Recommendations and Text for Discussion Purposes only
December 2, 2022

Interim Paper for the Accelerating Broadband Deployment on Unserved Agricultural Working Group

I. Introduction

The Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States ("Task Force") created a number of working groups including the Accelerating Broadband Deployment on Unserved Agricultural Lands ("Deployment WG"). The Deployment WG has analyzed what is required to increase broadband deployment on unserved agriculture lands with a focus on being able to meet the needs for PA including reviewing the recommendations from the 2019 Task Force and considering technology innovations, funding additions and other changes. Based on this analysis, we developed the following recommendations associated with how to accelerate broadband deployment on unserved agricultural lands, which is critical to having precision agriculture ("PA") become a reality on farms across the country, wherever they are located.

We started our efforts by examining the benefits of advancement of PA to the farm and ranch, as well to the entire country. We then reviewed the recommendations made by the previous Deployment WG to see which recommendations have been implemented and which remain outstanding. We did this while keeping in mind three principles that guided our work as discussed in Section II below.

While all the recommendations are crucial, we have included and updated the outstanding recommendations based on changes that have occurred since releasing the 2021 PA Report. We included policy, funding and related recommendations based on our analysis of what is required to successfully address the lack of broadband deployment that is required to meet the needs of farms and ranches for many uses, including PA.

With the U.S. Congress recently making over $65 billion available for broadband deployment, the United States government and the states have a unique opportunity to use this funding in a manner that will ensure broadband service is fully available on unserved agricultural lands by 2025. But as discussed below, this requires the funders to impose a series of conditions to ensure that the funding is used in a sustainable manner to support broadband deployment to the farms and ranches. In addition, we urge Congress and federal, state and local policymakers to consider the role of private networks for last acre purposes as another method to accelerate broadband to unserved agricultural lands. We also urge policymakers to make policy and spectrum decisions which will help to ensure that our agricultural lands do not now or in the future suffer from a lack of broadband and other required communications connectivity. This can be done by, as outlined below, creating incentives for build-out and ensuring that there are the required operational funds available for long-term sustainability of the broadband and other communications networks in the most rural parts of the country.

Accordingly, we urge the FCC, USDA, Congress and other interested government agencies to act now to ensure that by 2025 our agricultural lands do not continue to suffer from a lack of broadband services which are necessary to address critical issues including food security, health and education.

II. Guiding Principles of Our Recommendation

Throughout our discussions we focused on three guiding principles which we consider critical to ensuring the deployment of broadband to unserved agriculture lands. These principles are:

- **All technologies, terrestrial fixed and mobile wireless and wireline and satellite, have a role to play in the deployment of broadband/Precision Agriculture to the farm/ranch**
- **Broadband deployment funding and licensing decisions must prioritize deployment to under and unserved agriculture lands and isolated populations living on farms, ranches, or other isolated areas.**
- **Adequate resources (e.g., funding, expertise, etc.) must be allocated to meet the United States goal of providing broadband to under and unserved agriculture lands by 2025.**

We urge Congress and the federal, state and local governments to keep these three principles in mind as they review the recommendations we make and as they work to solve the critical issue of ensuring America's farms and ranches have access to the broadband services they require.

III. The advancement of precision agriculture brings significant benefits to the farm and to the United States

PA uses a variety of technologies such as sensing, information technologies, and electromechanical systems to manage different elements of farming and ranching in order to increase efficiency and yield. The key purpose of PA is optimization: to maximize productivity and efficiency while minimizing environmental risks and costs at as high a level of detail as possible, even to the level of small portions of a field. Gathering, processing, and analyzing data are essential to PA as the volumes of data grow with advances in sensing capability and the deployment of more sensors in the fields and mounted on equipment. The movement of data on-farm and in exchange with remote computers is a critical requirement for the advancement of precision agriculture. Farm fields are typically remote, and farm machines are typically mobile, so wireless networks that enable broadband data transmission across the farm's last acre are essential to modern agriculture.

The successful implementation of PA is dependent upon a robust last mile broadband network connecting the farm/ranch headquarters to the internet cloud as well as a last acre network that reaches across the area supported by the precision agriculture technology.

While the American people make up less than 5% of the world's population, American row-crop farms produce about 30% of the world's corn, 30% of soybeans, 13% of cotton, 12% of sorghum, and 8% of wheat.[1] The U.S. exports tremendous amounts of these commodities to feed and clothe the worlds' population and world consumption is expected to increase by 35% or more in the next few decades.[2] Furthermore, rising living standards worldwide raise the demand for animal protein, which adds an additional requirement for grains as feed. With the recent war in Ukraine, we have seen the fragility of the world's food system, so U.S. farms must maintain a high level of productivity to help meet the world's demand for food and related agriculture products.

On top of these worldwide demand pressures, expectations for environmental risk mitigation and sustainability are increasing, requiring that crop inputs be reduced.[3] Moreover, a changing climate adds uncertainty to future yield capabilities, and high-quality farmland is being lost to urbanization and road construction. Farm labor shortages are an exacerbating factor. Aside from the aging of farmers, rising living standards are reducing the desirability of farm work among the world's young; the average age of immigrant farmworkers in the U.S. rose by 5 years between 2008 and 2018.[4] Moreover, immigration issues worldwide are reducing the flow of migrant farmworkers making it critical that U.S. farms increase their operational efficiency.[5] This changing workforce on agricultural lands mandates that our farming and ranching must become more efficient to survive in the future where obtaining qualified workers becomes increasingly difficult.

PA provides vast opportunities to feed the country and the world while helping to restore and preserve the biodiversity of the earth. It does this by accounting for variability across a field in terms of topography, soil type and condition, plant health, etc. For example, in a corn crop, different portions of a field have the potential to produce different amounts of corn, so it is desirable to apply the right amount of fertilizer at each location to maximize economic return while not producing pollution by over-applying fertilizer. PA reduces chemical inputs into the

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[1] https://www.investopedia.com/articles/markets-economy/090316/6-countries-produce-most-corn.asp. Accessed on 23 OCT 2022.] [https://beef2live.com/story-world-soybean-production-ranking-country-0-164836. Accessed on 23 OCT 2022.] [https://worldpopulationreview.com/country-rankings/cotton-production-by-country. Accessed on 23 OCT 2022.] [https://www.indexmundi.com/agriculture/?commodity=sorghum&graph=production. Accessed on 23 OCT 2022. [https://www.visualcapitalist.com/cp/visualizing-global-wheat-production-by-country/. Accessed on 23 OCT 2022.]

