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August 28, 2020

Washington Headquarters Services
Acquisition Directorate (WHS/AD)
Office of the Under Secretary of Defense (Research & Engineering)
Washington, DC 22202

Re: OUSD/R&E STEM/BIO RFI-WHS-07222020
Posted Date: July 22, 2020

Dear Ms. Gess or Whom It May Concern,

The Crop Science Society of America (CSSA) represents more than 4,400 scientists in academia, industry, and government. We are the largest coalition of professionals dedicated to crop sciences in the United States. As such, we are deeply interested in the state of biotechnology education and workforce development and agree on the importance of ensuring American leadership in the bioeconomy. Please see below for answers to the specific questions posed in the RFI, Section II.

What is the current state of the biotechnology education and workforce in the US and what are the limits of current practice?

Biotechnology education is limited by the exclusion of agricultural biotechnology

Biotechnology is a fascinating subject – there is no shortage of interesting topics or laboratory experiments to pique students’ interest. Agriculture, for example, offers a huge range of interesting and important challenges that biotechnology is poised to address, from crops that resist drought and disease to livestock with a smaller environmental footprint. Overcoming these challenges will solidify America’s commitment to a successful and sustainable agricultural enterprise, which is the cornerstone of the U.S. economy. Further, our ability to produce more food than we need and to help other countries maintain their domestic food supply supports national and international security and increases our standing in the world.

But agricultural biotechnology is systematically and institutionally excluded from most biology and biotechnology curricula. For example, while medical biotechnology is taught at more than three thousand institutions in the United States, coursework that specifically links this training to agricultural uses is limited to only a handful of land-grant institutions and community colleges. This division represents a huge limitation on the current state of biotechnology education and practice in the United States. For example, graduates who feel comfortable moving from a biotechnology laboratory focused on cancer to one studying integrated prosthetics may nevertheless hesitate to switch to an ag biotech lab because they are fundamentally unfamiliar with modern agriculture, even though much of the

training they would need to succeed is the same. This curtails the American biotechnology workforce from engaging in the global agricultural enterprise.

What existing biotech or non-biotech EWD programs, program elements, or models could be leveraged or applied to support biotechnology EWD? What are the strengths and/or weaknesses of these example(s)?

Agriculture education should be available to all K-12 Science and Biology teachers

Agriculture Education programs prepare K-12 teachers to teach agricultural biotechnology in creative and compelling ways, but this training is not accessible to most science teachers. This is because agriculture is simply not part of a standard K-12 teacher's training. Education degrees regularly include many disciplines, such as Math, History, Nutrition, Physical Education, English, and Science, but they specifically exclude agriculture. In fact, the discipline of "Ag Education" is often confined to an agriculture department, school, or college entirely separate from "Teaching" or "Education" degree programs. This makes the subject unattainable to most prospective teachers. Moreover, because it is highly unusual for schools outside of rural areas to hire a teacher with an Agriculture Education degree, the degree itself is not as versatile, leading prospective science or biology teachers to avoid ag education in favor of a more generally applicable degree.

Despite these obstacles, successful agriculture education is not confined to rural areas. The Chicago High School for Agricultural Sciences is a sought-after magnet school and is one of the most diverse schools in the city of Chicago. The Walter B. Saul High School in Philadelphia is another exceptional, diverse magnet school with a focus on agriculture education. Expanding these model schools in cities and suburbs across the country would require coordination and funding.

USDA AFRI's Education and Workforce Development (EWD) program supports students and postdoctoral scholars interested in furthering their agricultural education, and it also supports professional development opportunities for K-14 educators. While this program does not address the fundamental lack of standardized agriculture training for K-12 teachers, it works well as a supplement. In FY2019, this program received approximately \$29 million.

"Ag in the Classroom" is an excellent program, but its resources are overshadowed by an abundance of sub-quality content

Biology teachers who wish to include an agricultural biotechnology segment in their curriculum face barriers in addition to their own lack of training. There are some excellent classroom resources available, for example, USDA's "Ag in the Classroom" program. Unfortunately, with only \$500,000 in annual appropriations, this resource is understandably crowded out on an internet full of uninteresting and biased teaching guides and sample student labs on agricultural biotechnology that tend to focus on one question: determining whether a food is a GMO or not. This may appeal to a teacher who is worried about eating GMOs, but there are serious problems with this question. First, it broadcasts the teachers' own fears of GMO food. Second, sampling and detection are boring – much more exciting would be for

students to make their own genetically modified plants, perhaps to modify them with fun or useful characteristics, or they could test the survival of beneficial insects or pests on engineered plants.

