FEDERAL COMMUNICATIONS COMMISSION (FCC) PRECISION AG CONNECTIVITY TASK FORCE

Encouraging Adoption of Precision Agriculture and Availability of High-Quality Jobs on Connected Farms

Preliminary Report to the Precision Agriculture Connectivity Task Force
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Background:

The United States agriculture industry faces a generational imperative to continue as a keystone on the national and international stage. Farmers are at the front lines of implementing solutions to address climate concerns and to contribute to geopolitical stability through the reduction of food insecurity that can prompt demographic uncertainties around the world. The continuing strength of the U.S. agriculture sector will be guided by sound public policy that encourages greater adoption of agriculture technology, as well as robust security and data privacy standards to secure one of the Nation’s most vital industrial sectors.

Farmers, and the multi-domain systems they operate that ensure the future of food, are fundamental to national security and geopolitical stability. Agriculture is at a multi-point intersection of increased responsibility; the pressure to grow more with less; and the rising challenge of satisfying stakeholder, trade partner, investor, and consumer demand for food, fuel and fiber to be produced in a sustainable, traceable, and humane ways. The proper broadband-enabled tools, relying on connectivity and data-empowered technology, will be necessary to better meet growing domestic and international demands.

Long before the COVID-19 pandemic, health issues and supply shortages among certain products demonstrated how even seemingly minor disruptions to the Nation’s food system could cause serious problems. And the war in Ukraine is additional evidence of how a disrupted agricultural system can have deep and global impacts. It is clear that ensuring that the security of the Nation’s food system demands attention that is commensurate to that paid to transportation and cybersecurity. Humanity, for all its advances through time, still requires food, clothing and shelter for survival. Agriculture provides those needs and technology is the mechanism that increases the efficient management needed for sustainable production.

Meaningful funding and effort must be invested towards:

- Increasing on-farm connectivity;
- Climate-smart agriculture and sustainable productivity;
- Improving collaboration, research, and innovation;
- Assuring long-term continuity of U.S. agriculture systems;
- Solidifying cyber-security and data-privacy requirements; and,
- Assuring multi-scale adaptability

Connectivity

Connectivity plays a critical role in securing and improving the future of food. Connectivity is necessary not only for meeting current agricultural needs, but also for providing new frameworks on which to build innovation. These include but are not limited to data gathering and modeling; increased granularity for understanding and affecting the food production process; increased market leverage for growers; greater ability for global insight for farmers at all scales; and collective effects for national security. These will enable a vast range of innovative technology and practices to empower farmers to increase productivity, decrease inputs, and become more efficient and profitable. U.S. policy regarding connectivity will be critical to meet those future needs of production demands as well as transparent and informative data. Moreover, increased and higher-capacity connectivity will strengthen both traceability and transparency, leading in turn to increased consumer confidence. Consumers who purchase domestically grown food, fiber, and biofuel products strengthen local economies and resilience. Connectivity enables transparency and traceability throughout the entire supply chain. Ubiquitous connectivity across farmland is critical to ensuring equal access for precision agriculture adoption. The disparity caused by connectivity gaps will only be more pronounced as technology continues to evolve and market adoption becomes the standard.

Recommendations:

- The USDA and FCC should consider precision agriculture connectivity as a critical component of our Nation's food and homeland security[1]
- USDA ReConnect should pivot to prioritizing on-farm connectivity

[1] This Working Group in the Task Force's 2021 Report recommended that the USDA and FCC should consider precision agriculture connectivity as an imperative driver of our nation's food security. *See* Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 107 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

Climate Smart Agriculture

While responsible for producing safe, healthy, and sustainable food and bio-based products, farmers and producers are dealing with the effects of climate impacts every day. The attention paid to production methods and management of inputs such as fertilizer and water is more difficult than ever given the dynamic and often unpredictable changes in weather. Moreover, farmers contemplate adjustments to crop and product mix, which can introduce significant impacts on equipment and infrastructure. The agricultural sector is already a major environmental player. Its impact on water resources, air quality, and carbon sequestration can be dramatically adjusted with agriculture technology. It is imperative that policy not only meet producers where they are today but build with them for their and the Nation's future. Farmers have engaged careful stewardship and sustainable practices for decades and proper policy can provide the tools and resources needed to capture climate-smart practices moving forward.

