AGROTEERRORISM: A LESS DISCUSSED YET POTENTIAL THREAT TO AGRONOMY

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Agroterrorism is not a much well-known and well-discussed topic like bioterrorism. Under the circumstances of ever-changing socio-economic status of the World, terrorists are always in search of something that destroys the economy and humanity. One of the easiest approaches that can impact the economy largely is targeting a nation’s agricultural practice and food supply. In a country like India, this kind of malicious attack can result in complete collapsing of national financially and socially. In this study, a number of international and national disasters have been described in terms of agroterrorism to make everyone aware of this unforeseen catastrophe.

Introduction

Under today’s turmoiling social and political circumstances most people are familiar with the term “terrorism”. Whenever we think of terrorism, it gives us an idea of threat and terror towards a large population in a society. The threats can be imposed by various actors or groups, which may include political or military actors or group of people motivated by various thoughts like political, religious, or other ideological objectives. Bioterrorism involves the deliberate dissemination of biological agents like microorganisms (bacteria, fungi or viruses), insects and toxins, or might be human modified naturally occurring species of the above agents to produce diseases and deaths among humans. Biological weapons may also be aimed at targeting crops or livestock, as carried out during both world wars and subsequently during the Cold War and Vietnam War.

Traditionally, biological warfare is a form of nonconventional warfare, but historically, it is quite significant. Long back in the sixth century BC the Assyrians mixed ergot fungus to the water wells of their enemies to dismantle them. During the fourth century BC Scythian archers tipped their arrows with animal faeces and used them in order to cause infectious wounds among their enemies. In 204 BC Hannibal famously utilised a form of biowarfare when he instructed his soldiers to throw clay pots filled with venomous snakes on to the decks of Pergamene enemy ships. During the Middle Ages, corpses and excrement of the bubonic plague victims were often used for biological attacks over castle walls using catapult.

Modern biological warfare began during World War I, when Germans deliberately infected Allied horses with glanders (Burkholderia mallei, a pathogenic bacteria) and anthrax (Bacillus anthracis). The French also employed glanders against German horses. A numbers of incidents took place in the history of terrorism, that targeted livestock and crops to create threat and terror. Some terrorism analysts doubt that attacks on animals and crops are more tempting to terrorists, who usually want a sophisticated media attention. Destroying the livestock and agriculture may not have the same terrorizing effect as fatal attacks against human beings. Therefore, the main motto of the terrorizing groups is to cause a major financial damage on a country in order to weaken its economy and agroterrorism is one of the easiest ways to achieve it. Terror analyst Peter Chalk of the RAND Corporation suggested, “Given its ease of execution and potential to elicit a highly ‘favorable’ cost-benefit ratio, agro-terrorism may be perfectly suited to the type of low-cost but highly
disruptive attacks that al-Qaeda has necessarily been forced to adopt in the 9/11 era."\(^6\)

Agroterrorism, or agriterrorism or agricultural terrorism, is an intentional hostile attempt to destroy the agricultural and food chain system of a population through the introduction of disease pathogens of plants or animals to cause devastating disease that affect agricultural sectors and livestock.\(^7\) The pathogens can either be introduced through genetically modified insects that harbour them or directly by infecting the foods and animals with the agents.\(^8\) Food and agriculture are key elements of the critical infrastructure of every country because they provide products that are essential for life. One specific aspect of this agroterrorism which makes it different from biological terrorism is that it is mostly an economic attack rather than killing or weakening people directly. However, an attack on agriculture would have huge devastating effects as a whole. Linked to the agriculture industry, a number of other industries like food supply, transports, distributors, and mostly restaurant chains could also be impacted heavily. Therefore, as agriculture is one of the easiest sectors of a country’s economy to disrupt, and its disruption could have disastrous consequences for the world economies, the agroterrorism is an alarming issue which have been discussed very less till now.

**Naming the Term “Agroterrorism”**

The terms agroterrorism, along with agriterror and agrosecurity, were first used by veterinarian pathologist Corrie Brown and writer Esmond Choueke in September 1999. The term agroterrorism was used publicly in a reprinted report of Dr. Brown by reporter Judith Miller, in the front page article of the New York Times on Sept. 22, 1999. An initial dispute between Dr. Brown and Mr. Choueke took place over the spellings agriterror vs. agroterror. The spelling with the “o” won, as it was closest to bioterrorism and thus would be easier to remember.\(^9\)

**Why Agroterrorism?**

According to Carlton Gyles, Emiratus professor, Veterinary Pathobiology, University of Guelph, Canada, a number of attractive features of agroterrorism have drawn attention of the terrorists.

a. Less difficulty in obtaining infecting agents and using them to infect plants and animals, no proficiency is required.

b. Frequent practices of intensive farming in most part of the world is very common these days, which may help in quick spread of infectious agents. Additionally, it is also difficult to recognize the signs of illness of individual animals from a large herd very easily.

c. Low cost involvement in agroterrorism, which favours the use of low-tech, less-costly methods to generate mass destruction. According to Gyles, development of a strong biological weapons arsenal would have involved a cost of about $10 million, compared to approximate requirement of $1 billion to build a nuclear weapon.