[2] van Dijk, M., Morley, T., Rau, M. L., & Saghai, Y. (2021). A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. Nature Food, 2(7), 494-501.

[3] Canavari, M., & Coderoni, S. (2020). Consumer stated preferences for dairy products with carbon footprint labels in Italy. Agricultural and Food Economics, 8(1), 1-16.

[4] Economic Research Service, U.S. DEPARTMENT OF AGRICULTURE. U.S. Farm Employers Respond to Labor Market Changes With Higher Wages, Use of Visa Program, and More Women Workers. https://www.ers.usda.gov/amber-waves/2020/october/us-farm-employers-respond-to-labor-market-changes-with-higher-wages-use-of-visa-program-and-more-women-workers/. October 5, 2020. [Zahniser, S., Taylor, J. E., Hertz, T., & Charlton, D. (2018). Farm labor markets in the United States and Mexico pose challenges for US agriculture.]

[5] Milbourne, P., & Coulson, H. (2021). Migrant labour in the UK's post-Brexit agri-food system: Ambiguities, contradictions and precarities. Journal of Rural Studies, 86, 430-439.

soil that can leach into ground water or runoff into rivers, uses less petroleum-based fuel, and increases the economic productivity of the land. PA is a technology with the potential to address multiple agricultural issues in the United States and globally including a reduction in available farm labor, a decrease in the number of farms, climate change, drought and declining aquifers, and the need to increase production to feed the estimated additional 2 billion people that will inhabit the earth by 2050 (9.7 billion inhabitants).[6]

PA can involve both crop farming and livestock farming and ranching. In both cases, PA incorporates advanced technologies to monitor and optimize the conditions of plants or animals and their surrounding environments. With livestock, monitoring may include weather, barn conditions, food consumption, health and well-being for every animal. With both crops and livestock, PA is benefitting from major technological trends including positioning technologies, sensors, big-data, artificial intelligence, and advances in computing and communications.[7]

Tractor guidance is a PA technology that relies on GPS/GNSS for positioning and can result in accuracy within one centimeter when planting, spraying herbicide, or applying fertilizer. Thus, a farmer can know the position of every one of millions of seeds planted in a field. The increased precision can result in fewer overlaps (areas with double application) and gaps (skipped areas) and overall improved economic and environmental efficiencies.[8]

The future of farming includes collecting images with remote sensing, which may involve satellites or Unmanned Aerial Systems (UAS, drones), as well as both stationary or mobile sensors for efficient mapping, spraying, etc.[9] For example, UAS can map a property of interest, report on crop health, monitor livestock and irrigation systems, and more. The ability to collect and analyze this type of image data in real time has tangible outcomes for farmers such as better crop yield, fewer resources expended on pesticides and herbicides, and overall improved management decisions.[10]

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[6] United Nations Department of Economic and Social Affairs. (2019). Growing at a slower pace, world population is expected to reach 9.7 billion in 2050 and could peak at nearly 11 billion around 2100. https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html#:~:text=The%20world%27s%20population%20is%20expected,United%20Nations%20report%20launched%20today. Accessed June 7, 2021.

[7] National Institute of Health, National Library of Medicine. Precision Agriculture for Crop and Livestock Farming—Brief Review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8388655/. August 9, 2021.

[8] Agricultural Research Service, USDA. Benefits and Evolution of Precision Agriculture. https://www.ars.usda.gov/oc/utm/benefits-and-evolution-of-precision-agriculture/. July 16, 2021.

[9] Business Insider. Precision agriculture in 2021: The future of farming is using drones and sensors for efficient mapping and spraying. Precision Agriculture 2021: Benefits of Farm Drones & UAV Tech (businessinsider.com). February 8, 2021.

[10] Business Insider. Precision agriculture in 2021: The future of farming is using drones and sensors for efficient mapping and spraying. Precision Agriculture 2021: Benefits of Farm Drones & UAV Tech (businessinsider.com). February 8, 2021.

Drones are beginning to be used to spray crops more precisely than a traditional tractor. Whether fertilizers or pesticides a spraying plan designates the right amount of product at each location requiring treatment to maximize crop health and economic return while not polluting or wasting chemicals by over-application. Some UAS can not only apply materials to a crop but also adjust the application rate using variable-rate technology (VRT) based on a prescription map.[11] UAS potentially offer farmers major cost savings, enhanced efficiency, and more profitability.[12]

Autonomous vehicles can potentially operate day and night to maximize productive time. Both large and small farms can potentially see significant economic and environmental savings as reductions in costs and changes in business models (e.g., robotics as a service, "RAAS") often lead to increases in profits. The precise guidance on autonomous machines offers more precise operations, which lead to reduced operator fatigue, higher yield, and the ability to work longer workdays during inclement conditions. These changes may significantly reduce fuel, labor, repair, and maintenance costs.[13]

Responsible use of water as a resource is of critical importance for sustainable agricultural development, food security, and overall economic growth. Add in the impact of climate change, drought, and wildfires and the competing demand for water from other economic sectors and it is obvious why water management is critical. The efficient and effective management of irrigation water is another benefit of PA technology. Precision irrigation allows applying a precise amount of water to crops at a precise time.

