part of the former Soviet Union) produced in the past. Some fear that some of these agents, weapons, or know-how are in circulation outside the control of the state.\(^31\) In addition, early military biowarfare programs were designed to promote sabotage, which is similar to terrorism.\(^32\)

By examining this history, it is possible to identify patterns concerning the identities of the perpetrators, where the bioterrorism attacks have taken place, why the attacks were conducted, and the modus operandi of the perpetrators.\(^33\) Historical research can be helpful when assessing the risks of the present and future. We analyzed some agroterrorism cases of different threat groups that used biological agents against agricultural targets. The identification of threat groups provides a better understanding of the selection of biological agent and the outcome of the agroterrorism attacks.

**METHODS**

The material and literature used for this article were limited to open-source information, such as scientific publications,
reports, public web pages, and media articles regarding cases of agricultural terrorism. Several non–open-access biocrime databases exist, but these were not used for this article.

There are many ways to categorize terrorism. Ferguson and Potter, for example, categorized terrorist groups or actors as apocalyptic sects, lone wolves, political terrorist groups, and religious terrorist groups. However, it is difficult to categorize many terrorist attacks since these groups and individuals may have different motives and may fall into more than one category. In this article, only non–state-sponsored terror groups or individuals focused on agroterrorism attacks have been considered.

**Definitions**

In this article we have defined terms as follows:

**Agroterrorism:** A subset of bioterrorism, defined as the deliberate introduction of animal or plant pests with the goal of generating fear, causing economic damage, and/or undermining social stability.

**Biocrime:** The threat or use of biological agents for individual objectives such as revenge or financial gain.

**Biological warfare:** The military use of biological agents, where targets of agents are predominantly soldiers, governments, or resources, that might hinder a nation’s ability to attack or to defend itself.

**Biological weapons:** Those weapons that achieve their intended effects through the infectivity of disease-causing microorganisms including viruses, infectious nucleic acid, and prions.

**Bioterrorism:** The threat or use of biological agents by individuals or groups motivated by political, religious, ecological, or other ideological objectives.

**Food terrorism:** An act or threat to deliberately contaminate food for human consumption with biological, chemical, or physical agents or radionuclear materials for the purpose of causing injury or death to civilian populations and/or disrupting social, economic, or political stability.

**Results**

**Bioterror Groups’ Modus Operandi**

At the same time as state-supported development of bio-weapons has declined, other groups have increased their interest in the use of biological weapons. The 4 categorized bioterrorist groups might have different motives for using biological weapons. Political groups could have revolution on their agenda, and they may not care about public opinion. Religious extremists, who have historically caused mass casualties, may be opposed to western values. Biological weapons might be used by separatist groups, activists, or criminals. The motives of groups may vary widely, but the common thread is their willingness to use biological weapons to effect changes in society. From their point of view, violence that might bring death, fear, and social disruption is an appropriate way to reach their goal.

**Apocalyptic Sects**

Apocalyptic groups believe that doomsday will occur in the near future and that they act on orders given to them by God. These groups are often led by charismatic leaders, and the people who join the sect often become isolated from the outside world. An example is the Japanese sect Aum Shinrikyo, which made several attempts to acquire and use biological agents to kill people in order to salvage their contaminated souls. Their failed biological weapons attacks include 3 incidents in 1990 and 4 in 1993.

**Lone Wolves**

There are many cases of lone wolf attacks. Lone wolves have a broad range of motives, including political and religious motives; the targets vary and so do their modus operandi. This category of terrorist is harder to control, because the planning and the work are done by one person, who may be impossible to monitor before the actual attack. Lone wolves are in many cases political or religious radicals. For example, Anders Behring Breivik, the Norwegian terrorist, was seen as a lone wolf and had a clear (to him) political agenda. Even though lone wolves may not belong to a specific organization, they often share radical ideologies or beliefs with organizations or groups. Bakker and de Graaf describe the threat and difficulties surrounding lone wolf actions: “Attacks by lone operator terrorists provide the most puzzling and unpredictable form of terrorism. Lone wolf terrorists are a nightmare for the counterterrorism organizations, police and intelligence communities as they are extremely difficult to stop.”

