

Another weakness of *Playing God?* is that Evans gives surprisingly few examples of the arguments used in the HGE debate. One would expect a work that attempts to explain why an ethical debate evolved as it did to pay close attention to the contents of the relevant arguments. But Evans downplays the contents of the arguments themselves, and his explanations of the changes in the debate rarely take into account whether those arguments are any good.

Despite these problems, *Playing God?* does contain some penetrating observations. Here Evans' recognition of the broad and narrow uses of the term "eugenics" comes to mind. As Evans argues, those who disapprove of germline HGE use the term broadly, applying it to any effort to alter the human germ line; but those in favor of it use it narrowly, applying it only to attempts to enhance characteristics that are already considered normal (such as intelligence and strength) and not to

attempts to eliminate disease. And Evans seems right in saying that there is no reason to assume that scientists proficient in the use of a technology such as HGE will also be proficient at deciding the ends to which that technology ought to be put. This supports his argument that the debate over the ethics of HGE could benefit from the addition of input by professionals other than scientists.

Unfortunately, the pervasive use of the confused, and confusing, distinction between substantive and formal reasoning diminishes the book's value. Evans builds a convincing argument that there has been an important change in the HGE debate since its beginnings, and his account of the history of that change is often interesting and insightful. But, largely as a result of his use of the concepts of substantive and formal rationality, both his explanation of why that change occurred and his claim that it has been deleterious are unconvincing.

World War I. Although both Germany and France attempted to develop a method of deploying massive amounts of Colorado beetles to attack potato crops in the 1920s, Japan had the most advanced BW program at that time, reportedly targeting northern China with wheat smut attacks.

But the most advanced BW program to date was the collaborative US–UK effort that, in addition to creating the first stockpiles of fungal spores in 1955, screened some 12,000 chemical agents for anti-crop potential. This research led to the deployment of chemical defoliants by the United Kingdom in Malaya in the 1950s and by the United States in Vietnam in the 1960s (Agent Orange), primarily for the purpose of decreasing jungle cover to eliminate ambushes, but there is evidence of crop targets as well.

More recently, the Soviet Union reportedly maintained 10,000 researchers in its agriculture-related BW programs well after the BTWC banned such practices in 1972, many of them involved with the genetic engineering of viruses and bacteria as those techniques evolved in the scientific community. Details about Iraqi programs in the past 15 years are less known, but there is evidence of stockpiles of fungal spores targeting wheat, likely intended for neighboring Iran, which is reliant on the grain.

Whitby uses these historical examples to build a persuasive case for the strengthening of the BTWC (in essence a "gentleman's agreement" to prohibit the development, production, and stockpiling of biological and toxin weapons) and to increase awareness of how to control the handling of genetically modified pathogens. It is important to note that early anti-crop BW research is extremely similar to research that seeks to defend plants against pathogens, and researchers should be mindful of how their work could, if misused, be used for such deleterious purposes, especially in this age of genomic revolution and genetic engineering. As of October 2001, the BTWC had only 18 signatories—all from countries that lack such advanced genomic programs. Notably, the BTWC has been broken in the past by the Soviet Union, and the United States has refused to sign it amid allegations of chemical and fungal attacks against the coca plant in Colombia.

Although *Biological Warfare Against Crops* could have been better organized (by beginning with the science background and then proceeding chronologically, for example) it remains an excellent resource for those interested in the history of state-run BW programs, not just for anti-crop programs but also for human- and livestock-targeted programs as well. 15

Harvester of sorrow

Aaron Bouchie

Biological Warfare Against Crops

By Simon M. Whitby

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Biological Warfare Against Crops claims to be "the first account of state-run anti-crop biological warfare programs." Author Simon Whitby does indeed deliver on this promise, drawing on a vast number of declassified official sources and secondary source material to essentially expand on a previous article of the same name that he cowrote with fellow members of the University of Bradford's (Bradford, United Kingdom) program on strengthening the 1972 Biological and Toxin Weapons Convention (BTWC; *Scientific American*, June 1999, 70–75). The book is a historical account of offensive programs run by the United States, the United Kingdom, France, Germany, Japan, and Iraq, and functions as a timely reminder that plant researchers should remain acutely aware of the potential ramifications of their work on the development of anti-crop biological warfare.

Whitby provides a rudimentary scientific background on plant pathogens that puts the seriousness of anti-crop biological war-

fare firmly into context. Although bacteria, viruses, nematodes, and insects regularly contribute to the loss of nearly 1 billion tons of crops each year, the number one culprit is far and away fungal pathogens. Two of the largest pathogen-triggered famines in recent history were caused by natural outbreaks of fungus: the Irish potato blight famine of 1845–1846 killed 1 mil-

lion people and displaced another million, and about 4 million people died in the 1942–1943 Bengal rice famine in India. Anti-crop warfare can be at least as devastating as a direct biological attack against humans—using anthrax, for example—especially in poor populations dependent on a single staple crop. Developed countries can also be hit hard economically by fungal pathogen of crops, such as a 1970 leaf blight that destroyed \$1 bil-

lion of corn in the southern United States. Because of the devastation that can be inflicted on a country by destroying its crops, Whitby notes that all biological weapons (BW) programs in the past century have included anti-crop measures, beginning with German infection of American crop shipments destined for its European allies in