According to RAND, National Defence Research Institute, USA, insufficient surveillance at agricultural farms, increased susceptibility of animals and plants towards infections, insufficient veterinary training, poor disease reporting management are increasing the vulnerability of the agriculture and husbandry towards terrorist attack.

**Instances of Agroterrorisms**

Relatively a small number of cases of agroterrorism have been discussed and drew attention of common people and researchers compared to other instances of bioterrorism that directly affect human beings. Nevertheless it is noteworthy to learn those few incidents for better understanding the motive and the mode of operations of the terrorists. Moreover, the enhanced knowledge about terrorist intentions may help to design better counter protective measures and policies.\(^10,11,12,13\)

Bioterrorism has always been used over the centuries to destroy enemies.\(^14,15\) This has been a trend of violence that has been practised in many parts of the World by terrorists with devastating plans in mind to destroy the enemies indirectly. Many countries all over the World had practiced malicious biological weapon programs in various times. During World War I, Germany killed thousands of horses and mules using infectious agents like *Burkholderia mallei* (glanders) and *Bacillus anthracis* (anthrax) in US through an American born German agent Anton Digger.\(^16\) This trend continued till World War II. Although not Germany, this time, it was the UK, which planned to drop 5 million cattle cakes infected with *B. anthracis* spores. At that time UK mostly relied on antianimal and anticrop agents for spreading bioterror attack.\(^15,17\) Russia also weaponized various malicious agroterrorism agents (1935-1992), that included – bacterial species like *B. anthracis, Burkholderia mallei, Brucella* spp. (causing brucellosis), *Chlamydiophila psittaci* (causing psittacosis), *Mycoplasma mycoides* (causing contagious bovine pleuropneumonia),...
viruses like - African swine fever virus, avian influenza virus, Foot and Mouth Disease virus, Newcastle disease virus, rawn grass mosaic virus, Orf virus (causing contagious ecthyma in sheep), Venezuelan equine encephalitis virus, and vesicular stomatitis virus, potato virus Y, wheat and barley streak mosaic virus, tobacco mosaic virus and the fungi Magnaporthe oryzae (causing rice and rye blast), Puccinia sorghi (causing maize rust), and Puccinia graminis (causing wheat stem rust)\textsuperscript{15,18}. In the US during the years 1943 to 1969, a number of plant and animal pathogens have been considered as agroterrorizing agents, which include-\textit{Bacillus anthracis}, \textit{Brucella spp.}, \textit{Chlamydia psittaci}, eastern, \textit{Phytophthora infestans},\textit{Venezuelan}, and western equine encephalitis virus, avian influenza virus, and rinderpest virus\textsuperscript{15,19,20}. US continued this practice even after.

The trend was not only confined to west, it also affected Asia. Japan used substantial resources for the development of biological weapons and used them against China. During World War II, they dispersed fleas infected with plague to infect Chinese villages\textsuperscript{21}. In Iraq, a deadly toxin from fungus \textit{Aspergillus} sp. named aflatoxins and the causative agents of cover smut/bunt of wheat have been studied for the purpose of agroterrorism\textsuperscript{19,20}. Even after World War II, the research on anti agrarian pathogens went on in several countries\textsuperscript{22}.

Today, the development of biological weapons is forbidden in most countries, under the Convention on the Prohibition of the Development, Production and Stockpiling of Biological weapons and Toxin that was signed on 10\textsuperscript{th} April, 1972\textsuperscript{23}. However, there are countries like Syria, Sudan, Iran, Libya, North Korea, who neither signed the treaty nor gave transparent information about the status of research and development of biological weapons\textsuperscript{22}.

\textbf{Importance of Agriculture on Indian Economy and its Vulnerability towards Agroterrorism}

India is seventh largest country and ranks second in terms of population in world, inhabited by a population of more than 1.3 billion\textsuperscript{24}. Agriculture, and its associated segments, is the biggest driving force of employment in India – nearly 70 percent of rural population depend largely on agriculture for their livelihood\textsuperscript{25}. Although, contribution of agriculture in GDP has sharply declined in recent years, it still significantly contributes to Indian economy\textsuperscript{26}. Since independence, the Indian government has focussed on agricultural sector to ensure food to fast rising population, to guarantee the livelihood of poor villagers and source of earning revenue from foreign trade. Due to adopting varied revolutionary plans, India today tops in producing milk, jute and pulses, while ranks second in wheat, rice, potato, cotton, sugarcane, groundnut, fruits and vegetables\textsuperscript{25}. India is one of the largest exporters of the agricultural/horticultural products to more than 120 countries, including SAARC countries, Middle East, European Union and United States and ranks the third largest net-exporter of rice\textsuperscript{27}.