Unstable people often act alone because they are unwelcome in political groups by the groups’ leaders, who may consider them to be security risks. In the aftermath of the anthrax letters in 2001 (also called Amerithrax) and their impact on the society, many fake threats were mailed by copycats. Statistics for threat letters are difficult to find in open-source databases, but several publications have described the threat of the anthrax letters. Since the 2001 attacks, law enforcement agencies have processed thousands of suspicious mail incidents globally, many of which are hoax bioterrorism threats. In Australia it has been reported that bio-insecticide preparations containing *Bacillus thuringiensis* spores have been involved in several threats, leading to the need for rapid and sensitive detection techniques for this organism, a close relative (but nonpathogenic) of *B. anthracis*. Suspicious anthrax letters have been sent to private people, companies, political groups, and government organizations including the US consulate in Sao
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Paulo, Brazil. And other agents have also been used: For example, ricin toxin was found in the mailroom of US Senate Majority Leader Bill Frist in 2004.

In New South Wales between October 2001 and February 2002, more than 1,000 incidents were investigated and 594 samples of suspicious substances were submitted for microbiological examination to the Centre for Infectious Diseases and Microbiology, Institute of Clinical Pathology and Medical Research in Westmead. None of the suspicious samples turned out to contain any biological agent. There also have been cases in which the attack was targeted at food and water.

Political Terrorist Groups

Terrorist groups of the 9/11 type are dominated by a combination of political and religious terrorists. “These groups are hybrids in that they have both political and religious motivations and objectives, which are tightly intertwined with their rhetoric, ideology, and action.” 17(p18)

Among political terrorist groups, there are many “single issue” groups. Radicalization in political activism must be taken into consideration—for example, groups who are opposed to abortion, those who espouse ecoterrorism, and animal rights activists. Ecoterrorists and animal rights activists have directed their attacks against the agriculture infrastructure, and these attacks have involved violence and vandalism rather than biological agents. Some examples of bioterrorist incidents in which political groups used biological agents include: Dark Harvest, which spread dirt contaminated with B. anthracis spores (October 10 and 14, 1981, UK), the Red Army Faction (1980s, Germany), and the Minnesota Patriots Council (1992, USA). Actions in which medical waste marked with swastikas was found at Temple Beth El in Stamford, CT (August 17, 1999, USA), and Temple Beth El in Norwalk, CT (August 18, 1999, USA), were probably actions by unidentified right-wing groups.

Religious Terrorist Groups

Several religious groups and individuals, including Al-Qaida, have shown interest in acquiring biological weapons. According to Al-Qaida, it is a duty to acquire weapons to fulfill their mission. In addition to acquiring biological weapons, the group has tried to acquire other CBRNE weapons, including uranium and the chemical warfare agent VX, among others. An example of the use of biological weapons is the actions by the Rajneeshe cult in July, August, and September 1984 using the bacterium Salmonella typhi. It has been reported that Osama bin Laden also attempted to acquire biological weapons in Sudan and Afghanistan in 1999.

At the beginning of 2012, 2 issues (Nos. 8 and 9) of the radical Islamic magazine Inspire were published. The first includes an article written by Shaykh Anwar Al Awlaki aimed at providing advice and guidance on questions submitted by readers. The article is inter alia devoted to justifying the use of poison and biological and chemical agents to carry out attacks against population centers in countries that are in conflict with Muslims; the United States, the United Kingdom, and France are mentioned specifically. Al Awlaki states, “The use of poisons or chemical and biological weapons against population centers is allowed and is strongly recommended due to its great effect on the enemy.”

