FEDERAL COMMUNICATION COMMISSION (FCC)
PRECISION AG CONNECTIVITY TASK FORCE
Encouraging Adoption of Precision Agriculture and
Availability of High-Quality Jobs on Connected Farms

Report to the Precision Agriculture Connectivity Task Force
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Committee Membership:

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Background:

Beginning in April 2020, the "Adoption & Jobs" Work Group (Work Group) launched meetings to undertake their respective portion of the Precision Ag Connectivity Task Force report to be submitted to the Federal Communications Commission (Commission). The information below is a draft of the issues the Work Group has identified as major priorities of discussion.

Connectivity

American farmers and ranchers work tirelessly to produce wholesome, safe, nutritious food, fuel, fauna and fiber across the United States. More than four hundred commercial crops become products including fresh produce, grains, nuts, animal proteins, dairy, and forage crops are grown through American agriculture year after year, season after season, in a wide variety of landscapes and climates. The adoption of precision agriculture and the availability of high-quality jobs on the farm are necessary components to maintain American leadership in agriculture.

Like the combustion engine, electrification, and municipal water supply systems before it, access to e-connectivity will shape the future and health of American agriculture. Affordable connectivity to farm structures and in the field is critical for precision agriculture adoption and the continued availability of high-quality jobs on the farm and rural communities.

Data networks, the key facilitator of precision agriculture, are operating to gather, calculate, and report intelligence from within agriculture production. These offer fiscal efficiency, superior environmental practice, and responsible resource allocation, leading to higher yields of safe and wholesome food, fiber, fauna and fuel products.

Connectivity must be deployed to sustain the capacity needs of the industry now, but more importantly into the future. Connectivity goals must be grounded in the need to support evolving precision agriculture applications. Current and future "next generation" precision agriculture technologies, however, require services that allow for greater upload of collected data. As the volumes of data to manage agriculture production increase, higher speeds will likely be necessary, requiring symmetrical data flows, with a better balance of download and upload speeds and reliability. Networks should be built for peaks, not averages. Just as highways are built to accommodate rush hour traffic rather than 12:00 a.m. traffic, broadband networks must similarly be designed to accommodate the full load of anticipated current *and* future demand. Building to peak demand is not excessive; rather, it is smart design that enables the network to be leveraged to enable fulfillment of precision ag's complete capabilities. As bandwidth increases so will application development, and many of those applications will be in the agricultural realm. Historically, every major advance in bandwidth has facilitated innovation that has brought new services and applications to digital life.

A variety of technology platforms exist today that can provide **Connectivity to the Acre**. The idea of a single point network to the farm house, shop, or barn is no longer feasible. Today's agriculture producers require multipoint, high capacity networks across their acreage.

- ***High Capacity* -** Precision agriculture produces large amounts of raw data including shape files, high definition satellite and drone imagery, and rapidly reporting network data points. A high capacity network is able to capture, secure, and transfer these robust data inputs and outputs.

- ***Reliability* -** Agricultural data inputs and outputs can indicate critical action items for the producer. Network reliability is of utmost importance when considering valuable resources including: time, fuel, feed, water, domestic animals, fertilizers, herbicides, and pesticides. America's farmers and ranchers cannot be asked to use a network that is unreliable.

- ***Data Network Symmetry* -** Agriculture production utilizes both downstream and upstream networking. Implementation of a network that provides download and upload capacity symmetrically or at a near symmetrical level is critical to precision agriculture adoption. The agricultural producer's data outputs are just as decisive as their inputs. As equipment continues to become connected, this becomes increasingly important.

- ***Scalability* -** Utility infrastructure in general is costly to build, repair, and replace. Consideration to the scalability of any new network should be considered. The evolution of data networks is far from over. A simple backward view over the last two decades from 56K dial up internet to current 1 gigabit offerings is a telltale window into network requirements to come. Any new network deployed in today's environment must take into account throughput growth rates, and an exponential increase of devices and data streams utilizing the network during its lifespan.

- ***Fiscal Investment* -** Agriculture production by percentage is conducted primarily in rural environments with low population densities. These low-density environments offer low cost recovery opportunities per network mile. Utility infrastructure must take into account the life of the network, repair and maintenance costs, and funding sources. Network investments must be future ready and upgradeable. Agriculture production takes place in high cost construction environments.

American agriculture has a tremendous challenge and responsibility to produce enough food to feed the domestic and international population, while conserving resources and taking care of the environment. Increased precision agriculture utilization will help American producers meet that challenge. The success of this undertaking will call upon the actions of Congress and the USDA to help create incentives and programs that will sustain American agriculture, farmers, and ranchers in this century and beyond. Moreover, and as an overarching perspective, rural broadband is critical to the viability of rural America, including the exponential benefits to job growth and availability for *all* job sectors, including middle skills jobs and opportunities grounded in Career and Technical Education training.[1] As highlighted by this Task Force, lack of connectivity is a key barrier to precision agriculture adoption and the availability of high quality jobs in rural America.

Incentives for Farmers to Adopt and Use Precision Agriculture

While the focus of the FCC Task Force on Precision Agriculture and Rural Broadband is centered more on connectivity issues, connectivity is just one of the many aspects of precision agriculture. American agriculture also needs the hardware, software, supporting industries, and government to work collectively and cohesively to achieve success.

The agriculture industry is just over a quarter of a century from the introduction of the yield monitor, with other technologies like guidance, autosteering, and boom control not far behind. While today's equipment comes standard with many technologies, similar to on road vehicles, with built in capacity to connect later, the nation has not yet achieved a 100% adoption and use rate in American agriculture.

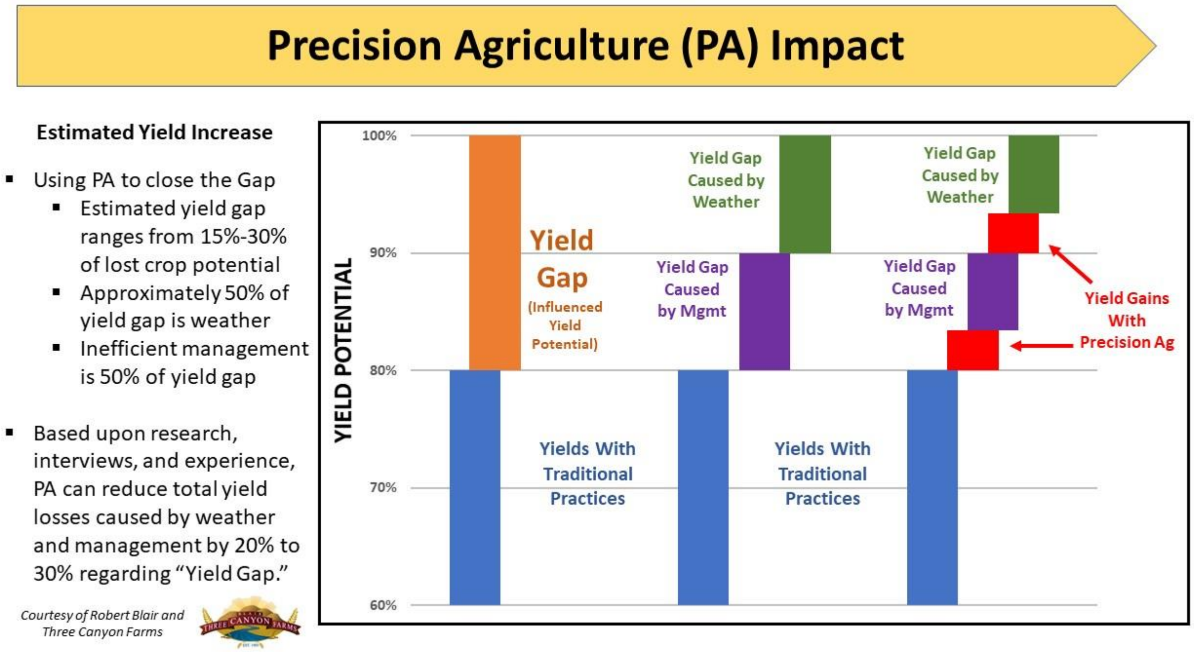
In the past 25 years, more technologies have come to market, including guidance for crop dusters, unmanned air systems, sensing technology, and greater utilization of imagery and other data to help make decisions. Less than 25% of American farms are using technology to help make direct management decisions.