In production of biotech crops, India ranks fifth, ahead of China. Production of Bt Cotton, the principal GM crop has made India the second largest exporter of cotton that accounts for almost 25 % of the global cotton produce\textsuperscript{28}. In spite of being a country topping in agrarian production, Indian agricultural sector is challenged with several substantive sustainability issues, like shortage of water, desertification, degradation of farming lands, extremes of climate change and attack from insects and pests. Therefore, it is necessary to analyse the vulnerability of Indian Agricultural sector towards the agroterrorism. Due to the presence of hostile neighbours this kind of threat is not completely unreal. Therefore, under present international politico-economic situation, the threat to Indian agricultural sector has to be taken seriously.

A fantastic favourite climatic conditions that help in easy multiplication and spread of pests and the trend of monoculture, are making the crops fairly vulnerable to pathogens attack. A number of harmful agricultural pathogens could be used as potential bio-weapons in India. Including among them, \textit{Pyricularia oryzae} (Rice blast), \textit{Puccinia triticina} (cereal rusts), \textit{Phytophthora infestans} (causing late blight in potato, tomato), \textit{Pyricularia graminis-tritici} (Wheat blast), \textit{Ralstonia solanacearum} (Ralstonia wilt of solanaceous crops), geminiviruses (causing leaf curl disease), rice tungro virus, citrus tristeza virus, banana bunchy top viruses are important from the point of Indian agricultural sector.

Recently, a study has been conducted on \textit{Phytophthora infestans} that caused 2013–14 late blight epidemics in potatoes in eastern and north-eastern India. It was found from the study that mainly in the bordering area of Nepal and Bangladesh, an aggressive and fungicide resistant European genotype of \textit{P. infestans} had been noticed in large numbers than the existing native populations\textsuperscript{29,30}. In 2016, the destructive wheat-blast causing fungus \textit{Magnaporthe oryzae} pathotype \textit{Triticum} (MoT), was reported from Bangladesh and adjoining districts of West Bengal (Nadia and Murshidabad). It was
its first incidence in Asia, since its outbreak in South America in 1985, which caused a loss several million USDs\textsuperscript{31,32}. Government immediately took a preventive measures to inhibit its further spread by banning wheat cultivation in these two districts for three years\textsuperscript{33,34} and banned farming within 5 kilometres of border area in other districts close to Bangladesh\textsuperscript{35,36}. Astonishingly, both of these incidents discussed above involve the border area of our country.

Another episode of devastating infection of cotton plants, namely cotton leaf curl disease (CLCuD), drew attention of researchers that might evoke a sense of terrorist attack. Cotton leaf curl virus is associated with the disease which is transmitted by whiteflies. Its repeated outbreaks severely damaged cotton crops in Pakistan, and in northwestern India. It has been investigated that the outbreaks are mainly caused by virulent strains, namely Cotton leaf curl Multan virus (CLCuMuV), Cotton leaf curl Kokhran virus-Burewala (CLCuKoV-Bu) and their interspecies recombinants in Pakistan\textsuperscript{37}, that is followed by their trans-border spread in adjacent regions of India\textsuperscript{37,38}. In 2015, a large attack of whitefly was reported from southern Punjab (India), followed by a severe outbreak of CLCuD, resulting in complete destruction of 2/3rd cotton crop that approximated a loss of 630–670 million US dollars\textsuperscript{39}. This impacted the national economy very badly and at least 15 cotton farmers committed suicide due to excessive economic loss, which resulted in a violent socio-political chaos in Punjab\textsuperscript{39}.

Surprisingly, virus sequences associated with 2015 CLCuD outbreak have not been reported from any of the farmer’s fields in Pakistan till date, but their complex sequences were actually reported only from experimental cotton plants (cultivated and non-cultivated varieties), from Cotton Research Station, Vehari and Central Cotton Research Institute, Multan situated in the Punjab province of Pakistan\textsuperscript{4,40,41}. Therefore, this sudden trans-border outbreak of CLCuD in India does not seem to be a natural pattern of transmission, which very surprisingly did not involve any farmer’s fields in Pakistan.

**Recent Locust Attack**

Huge swarms of the desert locust, one of the most devastating pests in the world, came down over parts of northwest and central India and created a huge loss to the standing crops, amidst this corona-laden injured period. The insects usually originate in West Asia, and come to India via Rajasthan-Pakistan border, just before the onset of the monsoon. They fly throughout the day almost 150 km a day and rest on trees during darkness where they remain throughout the night. They breed speedily making it difficult to control them.