Agroterrorism Cases

Agroterrorism is a subset of bioterrorism whose goal is agricultural sabotage, and an agroterrorist group may choose to use biological weapons for their purposes. It is relatively easy to acquire these kinds of biological agents directly from the environment. A group or an individual does not necessarily have to go through laboratories to acquire these agents, and many are not pathogenic for humans. At the same time, small groups of terrorists or even lone wolves could, in theory, acquire and use this kind of agent more easily than other biological agents that are pathogenic to humans. In addition, the risk of being caught in this kind of operation is low, and it has sometimes been difficult to distinguish a naturally occurring epidemic from an attack using biological weapons. The costs of the preparation of bioweapons are often much less than what it would cost, for example, to use nuclear bombs of various types. “Experts have estimated that for a terrorist group to develop a nuclear weapon could cost them a billion dollars.... But to develop a very good biological arsenal you would need about ten million dollars and a very small lab and a master’s degree in chemical engineering.”

Because of the relatively low cost and amount of effort required in agroterrorism, some terrorist groups may direct their attacks more frequently toward agricultural production in the future. In addition, globalization, with increased importation of food, global food trading, and transportation of animals, have made modern societies more vulnerable to terrorist attacks.

The terrorism agenda has changed through time and so have the instruments of terrorism. An attack with biological weapons would result not only in disease and death, but, depending on the society, also in panic, fear, disruption of economic activity, and more. Recent outbreaks, even though their origin was natural, have shown us the enormous effects of such an incident on society. The effects of an outbreak will not be limited to the direct economic impact on agricultural production but will also incur indirect economic losses, including disruption of trade. And experience has shown that the costs of recovery from an outbreak could be higher than those of the outbreak itself. The economic consequences of an attack...
with biological weapons are severe: “Even a minor disease outbreak can have severe economic effects due to export restrictions.”22(p5)

The motivations of terror groups and individuals show a wide variation. Some wish to cause panic or take revenge. For instance, Anne Kohnen writes in a report: “From the standpoint of the USDA, however, the most important motivations to consider are those that particular groups or individuals are known to hold. The 2 most common today are the profit motive and the anti-GMO (genetically modified organism) motive.”22(p11)

Agroterrorism has occurred throughout history,58 and biological terrorism attacks against food and water have also taken place. We looked at 4 agroterrorism cases during the period from 1945 to 2012, which are discussed in more detail below.

Mau Mau
Mau Mau was a nationalist liberation movement in Kenya whose main goal was to end British colonial rule. In 1952 the Mau Mau used a local plant toxin, the African milk bush plant (Synadenium grantii), which was common in the area, to poison cattle at the British mission station. This was confirmed after the Veterinary Research Laboratory in Kabete (Kenya) had ruled out other possibilities. The Mau Mau had first concentrated their attacks mainly on sabotaging British farmers. The poisoning of cattle was rare, which suggests that this action was an attack of opportunity.37,47

Contract Workers
In 1985 Mexican contract workers deliberately spread screwworm (Cochliomyia hominivorax) among livestock in Mexico close to the border with the United States. This was supposedly done because they wanted to protect their jobs, since they were working in a screwworm eradication program. Although the perpetrators never were charged, the USDA claimed that the Mexican contract workers were involved in deliberately spreading screwworm among livestock.57,47 Managing the screwworm population is complicated, and the history of sterile insect techniques goes back to 1930-1940; the concept is based on deliberately releasing insects of a pest species to introduce sterility into wild populations in order to control them.59

Sewer Water
Reports from Palestinian news sources in 2000 claimed that Israeli settlers in the West Bank had released sewer water into Palestinian agricultural fields. According to the Palestinian farmers, this was recurring and was done in an attempt to make the Palestinian farmers leave their land.37,47