Several factors create barriers for more rapid and increased adoption.

- Cost – While costs have come down considerably, it is still a cost that some farms are not able to overcome.

[1] *See, i.e.*, Seidemann, Joshua, *Rural Broadband and the Next Generation of American Jobs,* Smart Rural Community (2019) (https://www.ntca.org/sites/default/files/documents/2019-04/SRC%20Middle%20Skills%20Web%20Version.pdf) (accessed Sep. 24, 2020).

- Average Age – The average age of an American Farmer is 57.5 years and that average age is similar to that of the supporting businesses that serve them. This translates to being unfamiliar with the new technologies and management opportunities. The thought process is, "why should I invest into precision agriculture when I will be retiring in a few years?"
- Support – The machinery dealership networks have employees that understand the installation and troubleshooting of the technology; however, there is less application or work flow support to help farmers better understand how to use the technology's data for management purposes.
- Lending – As farms turn to operating loans during economic hardship, the lending system does not incentivize farmers to practice precision agriculture or adopt precision agriculture technologies, despite the fiscal benefits of doing so.
    a. Lending institutions are making it harder for farmers to make capital purchases such as precision agriculture equipment.
    b. Lending institutions are limiting the amount of custom services a farmer can use.
    c. Private industry, Land Grant Universities, and USDA have not done an adequate job of showing lending institutions the financial benefits from data driven management and applications.
- Government Programs – While the USDA has programs such as EQIP and CSP that encourage farmers purchase of precision agriculture equipment, they have not progressed traditional farm programs to reward and incentivize the utilization of precision agriculture and data.
- Government Regulations – With technology evolving at a rapid pace, regulations that impact agriculture's adoption and utilization of precision ag technology has been an obstacle at the federal and state levels. Examples are:
    a. FAA Beyond Visual Line of Sight (BVLOS) – The majority of agriculture land is in low population areas and where drones could operate safely. In particular, pesticide application where the drone is only a few feet above the crop canopy.
    b. EPA approved methods of application on labels – Drones with multiple rotors are not an approved type of aerial applicator and fall into a grey area. Their ability to operate in closer proximity to the ground and above the crop canopy would also make them comparable to an approved ground application method.
    c. Applicator Licensing – Each state has its own requirement for licensing applicators of crop inputs with some reciprocity between states. With the evolution of drones, the ability for the company/operator to move between states is being hindered by slow to no regulation evolvement.



Recommendations:

1. USDA- As highlighted throughout the 2018 Farm Bill, precision agriculture and precision agriculture technologies are recognized as critical to conservation, productivity and profitability. Therefore, precision agriculture and precision agriculture technologies should be established as "Best Management Practices" throughout the Department.

2. Crop Insurance – The USDA Risk Management Agency (RMA) "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 ag.

3. Ag Lending – The USDA Farm Service Agency (FSA) "Precision Ag Loan Guarantee." The FSA should work with traditional farm lenders and with their own lending arm to guarantee loans for producers to purchase direct cost and labor reducing precision agriculture equipment and services, recognizing them as 'Best Management Practices'.

4. Conservation Payment – 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.

5. USDA Modernization – The 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. Continued implementation of the USDA IT Modernization Initiative is critical for encouraging precision agriculture adoption.

6. Agriculture Regulation Relief – Congress should expedite beneficial regulation creation for precision agriculture use and implementation in order to keep up with the quickly evolving technologies and practices. Congress should allow a national applicators license to help businesses maximize their ability to operate interstate.

Interoperability of Precision Agriculture Technologies

One of the common topics that has been discussed among the Adoption Subcommittee is the absence of interoperability among precision agriculture equipment technologies. A priority should be focused on improving technology interfaces and having the ability to exchange information across multiple platforms and systems. Increased interoperability will encourage and increase adoption of precision agriculture.

Interoperability refers to the basic ability of computerized systems to connect and communicate with one another readily, even if they were developed by widely different firms or organizations. The connect and communicate functionality is critical for exchanging and making use of information. Interoperability requires that the interfaces be fully understood (by each party/program/algorithm) so that these different stakeholders/players can work presently and into the future without restriction.

Interoperability is important in precision agriculture, and digital agriculture approaches more broadly, to improve efficiency of the data pipeline that brings about improved decision making and the associated actions. With current systems, we seem to be far from "single entry" and those managing agricultural systems are busy managing the logistics and strategy of their operations and cannot find time to enter/re-enter data; they cannot find time (or may lack expertise) to wrangle one format of data into another needed by a different piece of software.

There are several reasons that interoperability in agriculture has not yet been achieved. Each of these also point directly to the complexity and difficulty of this issue:

- There are many stakeholders involved such as farmers, original equipment manufacturers, input providers (seed, chemicals), service providers, consultants, government agencies, software/analytics platform companies
- Multiple cloud platforms are typically required (because of the stakeholders list as well as a combination of private and public data)
- Data in agriculture is an immature market still in infancy with many startup companies and few standards beyond those recognized for equipment

Other aspects affecting adoption, covered elsewhere in this report include *analytics*, *incentives*, and *traceability*. Each of these inherently require interoperability. 1. The highest levels of analytics require strong metadata (contextual information about any data element or array) – and this contextual perspective often comes from disparate systems that are not functionally accessible. 2. One of the best incentives to adopt precision agricultural technologies is efficiency of resource use (land, seed, chemical, machinery, labor, management) and improved interoperability directly the quality of such decisions as well as the time needs to make/enact those decisions. 3. Traceability through a supply chain requires a degree of interoperability so data moves effortlessly as products change hands, processes occur, and services are performed.

The six levels of precision agriculture adoption (Figure 1) require increasing levels of interoperability. Levels 2 and above require disparate systems to communicate ("communicate" means "autonomously" *with minimal* human intervention). It is ironic that data itself, which is already digital, is becoming autonomous much later than the complicated machinery with embedded sensors which is generating the data. When data was solely used for strategic (infrequent, but important) decisions, there might have been time for offline wrangling to work around a lack of interoperability. However, we assert that data will be better when its use is near-term (because this will encourage data pipeline functionality, solicit better attention to calibration, etc.). Given this, the use of data toward improving logistics and tactical decision making also puts pressure toward improved interoperability because the data pipeline must function in near real time.

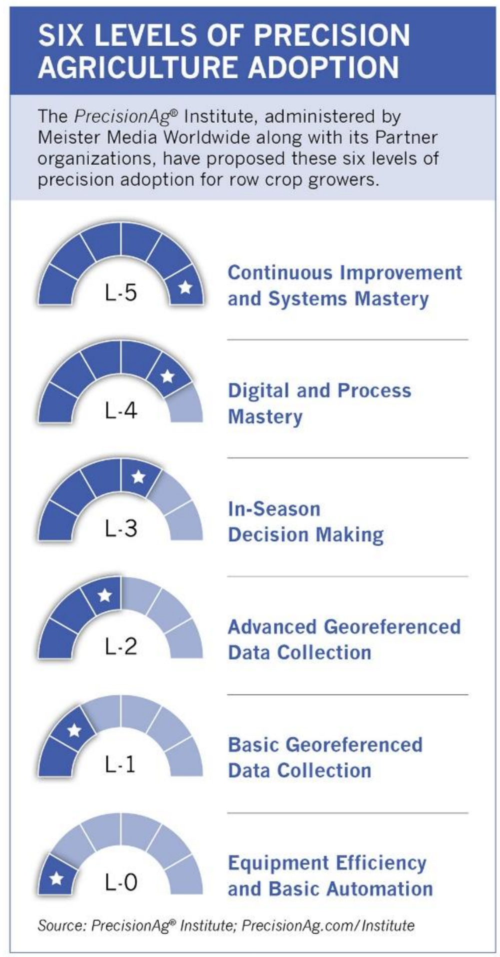


Figure 1. Six levels of precision ag adoption proposed by the PrecisionAg Institute (https://www.precisionag.com/institute/six-levels-of-precision-agriculture-adoption-identified-by-the-precisionag-institute/).

