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Genetic Engineering and the Fight Against Ebola

By Henry I. Miller

A handful of patients in the largest-ever Ebola outbreak have been treated with an experimental drug called ZMapp. American missionaries Dr. Kent Brantly and Nancy Writebol both received the drug and were recently released from the hospital. A Liberian doctor treated with the drug died on Sunday. The medicine is made through "biopharming," a relatively new and promising way to create drugs through genetic engineering, but the technology is stymied by regulation and fearmongering.

ZMapp is a mixture of three antibodies, obtained from tobacco plants that have been infected with genetically engineered plant viruses. When tobacco is infected with the viruses, which are harmless to animals and humans, the plants synthesize a large number of the antibodies. The tobacco is harvested and homogenized and the antibodies are purified. Then the antibodies are used to treat patients infected with Ebola.

Obtaining medicines from plants is not new. Many common medicines, such as morphine, codeine and the fiber supplement Metamucil are all purified from plants. But biopharming employs genetic engineering techniques to use crops such as corn, tomatoes and tobacco to produce high concentrations of high-value pharmaceuticals. In the case of ZMapp, that means producing high concentrations of antibodies.

More than a decade ago, scientists at Arizona State University created a biopharmed vaccine against Norwalk virus, the bug that causes millions of cases of diarrhea on cruise ships and in nursing homes annually. This vaccine, initially produced in tomato fruit and more recently in tobacco leaves, is now being studied to find the proper formulation for administration.

There is great potential in biopharmed medicines. The primary raw materials—water and carbon dioxide—are cheap. Biopharming also offers tremendous flexibility and economy. Doubling the acreage of a crop requires far less capital than doubling the capacity of a bricks-and-mortar factory. This allows drug companies to delay expensive investments in production facilities until later in the clinical-testing cycle or until the market for the new drug can be better estimated.

'Biopharming' has great potential to create medicines for many diseases, if regulators will get out of the way.

However, biopharming has run up against the zeal and risk-aversion of regulators. A company called Ventria purified two human proteins from genetically engineered rice and found that when the proteins were added to oral rehydration solution—typically water with sugar and salts—they shortened the episodes of diarrhea in children and reduced the incidence of recurrence. The company in 2010 approached the Food and Drug Administration for recognition that these proteins, which are found in human tears and breast milk, are "generally recognized as safe" under agency standards, but received no response. Ventria felt it couldn't market the product without the FDA's endorsement, and so it isn't available, an unconscionable loss for children in the developing world.

In 2003 the Agriculture Department's Animal and Plant Health Inspection Service announced onerous new rules for field testing biopharmed crops, which ended most entrepreneurial interest in biopharming. Mapp Biopharmaceutical, the privately owned company that makes ZMapp, has a workforce of only nine people and has been financed by government grants and contracts.

The USDA's rules impose highly prescriptive, one-size-fits-all "design standards" that impose strict constraints on the process. A more sensible approach would be "performance standards," which would specify a desired result—such as contamination no greater than a certain level—and allow investigators to meet the requirements in a variety of ways.

The ostensible objective of the regulation is to avoid biopharmed drugs winding up in food, if crop plants are used in the drug production. The food industry, including groups such as the Grocery Manufacturers of America and the U.S. Rice Producers Association, has raised "not in my backyard" objections, claiming that biopharmed plants could contaminate their food-grade crops.

But the fear is overblown, and contamination can be avoided in several ways. Production involving a nonfood crop like tobacco is an obvious one, as seen in the manufacturing decisions of many new biopharmed vaccines and drugs. For example, the developers of the Norwalk-virus vaccine recently switched to tobacco from tomatoes both to improve drug yields and to avoid becoming embroiled in disputes with NGOs and regulators about genetic engineering and possible food contamination.

The risk of plant-made drugs getting into food products is now virtually nonexistent because companies have switched to facilities with rigidly controlled environments. In 2010 the federal Defense Advanced Research Projects Agency invested more than $80 million in facilities to expand the tobacco-growing facilities at several biopharming companies. These facilities are essential for the reproducible production of high-quality drugs.

This public-private collaboration set the stage for ZMapp to be produced by one of the companies—Kentucky Bioprocessing. For Ebola and so many other diseases, if we are to reap what biopharming sows, we will need similar collaboration. That will require more funding, reasonableness from regulators, and tolerance from the food industry.

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The Neo-Neocons

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