During planting and growing seasons sensor data provides farmers with farm-level information that enables them to manage risk more optimally and more precisely apply fertilizer, seed, and herbicides and at harvest yield monitoring systems provide data on the results; all this information can be applied to planning future crops.[14]

The implementation of PA involves the integration of smart technologies in both farming and livestock, allowing the farmer to manage field variability and to monitor plant or animal performance with a focus on maximizing both efficiency and the cost–benefit ratio. Animal and plant health is key to the food and agriculture sector and industry as livelihoods are based on milk, egg, meat, vegetable, fruit, and grain production.[15] Again, the collection, processing, and

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[11] National Institute of Health, National Library of Medicine. Precision Agriculture for Crop and Livestock Farming—Brief Review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8388655/. August 9, 2021.
[12] Business Insider. Precision agriculture in 2021: The future of farming is using drones and sensors for efficient mapping and spraying. Precision Agriculture 2021: Benefits of Farm Drones & UAV Tech (businessinsider.com). February 8, 2021. National Institute of Health, National Library of Medicine. Precision Agriculture for Crop and Livestock Farming—Brief Review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8388655/. August 9, 2021.
[13] Agricultural Research Service, USDA. Benefits and Evolution of Precision Agriculture. https://www.ars.usda.gov/oc/utm/benefits-and-evolution-of-precision-agriculture/. July 16, 2021.
[14] Agricultural Research Service, USDA. Benefits and Evolution of Precision Agriculture. https://www.ars.usda.gov/oc/utm/benefits-and-evolution-of-precision-agriculture/. July 16, 2021.
[15] National Institute of Health, National Library of Medicine. Precision Agriculture for Crop and Livestock Farming—Brief Review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8388655/. August 9, 2021.

analysis of a growing volume of data are key to PA, and the seamless movement of these data is vital. Remote farm fields with mobile farm machines must have wireless networks that enable broadband data transmission across the farm in order to derive the necessary benefits from PA. The network, last mile and last acre, allows for the connectivity of smart technologies to be realized and integrated. Without the investment in a robust broadband network, PA will not evolve to achieve the goals for improved production and cost savings.

Accordingly, it is critical that we prioritize and work to solve the lack of broadband to support PA and other critical needs to unserved agricultural lands by no later than 2025. The recommendations below are critical to be acted upon if the United States is going to be able to meet this important challenge now and in the future.

IV. The Status of the 2021 PA Recommendations on Accelerating Broadband Deployment

The 2021 PA Task Force Report made the below recommendations on accelerating broadband deployment on unserved agricultural lands. We have updated or incorporated many of the yet-to-be implemented recommendations into our recommendations below to encourage action by the identified government agencies to ensure broadband is deployed as quickly as possible to unserved agriculture lands.

We would be remiss if we do not highlight several actions we have seen taken that are helping to meet the 2025 goal of broadband to all unserved agricultural lands. These include:

- Congress allocated over $65 billion in federal funding for broadband deployment
- The FCC's efforts at improving broadband mapping to determine how to best use scarce resources to deploy broadband where it is needed most
- The FCC established incentives for small businesses and tribal areas to be able to gain access to more spectrum.
- The FCC released additional spectrum for wireless build-out
- The FCC working to ease administrative burdens to enable tower deployment

These are some efforts are under way; we urge further action be taken:

- Consideration of a single broadband definition for funding and other purposes across all the Federal agencies and states
- Increased incentives in the spectrum auction process to encourage broadband buildout to unserved agricultural lands
- Define standards for broadband including speed and latency.

Several recommendations were not addressed. It is crucial that the Federal government continue to take important steps to enable and encourage the deployment of broadband to support PA on farms and ranches. These unresolved recommendations are key to the successful deployment of broadband to unserved lands by 2025 include:

- The FCC implanting geographic build-out requirements rather than population coverage requirements to enable build out of agricultural lands for auctioned spectrum
- The FCC should require auction bidders to demonstrate long term sustainability and scalability of their networks

Several of the unresolved recommendations are key to the successful deployment of broadband to unserved lands by 2025.

V. Federal and State Infrastructure Funding and impact on accelerating broadband deployment to unserved agricultural lands

Significant federal and state funding has flowed into broadband deployment since the conclusion of the 2021 Report. A significant amount of this funding, $65 billion, is earmarked for broadband deployment through the 2021 Infrastructure Investment and Jobs Act (the "Act"), signed into law by President Biden on November 15, 2021.[16] This funding falls into the following programs that are most relevant for PA: (1) the Broadband Equity, Access, and Deployment Program (BEAD) ($42.45 billion), (2) Digital Equity Planning, Capacity and Competitive Grants ($2.75 billion); (3) the Tribal Broadband Connectivity Program ($2 billion), (4) Rural Broadband Programs at the Department of Agriculture ($2 billion); (5) the Middle Mile Grant Program ($1 billion); and (6) Private Activity Bonds (~$600 million).

In addition, the FCC's The Rural Digital Opportunity Fund (RDOF) is in the process of disbursing up to $20.4 billion over a 10-year period to bring fixed broadband and voice service to millions of unserved homes and small businesses in rural America. As discussed below these programs have the potential to impact the acceleration of broadband deployment to unserved agricultural lands.

A. The BEAD Program

Title I of the BEAD is a formula-based grant program for U.S. states and territories. Designed to close the access gap for unserved & underserved areas of the country. In the Bead $42.45 Billion administered by NTIA in conjunction with State Broadband Authorities or Commissions to utilize for broadband deployment, mapping, and adoption projects. Each state, the District of Columbia and Puerto Rico are guaranteed a grant of at least $100 million. An additional $100 million will be divided equally among the United States Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands. In order to gain access to these funds, the States and territories had to submit five-year plans by the end of August 2022. These plans are now under review and funding disbursement should begin shortly.

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[16] In addition, other funds have been made available through other funding programs. See e.g., https://www.whitehouse.gov/bipartisan-infrastructure-law/#internetaccess

The remaining funding under BEAD will be distributed based on a formula that considers the number of unserved and high-cost locations in the state utilizing maps scheduled to be published by the FCC in November 2022. The funding priority is to provide broadband to unserved areas (those below 25/3 Mbps), followed by underserved areas (those below 100/20 Mbps), and then serving community anchor institutions (1/1 Gbps) (e.g., schools. libraries. medical facilities.)

Under the BEAD program, States are required to prioritize projects based on deployment to counties with persistent poverty or high poverty areas; speeds of service; expediency of completion; and demonstrated record of compliance with federal labor and employment laws. As with all the funding, states are required to award subgrants with the following prioritization: 1) Unserved Projects; 2) Underserved Project deploying to at least 80% of locations with 100/20 Mbps service, low latency (100 milliseconds or less), and scalable to gigabit speeds; and 3) Eligible Community Anchor Institutions.