Interoperability is often discussed solely regarding the technical/functional aspect. This is can be disaggregated into foundational, structural, and semantic levels. "Foundational" establishes secure inter-connectivity to send/receive. "Structural" adds format, syntax, and organization at the data field level which is required for interpretation. "Semantic" adds common underlying codification for a shared understanding (standards, publicly available vocabularies, published exemplars). Due to the interconnectedness and multiple stakeholders, interoperability also requires more than technical/functional aspects. Organizational interoperability, the social dimension, includes governance, policy, social, legal and organizational considerations. These components must be in place to enable shared consent, trust and integrated end-user processes and workflows.

Interoperability requires cooperation amidst competition. The many players must be incentivized to use open source middle layers of data architecture and tools for storage, transfer, and access. The proprietary benefits in data acquisition and analytics will be propelled by improved data pipelines that use secure, fully published application program interfaces (APIs). Data may eventually become a commodity, but the insights upon data leave lots of room for many companies, producers, processors, and consumers to prosper.

Recommendations:

1. USDA and FCC should collaborate with industry stakeholders and academia to establish a standard for interoperability.

Data Collection, Security, Management, & Analytics

There are several considerations around data collection, security, management, and analytics that must be addressed in order to accelerate adoption of precision agriculture.

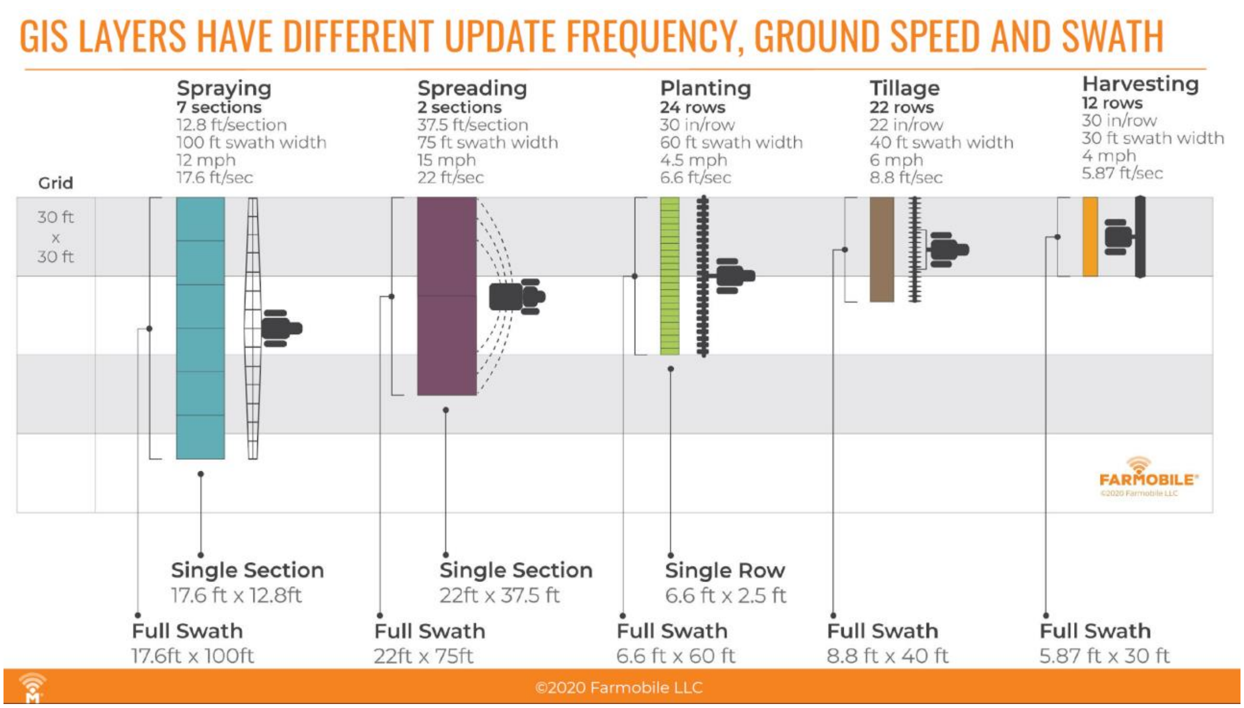
Data collection and speed will allow producers to make better decisions in real time. Today, adequate broadband connectivity is being defined as the capability to achieve 25mb/sec download and 3mb/sec upload and why symmetry of service with upload and download speed approximately equal is vital to long term sustainability of the industry of Agriculture. The standard of 25/3mb/sec has been developed as a benchmark for users to access or download data from a central repository, server or streaming service, enabling faster download and minimizing the upload requirements. The world of Digital and Precision Agriculture and the "Internet of Things" or the "Internet of Food" is a world of two-way communication, requiring both volume and frequency with low latency achievable only through symmetrical service levels. On October 11, 2017, Ohio State University research agronomist Trey Colley in the "Terra" project documented that a single 100-acre corn field can generate up to 60.2 terabytes of data with 2475 files using 39 different file types through the normal course of growing their crop in an approximate 110-day cycle. Trey stated, "We collected 18.4 total gigabytes of data for Terra, that's 28 megabytes per kernel. If we collected this amount of data for the whole 100-acre field, there would be 60 petabytes of data."[2]

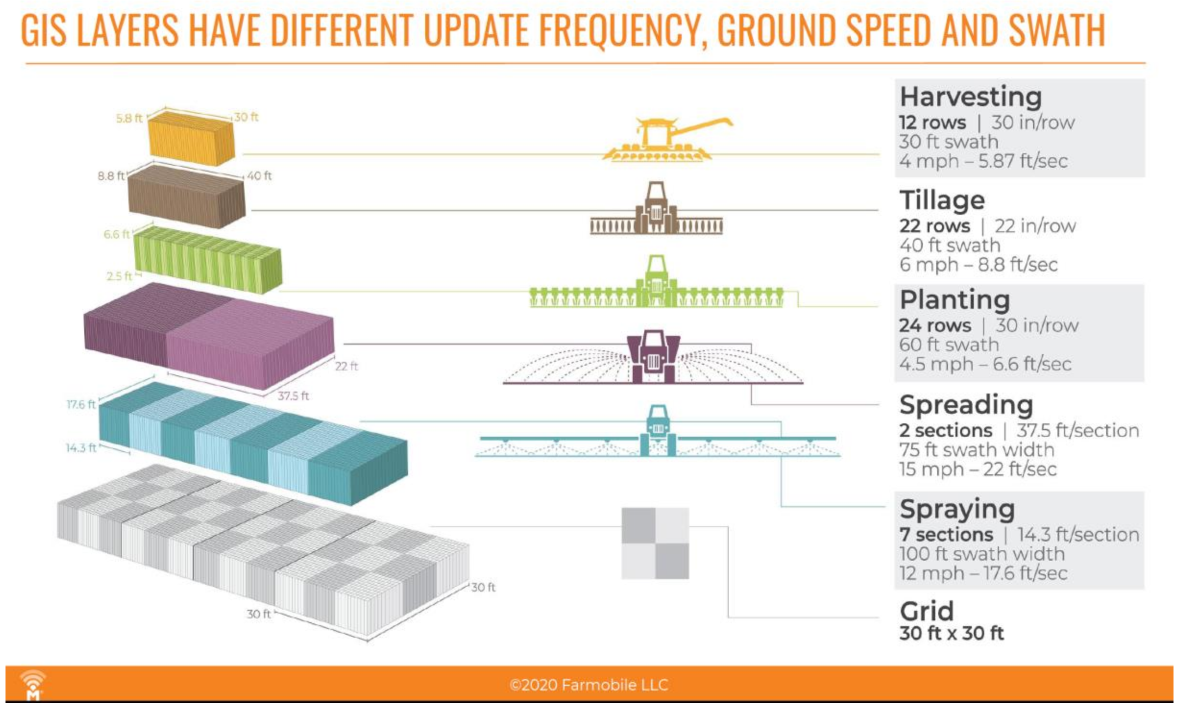
A 2019 study by the United Soybean Board found that 60% of U.S. Farmers and Ranchers do not believe they have adequate connectivity, which infers the stifling of production of up to $133 billion dollars in U.S. Gross Domestic product. 78% of the 2000 growers and ranchers surveyed do not have another viable option to change service providers, so they may also lack choice for alternative service providers. Even when farms are located within proximity to urban centers, they can experience significant challenges in achieving ample connectivity. This was evident from testimony by Jose Guevara, a pecan farmer near Austin, Texas, and Dale Artho, a farmer from Deaf Smith County, Texas, both members of this Work Group.

