Waging war on the economy

The possible threat of a bioterrorist attack against agriculture

2001 was a difficult year for the British farmers and for the government. The foot and mouth disease (FMD) outbreak is now supposedly under control, but not before it resulted in the slaughter of almost 4 million cattle and an estimated cost of £5 billion to the UK economy. A national election was postponed, the agricultural department was completely restructured and British meat exports may never recover to their pre-outbreak levels. The indirect effects were widespread, with the tourist industry suffering the greatest losses of all due to restricted access to the countryside. This FMD outbreak has been traced to a single farm in the North East of England and was due to natural causes. But if the disease had been deliberately introduced, the outcome would have been identical. 'Agricultural bioterrorism', or simply 'agroterrorism' as the phrase has now been coined, is clearly not aimed at agriculture *per se*, but at crippling the economy.

The events of September 11 have caused many aspects of society that were previously taken for granted to be looked at in a different light. Security, not only of the individual but also of the environment, is being re-examined. But even before last year, there has been a steadily growing awareness, mainly in the USA, that the agricultural industry needs to be protected against a possible terrorist attack. This has resulted in increased government spending, including the establishment of a new research institute in Texas in December 2001, to investigate the potential threats and devise countermeasures.

Agroterrorism could conceivably be perpetrated in a number of ways. It could manifest as a contamination of the food supply, such as the discovery in May 2000 that Palestinian terrorists had deliberately released salmonella-ridden eggs onto the

Israeli market. It is not known how many suffered food poisoning as a result, but at least two people died from the disease in 1999. However, this is basically product

tampering aimed at civilians rather than an attack against agriculture itself. This form of biowarfare more strictly encompasses the deliberate introduction of such diseases as FMD, rinderpest, African Swine Fever and avian influenza into livestock herds. Crops are at risk not only from direct infection by pathogens such as smuts and rusts, but also from imported seeds deliberately contaminated in their country of origin. Either way, the cost of containing and eradicating a severe outbreak would be high, both in terms of farmers' livelihoods and in the form of higher food prices for the consumer. Furthermore, as the UK BSE crisis has demonstrated, an outbreak can result in a long-term loss of confidence in a country and its food industry. As Larry Madden, a plant pathologist from the Ohio State University, said, 'This is not a human health issue, it's a social issue.'

But with more terrifying scenarios of anthrax or smallpox outbreaks grabbing the headlines, agroterrorism is generally not perceived as a serious threat by the increasingly urban-dwelling public. In industrialised Western economies, only a fraction of the working population is

employed directly in the rural sector, and food is equated with the groaning shelves of the local supermarket, not the farmyard. It is only when agricultural disasters invade the daily routine, as occurred during the BSE scandal or the recent FMD outbreak in the UK, that the public begins to appreciate its reliance on agriculture. Even then, such catastrophes tend to be blamed on inept management rather than an inherent vulnerability within the system. More importantly, agroterrorism is still a hypothetical threat against which action is unlikely to be demanded. According to Jason Pate of the Monterey Institute of International Studies, CA, 'It is an unknown phenomenon.

It has never happened unless one counts the product tampering cases.' But while this apparently benign form of warfare does not carry the same psychological impact as guns, bombs and anthrax-coated letters, it would be unwise to dismiss it as a remote possibility and to underestimate the need to protect agricultural resources.

Many countries have developed anti-crop and anti-animal weapons in the past, including the USA, Germany, Britain, France, Japan, Iraq and the former Soviet Union. These state-run biological weapons programs were extensive following

The cost of containing and eradicating a severe outbreak would be high, both in terms of farmers' livelihoods and in the form of higher food prices for the consumer

the first contemporary use of a bioweapon in World War I, when German agents infected horses that were being shipped to Europe with glanders and anthrax.

Although most of this research has now been put to peaceful use, it is well known that Iraq had a wheat smut bomb and stockpiles of rust spores and aflatoxin: nobody really knows if this is still the case.

Indeed, agroterrorism certainly has a number of advantages for the perpetrator over the more anticipated forms of bio-warfare aimed directly at humans. First, the agents are generally not hazardous to man and so can be produced and carried with minimal risk. The technical and operational challenges are reduced, since the pathogens rapidly reproduce and are easily disseminated—walking in a field with contaminated shoes, hiring a crop duster to infect wheat fields, wiping a cow's nose with an infected handkerchief could all be sufficient and could easily go unnoticed. Moreover, the trend towards planting monocultures with a high degree of genetic homogeneity, the concentration of single crops in one region and the intensive rearing of animals all aid the spread of disease, as the FMD outbreak has demonstrated. The targets are also vulnerable, in that security is at best low

Iraq had a wheat smut bomb and stockpiles of rust spores and aflatoxin: nobody really knows if this is still the case

for livestock and virtually non-existent in the vast fields of the USA. And the success rate does not even need to be that high: with current trade restrictions, a small number of disease cases—or even the rumour of them—can cause significant economic damage. When karnal bunt was discovered in wheat from Arizona in 1996, 32 countries banned US wheat imports within 1 day. Recently, the Belgian Prime Minister was forced to resign after the carcinogen dioxin was found in chicken and animal feed already distributed to 1400 poultry producers. European and Asian countries banned Belgian chicken products and subsequently pork and beef, which resulted in a loss of €1.12 billion to the Belgian economy.