In many cases, the State and/or territory or its collaborating local entities will allocate funds to subgrantees who will deploy broadband services in the required areas. Competitive selection of subgrantees must safeguards against collusion, bias, conflicts of interest, etc. Subgrantee solicitations may begin upon approval of Initial Proposal and continue for up to one year. Subgrantees will be selected based on the set criteria including:

- Most affordable gigabit service offer;
- Priority to subgrantees with demonstrated record of fair labor practices;
- Speed to deployment (required to deploy within 4 years grant issuance)
- Workforce equity and job quality
- Open access on fair/neutral terms to wholesale last mile service for life of network subsidy
- Local and tribal coordination

NTIA has determined that "Priority Broadband Projects" are those that use end-to-end fiber-optic architecture. NTIA decided that only end-to-end fiber will "ensure that the network built by the project can easily scale speeds over time to … meet the evolving connectivity needs of households and businesses" and "support the deployment of 5G, successor wireless technologies, and other advanced services." As discussed below, this determination has raised concerns within the Deployment WG since in some cases it may not be possible because of geography to deploy fiber, or it may be extremely costly.

B. Tribal Act

[To be developed for 2023 full report]

D. Enabling Middle Mile Broadband Infrastructure

The Middle Mile Broadband Infrastructure Grant (MMG) Program provides $1 Billion in funding for the construction, improvement, or acquisition of middle mile infrastructure. The purpose of the grant program is to expand and extend middle mile infrastructure to reduce the cost of connecting areas that are unserved or underserved to the internet backbone. The MMG was open to States, political subdivisions of a State, Tribal governments, technology companies, electric utilities, utility cooperatives, public utility districts, telecommunications companies, telecommunications cooperatives, nonprofit foundations, nonprofit corporations, nonprofit institutions, nonprofit associations, regional planning councils, Native entities, economic development authorities, or any partnerships of two (2) or more of these entities. Applications were due on September 30, 2022, and NTIA anticipates completion of award reviews by February 16, 2023.

E. USDA Rural Utilities Service

The Act allocated $2 Billion to the United States Department of Agriculture Rural Utilities Service for the ReConnect Program. The ReConnect Program offers loans, grants, and loan-grant combinations to facilitate broadband deployment in areas of rural America that currently do not have sufficient access to broadband. In facilitating the expansion of broadband services and infrastructure, the program will fuel long-term rural economic development and opportunities in rural America. Corporations, Limited Liability Companies and Limited Liability Partnerships, Cooperatives or mutual organizations, States or local governments, including any agency, subdivision, instrumentality of political subdivision thereof, United States territories or possessions, and Indian Tribes are eligible to apply.

F. Other Funding Opportunities

Through its Rural Digital Opportunity Fund (RDOF), the FCC has provided more than $6 billion in broadband deployment to 47 states. RDOF will eventually disburse up to $20.4 billion over 10 years to bring fixed broadband and voice service to millions of unserved homes and small businesses in rural America. RDOF participants must offer stand-alone voice service and broadband service at speeds consistent with their winning bids (which must be at least 25 Mbps downstream and 3 Mbps upstream (25/3 Mbps)) at rates reasonably comparable to those available in urban areas to all locations within an awarded area over eight years of the 10-year program. Initial interim deployment milestones are based on those adopted for the CAF Phase II Auction program. Carriers must complete a competitive application process with the FCC to be awarded RFOF grants. The most recent round of funding supported projects using a range of network technologies, including gigabit service hybrid fiber/fixed wireless deployments that will provide end-user locations with either fiber or fixed wireless network service using licensed spectrum.

- Agricultural Deployment Opportunities
- Public Private Partnerships
- Working with State Broadband Authorities and Commissions

- Coordinating efforts between programs
- Agricultural Deployment Funding Concerns
- Agriculture needs versus densification
- Covering vast acreage
- NTIA preference for fiber
- Need for wide area coverage
- Broadband Speed Requirements
- Incentive funding to build out to farms through state broadband commissions (or other relevant state bodies) and getting this info/program out to the farmer

While the Deployment WG welcomes the addition of the tens of billions of dollars being made available to increase broadband connectivity across the country, we remain concerned about this funding reaching the unserved lands that need it most. Accordingly, we recommend the following be considered:

Recommendation 1: U.S. Federal Agencies Should Use the Same Broadband Definition and Standards for Funding Decisions that is Updated on a Bi-Annual Basis. A continuing major concern is that there is no single definition of broadband as our federal partners make broadband decisions (this gets even worse if one looks at the states and localities). In order to ensure that all agricultural lands have access to a baseline of broadband services it is critical that federal agencies use the same threshold for establishing what is considered to be broadband service, (greater network capacity with a better balance between upload and download speeds) and align all support mechanisms and incentives. We further urge that this definition be reviewed, and if appropriate, updated on a reasonable basis such as every two years.

The Working Group, as well as the Task Force, is pleased to see steps taken by the FCC, NTIA and USDA to better coordinate and share information. We encourage continued efforts in these cross-agency activities and collaboration, including with States and localities.

As the Task Force recommended in its 2021 final report, we continue to encourage the USDA to develop funding programs to support the buildout of local/last acre networks to ensure the capability to use PA systems and devices.[17] USDA has a long history of proving support to build last mile telecom and broadband networks. However, Precision Agriculture needs a last acre network tied to this last mile network. These networks could be cost-prohibitive for many farming/ranching operations. Establishing a funding mechanism for last acre networks could help with the adoption of Precision Agriculture technology (See also Section VI below).

Recommendation 2: When determining agency broadband funding decisions, recommend prioritizing grant applications that include wide-area coverage to agricultural acreage

[17] Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 28 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

including to the farm office/house. Adding this criterion will ensure there is a robust broadband network as well as a wide area coverage to reach agriculture lands which require both wireline and wireless technologies to reach not only the farm office/house but the last acre. If not, we may continue to see funding going to residential and other areas over agricultural lands. [flesh out more]

VI. Private Wireless Networks [Note: maybe make appendix]

Federal and state funding is a primary element necessary to build-out last mile broadband networks to reach the farm or ranch. In addition to the last mile network, it is important to consider deployment to the last acre of a farm or ranch. PA needs both a last mile network and a last acre network to achieve the best possible results promised by PA technology. Private Wireless Networks have been considered a candidate for the last acre networks. Commercial networks would be a good solution for rural lands, however, because of the lack of users and other financial incentives it is very unlikely commercial networks will be built out and economically sustainable. This is where private networks may be the best solution.

