Testimony before the Senate Agriculture Committee

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Thank you for the opportunity to testify this morning on Title IX of the 2018 Farm Bill. My name is Dr. Brent Shanks and I am Director of the National Science Foundation Engineering Research Center for Biorenewable Chemicals led out of Iowa State University. Given the focus of our center, I am pleased to share the insights we have developed through our interactions with many companies in the renewable chemicals, biobased products and advanced biofuels sectors.

An important objective of Title IX within the Farm Security and Rural Investment Act is to support the development of advanced biofuels production from biomass. It is envisioned that this objective will be achieved through the development and commercialization of biorefineries, which could co-produce advanced biofuels and renewable chemicals and/or biobased products. Ultimately, the creation of functioning biorefineries will only occur with a required confluence of effective technologies, market viability of the products and requisite capital and supply chain infrastructure. These three areas are thoughtfully covered through several sections in Title IX. Technology development is addressed through actions authorized in Sections 9003, 9005, and 9008, market viability in Section 9002, and infrastructure in Sections 9003, 9009, 9010 and 9011. The authorized activities in the Farm Bill are completely consistent with the goal of advanced biofuel production from biomass.

There are two high-level overarching challenges to the advanced biofuel goal relative to the three key areas of technology, market and infrastructure. First, significant advancements are still required in all key areas to create viable biorefineries, which is acknowledged by having authorized actions in the Farm Bill for each. The second major challenge is that a viable advanced biofuel biorefinery will only be possible when all three areas simultaneously meet critical hurdles. For example, technology needs considerable research and development investments to de-risk before becoming commercially viable and the solutions that create a viable biorefinery when the market price is set by crude oil at $80/barrel might not be viable solutions at $50/barrel. Similarly, capital infrastructure costs for a brand new production facility might be too high even if a technological solution exists. This need for a coupled confluence of the three key areas creates a moving target and additionally leads to higher risk for successful implementation of advanced biofuel production.

The current federal strategy for advanced biofuels could be enhanced by some further decoupling of the risks between technology, market and infrastructure inherent in completely new biorefineries. This approach would allow for progress to be made towards the overall goal while having important intermediate successes along the way. What could this decoupling look like in each of the key areas?

Technology development: In the previous two Farm Bills, there has been increased discussion of the importance of incorporating renewable chemicals and biobased products for advanced biofuels production in a way that is analogous to fuels and petrochemicals production in crude oil refineries. The articulation of this connectivity has largely been positioned around viewing the higher value renewable chemicals and biobased products as "subsidizing" lower value advanced biofuel production through utilization of byproduct streams in a biorefinery. While achieving such a strategy would be a wonderful outcome, it actually increases the amount of overall technological risk because both advanced biofuel and renewable chemical technology would need to be developed in concert with one another. An alternative would be to also consider technology development with a near term focus on renewable chemicals that could be leveraged to technological needs for advanced biofuels. One example of this would be the development of new biotechnology tools that are first applied to renewable chemical production but are subsequently applicable to advanced biofuels. Another example would be targeting the production of an intermediate molecule that could be first converted to higher value renewable chemicals and through further technological advances could also be viably converted to advanced biofuels. In each of these scenarios, the initial technological success would be the production of a renewable chemical as a first target with the advantage that it would also continue down and enable the technological path towards advanced biofuels.

Market viability: Market viability is most strongly correlated to the price of crude oil and natural gas. While market acceptance of a biomass-derived product (renewable chemical or biobased product) as a replacement for a crude oil or natural gas-derived product is also important, market acceptance is well addressed by the BioPreferred program. Therefore, the remaining market viability risk mitigation needs to address the uncertainty of crude oil and natural gas pricing, which would require biomass-derived products to have valuations that are less tightly correlated to this pricing. The best market-based approach for diminishing the correlation is to have biomass-derived products that are different from petrochemicals and that impart improved performance attributes in their use. It is not coincidental that renewable chemicals moving forward in the commercial market are ones that bring enhanced properties in the final products, e.g., 1,3-propanediol in carpets and furan dicarboxylic methyl ester in plastic bottles.

Infrastructure: A crucial attribute in producing fuels and chemicals is the large capital infrastructure that is required for their manufacture. The capital infrastructure issue becomes an enormous challenge and risk for new biorefineries that are targeting novel process technologies for producing both advanced biofuels and renewable chemicals. Commercially, risk mitigation for biomass processing infrastructure can best be accomplished by adding on limited new equipment to an existing agricultural or wood processing facility or by co-locating the new manufacturing process next to ("across the fence" from) such an existing facility. This strategy is already happening in the industry. The State of Iowa recently passed a Renewable Chemicals Production Tax Credit, which is only available for new production. All of the companies that have begun the process of qualifying for that credit are adding capital infrastructure in or next to an existing processing facility. This incremental capital investment is important as it will allow for demonstration of new process technology and will help develop new markets for renewable

chemicals. Both of these outcomes are important steps for ultimately moving towards viable biorefineries.

There is no question that viable biorefineries would have significant positive impact on farm security and rural investment and as such are a worthy vision of the future. The crucial point is how to navigate from where we are today to that desirable future. As currently constructed, Title IX primarily emphasizes making simultaneous progress on technology, markets and infrastructure specifically directed towards these envisioned biorefineries, which means success can only be defined as achieving the final goal. I think there are opportunities for farm security and rural investment successes along the path to this vision that can be realized by allowing for some decoupling of biorefinery technological, market and infrastructure risk. Development of renewable chemicals represents an excellent opportunity to create earlier successes that will ultimately help to enable biorefineries.

The U.S. chemical market of >$200 billion/yr is only slightly smaller than the U.S. fuel market, so renewable chemicals have a large potential market. Importantly, companies using these chemicals continue to be interested in new types of chemicals that can provide improved properties. In the nearer term with low crude oil and natural gas prices, the best opportunity for renewable chemicals is their potential to create novel chemicals, which can be used to produce next-generation consumer goods, materials, nutraceuticals, antimicrobials, insecticides, herbicides, specialty chemicals, plastics, etc. These next-generation products, while enabling important societal benefits with their improved properties, would also create positive impact on the U.S. economy. By developing renewable chemicals with an eye towards facilitating biorefineries, it will be possible to have clear successes on the path to the ultimate goal of advanced biofuel production from biomass. It is my opinion that renewable chemicals should not be treated as an ancillary objective in biorefineries, but instead should be viewed as a crucial part of the pathway to biorefineries of the future.