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RE: Docket No. USDA-2020-0003: Solicitation of Input from Stakeholder on Agricultural Innovations

The Honorable Stephen Censky
Deputy Secretary
United States Department of Agriculture
1400 Independence Avenue, SW
Washington, DC 20250

August 1, 2020

Dear Mr. Deputy Secretary:

Founded in 1883, the American Seed Trade Association (ASTA), located in Alexandria, Virginia, is one of the oldest trade organizations in the United States. Its membership consists of over 700 companies involved in seed production and distribution, plant breeding, and related industries in North America. ASTA members research, develop, produce and distribute all varieties of seeds – including grasses, forages, flowers, vegetables, row crops, and cereals. ASTA member seed products support agricultural producers of food products and farm commodities in the United States and around the world.

Innovation in the seed industry is based on an increased understanding of plant genomes, refinements in breeding techniques, and identification of new traits so that farmers have a wide array of high quality, high producing seed varieties available when making their planting choices. The continuation of such innovation is crucial for the U.S. seed industry, global food security and more sustainable agricultural systems.

ASTA is pleased to provide these comments to the United States Department of Agriculture (USDA) in response to their request for written stakeholder input on the agency's Agricultural Innovation Agenda (AIA).

Question 1: What agricultural commodity, group of commodities, or customer base does your response pertain to or would benefit?

The seed and plant breeding sector is diverse, both from a company and crop perspective. The sector includes field/row crops, vegetables, flowers, grasses, cover crops, and specialty crop seeds. The diversity of companies is also a characteristic of the sector, including diversity in company size as well operational reach that can be global, US-only and regional/local. Farmers are the seed sector's primary customer base.

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On July 16, 2020, ASTA, in collaboration with a wide range of farmer/grower groups, held a webinar to explore respective challenges and opportunities and to identify cross-cutting priorities among the groups that participated in the webinar. This response is reflective of that discussion.

Question 2: What are the biggest challenges and opportunities to increase productivity and/or decrease environmental footprint that should be addressed in the next 10-to 30-year timeframe?

Challenges

The primary challenges that will need to be faced over the next 10 to 30-year timeframe can be grouped into 5 main categories:

- Climate variability
- Land and soil use
- Labor availability
- Expanding/Increasing nutrition for humans and animals
- Genetic vulnerability

It is important to note that these challenges need to be viewed in an integrative fashion. For example, climate variability will have an impact on land and soil use. Genetic vulnerability will be important to meeting the challenges of increasing yield and improving nutrition. Thus, progress addressing one challenge area may have direct or tangential benefits in another area.

Climate Variability

Climate variability leads to associated variability in disease and pathogen pressure which, in turn, means that breeders need the tools to anticipate future vulnerability to disease and pathogens. Breeders will also utilize these tools so that plants can adapt to the uncertain nature of water availability, both in terms of drought and flooding tolerance. Availability of water for agricultural uses also becomes a highly significant issue in arid to semi-arid climates. Shifting climates will also mean developing a range of heat and cold tolerances to adapt to increasing weather variability.

Land and Soil Use

Increasingly food production will be done on a more regionalized basis which will, in turn, mean that food crops will need to be adaptive to a varying range of land and soil. More efficient soil nutrient use will focus breeding goals on end points that maximize the mobilization of nutrients from the soil as well as maximize the utilization within the plant. The amount of land available for crop production will become progressively more limited putting pressure on increasing yield per unit land area. Genetic gain for yield and yield stability will thus become more important with a growing global population.

Labor Availability

The availability of labor is a constant challenge, particularly for those crops which are harvested by hand. Increasing emphasis is being placed on breeding for varieties which lend themselves to automated harvesting. However, limited resource availability for farmers will challenge the ability to automate in the short term versus relying on human labor for harvest.

Nutrition

Breeding for increased nutrition in food and feed crops has historically been an important goal of breeders. Looking to the future and an increased focus on nutrition, it will be necessary to also expand the range of crops that can be used for nutritional purposes or improve the nutritional aspects within a given plant species.

Genetic Vulnerability

Some plant species for food, feed, fiber or fuel have made little to no breeding progress because of limited resources applied to breeding and crop improvement or because of limited genetic variance, resulting in limited genetic gain for yield or performance improvement. If genetic variation becomes limiting or substantial disease or pest pressures occur, it may also be difficult to maintain the rate of genetic gain for those crops that have measured consistent genetic gain over the last century, such as corn, soybean, and wheat.

