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Innovation in American Agriculture: Leveraging Technology and Artificial Intelligence

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Chairwoman Stabenow, Ranking Member Boozman and Distinguished Members of the Senate Agriculture Committee, including Senator Durbin from my adopted home state of Illinois, I am Sanjeev Krishnan. I am a founding member and Chief Investment Officer of S2G Ventures, a direct investment firm that has been focused on sustainable food and agriculture solutions and technologies since 2014. I appreciate the invitation to share my perspective on how agricultural and food technologies have translated into value for the American farmer and consumer. I applaud the leadership of the Committee in convening today's hearing and, as always, for its thoughtful consideration of the risks, challenges and policy opportunities on the road ahead. This conversation is particularly timely as we begin to see the broader integration of artificial intelligence (AI) into commercialized agricultural technologies, and as U.S. farmers adopt these technologies at an unprecedented rate.

I help lead a team of more than 40 talented and passionate sector experts and investors focused on identifying promising technologies, companies and entrepreneurs across the food, agriculture, oceans, seafood and clean energy sectors. Today, we manage $2 billion of capital and our portfolio includes investments in more than 90 companies.[1] This includes companies at

[1] https://www.s2gventures.com/our-portfolio

the “seed” stage – meaning the company is taking its first steps to translate a promising concept into a viable product and business strategy – all the way through to companies listed on public markets, with proven products, extensive infrastructure, and demonstrated viability and impact.

At S2G, we seek out opportunities that produce financial returns and positive impact, including many that benefit U.S. farmers, ranchers and rural communities. We are based in the Midwest and deploy capital that creates jobs and returns in the Heartland. Nearly all of our portfolio companies are either headquartered in or maintain significant business, commercial, manufacturing and production, research and development, or other operations in the United States. In fact, our portfolio either operates, manufactures or distributes in every state represented by the Members of the Senate Agriculture Committee, including Alabama, Arkansas, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Nebraska, New Jersey, New Mexico, New York, North Dakota, Ohio, Pennsylvania, South Dakota and Vermont.

Over the course of my career, I have worked at various investment platforms, including CLSA Capital Partners, IFC (World Bank Group), Global Environment Fund and JPMorgan, and have served on a variety of advisory and corporate boards. Traditionally, venture capital is oriented around identifying and investing in winning companies believed to have long-term growth potential to generate a financial return in the relatively short-term. Throughout my career, however, I have been as interested in finding opportunities at the intersection of investment, sustainability and health, and innovation, in what is referred to as “tough tech.” It’s called tough tech because these sectors – including agriculture and food – often receive disproportionately

low investment and are less well-understood, with opportunities and challenges that cannot be solved through a single app, a consumer device or lines of software code. Tough tech requires patience and a longer-term investment approach to develop new ideas and learnings to tackle system-wide opportunities.

This tough tech philosophy drives S2G and is reflected in how we diligence investments and support our portfolio companies. We don't just write checks. We ask what problem needs to be solved and seek to understand how individuals experience it. What does the consumer in Iowa see, in terms of price and quality? What is a farmer in Michigan or a rancher in Colorado experiencing on the ground? How are communities in Mississippi impacted?

Using a systems perspective, we evaluate challenges in food and agriculture and, in partnership with farmers and food system stakeholders, we identify and invest in the missing pieces and needs. Rather than picking one technology, approach or product as a "winner," our investments span the entire agriculture and food supply chain, from how products are grown to the ingredients in our food to how consumer behavior is changing. This enables us to construct a portfolio based on a systems understanding of industry, while increasing our ability to create synergies between portfolio companies. As a result, much of our portfolio is in the "in-between" spaces across the supply chain where the needs are both most pressing and not currently being met with adequate financial support. This includes investments in less headline-grabbing, though incredibly impactful, innovations in agricultural inputs, new crop traits, on-farm technologies and techniques, and new financing and merchandising solutions. These innovations enable

farmers to derive more value from their land in a less intensive way and de-risk farming in an increasingly volatile operating environment - all while meeting global demand for food.