[2] "World Record for Data Collection Set by OSU Precision Ag Team," Ohio's Country Journal (Oct. 11, 2017) (https://ocj.com/2017/10/world-record-for-data-collection-set-by-osu-precision-ag-team/) (accessed Sep. 24, 2020).

The issue of ample connectivity with respect to adoption may be best represented in the phrase "perception becomes reality." Users adopt a technology only when they trust it is robust, consistently available and proven dependable. This adoption curve was experienced throughout the United States both with rural electrification in the 1930 and with rural telecommunications in the 1940's. In 2020 and beyond, businesses are becoming increasing dependent, not only on connectivity, but on internet service at speeds with low latency enabled by symmetrical service to support full cloud-based access and business decision making. Software solutions to run small businesses are migrating from desktop and server-based solutions to cloud-based solutions improving both reliability through centralized security of a server farm, as well as cost effective access to cutting- edge back office systems. Farms and farm service contractors are small businesses located across rural America. Access to such infrastructure is both vital to their operations and critical to their long-term economic sustainability. Today, they stand on the edge of the digital divide. When faced with ambiguity about availability, dependability, lack of choice amongst local service providers and other considerations at their office (as well as for remote equipment and infrastructure in fields), farmers are faced with few options. Oftentimes, the most risk adverse choice is to sell the farm or business to someone with a larger scale of operations over which to spread such infrastructure intensive and capital costs and IT support responsibilities.

Below are some examples from Farmobile LLC, a provider of telematics to the industry, that illustrates aspects of both the complexity as well the challenges of bringing together differing data layers.





Graphics provided courtesy of Farmobile LLC, an agricultural technology company located in Leawood, KS.

Recommendations:

1. Improvement of use and encouragement toward Federal reporting and agencies to align their existing and individual file management systems to have the capability to receive electronic data layers that are often created through the normal course of farm operations as cited throughout this document.

Specific examples are "As Tilled or As Planted" records to be used as Acreage reporting for FSA compliance and allowance of electronic records or files from combines and grain carts to facilitate crop insurance compliance reporting in a way that streamlines both reporting and remittance to growers and facilitated by electronic exchange of data layers or electronic files. The phrase often used is "report once, use many times" regarding data interoperability within all agencies of the USDA requiring interaction with producers as part of their reason for being. It is not enough for an individual agency of the USDA to have "the capability" of interacting with electronically-reported information from producers, they have "the duty" to accept electronically-submitted information, as verified and accepted by other USDA agencies, as being accurate and true. The entire system breaks down if individual agencies refuse to accept information as reported electronically.

Recommendations for Alternate Work Group:

1. Agriculture production utilizes both downstream and upstream networking. Implementation of a network that provides download and upload capacity symmetrically or at a near symmetrical level is critical to precision agriculture adoption. The agricultural producer's data outputs are just as decisive as their inputs. As equipment continues to become connected, this becomes increasingly important. (Examining Current and Future Connectivity Demand for Precision Agriculture Work Group should further explore this recommendation upon Task Force approval)

Additionally, data security and protection of farm data is a concern as precision agricultural applications expand. On 03 October 2018, the Department of Justice (DOJ), Federal Bureau of Investigation (FBI) Cyber Division published Private Industry Notification (PIN) 20181003-001 titled "Advances in Precision Agriculture Increasing Vulnerabilities to Cyber Threats as Smart Farming Gains Wider Acceptance". The following are excerpts from that document.

The project found most of the threats facing precision agriculture's embedded and digital tools were consistent with threat vectors in all other newly-connected industries. Malicious actors could target precision agriculture to generate similar outcomes: data theft, stealing resources, reputation loss, destruction of equipment, or gaining an improper financial advantage over a competitor through theft of intellectual property or proprietary data. Common threat vectors such as improper use of removable media, spear phishing, and malicious cyber attacks, can easily target precision agriculture. Generally accepted mitigation techniques in other industries were found to be largely sufficient for creating a successful defense-in-depth strategy.

Confidentiality, Integrity, and Availability (CIA) model to Identify Potential Threat Vectors

The project uncovered potential threats to the crop and livestock sectors using the CIA model of information security. These threats could impact the agriculture sector's resiliency to withstand new types of disruptions which did not previously exist or dramatically scale up the impact of pre-existing threat vectors.

Based on the diverse nature of the crop and livestock sectors, different aspects of the CIA model were identified as assuming greater importance at different points in the agriculture production chain.

Confidentiality Standard Threats

- Intentional theft of data collected through decision support systems or the unintentional leakage of data to third parties;
- Intentional publishing of confidential information from within the industry such as from a supplier to damage the company or cause chaos;
- Foreign access to unmanned aerial system data;
- Sale of confidential data for financial or other gain.

Integrity Standard Threats

- Intentional falsification of data to disrupt crop or livestock sectors;
- Introduction of rogue data into a sensor network which damages a crop or herd;
- Insufficiently vetted machine learning modeling.

Availability Standard Threats

- Timing of equipment availability;
- Disruption to PNT systems – space-based;
- Disruption to PNT systems – ground based;
- Disruption to communication networks;
- Foreign supply chain access to equipment used in precision agriculture.

Agriculture, like many other newly connected industries, can be expected to go through a cyber security learning curve. In 2019 and 2020, many public institutions were the victims of cyber-attack where rouge interests utilized ransomware to disrupt operations and stakeholder services. Agriculture is an essential industry and will be subject to many of these same vulnerabilities. Improved access and conventional service providers employing similar protection for power and utility systems, public telecommunications, and business-to-business connectivity services would help the industry improve its self-reliance and mitigate potential security threats.

Recommendations:

- Federal cyber security and cyber protection policy provide for farm and farm record data to be recognized at level that is equal to any other independent business entity. It should be recognized that farm data and records are a matter of national security. Such data should be considered highly sensitive and malicious acts should be treated accordingly.

Existing Funding Mechanisms Should Pivot to Precision Agriculture

An important consideration as policymakers encourage continued expansion of connectivity to support precision agriculture is the need to ensure that funding mechanisms enable comprehensive support for deployment that enables connectivity throughout cropland and within and among farm structures, facilities, and equipment.

- The average connected household in the United States now has approximately 14 connected devices. Farms, as small businesses employing substantial mobile assets, carry the potential to host a significantly larger number of necessary connections. In today's Digital Farm, we can find a number of Smart Connected vehicles and implements that may be moving or stationary, performing a task with the need to feed data about work or progress back to both a central repository, as well as offices and people. An example presented to our committee can be found at www.grandfarm.com.