Similar to last mile networks, one of the primary challenges to deployment and adoption of private wireless networks (PWN) is their high cost. Accordingly, as part of funding decisions being made by the Federal, State and local governments, it is critical that PWNs are included in that equation.

Access to licensed spectrum is another significant challenge for these networks. Licensed spectrum is preferred because it is not subject to the same potential for interference that unlicensed spectrum can be. For example, if the last acre unlicensed spectrum network is far from any densely populated community, there is a possibility that unlicensed spectrum may be sufficiently to support the needs of the PWN. However, the quality of communication using unlicensed spectrum in more populated rural areas may degrade significantly due to interference from other users and devices.

Other considerations are both the technology used for PA activities and the use of the spectrum itself may dictate the type of spectrum needed. Low-band spectrum will reach further distances and is more able to handle terrain and vegetation obstacles, but the data throughput capacity is limited by the low-band spectrum. Conversely, high-band spectrum has greater data throughput capacity, but generally has a shorter range and is impacted to a greater degree by terrain, vegetation and weather.

The following scenarios demonstrate how a last-acre PWN may be deployed for PA use. These examples are based on information gathered and confirmed by meeting with network engineers from a wireless communication company that designs, implements (or installs?) and operates mobile wireless and fixed wireless networks.

The four scenarios described range from a pure private wireless LTE network to a hybrid/managed wireless LTE network to a "private like" wireless LTE network and a WiFi-6/LoRa wireless network option. Each scenario uses a consistent set of details:

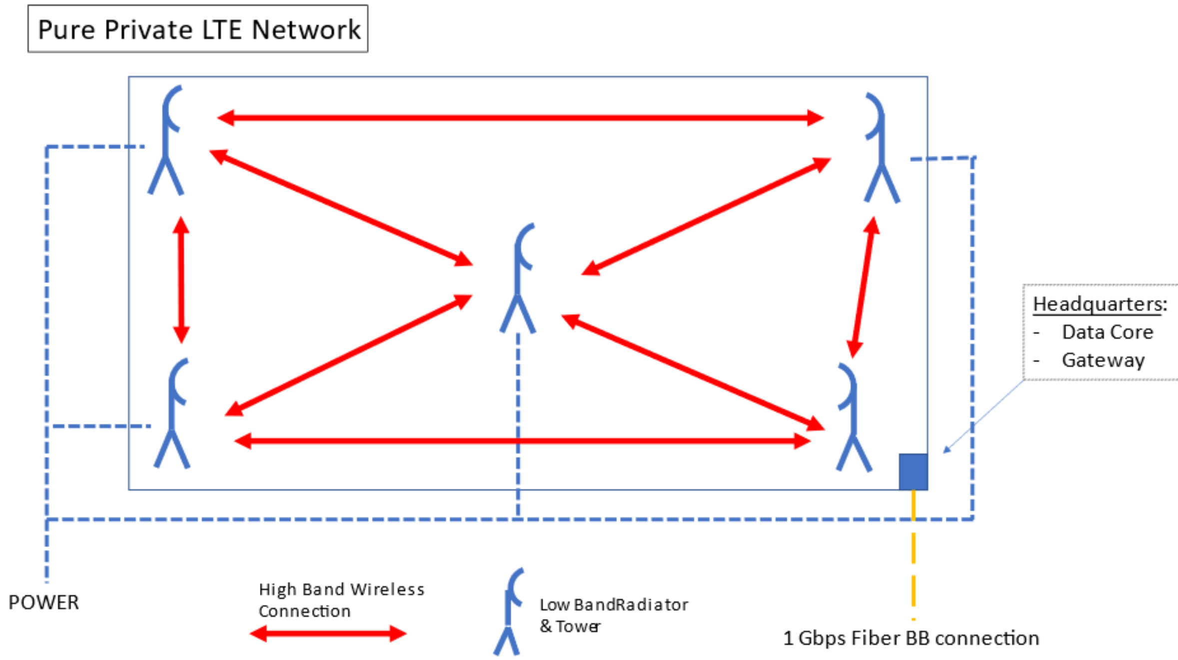
- The network for the first three scenarios will be based on LTE (4G or 5G) technology.
- The farm/ranch is 1,000 contiguous acres that is rectangular, almost square-like, in shape.
- The farm/ranch headquarters is connected to a low latency (>15 millisecond) 1 Gbps fiber broadband connection. Eventually, latency requirements will need to be lower as PA technology evolves with real-time applications.

Scenario 1: Pure Private LTE Network

A pure private network in many ways will look like a smaller version of a fixed or mobile network. For the first example this network will have 5 radiators (receiver/transmitters on a "tower") and power will be required at each location. A full suite of PA devices will require two spectrum bands consisting of approximately 100 MHz of high band and approximately 50 MHz of low band. The high band spectrum (up to 10 GHz frequency) will allow for point-to-point communication between all the radiators and the lower band (1-2 GHz frequency) would be used for data transmission to and from the PA devices.