FMD Threat
In 2011, a South African man was arrested for threatening to spread foot-and-mouth disease in the United States and Great Britain if he was not paid US$4 million. He believed the governments of both nations had been too passive when “white” farmers had lost their land in Zimbabwe. He was convicted for terrorist activity and money laundering. It was reported, “This biological agent, if deployed, would have caused the destruction of property and resulted in major economic loss.”60 Investigations showed that this person did not have FMD virus in his possession.60

Discussion
Natural outbreaks of FMD have been reported in the media as having serious consequences.61 A deliberate spread of agroterrorism agents must have appropriate countermeasures. According to Suffert and colleagues, “Agroterrorism as warfare has been deemed low-tech, high impact.”26(p222)

Only a few cases of agroterrorism have been described in public media, and none has attracted much attention. Even though no case in recent history has had a severe impact, it is important to consider the potential impact that an attack might have. The 4 cases described here were politically motivated actions. These cases occurred in different places, used different dispersion methods, and had different targets (though mainly livestock) and different political motives. The agents used in 3 of these cases—African milk bush, screwworm, and sewer water—are not on the traditional lists of high-risk agent.27-29 By contrast, the FMD hoax in 2011 serves as an example of a threat with an agent that is on the agricultural select agent list.29 The cases of contract workers using screwworm and settlers releasing sewer water are accusations. The Mau Mau attack is a confirmed case of the deliberate spread of a plant toxin. The FMD hoax resulted in prosecution and a prison sentence. There are forensic challenges associated with agroterrorism incidents, and it is often difficult to distinguish whether an outbreak is natural or intentional.

In the cases presented here, the agents originated in the local environment, in contrast to some bioterrorism and food terrorism incidents in which the agents were characterized in laboratories before they were used. For example, the Rajneeshee sect used the reference strain Salmonella typhimurium ATCC 14028,62 and the Amerithrax letters contained an anthrax strain isolated in the US.63,64

It is also of interest that the perpetrators in these 4 cases seemed to prefer simple and easily obtained agents and toxins. The African bush milk was common in the area of operation; sewer water that was allegedly used by the Israeli settlers also can be seen as a simple means to carry out an attack. The screwworm incident also shows the simplicity of the chosen agent to carry out the attack in an effort to keep the contract workers’ jobs. No live FMD virus was
ever found in the investigation of the case in 2011. However, the authorities took this threat seriously and pointed out that the attack, if the perpetrator had actually carried it out, would have had serious consequences. This was confirmed by the US Department of Justice, which stated, “Agricultural experts say that today they are most concerned about the intentional introduction of foot-and-mouth disease virus into the food supply.”

Even though there have not been many cases of agro-terrorism, it must considered in preparedness planning. Casagrande and Wills state, “Because limited disease outbreaks can cause severe economic consequences, a terrorist need not cause a massive, uncontrolled infection to hurt its target.” Various groups may shift their modus operandi and decide to use biological weapons against agricultural targets to affect the economy of an enemy. The prevention of a lone wolf attack is complex, and it is difficult to determine whether a lone wolf is in fact operating alone or as an individual acting on behalf of a larger group. It is important to consider the possibility that a larger group or network could be behind these individuals. At the same time, a small group or even one individual can cause a lot of damage.

History has shown that terrorists often rely on a lack of preparedness, and our study shows that agroterrorism case studies are not common. It is recommended that the authorities develop plans to prevent such attacks.

**Conclusion**

Agroterrorism has not been a serious problem in the period from 1945 to 2012. This might be the result of a lack of empiric data. In addition, the open-source information and the reliability of the references vary in quality. In 2 of the 4 agroterrorism cases described here, sufficient evidence to bring charges was lacking. Nevertheless, these cases demonstrate that incidents have taken place at various geographical places with different targets, using various biological agents. The attackers had various motives for the attacks, but all are related to political interests, including sabotage for economic gain. Atypical biological weapons or non-high-risk agents were used in these attacks. The lessons learned from this study should be used to improve future preparedness planning and the development of countermeasures.

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