In practice, this might look like identifying a durable consumer trend. We would then consider investments not only in new consumer products, but also in companies using machine learning to rapidly develop improved seed genetics that pair desirable ingredient attributes, such as better texture and flavor or improved nutrient density, with crop performance. We would also look at what farmers need to plant this crop, such as tools that more precisely measure soil health co-benefits and enable farmers to profit from them; less intensive ways to nourish crops that could further stack environmental benefits and profit potential; the infrastructure to take crops from the farm field to finished products; and fintech solutions that help de-risk the transition to a new crop. We also support our ecosystem by making introductions, sharing knowledge and generating leads for our network with the goal of increasing access to capital industry-wide. That includes spurring deeper conversations and building relationships that will drive meaningful impact and return on investment for the entire food and agriculture system, not only our individual investments or portfolio companies.

It is from the combination of this experience and system-wide perspective that I draw from in my comments to the Committee:

The journey of the American farmer is a remarkable story of hundreds of years of continuous innovation and transformation. Tech and, increasingly, artificial intelligence build on that tradition. They offer a unique toolkit to rapidly accelerate

breakthrough solutions and significant per-acre value generation opportunities. While these technologies and their applications and implications are just beginning to emerge, American agriculture's history is rooted in a strong legacy of embracing and rapidly adopting innovation. The impacts of these roots can be seen in the ways that productivity and markets have shifted and evolved over time.

Today, farmers are drowning in data, but not in solutions. The power and promise of data have long been a topic in agriculture. We now have aggregated data points from sensors, machinery and many other sources. The new wave of solutions is rooted in improving the quality of that data and better utilizing data to drive better, faster, more efficient and precise solutions. To varying degrees, these solutions will be able to account for, automatically adapt to, and moderate the negative impacts of the high level of variability in weather patterns, in the soil, in commodity prices, and other global and local factors that drive volatility. This also represents a new frontier of deriving value from on-farm data.

AI is not magic, nor is it a replacement for the foundation on which the agriculture system is built: a trusted community. Ag technology and AI can, however, be powerful co-pilots to further strengthen that trust, if deployed thoughtfully and responsibly.

Public policy plays a critical role. Realizing the full potential of tools ready to deploy today will rely on enhancing or building programs that support – or do not unnecessarily hold back – scaling. Federal loan guarantees and other financing opportunities offer

security to the developers of nascent technologies that, once they are at scale, offer a public good in the form of improved sustainability or profitability. Developing innovative financial instruments will continue to be an important area for public-private partnership. Finally, improving data quality and sharing will become increasingly critical with emerging applications of AI. The public and private sectors each have roles to play in avoiding duplicative work and focusing limited resources on filling data gaps, while protecting privacy, supporting the farmer and building tools that account for the full diversity of the food and agriculture system.

A Legacy of Continuous Innovation and Transformation and the Anthropology of Market Change

For more than 10,000 years, agriculture and food systems have been at the forefront of adopting innovations that have transformed societies and economies. In the more recent history of American agriculture, these trends have only accelerated as farmers have adopted and adapted the new "toolkits" enabled by the science and innovation of the day into productive solutions that feed not just our nation but the world.

Innovations in the late 18th and early 19th centuries, including the development and widespread deployment of the steel plow, laid the foundation - and drove the need - for a higher degree of control over crop nutrition and pest management. Through the 20th century, the scientific revolution - and concurrent global population boom - drove the development of synthetic fertilizers, higher-yield crops, improved irrigation and better machinery, all in service

of further increasing yields and reducing inefficiencies in the agriculture system to meet booming food and fiber needs. Digital agriculture and precision farming built upon this foundation, beginning with the application of GPS technology to agriculture in the early 2000s, and has now expanded to include integration of big data and analytics - from an array of sources, including drones, satellite imagery, remote sensing and more - to support on-farm decision making.

This ongoing embrace and adaptation of broad innovation to the specific needs of agriculture underpins the leadership of American agriculture on the global stage. America feeds the world, exporting more than $200 billion worth of agricultural products to customers around the globe, a figure that has steadily increased for the past 25 years.[2] Alongside our crops, we export our on-field machinery, our seeds, our fertility, crop protection and biological products, and the sophisticated land management practices and know-how that enables food security around the world. Agriculture productivity, production and food security are essential elements of our national security, and global food security depends on American leadership.