They usually come to India during monsoon, in the month of June-July; but this year, they came quite earlier in April and in much larger numbers. The State government of Gujrat reported a locust attack extending a total area of 19,313 hectares\textsuperscript{42} and a good amount of crop damage in this year. Apart from Gujrat, Rajasthan, Madhya Pradesh, Uttar Pradesh, Maharashtra, Chaatisgarh, Bihar, Haryana and Uttarakhand also suffered the attack and damage. The scientists are blaming the sudden climate change, longer-than-usual monsoon across the India-Pakistan border region, and frequent cyclones in the Indian Ocean. Although no evidence of bioterror conspiracy was associated with this sudden locust attack, but insects can be exploited easily to serve as a vector of various pathogens. Since most of the vulnerable incidents in our country discussed above involve the border area; the locusts also follow the same route, it is important to be aware about the locust attack in future as the socio-political condition all over the World and of course around India is not very much favourable.

Recommended suggestive measures to combat the plausible threat of agroterrorism

By investigating diverse cases all around the world, it is possible to outline the motive associated with the bioterrorism attacks and prepare the strategies for counter protective actions. According to the RAND\textsuperscript{5}, National Defence Research Institute, certain preventive and response measures could be taken to avoid the cases of Agroterrorism. As an immediate response means it is most important to identify the disease pathogens and understand their spreading pattern, epidemiology and treatment policy. At the same time implementation of the containment strategy, proper disposal of carcasses, appropriate education, training, public awareness and development of proper economic strategic plans are also recommended.

As preventive measures, RAND suggested the requirement of International counterproliferation treaties, protocols, and agreements, proper monitoring program to identify the possible threat, implementation of well-built biosecurity and surveillance systems in order to counteract any emergency situation.

A number of countries have adopted a number of counterprotective measures\textsuperscript{43} to combat agroterrorism which are described briefly below:
The US Model

In US following the events of 9/11, 2001, new financial support was provided against a series of Homeland Security orders that granted action to explicit food chain elements within the overall CNI (Coalition for Network Information) protection mechanism. The main focus of a 2013 Government Accountability Office report was an early detection of agroterrorism (GAO, 2013). In this regard, state and county level Agriculture Response Teams were formed to circulate any information, and universities offer courses on agroterrorism to first responders. However, more involvement of law enforcement is required to resolve effective pathways locally.

The Australian Model

The strategy taken by Australia is to some extent similar to the USA, however, unlike USA the Australian Dept. of Agriculture, Fisheries and Forestry (DAFF) implement strict border quarantine standards to maintain their disease-free status, instead of early detection of pathogens. Here also, the information is disseminated through a common platform called the Trusted Information Sharing Network (TISN) under control of the Critical Infrastructure Advisory Council that operates right down to local Food Chain Assurance Advisory Groups and the food industry.

The UK Model

The UK model adopts an “All Risk” approach to combat agroterrorism. The main Government Department for all agriculture matters is the Department for Environment, Food & Rural Affairs (DEFRA) and apart from that, the Food Standards Agency (FSA), Civil Contingency Secretariat (CCS), Security and the National Counter-Terrorism Security Office (NaCTSO) together monitor the protection of food chain. DEFRA and FSA together began a new journey ‘PAS96:2014’ that took an ‘Threat Analysis Critical Control Point’ (TACCP) approach that recognizes the vulnerabilities at specific points from ‘farm to fork’, means all stages of a food chain, from production to packaging and distribution.

In India, the agricultural sector, which is very much vulnerable and critical segment, remains very much neglected and unguarded in terms of terrorist attack. This might be due to lack of any proper incidence of agroterrorism. Under today’s turmoil socio-economic situation and with hostile neighbours around, India can be very easy target for agroterrorism attack. Many developed countries have already taken measures to counteract the menace and it is high time when our own country should take some serious steps in terms of maintenance of proper surveillance system as well as creation of an appropriate awareness to combat this less discussed, unforeseen threat.

Conclusion

Unfortunately, the issue of ‘agroterrorism’ has not become a hot cake like bioterrorism which target human beings directly. It is comparatively difficult to monitor and keep surveillance on agroterrorism due to presence of very large numbers of plants in agricultural area, unlike disease outbreaks in human, thus the disease transmission easily becomes rapid and significant even before being visible or detected. Frankly speaking the surveillance system in agricultural field in most of the countries, including India, is not much stringent. Additionally, the methods of detection of plant diseases rely mainly on classical techniques. The cases discussed this study is mainly intended to improve future planning and the development of countermeasures. Thus, an overall increase in surveillance, an accurate and early detection of plant infection using advanced high throughput tools, proper awareness and education are very much important to effectively prevent and contain an act of agroterrorism.

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