Climate smart agriculture focuses on three things:

- Increasing sustainable productivity (efficiency)
- Increasing resilience (adaptation)
- Decreasing Net Greenhouse Gas Emissions(mitigation)

Ag tech can contribute toward each of the above-stated goals. Although many solutions to support these aims have been developed and are implemented today, adoption is not widespread due to challenges in connectivity, interoperability, and education. Those challenges moreover affect the types and numbers of jobs in precision agriculture.

Academic literature on healthy soils indicates several regenerative agriculture opportunities that address climate smart ideals that require precision agriculture technologies for fullest impact.[1]

Sustainable productivity

The achievement of maximum improvements in efficiency and productivity requires a holistic analysis of the ag production system. However, integration of public data (weather, topography, market prices) and private data (sampling (as applied inputs), yield, equipment, treatments, operations) is difficult. Resultant decisions generally fall into two categories: strategic and tactical. Strategic decisions, such as determining which crop should be planted in which field, or nutrient application regime, are less frequent but invoke significant outcomes. Tactical decisions, in contrast, address logistics, such as which field to plant or harvest first and in-season pest treatments. Those decisions require a deep level of information synthesis that can be supported with data and models.

Many farmers are now paying increased and careful attention in cropping systems to the role of the "4Rs" (source, rate, time, place) of nutrient management, which directly influence efficiency, effectiveness, and utilization.[2]

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[1] *See,* E2 report (Wilder and Lederer, 2021); (AEM, 2021).
[2] *See,* nuitrientstewardship.org.

In similar vein, “4Rs” of data have also been identified:[3]

- Right data (appropriate data points)
- Right data infrastructure (stored appropriately -**F**indability, **A**ccessibility, **I**nteroperability, and **R**euse
- Right data pipelines (system architecture for data acquisition, flow, security)
- Right talent (data interoperability requires *people* interoperability, with data transforming from mere numbers to insight)

These 4Rs of data are critical to the adoption of ag tech practices. The right data includes an appropriate level of resolution in both time, space, and precision. Accurate data is critical when assessing probabilities of outcomes in analyses and decisions. Nevertheless, acceptance of applicable decision aids or tools, even when validated, requires trust. Some of that trust comes from experience which includes more explicit expression of uncertainty and some will come from training. This type and quality of training and experience can be supported by policies and programs that promote adoption of applicable technologies that sustain productivity.

Recommendations:

- The USDA should focus eligibility and awards on climate smart outcomes rather than specific practices or solutions
- The USDA should increase funding available to producers through the Environmental Quality Incentives Program (EQIP)
- The USDA conservation programs should incentivize practices that have multiple environmental benefits (for example to improve water use efficiency may also improve water quality due to less runoff; optimally using nitrogen reduces life-cycle energy for crop production and can improve water quality)

Resilient Agriculture and Adaptation

Changes in weather patterns (rainfall per event, durations of rain-free periods, localization of weather events) can dramatically affect production and the condition of planting locations. Conventional best practices can still result in poor yields, excessive nutrient loss, and crop damage or loss. In turn, these can affect significantly the energy, water, and environmental footprint of

[3] Kolakowski (2022)

operations within a growing season. Adoption of technological solutions that enable in-season adjustments, however, can improve the resilience of our production systems. Data-driven insights, perhaps through biophysical or artificial intelligence models that project likelihoods of outcome for the relatively near-term future, can lend counsel that includes risk assessment. The title of Annie Duke's 2018 best seller book, "Thinking in Bets – Making Decisions When You Don't Have All the Facts" suggests that almost all decisions are made with uncertainty. Managing that uncertainty can be improved with precision technologies, but adoption of those connected technologies must be facilitated.