In the U.S. and around the world, various plant species have become increasingly vulnerable to pests and diseases in recent years, including a few examples, such as maize susceptibility to fall armyworm and other Lepidopteran species, citrus susceptibility to citrus greening, Cavendish bananas susceptibility to Panama disease (Fusarium wilt), soybean susceptibility to Asian Soy Rust, and lettuce susceptibility to Downey mildew-- to name a few. Some of these genetic vulnerability issues would be relatively straightforward to solve if global regulatory policies were less restrictive, fully enabling innovative technology applications to address the problem.

Opportunities

Public/Private Partnerships

We believe that an important measurement of success of the USDA's AIA will be the formation of public/private sector collaborations. A long-standing example of public/private sector collaboration is the Germplasm Enhancement of Maize (GEM) project which is a cooperative effort of the USDA's Agricultural Research Service (ARS), land-grant universities, and industry. GEM's objective is to widen the germplasm base of commercial hybrid corn in the United States through the introduction and incorporation of novel and useful germplasm gathered from around the globe.

Similarly, the close collaboration between agricultural technology companies and University of California Davis (UC Davis), has resulted in identifying key pre-commercial research priorities. Seed Central at UC Davis provides a networking forum that facilitates the public/private collaborations often needed to shift these pre-commercial research priorities to commercial applications.

There are also expanding opportunities for public/private collaborations beyond the traditional agriculture system, for example with Department of Energy, the automobile industry and the manufacturing sector, as the range of crop applications expand.

Public and private breeding sectors and the agricultural producers of our food, feed, fiber and fuel supply could benefit from increased collaboration opportunities. Potential examples of collaborations that could begin and endure over the 2020-2050 timeframe are:

- Devising entirely new crop rotation systems that introduce new crops into existing rotation patterns
- Identifying cover crop systems that fit into the growing season of the more northern latitudes that struggle to have a cover crop established prior to a freeze
- Modeling cropping systems and predicting durability of a range of pest solutions
- Identifying species that have substantial genetic vulnerabilities to pests due to lack of genetic diversity and determining solutions

- Initiating collaborations that are similar to the GEM for other species, where the private sector enables the collaboration with germplasm as well as in-kind support and the public sector leads the “pre-breedin” efforts to diversify the species
- Strategic education of future public and private sector agriculture employees with forward looking goals of developing new skill sets that will be required for the next generation
- Increasing the number of employees that shift from the public sector to the private sector and vice versa through revised sabbatical systems or planned employment shifts, including private sector sabbaticals where scientists visit universities and USDA facilities
- Leveraging the information and ideas received through this RFI to plan an AIA summit specifically to propose new public/private partnerships

Precision Farming

Ultimately, to reach sustainability goals, the focus should be on a systems approach to farming practices that include precise use of inputs for pest, disease and weed control, as well as more precise modes of action for these inputs. This will include the automation of decision tools and applications as well as data mining and modeling. An integrated approach using automation, synthetic design and big data management will be necessary to tackle complex problems and to provide for early detection of biotic and abiotic pressures.

Precision Breeding Methods

The goals of plant breeders have always been to create new variations of plant characteristics, to provide solutions for diseases and pests, to increase tolerance to environmental stress, to improve quality and yields, and to meet consumer expectations. Plant breeding depends upon genetic variability within and across related species as a basis for developing new plant varieties with improved traits. Precision breeding methods, such as gene editing, will be an important component for a precise systematic approach to farming.

Plant breeders are continuing to develop precise, yet flexible, methods to safely increase specificity and farmers continue to strive to produce more food while using less resources more efficiently. They are overcoming obstacles such as drought and plant disease with improved seeds, healthier soils, precision equipment and useful data as well as other basic tools of modern agriculture. Increased efficiencies of plant breeding, decreased development time and cost, and increase genetic diversity for breeding programs are needed to further improve species that have received little to no breeding resources in the past.

Genome editing has a wide range of possible applications in the breeding process. It can be used for gene discovery, making the breeding process more efficient as well as precisely targeting a change to a specific gene(s) in a plant’s genome to create the desired plant trait. It can also be used to identify a gene in a plant’s wild relatives and to precisely and efficiently introduce that gene and the desired trait into an existing, high-performing commercial variety, without the negative performance that arises from using donor germplasm that is not up to commercial performance standards. Future generations of genome editing offer the possibility to launch the world into a post-genomic era, where genes and gene networks can be leveraged to maximize the performance of a variety to a given set of environments, and finally eliminate the biotic and abiotic pressures that reduce a plants performance.

