How are governments regulating CRISPR and New Breeding Technologies (NBTs)?

While genetically engineered crops traditionally take on average 7 years and hundreds of millions of dollars to make their way through the regulatory system in the United States (and often are not approved in other countries), two recent genetically engineered products sailed through the US regulatory process.

The non-browning Arctic Apple was made through a process called gene silencing turning down the expression of an enzyme that causes browning. Simplot's Innate potato was developed using a similar silencing approach, using DNA from a wild potato relative to stimulate RNA interference, which silences the genes related to the expression of black spots and reduces the amount of the chemical that leads to the production of potentially harmful acrylamide.

Both innovations were developed in a few years at minimal cost and sailed through the regulatory process. The newly approved products were also a milestone in the agbiotech industry because they were developed by companies outside the small club of multinational corporations that dominate the biotech crop market.

The approvals raised hackles with GMO critics. Doug Gurian-Sherman, scientist with the Center for Food Safety, said more research is needed to determine if the silencing processes are safe for human consumption or might cause ecological mischief.

The majority of the mainstream science community disagrees. "From a regulatory standpoint, the potato is about as safe as you're going to get," says Alan McHughen, a biotechnologist at the University of California, Riverside. "They are incapable of escaping and becoming wild weeds, or cross-pollinating with other potatoes."

The NBT techniques under evaluation:

- *Site-Directed Nucleases (SDN) including Zinc finger nuclease technology, CRISPR and TALENs*
- *Oligonucleotide-directed mutagenesis*
- RNA interference (RNAi)
- *Cisgenesis*
- *Intragenesis*
- *Grafting*
- *Agro-infiltration*
- *RNA-dependent DNA methylation*
- *Reverse breeding*

Government agencies are facing fierce lobbying pressures from both sides about whether and/or how to regulate NBTs. Because no DNA from other species has been introduced, many scientists and regulators believe these technologies should be treated no differently than conventional breeding that has been taking place for centuries.

There has even be some discussion that NBTs could be embraced by organic farming.

Government's around the world are just beginning to address this conundrum. Argentina announced in 2015 that edited plants fall outside their GMO legislation. Canada currently does not rely on a GM/non-GM distinction and considers NBTs to be adequately covered by its domestic legislation and regulation.

In 2015, the Swedish Board of Agriculture ruled that some plants developed through CRISPR did not fall within the European Union's definition of a GMO. The decision was hailed by Stefan Jansson, at Ume University, which sought the clarification:

> *What we now have done pinpoints the problem; using CRISPR-Cas9 we can create a plant that in ALL aspects is identical to one that is not considered to be a GMO.Common sense and scientific logic says that it is impossible to have two identical plants where growth of one is, in reality, forbidden while the other can be grown with no restrictions; how would a court be able to decide if the cultivation was a crime or not? But regulatory logic is not necessarily the same as scientific logic, and it is therefore important that the Swedish Board of Agriculture has interpreted the definition in this way.*

Supporters of these techniques are pushing for a regulatory system that focuses on the final result known as "product" based regulation rather than the "process" used to get there. The United States leans toward a product-based system while European regulation is more focused on regulating the process. Many scientists also worry that development and acceptance of new products could be hampered by the political stigma associated with GMOs.

It remains to be seen whether the European Union, which is generally hostile toward GMOs, will agree with this limited ruling. Regulators were expected to issue a ruling by the end of March 2016, but said a decision has been delayed. Opponents, like Greenpeace, contend that NBTs fit under the World Health Organization's GMO definition, which includes things created "in a way that does not occur naturally by mating and/or natural recombination." It contends:

> *"Gene editing techniques can still display unexpected and unpredictable effects, which can have implications for food, feed or environmental safety. If these new techniques were to be exempted from the EU's regulations for genetically modified organisms (GMOs), there would be no requirement to detect and assess such unintended changes or to assess any potential negative safety effects. Also, there would be no requirement to make the products traceable and label them as GMOs. The GMO regulations in the EU must be interpreted in their intended sense, to encompass all modern biotechnological processes that directly modify genomes."*

The United States is reevaluating the way it regulates products created through genetic engineering, collectively are known as the Coordinated Framework for Regulation of Biotechnology. In its decision in April 2016 to approve its first CRISPR edited food, a non-browning mushroom, USDA wrote. “APHIS does not consider CRISPR/Cas9-edited white button mushrooms as described in your October 30, 2015 letterto be regulated,” the agency wrote in a 13 April letter to the developing scientist. It also chose not to regulate a strain of his-yield way corn created using CRISPR by DuPont Pioneer.

Future products, depending on the individual circumstances, could still be handled by a patchwork regulatory net involving the Environmental Protection Agency, Food and Drug Administration and the Department of Agriculture. The problem is that the U.S. is trying to do this with laws written in the 1950s and re-interpreted in the 1980s that were not designed to deal with modern genetic modification. Essentially, they only cover crops engineered with Agrobacterium tumefaciens, a bacterium used to insert DNA into plant genomes.

That has created challenges for regulators when it comes to examining crops made through newer technologies. For example, Scotts Miracle-Gro has engineered new grasses using a gene gun, which fires DNA-coated gold particles in a target plant’s cells. That new DNA can be incorporated into the plant’s genome. The Department of Agriculture says it has no jurisdiction over the grasses made this way, since the process does not rely on Agrobacterium tumefaciens infuriating critics.