Recommendations:

- The USDA should allow all new smart irrigation systems to be funded under EQIP (currently, only systems that have been deployed for two years apply are eligible for upgrades).
- As the Task Force previously recommended in its 2021 Report, the USDA Risk Management Agency (RMA) should include in crop insurance "Precision Ag Premium Reduction." When farmers utilize precision agriculture equipment and data management, they lower their operational risk profile through automation in each cropping year and establish crop records that create sustainable long-term value of historical practice. Reductions in premiums to reflect those lower risks would encourage farmers to adopt precision agriculture.[2] We support this prior recommendation and also recommend that these reductions in premiums reflecting lower risks will also encourage adoption of precision agriculture technologies that often also conserve natural resources.
- Crop Insurance, generally, should reflect the influence of improved accuracy of field size and climate/conservation practices on actual production history (APH) needs careful consideration - particularly during transition years. The use of actual "as planted" maps can both reduce premiums and improve accuracy with improved measurement and reporting of active farmable area.
- Using less energy through improved efficiency via better lighting, insulation, equipment maintenance, etc. should be rewarded similarly to generation of renewable energy. The agricultural landscape offers opportunities to generate renewable energy via digester, solar, wind, and geothermal systems and these can improve the economic resilience of farms.

We also acknowledge and support the Task Force's previous recommendation that the USDA Farm Service Agency (FSA) "Precision Ag Loan Guarantee" should work with traditional farm lenders and with their own lending arm to guarantee loans for producers and purchase direct cost and labor-reducing precision agriculture equipment and services, recognizing them as Best Management Practices (BMPs).[3]

Fewer Net Greenhouse Gasses

Increased adoption of precision agriculture can contribute to net greenhouse gas reductions. These potential reductions could come from improved productivity on the land in current and active production, as well as through prospective gains from conversion of land not yet actively being farmed. More optimal use of nitrogen in production systems can be obtained through improved

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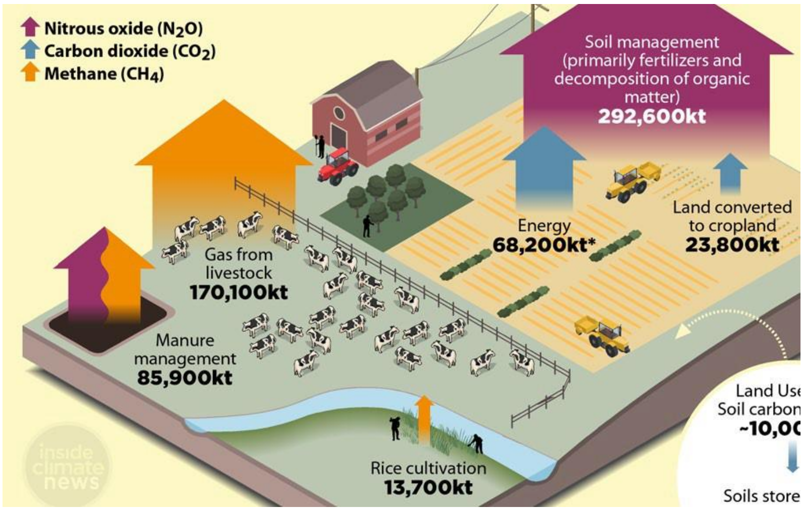
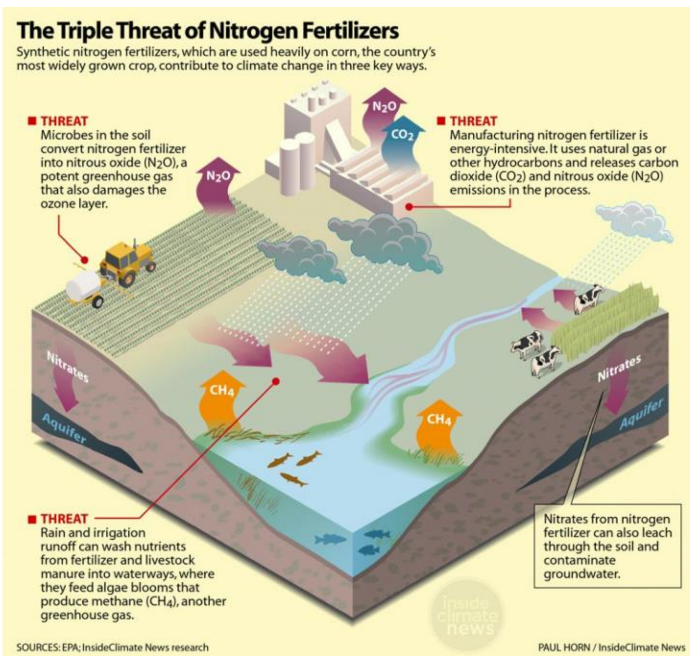
[2] Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 79 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