Leveraging Artificial Intelligence as the Next "Toolkit" to Solve 21st Century Challenges in Agriculture – And Better Utilize Farm Data in a Way that Directly Benefits Farmers

American agriculture has existed for centuries in a state of constant transformation and evolution, which has built the critical foundation of necessary experience, adaptability and resiliency as we enter a new era of food system transition. The past few years have shown us the

[2] https://www.ers.usda.gov/topics/international-markets-u-s-trade/u-s-agricultural-trade/u-s-agricultural-trade-at-a-glance/

signature calling cards of the next century: an unknown future economic and geopolitical order; a new generation of consumers; increased volatility in the factors that impact productivity from access to labor; volatility of input and output commodity prices; and increasingly, extreme weather patterns and climatic events. As in the past, a new toolkit of solutions well-suited to adapt to and overcome the rising challenges of the food system transition has emerged: artificial intelligence (AI).

AI is projected to transform nearly every industry in the world over the next decade. The power of new classes of AI models, combined with the advancements in and economics of creating massive amounts of data to feed into models, means that we will see dramatic shifts in how we use AI to augment and advance the ways we do things today. While difficult to project, McKinsey estimates that this will create over $4.4 trillion in new value in the economy across sectors.[3] In the coming years, hundreds of billions of dollars will be spent developing data, training models and building products around AI.

AI also has the potential to provide breakthrough new solutions and generate significant value in agriculture, offering innovative solutions to improve crop yields, optimize resource utilization, enhance overall farm management and more. We are just now at the beginning of unlocking the potential of AI in agriculture, and the pace of development we may see in these areas will be staggering.

[3] https://www.mckinsey.com/mgi/overview/in-the-news/ai-could-increase-corporate-profits-by-4-trillion-a-year-according-to-new-research

At the core of this development, however, is data. The most powerful and effective AI solutions will be those that have access to the best data and have developed the most effective ways to translate that data into appropriate training sets that feed AI models.

One of the most common pieces of feedback we hear – via S2G portfolio companies that partner directly with farmers and through our own direct engagement with farmers and agriculture and food system stakeholders – is that, thanks to the technological advancements of the past five to 10 years, farmers now have access to an astonishing amount of data. The agriculture and food system is still in the relatively early stages of digitization. The average farmer generates an estimated 500,000 data points every day and, by 2036, the amount of data generated daily is expected to increase by 800 percent.[4]

Despite this rapidly growing amount of data, the connection today between that data and trustworthy decision tools remains lacking, limiting our ability to access and apply actionable insights based on the information collected. Improving the quality of data collected and aggregated in agriculture, and using AI to analyze, synthesize and apply that data through existing and future agricultural technologies could have immediate implications on many aspects of agriculture, including enabling farmers to fully act on real-time changes across many fields that are changing every day.

For example, fresh water is becoming an increasingly scarce resource in the United States. Just last year, the California Department of Water Resources provided financial

[4] https://blogs.idc.com/2022/10/12/the-problem-potential-and-promise-of-a-data-revolution-in-agriculture/

incentives of up to $2.5 million per farm to fallow fields in "critically overdrafted basins," meaning areas where drinking water wells have gone or are in jeopardy of going dry.[5] A 2023 United Nations report on the economics of water found that global demand is expected to outstrip supply of fresh water by 40 percent by the end of this decade.[6]

AI presents an opportunity to better address this challenge, particularly when paired with the right high-quality data and intuitive decision tools and apps. AI could enable farmers to significantly increase production, using the same amount of water. This will be made possible by driving the dynamic daily decisions around irrigation with powerful AI that can incorporate millions of data points in real-time, optimize risk versus reward, and even take into account societal goals around water conservation.

According to U.S. Department of Agriculture estimates from 2019, realizing the full potential of digital agricultural technologies at scale, including building the requisite infrastructure, could create $47 - $65 billion annually in additional gross benefit to the U.S. economy.[7] These figures, developed just five years ago, now likely underestimate the scale of potential future benefits given the emergence and rapid ongoing integration of AI into ag technologies.