These stationary and non-stationary assets perform work functions and rely increasingly on high-capacity fixed and mobile broadband connectivity for two-way symmetrical data traffic communication. These high-capacity, high-speed data streams are necessary to enable the use of cloud-supported, AI-powered solutions that enable on-the-go responses. Examples include:

- Tractors, performing tasks of tillage, planting, cultivation, or other aspects of crop care.
- Sprayers, dispersing and reporting fertilizers or restricted use plant protection products.
- Combines and Harvesters of crops, capturing records of yield and traceability.
- Seed tenders, providing accountability and traceability of seeds as they are planted.
- Grain Carts that receive harvested crop and transfer it into trucks to begin processing.
- Feed mixers, that receive ingredients, mix, and transfer rations to beef and dairy cattle.
- Spreaders of fertilizer or manure, that are dispersing crop inputs and creating records
- Irrigation systems, that are dispersing water often with nutrition to growing crops.
- Elevators receiving and distributing grains, enabling food traceability.
- Grain Handling and drying facilities, for optimization of energy with product traceability soil moisture or other stationary probes to monitor crops.
- Wearable electronics on cows and large animals to track their health and activity.
- Feeding barns and watering troughs for beef cattle.
- Milking parlors for Dairy cattle that track cattle through the milking process.
- Milking systems, often working semi or autonomous, recording volumes and cycle time.
- Closed and contained feeding barns for pigs, poultry, and other small animals,

The labor efficiencies and economic gains promised by precision ag are documented in a growing number of reports.[3] Moreover, adoption can be expected to increase as the cost of components

[3] *See, e.g,* "4R and Precision Agriculture – Where's the Payback?", Nutrient Stewardship (2014) (available athttps://nutrientstewardship.org/implementation/4r-and-precision-agriculture-wheres-the-payback/) (accessed Sep. 1, 2020), and "Big Savings from Variable Rate Fertilizer," Ohio Farmer (2008) (available athttps://www.farmprogress.com/story-big-savings-from-variable-rate-fertilizer-9-20801) (accessed Sep. 1, 2020). The USDA Economic Research Service takes a more conservative view but finds

decreases.[4] And, inasmuch as adoption rates are higher on large farms than small farms, one can expect standard economic principles to drive prices lower as initial users are high-volume users.[5] Accordingly, multiple indicators point toward the *benefits* and trends toward *increased adoption* of precision agriculture. Ag, food and related industries contributed more than $1 trillion to the U.S. GDP in 2017, or about 5.4% of GDP.[6] Therefore, the increased adoption of technologies that increase efficiencies and performance in those industries should be pursued. There, Federal broadband policies should address the need for bi directional and symmetrical connectivity on the farm.

Federal broadband policy is rooted in the Communications Act of 1934, as amended. The universal service directives in the Act mandate that residents of rural and insular areas of the Nation enjoy access to communications services that are reasonably comparable to those available in urban areas, and at reasonably comparable rates.[7] Even as precision ag adoption grows on large farms, it is useful to remind the discussion that even the largest of the Nation's farms are in rural areas. Therefore, adherence to the principles of "reasonable comparability" among rural and urban spaces is necessary to support precision ag deployment on the largest farmlands. Accordingly, existing mechanisms may be augmented to promote the adoption of precision agriculture by including the following in Federal policy making:

Inclusion of Farms and Farmlands in Broadband Mapping as "Potential User"

Broadband mapping is currently focused on identifying residential and business locations. The inclusion as cropland as a location subject to buildout requirements could be difficult inasmuch as different farm and croplands, whether for beef, dairy, row crops or specialty crops, may have different bandwidth requirements and rely on technology ranging from stationary and mobile sensors to sophisticated AI-reliant, cloud-supported devices that require high-capacity wireless support to enable real-time applications. Accordingly, *how* farmland is to be accounted will require an examination of the current and anticipated precision agriculture needs for each livestock and

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savings proportional to farm size. *See, generally,* Schimmelpfennig, David, "Farm Profits and Adoption of Precision Agriculture," Economic Research Service, USDA (Oct. 2016).

[4] *See,* "Threats to Precision Agriculture," 2018 Public-Private Analytic Exchange Program, U.S. Department of Homeland Security. "Threats to Precision Agriculture" at 9 (2018) (available at https://www.dhs.gov/sites/default/files/publications/2018%20AEP_Threats_to_Precision_Agriculture.pdf) (accessed Sep. 1, 2020).

[5] Although it may be considered that increased demand will spur price increases, unit fixed costs in the production of precision agriculture equipment would be inversely proportional to sales volume, thereby decreasing cost per unit pricing.

[6] "Ag and Food Sectors and the Economy," Economic Research Service, U.S. Department of Agriculture (available at https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/#:~:text=Agriculture%2C%20food%2C%20and%20related%20industries,about%201%20percent%20of%20GDP) (accessed Sep. 1, 2020).

[7] 47 U.S.C. § 254.

crop set. Those sets, in turn, will assist in defining the type of networks and support that are required to support precision agriculture in those regions. For example, a service territory whose predominant farming operations consist of row crops may be calibrated differently for support than a region whose predominant farming operations are dairy production. Regions that support both types of farms would be evaluated through calculations that estimate the relative anticipated farming needs and then extend support accordingly.

Weighting of Farms Served when Contemplating High-Cost Support Allocations
The USDA ReConnect program includes "weights" that favor areas with farms. While no rural or high-cost universal service support area should be subject to diminished or deprivation of support for *lack* of farmland, the USDA program indicates that the Federal policymakers have already recognized the role of broadband in farms, and the role of farms in building local communities. Accordingly, the USDA ReConnect program paves the way for the FCC to offer specific consideration in the USF and CAF high-cost programs for farmland. As described above, this may be accomplished by including the cost of connecting farm fields and facilities to broadband.

Recognition that Precision Ag Relies Upon both Fixed and Mobile Connections
FCC policy must recognize, consistent with its recent Section 706 reports, that fixed and mobile services are not substitutes but are rather complementary services. In the microsystem of a farm this may be seen in the following example: a rancher may rely on remote sensors that track the health, food consumption and activity of its cattle in the field. These will rely on mobile wireless capabilities. At the same time, the rancher may participate in online cattle auctions that rely on high-capacity, low-latency wired broadband services. In this example, the complementary systems of both fixed and mobile services are necessary to support the farm. Moreover, and as expressed in numerous papers and studies, wireless services require wires. At some point, and particularly as 5G is investigated for increasing industrial and other uses, fiber deep into the network will be necessary to provide sufficient backhaul capability.

Recommendations for Alternate Work Group:

1. The FCC should accelerate the subsidized investment in agricultural lands through existing and new mechanisms to advance technology adoption in agriculture and ensure that these programs are fully funded. (Mapping and Analyzing Connectivity on Agricultural Lands, Examining Current and Future Connectivity Demand for Precision Agriculture, and Accelerating Broadband Deployment on Unserved Agricultural Lands should further research this topic upon full Task Force approval.)

Sustainability and Traceability

Sustainability: Today's consumer demands a product that is more sustainable. Those buying decisions filter down the supply chain to the production level. Sustainability is becoming a recognized trend in the packaged goods and fashion industry as environmental concerns are increasingly top of mind for consumers. According to Nielsen, the U.S. sustainability market is projected to reach $150 billion by 2021.

Precision agriculture plays a major role in sustainability in today's market. It has been made possible by the rapid development of sensing technologies, management information systems, advances in farm machinery and appropriate agronomic and economic models. The benefits of using precision agriculture practices include increasing crop yields and animal performance, cost reduction and optimization of process inputs. Thus, precision agriculture aims to reduce the environmental impacts of agriculture and farming practices, contributing to the sustainability of agricultural production. These production technologies vary by farm operation. They include:

- For crop operations: weather modeling, pest and disease modeling, frost detection, precision seeding, variable rate applications, machine learning & visioning, irrigation management, soil moisture technologies, machinery & labor coordination, and commodity storage monitoring.

- For livestock operations: animal tracking (RFID tags), fertility planning, feed management, health & stress detection, environmental control, robotic operations, unmanned herding, waste management, and automated sorting.

While digital technologies are already creating value within the agriculture industry today, realizing the full potential of these technologies, according to USDA, could create approximately $47–$65 billion annually in additional gross benefit for the U.S. economy. In other words, if broadband Internet infrastructure, digital technologies at scale, and on-farm capabilities were available at a level that met estimated producer demand, the U.S. could realize economic benefits equivalent to nearly 18 percent of total production, based on 2017 levels. Additionally, according to USDA, further adoption of these technologies can reduce fuel consumption by 40%, reduce water consumption 20-50%, and reduce chemical applications up to 80%.

Traceability: From a policy perspective, the accurate and timely traceability of products and activities in the supply chain has become a new factor in food and agribusiness. Increasingly, consumers in many parts of the world demand for verifiable evidence of traceability as an important criterion of food product quality/safety. Food safety and traceability are currently at the forefront of both government and industry discussions around the world from a food safety perspective.