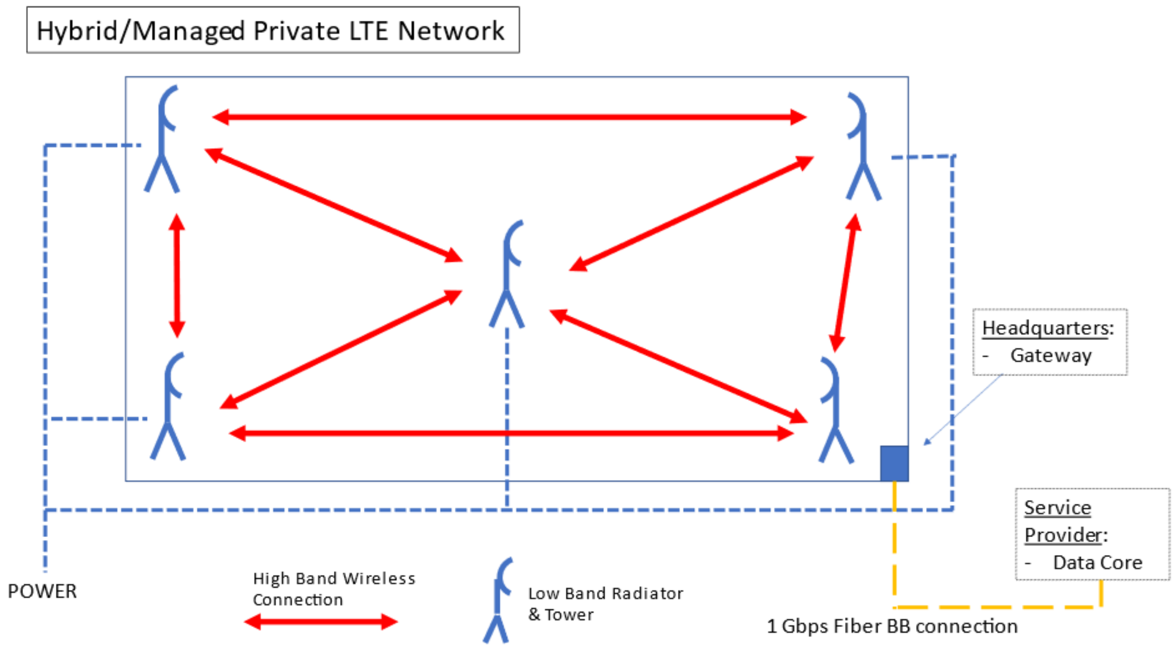
Two of the challenges of licensed spectrum are that generally the cost of spectrum is high and the geography of a spectrum license, whether it be a PEA or county boundary, does not match the footprint of a farm/ranch. The 2021 Task Force recommendation to have spectrum carve-outs specifically for PA is very applicable to deploying a PWN. Another important 2021 TF recommendation is the requirement for precision ag device standards and network standards. Without required standards, real-time PA implementation will be limited.

Infrastructure at the farm/ranch headquarters will require a data core to facilitate and aggregate the LTE data, provide ubiquitous band support and security. Additionally, the headquarters requires a gateway that connects the farm/ranch network to the internet cloud via the local ISP. In order to design, implement, operate and maintain the private network, an RF Engineer will be needed to design and deploy the private network, a core engineer will be necessary to manage the core and the gateway, and a technician will be needed to work on the towers and related equipment. The approximate costs associated with designing, building, operating and maintaining this type of network are Staffing = $200-250,000 + benefits; Equipment = $300,000; Spectrum = spectrum for this purpose in an isolated footprint is not currently available; Deployment costs = $100,000; Ongoing operational costs will generally include an annual fee of approximately 12% of the initial hardware costs in addition to the wages for the technician and engineer.



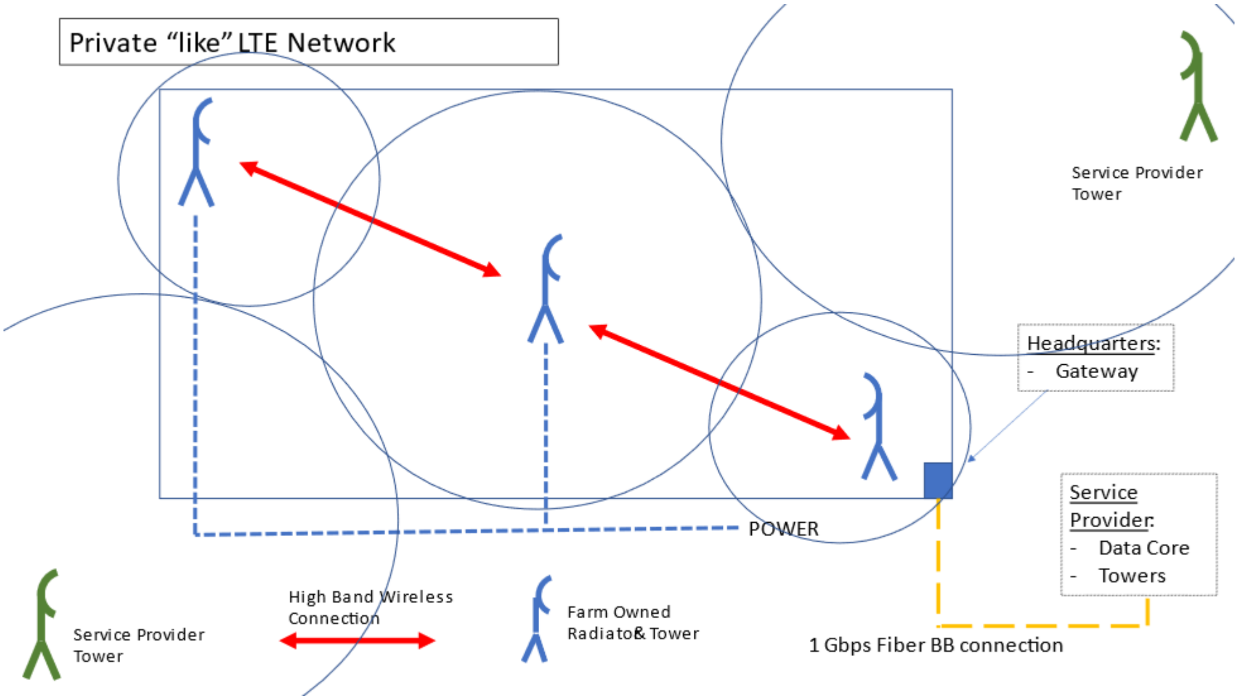
Scenario 2: Hybrid/Managed Private Network

A Hybrid or Managed Private Network combines a private network and a wireless service provider's public network. In this example, the farm/ranch cannot manage the data core and decides to work with a local wireless service provider to manage the network. The farm headquarters will still need a server/gateway and connectivity established directly with the wireless service provider. Standards for PA are still necessary for the devices and the network. This deployment will still need to have the five radiators/towers with power to each. Staffing requirements change due to the outsourced arrangement with the wireless service provider. The RF Engineering and Core Engineer functions are now handled by the wireless service provider and becomes an outsourced operational cost. However, the onsite technician would still be recommended for maintaining the network. The cost of this type of deployment looks different than the pure private network: Staffing = $80,000 + benefits; Equipment = $200,000; Spectrum = spectrum for this purpose in an isolated footprint is not currently available; Deployment costs = $100,000; Ongoing operational costs with the service provider will average approximately $1,200/week for ongoing operations specific to this network plus approximately $10,000/month for management of the core and the ongoing staff technician costs.