There are numerous specific use cases where AI can deliver gains in efficiency, productivity and sustainability for farmers and society, including:

[5] https://www.cbsnews.com/sacramento/news/ca-program-pays-farmers-fallow-fields-preserve-water/
[6] https://turningthetide.watercommission.org/
[7] https://www.usda.gov/sites/default/files/documents/case-for-rural-broadband.pdf

Precision Agriculture: AI-powered systems can analyze vast amounts of data from sensors, drones and satellites to provide farmers with real-time insights into crop health, soil conditions and weather patterns. This would further enable farmers to make more precise decisions about irrigation, fertilization and pest control, leading to reduced waste, increased yields and improved environmental sustainability.

Disease and Pest Detection: AI algorithms could identify early signs of plant diseases and pests by analyzing images and videos captured from fields. This timely detection would allow farmers to take early action to prevent the spread of diseases and protect their crops, reducing yield losses and improving overall crop health.

Robotic Harvesting and Automation: AI-powered robots are being developed to automate various tasks in agriculture, such as harvesting, weeding and pruning. These robots can work tirelessly and precisely, potentially reducing labor costs, improving efficiency and enabling farmers and farmworkers to focus on other higher-skilled and less labor-intensive tasks.

Livestock Monitoring and Management: AI systems could monitor the health and behavior of livestock, providing farmers with valuable insights into animal welfare and productivity. This information could be used to optimize feeding strategies, detect early signs of illness and improve overall herd management.

Predictive Analytics and Market Insights: AI algorithms can analyze historical data, market trends and weather patterns to predict future crop yields, prices and demand. This information could help inform decisions about planting, marketing and financial planning.

AI-powered Agricultural Drones: AI-equipped drones can be used to monitor crops, collect data and apply pesticides and fertilizers with precision. These drones would cover large areas efficiently, reducing environmental impact and improving crop health.

Ag Technology and Artificial Intelligence Can Support and Strengthen Community and Enhance Trust

As the Committee well knows, American agriculture is rooted in trust. Ag technology tools – further enhanced by artificial intelligence – have the potential to build community in agriculture and create and expand connections in a way that complements the existing network of trusted advisors in agriculture. I believe this will play out in multiple ways but want to spotlight two particular examples today.

The first is artificial intelligence's ability to make existing ag technologies better and more effective at doing what they say they can do. Certainly, there are powerful tools available today. Farmers and agricultural stakeholders also have a healthy skepticism as a natural consequence of being presented with technologies and tools that have claimed to do it all but

have failed to deliver. I believe that the application of artificial intelligence could: a) further improve and refine existing technologies and approaches; b) help stakeholders verify the impact of technologies and practices with clear, accurate and high-quality data; and c) enable stakeholders to truly weed out ineffective approaches and focus resources and time on options that work best for the conditions on their operations.

And, while it may sound counterintuitive, I believe ag technology, data, analytics and AI have an important role to play in strengthening human relationships and our ties to our communities – particularly the trust between the farmer and their network of advisors.

For example, AI can almost instantly intake, analyze and identify patterns in all research ever conducted and all aggregated on-farm data ever collected on, for example, sheath blight in rice. Enhanced by their own experiences on the ground, a certified crop advisor or independent agronomist can use AI to offer more precise advice and actionable insights more quickly to a farmer in Arkansas battling a crop disease. AI takes the burden off those advisors or agronomists to intake and synthesize this same information. AI-powered chatbots and virtual assistants – paired with the expertise of the existing system of trusted farmer advisors, including certified crop advisors, independent agronomists and ag retailers – could provide farmers with real-time advice and support, answering questions about crop management, pest control and market trends. These tools would be particularly valuable for farmers in remote areas or with limited access to agricultural experts.

Policymakers Have a Critical Role to Play in Positioning U.S. Agriculture to Maximize the Benefits of Ag Technology and Artificial Intelligence – and Establishing Thoughtful Guardrails

There are multiple opportunities for the federal government to ensure the leadership position of the U.S. in ag tech and solidify it as a global leader in AI for agriculture, while continuing to protect and support farmers and agricultural system stakeholders.