But there are difficulties in trying to protect agricultural resources against an attack, both physically and conceptually. First, it is a matter of pure scale. 'US agriculture is very vulnerable but there is no physical way of protecting the fields, we can't be watching them the whole time,'

Madden commented. However, according to Pate, there is some attempt to improve this situation. 'The US Department of Agriculture has several programs in place to address the issue [...]. Local-level farmers etc. are implementing much more aggressive security measures in the field.' This equates to stressing a need for increased surveillance, particularly in the more deserted rural areas where suspicious behaviour should automatically attract attention. Madden and many others also believe that diversification and a move away from monocultures would be a significant step forward. 'Plant diseases are not a problem in a mixed environment, they only become a major determinant as you move to uniformity. It is well established by the plant pathologists that mixing rice with beans drastically reduces the severity of disease, but nobody listens.'

With current trade restrictions, a small number of disease cases—or even the rumour of them—can cause significant economic damage

Another difficulty is that, unlike with human diseases, it is not obvious which organisms pose the greatest threat, with no definitive 'A' and 'B' list of pathogens. Pate therefore believes that a better way to tackle the spectre of agroterrorism is to look at it in terms of dealing with an outbreak regardless of the source. 'If an FMD outbreak occurs in the US, and it probably will one day occur, then it really does

not matter whether the outbreak is natural or deliberate. Given that, and the "new" fears being debated today, why not design and implement strategies and policies that allow us to address the disease threat generally?' he asked. Added to the already known diseases, a popular scare story is the genetic engineering of pathogens to increase their destructive potential, but Madden does not consider this to be a major concern. 'Futurists talk about inserting genes into pathogens to broaden host range etc., which is ultimately a possibility, but I don't find that a likely scenario in the short term. Usually a naturally occurring pathogen is sufficient. Super-bugs are not ecologically competent—they may be more pathogenic, but they don't necessarily compete well and revert to wild-type.'

Part of the USA's latest defence strategy has been to grant funding for a new institute at Texas A&M University's Center for National Resource Information Technology specifically dedicated to addressing the threat of agroterrorism. First envisaged over 2 years ago by Neville Clarke, the institute's director, the National Center for Countermeasures against Agricultural Bioterrorism has recently been approved by its Board of Regents and has received US\$400 000 in fiscal funding for its instigation in 2002. 'The system has been adequate in the past for prevention and response, but it sorely needs new vision to be able to respond to these types of attack,' Clarke said. The Center will investigate the use of satellite imaging, surveillance networking, field and laboratory diagnostics and computerised information systems. 'There's the whole area of biotechnology, informatics, genomics and information technology that would let us create the next generation of systems to help prevent bio-

terrorism and to deal with it should it occur,' he said. More widely, the US Department of Agriculture requested US\$41.3 million for counter-terrorism in 2001, a rise from US\$12.3 million in the previous year.

Unless there are obvious indications to the contrary, it would be difficult to distinguish a terrorist attack from natural outbreaks that are relatively common in

agriculture, particularly for crop diseases whose symptoms may only be noted two or three seasons later. Indeed, this could

be described as product tampering with chemical agents such as the injection of mercury into Israeli citrus fruit in 1978.

It would be difficult to distinguish a terrorist attack from natural outbreaks, particularly for crop diseases whose symptoms may only be noted two or three seasons later

be seen as an advantage for those with malicious intent who do not wish to risk the loss of any public support for their cause. According to a database held at the Center for Nonproliferation Studies at the Monterey Institute of International Studies, there have only been 21 recorded sub-national agroterrorism incidents—including hoaxes—prior to August 2000, 16 of which were classed as ‘politically motivated’ and none of which had a significant impact. This is obviously not a new phenomenon nor limited to the USA, since cases have been recorded in various countries such as Kenya, China, Australia, Israel and throughout Europe. Three hoaxes and three actual incidents involved the use of biological agents, including the earliest record in the database where the Mau Mau, a violent nationalist-separatist movement in Kenya, poisoned cattle with the African milk bush toxin in protest against British rule in 1952. The remainder are more accurately

Pate co-authored a 2001 discussion paper with Gavin Cameron of the University of Salford, UK, entitled ‘Covert biological weapons attacks against agricultural targets: assessing the impact against US agriculture’, in which they stated: ‘The number of actions directed against agriculture *per se* has been limited, and none appears to have occurred on the scale presently being envisaged.’

This lack of incidents implies that this form of sabotage is either simply too subtle for the terrorists or that the generation of widespread impact is significantly more difficult than is commonly perceived. Fortunately, biowarfare is not an easy undertaking and there are still a number of uncontrollable factors such as the weather. Indeed, a drought in the Eastern USA in 1999 prevented university plant researchers from establishing a controlled epidemic of Late Blight, the causative agent of the infamous Irish potato famine of the 1800s, despite using

the most susceptible varieties of potatoes. And, although agroterrorism attacks have been rare, natural outbreaks of crop diseases are common and this experience could be invaluable. ‘Crop diseases are not eradicated in the US like animal diseases must be, primarily because they can’t be detected soon enough,’ Madden said. For example, barley stripe rust first detected in Texas in 1991 had spread to the whole of the Western USA by 1995 and is still present today, albeit at a manageable level. ‘Diseases are typically accepted at these low levels,’ Madden

‘The number of actions directed against agriculture *per se* has been limited, and none appears to have occurred on the scale presently being envisaged’

said. ‘In this respect, a crop attack is better than one against animals or humans because we are used to managing such diseases on a regular basis. We could adapt the standard controls. With enough time, we could deal with it.’

Susan R. Owens

DOI: 10.1093/embo-reports/kvf043