[3] Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 79 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

timing in the crop growth cycle; active or passive sensing and accurate application control based on current need rather than average or benchmark recommendations (resulting in less N_2O and less energy for fertilizer manufacturing); and improved efficiencies in field operations (directly reducing fuel and associated emissions). Each of these require data driven insights stemming from precision technology adoption and the ability to collect data and act upon it in a timely fashion, enabled by wireless connectivity that itself is undergirded with sufficient wired bandwidth capabilities. Most pertinent is the fact that it is management practices on agricultural lands that account for just over half of the agricultural GHG emissions.[4] Climate smart agriculture needs to target this specifically and sensors, predictive modeling, and accurate controls are key precision technologies that can enable better nutrient management while sustaining production.



Farm contributions to climate change (Source: P. Horn, 2018)



Triple threat of nitrogen fertilizers (Source: P. Horn, 2018)

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[4] (EPA, 2022). (EPA, 2022).

Opportunities for carbon offset programs are growing, but payment level, liability of non-compliance, and skepticism lead the reasons stalling adoption.[5] Even when those factors are addressed, the data supporting honest brokering must be addressed. The Illinois Soybean Association identifies the data essential to capitalizing on the carbon market.[6] Fortunately, with regard to adoption, many of these same data elements can also inform strategic and logistics decisions on the farm. The challenge is generally that this information is rarely digital, rarely interoperable when it is digital, and unfortunately, not conveniently tied to government programs or industry incentives.

Pre-Season Activities • Confirm master field boundaries • Pre-populate all monitors with same set-up files	• Set clear data expectations with your drivers and team members
FARM RECORDS – "Data" to Capture	**What About Electronic Field Records?**
Soil Tests	• Request from your lab if available. (MODUS is an emerging soil test standard, but the variety of file formats for tests remains a weak link in the data chain.)
Fall and Spring Tillage Date Type of Tillage Equipment Used Disk or Coulter Angle (if applicable) % Row Width Cultivated	• Tillage passes are equipment dependent but generally not auto-generated in a useful form, making non-EFR records important! • Programs like FieldView are developing tools to create after-the-fact tillage maps
Fertility Date Type / Product Application Method Time-Release Injection Depth Rates N, P, K Inhibitor Used Manure: Rate, C:N Ratio, N %, Moisture %	• Make receipt of variable rate prescriptions and as-applied files a requirement of your ag retail and custom application relationships • Remember variable rate prescriptions may be easier to collect than actual as-applied
Planting Date Crop Variety Population Row Spacing	• Planter data should be considered a must-have with today's equipment
Crop Protection Date Type / Product Application Method Application Rate	• Equipment and ag retailer dependent • Be aware of the complexity of multi-product tank mixes and the need to keep non-EFR detailed records
Harvest Date Yield Moisture Residue Removal	• Yield data is a must-have with today's equipment
Cover Crops Planting Date Crop Variety Seeding Rate Termination Date Termination Method	• Planter data may be available • Use a smartphone camera with GPS-tagging enabled to document planting, seed tags, and termination
Post-Season Activities • Organize and complete back-up records • Pull original raw data files from monitors • Review data for holes and inconsistencies	• Document or create EFRs for unrecorded passes • Post-calibrate yields

Farm data checklist (Source: Illinois Soybean Association, 2022).

Farm types and sizes vary tremendously across the country and programs that encourage a net reduction in greenhouse gasses should lend equity across farm types, size, and locales. The merit of adopting practices must be science based, *i.e.*, to tie back to benchmarks and data, but tied to actual additionality.

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[5] Thompson, et al., 2021.

[6] Carbon and Data Guidebook

Recommendations:

- USDA programs should empower farmers to use the hardware and software systems that improve machinery efficiencies or reduce passes over the field.
- The USDA should continue the Regional Conservation Partnership Program (RCPP) program to enhance collaboration between university, stakeholder, and public/private partnerships. Greater clarity regarding use of the funds toward enabling technology could lead more to adoption as would lightening the match requirement.
- USDA should consider a voluntary program such as established in Growing Climate Solutions Act that includes carbon credits, nitrogen optimization, and water use efficiency
- USDA or other relevant Federal agencies should dedicate increased funding to promote adoption of cover crops, reduced tillage, and other practices that promote soil organic matter that brings many benefits in utilization of all nutrients.