I would be remiss if I did not acknowledge that along with tremendous potential benefits of ag tech, the future ubiquity of AI also raises difficult questions about how to ensure these technologies are safe and equitable, particularly as more and more decisions are made with the assistance of or directly by AI. At this point, the future prevalence of AI throughout our lives, industries and economies is inevitable. The key will be to ensure that the right balance is struck between human control and oversight and leveraging the immense power of AI to change our world for the better.

There is a tremendous amount of innovation already happening. To succeed and scale, we need to take a systems approach to continue developing these solutions - including through private capital investment, government and public sector investment, philanthropic funding and other creative, collaborative delivery mechanisms.

While not an exhaustive list, there are several areas that, based on what I see and hear in my role, I recommend the Committee explore further as it considers thoughtful policies and

programs that can support the further scaling of the ag tech commercially available today, as well as how best to use policy tools to facilitate the productive application of AI to further enhance and improve those technologies, while protecting stakeholders and ensuring that the benefits of ag tech and AI are equally distributed. These include:

- **Harnessing the Potential of AI in Agriculture Effectively and Responsibly:** AI is driven by data, and fundamental questions about data ownership in agriculture must be fundamentally addressed. In agriculture, the conversation around protecting data privacy and confidentiality and ensuring that farmers maintain and derive value from ownership of their on-farm data has been ongoing. Again, while information security and protection concerns did not arrive with AI – nor are these concerns elevated by AI in a unique way – these conversations should expand to include applications in AI as they continue to emerge.

  In addition, ethical guidelines for AI development and deployment in agriculture will be important to ensuring that AI systems do not perpetuate biases, are transparent in their decision-making processes, and are accountable for their outcomes. This could involve developing industry standards for data collection, usage and transparency to ensure that AI systems are reliable, ethical and do not harm the environment or market dynamics. In addition, a set of benchmarks to validate the claims of AI-powered services could further support accuracy and transparency, and act as an important tool in building trust. Finally, engaging in international collaborations to share knowledge, best practices and regulatory

frameworks related to AI in agriculture can help harmonize standards and promote global food security and farmer profitability.

- **Promoting Data Sharing Standards and Initiatives:** Encouraging the sharing of agricultural data among farmers, researchers and AI developers while ensuring data privacy and security will be critical to leveraging the power of new, innovative agricultural technologies and AI to the benefit of farmers. This could be facilitated through the establishment of agricultural data cooperatives or platforms that aggregate data while protecting individual privacy. AI could also be a powerful tool in enhancing federal customer service, such as using AI techniques to replace paper-based and lagging analytics. Increasing funding for AI research, specifically in the domain of agriculture, could further spur necessary innovation for farmers. This could include grants for land-grant universities, public-private partnerships and incentives for startups developing AI solutions for agricultural challenges.

- **Boosting Digital Infrastructure and Investing in Digital Literacy, Particularly for Small Farmers:** Improving rural digital infrastructure can help ensure that farmers, especially those in remote areas, have access to the high-speed internet required to take advantage of new agricultural technologies, including AI. In addition, programs to train farmers and agricultural workers in AI and related technologies could involve partnerships with educational institutions, online courses and on-site training programs. Programs to specifically support

small and marginalized farmers in adopting AI technologies could involve subsidized access to AI tools, financial assistance and technical support.

Conclusion

Chairwoman Stabenow, Ranking Member Boozman and Members of the Committee, I commend you on your leadership in convening this hearing. I believe that we are at a critical moment for farmers and ranchers, rural communities, innovators and entrepreneurs, and for the food and agriculture system as a whole. This is an incredible opportunity to leverage and direct the power of artificial intelligence, with appropriate guardrails and protections in place, to make technologies, programs and practices across the food and agriculture system work better, faster and more efficiently to improve our lives in innumerable ways. By stepping up now and taking on the mantle of leadership, we have the opportunity to control, direct and optimize that future to the benefit of the American farmer, the American consumer and the global food and agriculture system. Thank you for the opportunity to share my perspective and I look forward to responding to questions.

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