Similarly, genome editing and genomics offer the potential to accelerate the domestication of unimproved plant species opening the door to new, heartier crops that are both nutritious and convenient. Genome editing has been used to improve the agronomic characteristics of several, unadapted, plant species, such as groundcherries, wild tomatoes, and perennial intermediate wheatgrass.

Virtually all crops today have gone through some degree of domestication and improvement through human intervention. Numerous other wild species or species related to these crop species have not gone through any active human selection or improvement. As an example, maize has numerous relatives such as *Zea diploperennis and Zea mays parvaglumis or mexicana (teosinte)* that have been considered progenitors of modern maize. Genes of commercial value could be identified in such wild species or in the over 250 races of maize that are well represented in the USDA National Plant Germplasm System. Other field crop and vegetable species have already benefited from genes from more "wild" sources from within or closely related species.

Reliable, automatic, multifunctional, and high-throughput phenotypic technologies are increasingly considered important tools for rapid advancement of genetic gain in breeding programs. With the rapid development of high-throughput phenotyping technologies, research in this area is entering a new era called "phenomics". During the past decade, plant phenomics has evolved from an emerging niche to a thriving research field, defined as the gathering of multi-dimensional phenotypic data at multiple levels from cell level, organ level, plant level to population level. Phenomics is entering the era of "Big Data", which combines artificial intelligence technology for analyzing crop phenotypic information in a high-throughput manner and ultimately can associate phenotypic variation with the underlying DNA sequence variation. The ability to "genotype" and generated molecular data to characterize the genome costs 1000-fold less, compared to 20 years ago. Similarly, the cost of a phenotypic assay to characterize a particular trait for a species will become substantially lower in the next 30 years for traits that are important to both farmers and consumers.

Greater Adaptability of Crops

The plant systems that we deploy should be made more diverse and/or more adaptable to provide a buffer to grower profitability and the environment. Changes in weather patterns, land uses, production systems, and ecology inevitably create ever-changing and new stresses on the economically important crops or plants that we choose to grow. Changes in markets, prices, technology and consumer preferences create challenges as well as opportunities. To better address these challenges and opportunities, we need to accelerate our ability to develop new plant varieties.

Nutrition

Farmers continue to strive to produce more food while using resources more efficiently. One specific challenge is the continuing need to both improve yields while maintaining and improving the nutritional value of crops under increasingly challenging environmental conditions. As an example, recent data indicates elevated CO2 levels in the atmosphere can lead to a reduction in zinc levels in crops that are key sources of this essential micronutrient. Hidden shifts of the ionome of plants exposed to elevated CO2 depletes minerals at the base of human nutrition. Drought conditions similarly have been shown to reduce the nutritional quality of staple crops.

To be successful, future crops and production practices will need to combat the double burden of malnutrition/nutritional deficiencies as well as the growing global problem of obesity. There is also significant opportunity to use genomics and advanced breeding tools like genome editing to generate new sources of plant-based proteins and other nutrient dense foods. For example, cotton has been modified, resulting in ultra-low levels of the antinutrient gossypol, generating a new, high quality source of protein for human consumption especially in poor, cotton growing countries, as well as animal feed as a source of protein and oil.

Yield

There is a tremendous potential for improving crop yields as we better understand the genetic components controlling yield potential. For example, plant architecture of fruiting crops plays a fundamental role in determining potential yield. Current advances in understanding the triggers of flowering and heterosis are yielding significant alterations in plant architecture that result in greater numbers of flowers, longer plant life, and greater yield. Discoveries in one crop appear to have potential application across a wide range of species. Improved yield is also related to photosynthetic efficiency, drought tolerance and resiliency leading to broader adaptation to environmental conditions. Yield is often defined by tons/acre but relevant to the topic above, it can also be measured via the nutritive content per acre. In other words, by increasing nutrition we can also increase yield.

Flavor

Flavor is highly complex and multigenic. To date, most breeding efforts have focused on the major drivers of flavor, sugar and acid. Allelic variation does exist in many commodities for these components of flavor. However, little has been done to tap into the depth of flavor improvement as we are only at the beginning of linking allelic variation to other components of flavor such as volatiles. As an example, there are over 80 volatiles in tomato. Manipulating these volatiles via more traditional means is a very time-consuming process involving taste panels and sophisticated laboratory equipment. This work is necessary to identify the genes but once accomplished, it need not be repeated. Going forward, genome editing would allow the customization of flavor profiles via the modification of volatile profiles. Further, the potential to develop high-thru-put assays that predict human flavor preferences are possible through further development of phenomics.