Traceability plays a significant role in helping businesses be competitive in the domestic and global marketplace. The ability to trace a product through all stages of production on farm, processing, distribution, transport and retail to the end point, or consumer, is becoming a standard business practice for all involved in today's food supply chain. Adopting traceability is not a choice. It's a question of how do we do this in the best way possible, and how do we take advantage of the opportunities that are emerging.

- Produce Industry: Traceability has been important to the produce industry for many reasons, including improving food safety by being able to quickly and accurately remove potentially harmful products from the supply chain. The produce industry launched an effort to address the topic of traceability. The Produce Traceability Initiative was formed in 2008 by representatives from over 40 companies including growers, packer/shippers, marketers, distributors and wholesalers, food service and retail and eight trade associations to begin working on an action plan to ensure the industry has a process that will work for the entire supply chain.

1. Beef Industry: A comprehensive animal disease traceability system has been a priority for USDA for the beef industry for quite some time, from a disease outbreak standpoint. USDA is committed to implementing a modern system that tracks animals from birth to slaughter using affordable technology that allows for quick tracing of sick and exposed animals to stop disease spread. In September 2018, USDA established four overarching goals to increase traceability. These goals are: (1) Advance the electronic sharing of data among federal and state animal health officials, veterinarians, and industry; including sharing basic animal disease traceability data with the federal animal health events repository (AHER). (2) Use electronic identification tags for animals requiring individual identification in order to make the transmission of data more efficient; (3) Enhance the ability to track animals from birth to slaughter through a system that allows tracking data points to be connected; and (4) Elevate the discussion with States and industry to work toward a system where animal health certificates are electronically transmitted from private veterinarians to state animal health officials In a recent article in *Beef Daily*, author Amanda Radke discussed how several Wyoming ranchers are working with a company to implement a traceability program using block chain technology. One of the struggles their operation is facing with the systems is a lack of connectivity. According to the National Cattlemen's Beef Association, it is estimated that approximately 61 percent of global beef exports come from countries with nationally significant traceability systems in place. If connectivity lags, traceability lags, so the U.S. will fall behind its international competitors. According to a 2019 study by the United Soybean Board, 60% of U.S. farmers and ranchers do not believe that they have adequate internet connectivity to run their business. Connectivity still remains one of the largest obstacles for precision agriculture adoption.

Recommendations:

1. With the special focus on sustainability, there should be additional federal resources devoted to precision agriculture applications that promote sustainable farming practices though the USDA.

2. Due to the food safety components of traceability, there should also be federal resources devoted to agricultural traceability technology and connectivity issues by FDA and the USDA.

Recommendations for Alternate Work Group:

1. Work in collaboration with Examining Current and Future Connectivity Demand Work Group to further policy initiatives for above mentioned recommendations

Automation and Telemetry

Initial findings show automation and remote telemetry technologies utilized in precision agriculture will help alleviate labor shortages, enhance sustainability and traceability, and increase efficiencies while driving the demand for skilled jobs such as IT techs, field techs, network engineers, administrators, and agronomists. These technologies are also recognized for their positive impact on natural resource conservation and energy management in the 2018 Farm Bill.

However, challenges of the small and medium sized grower and their razor thin margins make them hesitant to invest in new technology without a very clear return on investment and understanding of how the technology will reduce operation risk and streamline operations. Those that are interested may face resistance from their banks or difficulty understanding and adopting the recurring revenue business models (*e.g.* SAAS) favored by younger companies. Larger cooperatives are making technology investments, but their tolerance level for interacting with young, unproven technology companies is low. This is an excellent focus area for targeted, appropriate subsidies – one of our interviewed companies had definitive proof of greater adoption in Nebraska when their product was subsidized for the first year.

Recommendations:

1. Expand federal programs such as CSP and EQIP to be more proactive rather than reactive to areas considered "high stress" only

2. Reduce red tape for subsidies: A prohibitive amount of red tape and administrative requirements were a disincentive to using them. Other countries' programs such as Israel and New Zealand were highlighted as having low barriers to adoption and reduced red tape.

3. Focus subsidies on outcomes, not solution types. Currently, NRCS subsidies require the use of certain technologies (such as soil moisture sensors) instead of focusing on desired outcomes. For example, alternate technology may achieve the same end (more efficient water use) through measuring the plants instead of the soil. Ensuring that subsidies are *objective* focused instead of *solution* focused will broaden the available solution types and encourage competition among solution providers.

4. Designated Test Farms: National test farm sights were highlighted as a particularly effective method of increasing producer awareness and trialing new agriculture technologies. While the US Government does not typically participate in markets, this could easily be overcome through USDA/NRCS designation of 'technology leading' producers – individual small / medium farms who receive subsidies to try new technologies of interest and/or through

partnership with Land Grant Universities. An example of this type of program is reflected at University of Nebraska's 'Testing Ag Performance Solutions (TAPS)' program.

The Role of Land Grant Universities, Extension Programs and Community Colleges

Another major topic identified was the success of STEM and precision agriculture technology tracts offered by land grant universities, extension and community colleges. Currently there are dozens of institutions involved in research and real-time development of precision agriculture strategies. However, higher education's efforts to prepare an adequate diversified workforce to support the skilled job demand caused by precision agriculture adoption requires concerted focus.

That said, some excellent work has begun at the Community and Junior College level, as exemplified by Northeast Junior College in Colorado. Another great example shines through in a public-private partnership with the IoT4Ag Project funded by the National Science Foundation. "Collectively, the IoT4Ag Center will educate students, engineers, agriculture professionals and other members of farming communities through audience-specific lessons and hands-on classroom, laboratory and field activities. Bringing together academic, government and industry partners with the farming community, the center will create an innovation ecosystem that ensures the rapid translation of IoT4Ag practices and technologies into commercial products and economic impact."[8] Workforce development is one of the main pillars of this project.

The Irrigation Innovation Consortium (IIC) is another example of public-private engagement to advance research, development and training in the precision agriculture space. The goal of the IIC is to accelerate the development and adoption of water and energy-efficient irrigation technologies and practices through public-private engagement involving five leading agricultural research institutions plus 15 of the leading private sector irrigation technology providers. The IIC has a 5-yr, $5M grant from the Foundation for Food and Agricultural Research (FFAR) to advance pre-competitive irrigation research in the areas of water & energy efficiency, remote sensing & big data applications for improving irrigation water management, systems integration & management, and accelerating technology development and/or adoption. This FFAR grant requires a 1:1 match from any nonfederal funds to be utilized for a total investment of $10M over 5 years.

These types of multi-region, multi-crop and multi-disciplined projects are examples that should be replicated.

Increased enrollments in STEM and agriculture tracts as well as student- led Ag Tech start-ups demonstrate that many institutions are succeeding in promoting precision agriculture as a viable and exciting career path. Cooperative program outreach by community colleges, extension locations, and in particular, through distance learning collaborations between institutions presents

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[8] "Purdue University to Collaborate in NSF-funded Engineering Research Center to Develop the Internet of Things for Precision Agriculture," (Aug. 10, 2020) (https://www.purdue.edu/newsroom/releases/2020/Q3/purdue-university-to-collaborate-in-nsf-funded-engineering-research-center-to-develop-the-internet-of-things-for-precision-agriculture.html).

a major opportunity. These programs would support rural citizen retention, diversify the skilled workforce and support the adoption of precision agriculture and demand for rural e-connectivity.

Recommendations:

1. Streamline the ability for school districts, local extension agencies, and land grant universities to further partner with public companies to increase educational opportunities and entrepreneurial programs

2. Encourage state legislatures to increase their funding for STEM programs, K-12 and community colleges

3. Increase access to distance learning, allowing rural citizens to satisfy post-secondary education and college level degrees, more specifically allowing individuals engaged in farming to stay active in operations while achieving their educational goals

4. Develop a robust program tract for AgTech/ IT Security Specialist

<u>The Need for Career and Technical Education and Apprenticeships</u>

With the demand for skilled jobs expected to increase with the adoption of Precision Agriculture, Career Technical Education and Apprenticeship programs provide an avenue to rapidly fill this demand while providing hands on training for a skilled workforce:

> On dairy farms, for example, automated devices that milk and feed animals can also track each cow's activity and alert producers to potential problems. Because these tasks are traditionally done by the producer and farm personnel, e-connectivity can substantially reduce the amount of time and effort necessary to run farms. This leads to dramatic increases in flexibility, enabling time and talent to be directed to more advanced tasks.[9]

These programs provide the specialized training to upskill on farm personnel and expand high-quality training programs across precision agriculture verticals. The Department of Labor's 'Industry Recognized Apprenticeship Programs' (IRAPs) as well as multiple state initiatives have been identified as beneficial tools to attract and develop a technologically skilled workforce to support the deployment of rural broadband networks and precision agriculture technologies.

