THREAT OF BIOTERRORISM TO CROPS: THE ROLE OF AEROBIOLOGY IN ASSESSING RISKS

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There is considerable concern about the use of microbes as biological weapons against the human population of the U.S. and other countries. However, microbes also pose a serious threat to crops because of the vulnerability of agricultural systems to attack, the economic importance of agriculture, and the fact that it is known that some countries are developing biological weapons targeting crops (Wheelis et al., 2002). In particular, it is established that Iraq has a biological weapons program aimed at crops and that several former Soviet states have the capability of producing biological weapons (Horn and Breeze, 1999; Whitby, 2002).

A formal risk assessment is needed to evaluate the magnitude of the threat and develop plans for preventing, deterring, detecting, and responding to attack. For instance, the risk (*R*) of pathogen X could be defined as: $R = A*E*S*H*(1-C)$. *A* is the probability that the pathogen will be introduced (i.e., arrive) in the U.S. (dependent, in part, on the motivation and capability of perpetrators); *E* is the probability of initial establishment (dependent, among other things, on the susceptibility of the crop and favorableness of the environment); *S* is the probability of long-term persistence, spread from the initial focus, and widespread high incidence of disease (dependent, in part, on the dispersal of the pathogen and high reproductive rate), *H* is the probability of the disease causing major economic damage (i.e., hazard); and *C* is the probability of practically controlling or containing the pathogen. Considerably more research is needed to determine values for *E* and *S*. Both depend on the epidemiology (i.e., population dynamics) of the disease, and *S* depends heavily on the aerobiology of the pathogen. In particular, the dispersal of spores by wind and rain is a key component contributing to the rate of disease spread from a source. Madden and van den Bosch (2002) developed an epidemiological model for diseases in annual crops that can be used to provide a partial basis for quantifying *E* and *S*. The concept behind the model is that reproduction during each growing season and survival between growing seasons can be jointly used to predict epidemic outcomes in the long term, once a pathogen is introduced. Combining these theoretical results with dispersal functions (van den Bosch, et al., 1999) can show the magnitude of disease spread in relation to biological and meteorological factors.

Horn, F. P., and Breeze, R. G. 1999. Agriculture and food security. Pages 9-17 in: T. W. Frazier and D. C. Richardson, editors. *Food and Agricultural Security; Guarding Against Natural Threats and Terrorist Attacks Affecting Health, National Food Supplies, and Agricultural Economics.* New York Academy of Sciences, NY.

Madden, L. V., and van den Bosch, F. 2002. A population-dynamic approach to assess the threat of plant pathogens as biological weapons against annual crops. *BioScience* 52: 65-74.

van den Bosch, F., Metz, J.A.J., and Zadoks, J.C. 1999. Pandemics of focal plant disease, a model. *Phytopathology* 89: 495-505.

Wheelis, M., Casagrande, R., and Madden, L. V. 2002. Biological attack on agriculture: Low-tech, high-impact bioterrorism. BioScience 52: 569-576.

Whitby, S. M. 2002. *Biological Warfare Against Crops*. Palgrave, NY.