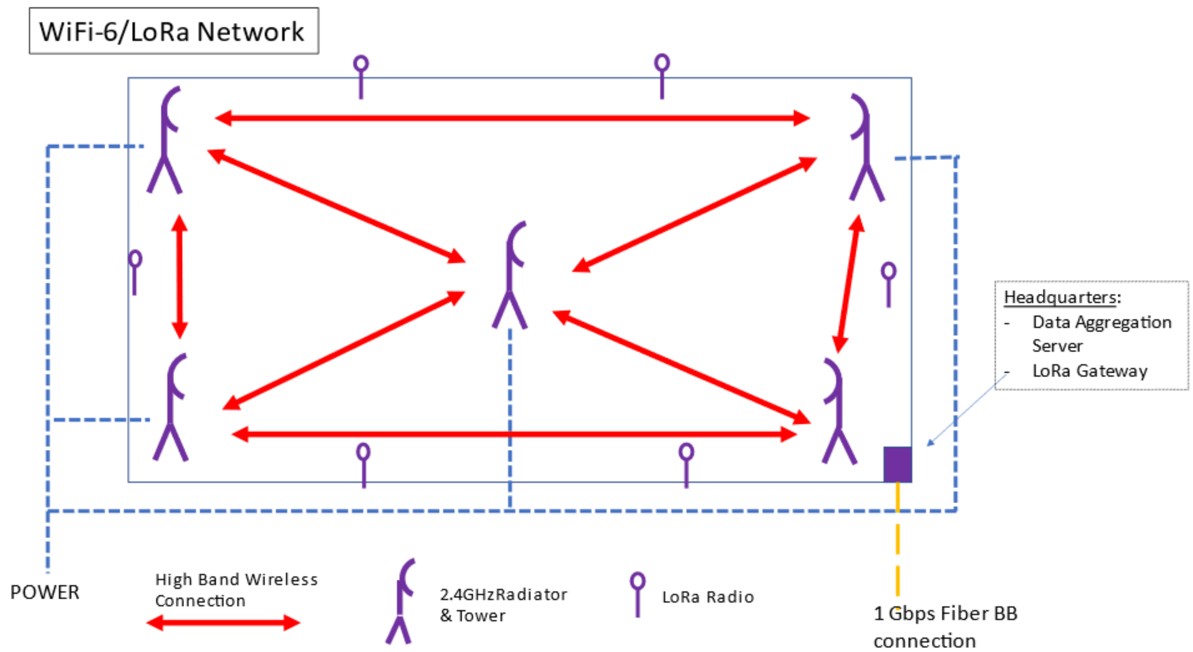
Scenario 3: "Private-like" Network

A "Private-like" Network is an option if a local service provider with strong wireless service at the edge of the farm/ranch is available. In this type of network deployment, the farm/ranch deploys less infrastructure and makes greater use of the service provider's network. In this scenario, if the farm/ranch cannot acquire spectrum, the wireless service provider may allow the farm/ranch to use licensed spectrum they own. The data core is managed by the service provider, some of the radiators have been transitioned to the service provider's tower and network. The service provider's towers would need fiber backhaul to mitigate negative effects of latency. The farm/ranch may need a radiator near the center of the farm/ranch where the service provider's signal does not reach; or as shown in this example three small cells fill in the coverage gaps. The headquarters still needs a gateway, provided by the service provider, to facilitate the transfer of data into the network from the service provider and back out to the internet cloud. Technician staff is no longer necessary since the farm/ranch is outsourcing these tasks to the service provider. The cost of this type of deployment looks different than the other networks: Staffing = $0, Equipment = $75,000; Spectrum = spectrum for this purpose in an isolated footprint is not currently available; Deployment costs = $10,000; Ongoing operational costs with the service provider will average approximately $25,000/month for ongoing operations of the core, the gateway, technical expertise and manhours, engineering design, as well as ongoing maintenance and upgrades, devices sourcing, authentication and security.



Scenario 4: WiFi-6/LoRa Network

The WiFi-6/LoRa "network" is something at the low end of the technical and secure range but it is workable. In this scenario, this network is a hybrid Wi-Fi + LoRa network, and is based on a 1,000-acre farm with a low latency 1 Gbps fiber connection. For this kind of deployment, we do not consider the use of licensed spectrum, therefore the need to be in an isolated rural area helps to mitigate the potential for spectrum noise, which could keep it from working optimally. Using 2.4 GHz spectrum, place radios around the property to allow for coverage across the farm or ranch. Eventually 6 GHz could be added when dual mode capability becomes available. High band spectrum can allow for communication between these radios. Power will be needed for these radios. Interconnect these radios with 5.8 GHz spectrum. Place LoRa repeaters for filling gaps and to reach subsoil sensors. These can be battery, solar or wind powered. The headquarters will need a LoRa gateway and a data aggregator for the 2.4 GHz network; there will need to be a device that aggregates the data from each of these in order to compile and synchronize the data received. PA standardization is still required. To make this work, you would need one technician either on staff, or outsourced, to manage the network and the devices. The cost of this type of network is low, but this is really a Do-It-Yourself option using equipment currently available. Costs include Technician = $80,000 (on staff or outsourced); Equipment = $40,000; Deployment would be done primarily by the technician, but there will be a cost to extend power to the remote radios. Spectrum used for this example is unlicensed. If the farm/ranch is located near any notable population, it most likely won't work due to RF noise.



Summary

The above examples demonstrate how a last acre private wireless network may be achieved. However, there are challenges for each of these examples, primarily in relation to costs and spectrum. The average lifespan for the equipment on most of these examples is limited to no more than 10 years, but storms and other weather challenges will likely reduce this timeline for many of the outdoor devices. Some of these options could be scaled and costs shared through some type of shared or cooperative effort. However, this would lead to more complex and more costly network deployments. The low latency fiber connection to the headquarters is recommended because any real-time PA activities will require extremely low latency, and when incorporating high data packages, a higher speed connection is preferable.

Accordingly, we make the following recommendations:

Recommendation 3: The FCC should make available dedicated spectrum for PA at a low cost. The FCC should provide a carve-out of Low-band, Mid-Band and High-Band spectrum specifically for PA usage at a low cost. The exclusive availability of spectrum for PA will ensure that licensed spectrum is available in last-acre Private Wireless Networks and having a low-cost provision will help ensure that the licensed spectrum costs can be managed by the FCC. This will also help with the establishment and manufacture of PA specific equipment and systems tied to specific spectrum metrics.