Poor agricultural biotechnology classroom resources lead directly to poor science instruction. These poor-quality teaching guides and lesson plans for agricultural biotechnology are built around pro/con GMO arguments that assume both sides are equally scientifically valid. In fact, there is vastly more scientifically supported evidence in favor of the safety of GMOs. The false dichotomy serves to support students' misunderstandings and draw them away from learning more. For example, the objective of a PBS Nova Teachers Classroom Activity on the subject is "To research and debate the arguments for and against the use of genetically modified foods." The activity is based on a broadcast called "Harvest of Fear," uses a worksheet titled, "Are Genetically Modified Foods Safe?" and asks students to "research and report" their opinion, presumably using the internet and without any further guidance. Importantly, whether a GMO is safe is not determined by how well a student argues the point.

By contrast, the "Ag in the Classroom" lesson plan "Apple Genetics: A Tasty Phenomena" suggests asking students to think about why different apples have different flavors and lets students compare the non-browning properties of the genetically modified Arctic apple to the non-browning Opal variety, which was conventionally bred for non-browning. Just this year, the Food and Drug Administration supplemented its award-winning *Science and Our Food Supply* curriculum with classroom resources on biotechnology that include activities like extracting DNA from strawberries for inquiry-based learning. Fun and interesting classroom materials like these need increased support and visibility.

How can inclusion and participation of minority and under-represented groups be encouraged in biotechnology? What are the current barriers to increased minority and under-represented group participation in biotechnology? How can these barriers be addressed and overcome?

The agriculture educators most likely to include agricultural biotechnology in the classroom are underrepresented in the suburban and urban districts where minority and under-represented students live

Food is fun, engaging, interesting, and important, and agricultural biotechnology represents an incredible opportunity to engage minority and under-represented students with an accessible topic. Teachers with Agriculture Education degrees are the most likely ambassadors for this subject matter, but K-12 agriculture education classes are rarely offered outside rural areas. Suburban and urban areas represent four fifths of the population of the United States and most of our racial and ethnic diversity. Minority students, therefore, are unlikely to have an Agriculture Education teacher or even to learn that agricultural biotechnology exists, let alone what kinds of careers are available. Supporting agriculture education in K-12 teacher training, and resources like USDA's "Ag in the Classroom," will go a long way to supporting a diverse biotechnology workforce that is versed in critical thinking skills, hypothesis testing, and major global issues like access to food, clean water, and environmental stewardship.

What skill sets and capabilities are most important to foster in the future biotechnology workforce? Are there different skills and capability needs for different components of the biotechnology workforce?

Classroom resources that focus on hypothesis testing and data interpretation are urgently needed for agricultural science topics in all grade levels

With the notable exception of “Ag in the Classroom” materials, classroom resources for agricultural biotechnology found on the internet suggest students debate pro/con arguments for GMO food. These debates do not stimulate hypothesis testing or data interpretation – they are not an experiment.

Rather than asking only “Are Genetically Modified Foods Safe?” classroom activities are desperately needed that relate to a diversity of lived experiences. For example, students could ask “What Food Traits Would Help My Community?” with examples along the lines of increased shelf-life, culturally important crops that could be grown in a school garden, and healthy vegetables that are more delicious. Students could engage in projects to create glow-in-the-dark “nightlight” houseplants or sensor plants that can change color when detecting a dangerous gas like carbon monoxide. To engage future biotechnologists, students need to engage in hypothesis testing, creative thinking, and data interpretation, not pro/con arguments that parade as scientific inquiry.

The world is facing challenges related to food, water, soil, nutrient loss, and greenhouse gas emissions, all with the backdrop of a changing climate, and all related to agricultural science. To tackle these challenges, future biotechnologists will need curiosity, critical thinking, and a love of problem-solving that drives them to hypothesis-driven research. They will also need a broad background in not just medical and microbial but agricultural science to move fluidly through scientific and career opportunities as they arise.

Thank you for accepting these comments in response to your RFI on the state of biotechnology education. The Crop Science Society of America stands ready to offer any further suggestions or information that you require.

Sincerely,

A handwritten signature in black ink, appearing to read 'Nick Goeser', written in a cursive style.

Nick Goeser, CEO
American Society of Agronomy
Crop Science Society of America
Soil Science Society of America