We also acknowledge and support the Task Force's previous recommendation on conservation payment on the USDA FSA 'Precision Ag Environment Payment', NRCS 'Environmental Quality Incentives Program' (EQIP) and Regional Conservation Partnership Program (RCPP). As highlighted throughout the 2018 Farm Bill, precision agriculture and precision agriculture technologies are recognized as critical to conservation, production and profitability. Therefore, precision agriculture technologies and practices should be recognized as Best Management Practices and direct payments for its utilization should be established.[4]

Continuity of Agriculture Systems

Producer methods, practical knowledge, culture, and the ability to innovate are intergenerational assets that support our Nation's stable food system. It is critical those qualities continue to be supported for long-term continuity. National agriculture policy that fosters partnerships between farmers and ranchers, universities, and the government have resulted in our Nation's ability to be one of a few countries in the world that has staved off famine for its population. Effective continuity over time will require farmers to leverage active insight and power in their relationships with trade partners and consumers, a broader social recognition of the role of ag and ag technologies; and the investment in long-term development of agriculture workforce.

Farmers empowered by greater technological reach and innovation will enjoy stronger market positions for effective trade that supports their needs, rural economic viability, and consumer interests. U.S agriculture's economic and social strengths are fundamental to our Nation's standing on geopolitical stage. Food traceability is but one asset that farmers can deploy.

For more than a decade, consumers have become increasingly aware of their food and food systems. They are interested in its origin, how it was grown or raised, and its level of processing. Consumers are often willing to pay a premium for products they trust. Agriculture technology enables farmers and producers to not only cut costs and increase productivity, but to increase traceability and to assure consumers of the practices they value such as food safety, sustainability, and organics, creating greater margin for producers and confidence for consumers.

[4] Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 79 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

The greater incorporation of technology in agricultural production, whether to support traceability or more efficient production and farming, will demand a skilled workforce that masters both farming and technology. Dedicated investments for agriculture tech workforce development will require focused attention to technology, culture, and infrastructure in ag-based communities. These investments, however, will support the ongoing revitalization of rural communities by growing high-quality talent that can drive economic growth in the areas of the country that are often among those in most need. These strategies will keep next generation farming and ensure an ag tech future that is attractive, profitable, and a beneficial career to enter.

Recommendations:

- The USDA should lead increased marketing and education program across agencies to promote the value of precision agriculture technologies and agriculture benefits to the United States

Multi-Scale Adaptability

The full scale of farming systems needs to be supported in order to provide all farmers a variety of continually innovative means to adapt to the volatility of the future. Continual support for innovation across scales of farm sizes will grow integrated competencies and lend optionality to solve the problems necessary to secure a more resilient food system.

Technology across these scales will increase production through the more efficient use of input resources, the efficient increase of caloric production harvest and effective storage savings. Barriers to the adoption of precision agriculture across farm sizes and types must be acknowledged and addressed. Efforts to provide support for continued innovation must include assistance or cooperative models for mid/small producers, lending programs, and supporting domain know-how.

Recommendations:

- The NRCS should consider nationwide on-staff technologist and precision agriculture specialist.
- USDA operating loans should be increased as a means to allow for ag tech adoption to mitigate operational risk and prepare for climate adaptability tools.

We also acknowledge and support the Task Force's previous recommendation that USDA should implement department and agency wide interoperability and symmetry of internal program formats to utilize operator driven data for future operator mandatory reporting, farm program creation and cohesive agency interaction of the data.[5]

[5] Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 79-80 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

Collaboration, Research and Innovation

Addressing the volatility of the future will require not only solving foreseeable problems but actively developing optionality to solve unforeseeable problems. National security, climate solutions, and global stability all rest on the ability for agriculture to be adaptive. To do that, ample education and technical assistance must be leveraged to drive precision agriculture adoption in a manner that recognizes the complex nature of agricultural systems. The ultimate goal of every good management practice is to put the informed and technical research findings in the hands of the producer. Education and pragmatic information related to precision farming will be critical in the future. This is not only for current researchers, but for students at colleges and universities across the United States. It will be essential that students and researchers alike have cutting edge research and recommendation for management to be the most efficient and cost-effective farmers to feed the world. Funding should be aimed toward research, innovation and securing national security.