Recommendation 4: USDA should provide funding for build-out and operation of last-acre networks. The USDA should make funding available specific to the buildout and operation of last-acre networks. Any last-acre network option is going to be expensive, and this cost will be an obstacle for the small and mid-sized farm and ranch operations across the country.

VII. Recommendations on Spectrum Efficiency and Network Deployment

Based on the need for broadband connectivity to unserved areas, it is critical that the FCC and other government agencies continue to work to improve spectrum efficiency and encourage network deployment. The following recommendations build on these requirements:

Recommendation 5: The FCC should continue to make available incentives to encourage broadband deployment for precision agriculture. The FCC, in its Enhanced Competition docket, began to address ways to incentivize the use of spectrum on tribal and other unserved lands. However, as previously noted, there may be fewer spectrum auction opportunities in the future. It is too early to understand how a reduced number of auctions will impact deployment. However, we urge the FCC to continue to explore and examine methods in which to further incentivize the use of spectrum to support unserved agricultural lands for all technologies. For example, the FCC should consider use of bidding credits or other financial benefits for service providers who as part of their auction bids commit to deployment of broadband to unserved agricultural lands in a set time period.

Recommendation 6: The FCC should revisit its broadband satellite service coverage requirements for NGSO satellite systems to the extent technically feasible: The FCC, in a recent docket [add in docket/date], eliminated the requirement for country-wide coverage by NGSO satellite systems. This means the broadband satellite systems that should be able to support the broadband needs of the most rural portions of the country, are no longer required to do so. The FCC should revisit this decision in light of the needs of the agricultural community to have access to competitive broadband services while balancing that technical requirement of the system.

Recommendation 7: The FCC Should Implement Geographic Build-Out Requirements for spectrum-based licenses and the FCC, USDA and NTIA should use this metric for funding to ensure the coverage of unserved agricultural lands on a timely basis. Today, the FCC uses population-based metrics for its build-out milestones for terrestrial wireless network. However, these metrics have largely failed to result in the build out of wireless networks to the most rural portions of the country. Accordingly, the FCC should implement geographic buildout requirements, rather than population-based requirements, tied to spectrum auctions with shorter buildout timelines. Funding guidelines for 5G broadband should require area-based coverage that includes verified device population and usage data. Precision agriculture, by its very nature, will require the use of geographical based buildout instead of the more traditional approach based on population. Spectrum auctions should include a shorter and more aggressive buildout timeline as positive consideration in winning bids. Although available spectrum for future auctions may be limited, we believe this is necessary for last mile, and even more so, for last acre implementation of Precision Agriculture. These same types of milestones should be included as part of funding received from NTIA, USDA and the FCC.

Recommendation 8: The FCC, NTIA and USDA should require the use of interoperability standards as part of the funding process for precision agriculture-focused broadband deployment and encourage the use of such standards through outreach, etc. As part of the funding process, the FCC, NTIA and USDA should require service providers receiving grants to utilize network equipment and devices that are compliant with industry-led interoperability standards as seen with the evolution of the connected home and smart/connected devices. A similar process used to develop the interoperability standards required to allow the smart home and device ecosystem to grow and evolve. Accordingly, we acknowledge the work of the Adoption and Jobs Working Group and the Task Force to recommend, as part of PA, that the government must ensure standards enabling interoperability across manufacturers and platforms to allow this same type of evolution to achieve the goals of PA.[18]

Recommendation 9: The FCC strengthen policies that require auction bidders to show the long-term sustainability and scalability of their proposed networks recognizing the need to raise the bar significantly on both upload and download speeds. All deployments of networks and use of spectrum should be able to adapt to growing demands of the consumer. PA needs will evolve and require networks to evolve to allow for the improved services offered by new technology. Accordingly, it is critical that in order to participate in auctions, as part of the application process, bidders are required to demonstrate the long-term sustainability of their networks.

<u>Recommendation 10</u>: Additional incentives to build-out to rural land headquarters. The FCC and USDA should support rural broadband networks by including incentives for connectivity to rural ag land headquarters. NTIA's BEAD funding allocations to the States is still pending the new FCC mapping. This is an unprecedented amount of funding for the buildout of broadband networks. We recommend an additional incentive for applicants that can and will build out broadband networks to reach rural farm and ranch headquarters. Similarly, USDA can implement this criterion in future ReConnect funding opportunities.

Recommendation 11: The FCC and USDA should work with stakeholders to build a playbook for the creation and operation of rural community-based, non-profit solutions for deployment (modeled after NTIA playbook). An important key to the success of these types of

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[18] Task Force for Reviewing the Connectivity and Technology Needs of Precision Agriculture in the United States, Report adopted as of November 10, 2021 at 80-83 (2021), https://www.fcc.gov/sites/default/files/precision-ag-report-11102021.pdf.

solutions is for the entities involved to leverage the expertise of local, independent, existing operators to build these community-based high-speed networks. By providing direction, the FCC and USDA can establish guidelines that help public-private partnerships that are most likely necessary to accomplish successful builds in areas currently unserved by a local service provider.

Recommendation 12: The FCC working with States and localities should address zoning issues to ease regulatory and administrative burdens associated with deploying broadband networks such as laying cable, setting towers or establishing satellite base stations. We urge the federal government to work with state governments and localities to ease zoning and other administrative burdens. While the FCC has taken some important initial steps, more needs to be done on the local level.

VIII. Conclusion

The Deployment WG applauds the 2019 Task Force and is pleased to build on their recommendations to advance the deployment of broadband for on unserved agricultural lands. We urge Congress and government policy to fully consider the recommendations, both those carried forward and new recommendations, of the Task Force to ensure that broadband is available to all agricultural lands no later than 2025. Failure to do so increases the risk to the climate and the lives of people across the country and the world who depend on the farms and ranches across the United States for food and other agricultural products.

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Members:
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Chief Executive Officer & General Manager, *Nex-Tech*

Dominic Walkes
Director of Strategic Initiatives, *Raven Applied Technology*

The Honorable Dan Watermeier
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Farmer and Board of Directors Member, *American Soybean Association*