Automation

Poor availability of labor can have a dramatic impact on a farmer’s economic success. When commodities like baby leaf spinach have been adapted to mechanized harvest, the result will be an increased availability of a less expensive nutritious food. Ongoing breeding efforts exist to enable this transformation in most crops. Ease of harvest and a high harvest index are necessary components to making this work. Agricultural engineers are working with plant breeders to find collaborative solutions.

Breeding for automation is often necessary in areas such as harvesting where you must breed a crop to present the product in a manner to be machine recognized/located. Some crops will require specific plant spacing to assure ideal and uniform leaf sizes, which, in turn, required optimal plant populations and planters to assure the correct spacing. In vegetables, harvesting robots must be gentle with the produce to avoid bruising and damage. Harvesting machines require varieties that ripen uniformly, store well in the field, separate from the plant easily, and can withstand handling. These are all areas that require special breeding to achieve the traits necessary to succeed.

Storage Traits

Breeders deploy many resistance genes to minimize the risk of plant disease. However, the development of post-harvest disease resistance is relatively new and can help to minimize food waste.

Reducing risk of mycotoxins during the growth of the plant, as well as the storage of vegetables and grain would be a critical improvement that is needed for the safety of our food supply.

Foodborne Pathogens

Breeding for and selecting plants that do not support the growth of foodborne pathogens is a relatively new idea. While the pathogen may not be injurious to the crop, it can be harmful to the consumer. Realizing that phenotypic variation exists with respect to the ability of plants to exclude harmful microbes and promote beneficial microbes, it may be possible to use plant breeding to help tackle a persistent food safety issue. Breeding could, thus, be a component of a pre-harvest systems approach in the management of food safety.

Shorter supply chains

There is an increasing demand from the consumer to purchase products closer to the producer of that product. There is also an increasing demand across the value chain for broader choices and for higher value characteristics. This puts even more pressure on the wide adaptability of crops. To meet this need, supply chains and distribution channels will need to be optimized. Higher value traits such as improved nutrition, flavor and health attributes combined with sustainability traits will be important to meeting these supply chain needs.

Question 3: For each opportunity identified, answer the following supplemental questions: What might be the outcome for the innovation solution (e.g., the physical or tangible product(s) or novel approach) from each of the four innovation clusters?

The opportunities described above are inter-related in terms of advancing a concrete innovative solution. However, yield and quality are the ultimate parameters of whether a solution is, in fact, successful. Greater output of crops with fewer inputs will, in the end, be a key determiner of reaching sustainability goals. Some specific approaches toward this end are:

- Focus research on key components of yield and understanding the biology behind the maximum yield potential
- Use new breeding tools to create new sequence variation to maximize yield
- Leverage genetic information from crop wild relatives to increase yield
- Use genomics to redesign plant architecture for non-traditional farming such as vertical farming and automated harvesting in the field
- Increase automated search capabilities for germplasm accessions
- Support the genomic sequencing and phenotypic characterization of crop species in the National Plant Germplasm System collections through the USDA ARS NP301 resources.
- Update and maintain crop specific genetic vulnerability statements through USDA ARS NP301
- Increase automated genomic characterization capabilities for leveraging genomic information for crop improvement, such as genomic characterization of host/pathogen interactions to unlock plant resistance solutions and for genetically complex characteristics such as nutrition and flavor
- Research in seed physiology to develop seed that performs better under climatic challenges

Question # 4 What are the specific research gaps, regulatory barriers, or other hurdles that need to be addressed to enable eventual application, or further application, of the innovation solution proposed from each of the four innovation clusters?

One of the key barriers to application of innovative solutions, is gaining the trust of consumers in accepting these innovative solutions. Therefore, communication across the value chain about the value and benefits of these solutions will be critical. Burdensome regulatory burdens will also hinder the realization of innovative solutions. Undo regulatory burdens will limit the application of innovative technologies, both from a crop and trait perspective. This regulatory burden does not only take the form of biosafety regulations but also regulations that inhibit the flow of and the ability to access germplasm from accessions in other countries.

The USDA ARS together with the private sector could come together with improved collaboration to address the US policy agencies to further reduce the regulatory burdens for commercial product development that utilize innovative technologies such as genome editing. Joint efforts should be made to educate policy agencies in the U.S. and globally regarding the safety of enabling technologies that increase plant performance.

Again, ASTA appreciates the opportunity to provide a response to this Request for Information. We are looking forward to working with USDA on this critically important initiative.

Sincerely,

Andrew W. LaVigne
President and CEO