Recommendations:

- Increased collaboration amongst government agencies and Land Grant System regarding the importance of agriculture, precision ag technologies, and connectivity.
- The USDA in partnership with DoD/DHS/NSF should establish a biosecurity/cybersecurity research and innovation facility through the Land Grant University System.
- USDA study on technology adoption benefits to productivity/profitability to ensure food and water security.
- Land Grant University Extension Systems must be fully funded and hiring qualifications must prioritize technology know-how and on-farm adoption assistance.
- Increased national collaboration amongst USDA NRCS and Land Grant University System in respect to as-applied research, technology use and training.
- Increased curricular offerings at technical and community colleges to support precision agriculture tracts such as but not limited to: ag technology, data science, agronomy, rural wireless networks, and cyber security.

Cyber-Security and Data Privacy

With increased technology adoption and accessibility enabled by wireless connectivity, comes the increased need and responsibility for consideration of Cybersecurity. Through the most recent pandemic, our country has recognized both essential industries and supply chains, as well as become increasingly exposed to threats of cybersecurity and activity by “threat actors” upon both public and private institutions. Examples of these strategic vulnerabilities have been identified and leveraged in both the food supply chains with the active cyberattack a on a major US meat supplier, as well as an increase in individual attacks on hospitals and rural cooperatives, private businesses and other stakeholders located in rural America that are potentially active within the local economies and delivery of services to the public.

As a working group, we focused on both vulnerabilities and lines of defensibility. Vulnerabilities can be classified into two categories: (1) single point vulnerability with the disruption of operations to an individual business and (2) system vulnerability or the potential infiltration of an individual link within the supply chain resulting in a disruption or stoppage of the entire supply chain.

Individual farms and agribusinesses are most vulnerable as they frequently have these characteristics.

With alignment and use of cloud-based platforms comes many hallmarks and cybersecurity defense mechanisms inherently designed into the architecture, representing a viable mitigation strategy. Examples of these include 128+ bit encryption, various firewall and monitoring techniques etc.

It should be recognized that migration from desktop and individual server systems to cloud-based architecture, comes with it an inherent follow-on dependency for both bandwidth frequency and readily available connectivity, both wired and wireless.

As Rural America engages into the challenges of improving cybersecurity, the corresponding dependency upon high bandwidth connectivity also becomes a requirement of necessary infrastructure. Individual farms represent single point vulnerability as individual businesses susceptible to interruption. The more significant vulnerability is that of systemic vulnerability for disruption of larger scale stoppages within the supply chain.

Agriculture, by its very nature is subject to seasonality and seasonal changes local to specific geographies. When weather conditions and soil temperatures are ideal for planting, there is a natural tendency for many farms in a common local geography to begin planting at the same time.

A second aspect of systemic vulnerability can be characterized into the upstream and downstream infrastructure that serves individual farms within those localized geographies. The supply chain of inputs (fertilizer and fuel) or the downstream custody of on and off farm storage of grains or other agricultural commodities, off farm transportation and eventual downstream processing capacities all represent an additional potential threat of systemic vulnerability.

In that interest, rural businesses such as electrical cooperatives, agricultural cooperatives, telco's, internet service providers and other providers of necessary rural infrastructure need to be equally protected from the potential threats represented by threat actors seeking to impact the supply chain.

Recommendations:

- All systems need to contain the architectural element of a layered security strategy, as a means of defensible architecture.
- Due to the sensitive nature of farm record data and the potential for vulnerability, all systems should have the requirement of multi-factor authentication.

AEM, Future of Food Production, https://www.aem.org/future-of-food-production

The evolution of agriculture and the future of food is being driven not only by technology but also by changing consumer preferences, social trends, overall increasing global demand for food and, of course, climate change. How and which foods are produced where has economic, demographic, political and environmental impact. Precision agriculture can address many of the challenges and opportunities the future presents.

Innovation is at the heart of American agriculture. Connectivity-enabled ag tech will provide a range of resources for farmers to continue to rise to the challenges of the 21st century globalized food, fuel and fiber systems.

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