Over the course of our research, public-private partnerships were identified as a key driver to establishing successful and sustainable initiatives:

- Pennsylvania Ag Education

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[9] "A Case for Rural Broadband," Economic Research Service, United States Department of Agriculture, at 19 (2019) (https://www.usda.gov/sites/default/files/documents/case-for-rural-broadband.pdf).

a. In 2017, the General Assembly amended the Public-School Code of 1949 to establish a state Commission for Agricultural Education Excellence to assist in developing a statewide plan for agricultural education and coordinating implementation of related agricultural education programming within the Pennsylvania Departments of Agriculture and Education.[10]
b. The program supports FFA participants, including contracting with the Center for Professional Personnel Development at Penn State University to design and provide teacher training courses in electronics and hydraulics.
c. The Pennsylvania Department of Education furthered vocational certifications for teachers from industry in six curricular areas within agriculture education
d. Established Apprenticeship for Ag Equipment Service Technicians, one example of the highly focused training for careers in agriculture.

- 4-H

1. 4-H Spin Clubs are special interest clubs that allow four or five individuals to learn together about a various topic including coding, STEM, and other related topics. These clubs have increased in popularity in recent years highlighting interest in technology fields within agriculture career tracts.
2. 4-H *Game Changers* introduces children ages 8-14 to problem-solving skills leveraging computer science concepts, creating the connection between physical activity, real-world application and agriculture.

- Agriculture Future of America

a. A non-profit organization that connects college students and young professionals with careers in agriculture and food, through premiere training and professional development

Recommendations:

1. Expand the model exemplified by Pennsylvania to further expand AgTech careers at the state and local level.

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10 ² "Commission for Agricultural Education Excellence," Pennsylvania Department of Agriculture, Pennsylvania Department of Education (May 2020) (https://www.agriculture.pa.gov/Business_Industry/workforce-development/Documents/Agricultural%20Education%20in%20PA%202020.pdf).

2. Further fund programs such as Ag Futures of America, FFA and 4-H through partnerships with the USDA and other public agencies.

3. Promote the Department of Labor's Industry Recognized Apprenticeship Programs across associations and organizations within the agriculture space in order to expedite the commencement of such programs.

4. Federal, state and local funding should establish an AgTech/IT Security Specialist program tract.

COVID-19 Broadband Availability & Connectivity

COVID-19 has changed the world as the home has become the office, the school room, the medical exam room, the store and the entertainment hub. Precision Agriculture adds yet another level of demand on networks that are already running at capacity in much of our rural regions here in the US. As a result, homes will require greater capacity, more reliability and continue to maintain a level of affordability; however, precision agriculture connectivity will suffer as the home takes network precedent. We need to focus on scalable, future proof networks that will scale to the applications that are yet to be developed as well as continue to meet our daily increased demand. COVID-19 has expedited this issue and it is not likely we will be going backwards to pre-COVID practices. There will be more telework, remote learning, telemedicine, commerce and precision agriculture data that will need to share the same connection. Demand for upload speeds will match those of download speeds as data is collected and more widely shared.

COVID-19 aimed a spotlight on the usefulness of, and need, for broadband to support education, healthcare, telework and other critical industries such as agriculture. The focus on our nation's food supply has never been so magnified as the last several months preceding this report. The demand placed on our producers to provide safe, healthy and abundant food must be met with on-farm connectivity and policy needed to support the call. Without on-farm connectivity, it is impossible to track goods through the supply chain during time of high demand as experienced through the pandemic. These imperatives have been championed consistently by rural advocates in prior years, as economies of scale might not support economic, educational, or healthcare opportunities that are available in more densely populated urban regions. In this section we will describe sector-specific needs and provide examples of rural broadband deployments that met the challenge of COVID-19. These accomplishments offer experiential validation of prior expositions while defining a road map for future rural needs that will encourage precision agriculture adoption and support high-quality jobs.

Economic Development

Broadband plays a critical role in supporting both on-site and telework opportunities in rural regions. For firms with an on-site presence, a robust broadband connection expands marketplace opportunities by broadening the range of interactions that can be enjoyed with clients and customers. For telework-based firms and their employees, broadband enables firms to not only balance various needs of their employees but to also recruit from a deeper pool of qualified candidates. COVID-19 and office closures illuminated the crucial need for telework capabilities.

According to the U.S. Bureau of Labor Statistics (BLS), non-farm unemployment reached 10.2% in August 2020. While this was a decline from 14.7% in April 2020, it still rivaled peak unemployment during the Great Recession, which reached 10%.[11] Against this backdrop, telework emerged in 2Q20 and 3Q20 as a lifeline for many jobs. This is important especially in rural areas as the economic benefits of telework stimulate economic activity beyond the home of the worker and into the general community through follow-on impacts generated by consumer spending. Of course, not all jobs can be teleworked: according to data cited by Pew Research Center, about 60% of U.S. jobs must be done on-site, including those that rely upon machines and equipment.[12] The remaining 40% of U.S. jobs, however, offer important telework opportunities. Although the ability to telework does not necessarily translate to zero job loss, data indicate a lower *likelihood* of job loss. Pew notes that from February to March, employment in jobs that could not be performed via telework were down 2.7%, while telework-capable jobs decreased 0.5%.

These indicia lead to several conclusions: First, the rapid, necessary transition to telework demonstrates that even if full telework is not ideal for all sectors, some measure of telework greater than that formerly entertained will likely be the norm in the future. Second, regions where telework cannot be engaged will be foreclosed in some measure from relief when conditions close usual venues of employment. Third, current so-called "forced telework" may shift perspectives of both employers and employees. As some anecdotes of people considering leaving "the city" emerge (even if long-term demographic impacts cannot be predicted), it is safe to say that the topic is enjoying fresh consideration from new-found perspectives.[13]

Wabash Communications of Louisville, Illinois, noted the steep increase in telework during the COVID-19 emergency and provided free upgrades to all Fiber to the Home (FTTH) customers,

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[11] "Employment Situation Summary," U.S. Bureau of Labor Statistics, USDL-20-1503 (Aug. 7, 2020) (https://www.bls.gov/news.release/empsit.nr0.htm) (accessed Aug. 26, 2020). Overall, improvements from 2Q20 to 3Q20 were tempered by residual impacts in many sectors. Retail trades added about a quarter-million jobs, but employment was still down nearly one million from February 2020. Employment in hospitals, dental offices and home care services increased, but job losses in nursing and residential care facilities continued to decline. Manufacturing and financial services enjoyed modest gains. Overall, the largest job losses since April 2020 were in leisure and hospitality; employment in professional and business services increased slightly, but mostly due to temporary help services.

[12] "Telework May Save U.S. Jobs in COVID-19 Downturn, Especially Among College Graduates," Rakesh Kochhar and Jeffrey Passel, Pew Research Center (May 6, 2020) ((https://www.pewresearch.org/fact-tank/2020/05/06/telework-may-save-u-s-jobs-in-covid-19-downturn-especially-among-college-graduates/) (accessed Aug. 26, 2020) *citing*, Dingel, Jonathan I. and Neiman, Brent, "How Many Jobs Can be Done at Home," National Bureau of Economic Research (Apr. 2020) https://www.nber.org/papers/w26948.pdf) (accessed Aug. 26, 2020).

[13] "Coronavirus is Making Some People Rethink Where They Want to Live," Catherine E. Shoichet, Athena Jones, CNN (May 2, 2020) (https://www.cnn.com/2020/05/02/us/cities-population-coronavirus/index.html) (accessed Aug. 26, 2020).

increasing 100Mbps and 250Mbps packages to the 500Mpbs package for free through the end of the school year when at-home demand might be strained by remote learning students and teleworking parents. Rainbow Communications in Everest, Kansas, installed thirty (30) community Wi-Fi hot spots throughout its service area in Northeast Kansas that provides free internet access. It also increased the internet plans at local libraries to accommodate the higher usage demand. Yard signs have been posted at the locations to make the community aware of the free service in addition to social media posts. These steps assisted residents with job searches at this time.

To be sure, COVID-19 data sets are yet developing. But one element is axiomatic: where jobs can be retained through telework, the "tele" aspect must be available. Without broadband, those opportunities and the follow-on economic benefits would be lost.

<u>*Education*</u>

By the end of the 2019/20 school year, about 55 million American students had been affected by COVID-19 related school closures.[14] Given current trends, it appears that students will continue to be affected when the fall term opens. Early indications point to the possibility that it many jurisdictions, full openings will not occur, and that some blend of staggered schedules and remote learning will be implemented for at least the short/medium term. Sufficient broadband capability in each household will be necessary. Of the 32 million U.S. households with children 18 and under, 91.3 percent have at least one working parent.[15] Accordingly, given telework statistics gathered during COVID, it can be expected that 11.7 million U.S. households with children will need to serve multiple broadband users during the school/workday.[16] The promise of rural broadband in meeting current and future educational needs can be seen in the actual performance of small, community-based broadband providers in the past months of COVID-19.

BBT (Alpine, Tex.) increased speeds for all customers, suspended data overage charges, and provided Wi-Fi to first responders and utility technicians; Ben Lomand Connect (McMinnville, Tenn.) established free community Wi-Fi spots; Skyline Membership Cooperative (West Jefferson, N.C.) offered two months free internet to students in need; and, West Carolina Tel

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[14] "Map: Coronavirus and School Closure," Education Week (Sep. 14, 2020) (https://www.edweek.org/ew/section/multimedia/map-coronavirus-and-school-closures.html) (accessed Sep. 14, 2020).

[15] Duffin, Erin, "Number of Families in the US by Number of Children 2000-2019, Statista (Nov. 12, 2019) (https://www.statista.com/statistics/183790/number-of-families-in-the-us-by-number-of-children/) (accessed Sep. 14, 2020).

[16] *See, "*Telework May Save U.S. Jobs in COVID-19 Downturn, Especially Among College Graduates," Pew Research Center (May 6, 2020) (https://www.pewresearch.org/fact-tank/2020/05/06/telework-may-save-u-s-jobs-in-covid-19-downturn-especially-among-college-graduates/#:~:text=In%20a%20Pew%20Research%20Center,result%20of%20the%20coronavirus%20outbreak.&text=The%20potential%20for%20the%20labor,already%20be%20stretched%20to%20capacity) (accessed Sep. 14, 2020). This calculation relies upon 32.17 million U.S. households with children ages 6-18, with an employment rate among those households of 91.3%, and a 40% telework rate.

(Abbeville, S.C.) offered free internet to new student or teleworking customers, and upgraded existing student or teleworking customers for two months. Another rural broadband provider is planning a "no student left unconnected" approach for the coming year. These steps are important: even at medium quality, Zoom consumes about 1.35GB/hr. at 720p. And with the prospect of blended learning and staggered days, connectivity will be critical. These data and anecdotes inform policies to promote robust rural deployments that will enable not only remote learning in times of crisis but also access to learning where economies of scale do not support certain opportunities in rural areas.

Health Care

Rural residents, on average, are older and face higher rates of chronic and acute conditions than their urban counterparts. When combined with distance from specialists and other socioeconomic factors, access to adequate and affordable health care in rural areas can be difficult. Broadband, however, can help shatter these barriers and result in improved health outcomes at lower costs.

By way of example, COPD (chronic obstructive pulmonary disease) is more common in rural areas than urban.[17] But, for better or for worse, those rates are not related to unsolvable conditions. Rather, the CDC (citing a University of Wisconsin study) explains that rural COPD rates are due, in part, to "less access to smoking cessation programs" and the fact that "[r]ural residents are also likely to be uninsured and have higher poverty levels, which may lead to less access to early diagnosis and treatment."[18] While these are not insignificant obstacles, neither are they impossible. In similar vein, sparse populations, challenging terrain, and capital-intensive networks would seem to stand in the way of broadband deployment in those same rural regions, but the right public policies combined with community commitment have proven successful in building rural broadband. Actions intended to meet the COVID-19 challenge demonstrate how telehealth demand grew and was met.

In March 2020, the U.S. Department of Health and Human Services (HHS) amended Medicare Fee-For-Service (FFS) rules to ease Medicare beneficiaries' access to healthcare. More than 100 additional services were added to the "telehealth eligible" list. This action was especially important at a time when many health care systems curtailed elective procedures and limited in-person visits. Physicians and patients responded impressively: according to HHS data, in April 2020, 43.5% of Medicare primary care visits were conducted via telehealth, a remarkable increase from the previous February in which only 0.1% of primary care visits were via telehealth. Iowa, South

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[17] Rural Health, COPD, Centers for Disease Control and Prevention (https://www.cdc.gov/ruralhealth/copd/index.html) (accessed Aug. 26, 2020).

[18] "Urban-Rural Differences in COPD Burden," Chronic Obstructive Pulmonary Disease (COPD), Centers for Disease Control and Prevention (https://www.cdc.gov/copd/features/copd-urban-rural-differences.html#:~:text=Rural%20populations%20may%20have%20more,living%20in%20more%20urban%20areas) (accessed Sep. 14, 2020) *citing* 2016 County Health Rankings: Key Findings Report, Population Health Institute, University of Wisconsin (2016) (https://www.countyhealthrankings.org/sites/default/files/media/document/key_measures_report/2016CHR_KeyFindingsReport_0.pdf) (accessed Sep. 14, 2020).

Dakota, and Oklahoma saw 33% increases in telehealth usage; even Nebraska, which logged the lowest telehealth increase, saw a stunning 22% increase.[19] Fortunately, data point not only to acceptance of telemedicine among younger Americans, but among older populations, as well. While studies have shown that relative interest in telemedicine tends to decline disproportionally to age, it must be remembered that those surveys are snapshots in time. Take, for example, broadband adoption, generally. Although trends indicate that older users are less likely to adopt, the total number of older users is actually increasing over time.[20] Perceived relevance is increasing as more aspects of daily life go "online," and users who were in the 50-60 demographic a decade ago now populate the 60-70.[21]

In rural areas, small, facilities-based, locally operated broadband met the COVID-19 challenge with broadband. In Hazen, North Dakota, West River Telecom worked with area hospitals and clinics to plan for overflow locations and ensure connectivity. Ben Lomand Connect in McMinnville, Tennessee, provided resources for customers via social media including livestreaming experts on mental health. These and other rural broadband-enabled rural telehealth efforts offer not only qualitative benefits, but quantitative benefits, as well. Telehealth enables users to avoid lost wages and travel expenses while increasing local medical facility revenues. A 2017 report projected substantial economic benefits from rural telehealth deployment, including: travel expense savings of $5,718 per medical facility, annually; lost wages savings of $3,431 per medical facility, annually; hospital cost savings of $20,841 per medical facility, annually; increased local revenues for lab work ranging from $9,204 to $39,882 per type of procedure, per medical facility, annually; and increased local pharmacy revenues ranging from $2,319 to $6,239 per medical facility annually, depending on the specific drug prescribed.[22]

These are but a few examples of how rural broadband helped blunt the impacts of COVID-19 in rural spaces and offer examples of best practices and policy visions for even ordinary times. Indeed, the formation of the American Connection Project Broadband Coalition, a large, multi-party coalition evidences growing recognition of the need for better broadband connectivity

[19] "HHS Issues New Report Highlighting Dramatic Trends in Medicare Beneficiary Telehealth Utilization Amid COVID-19," US Department of Health and Human Services (Jul. 28, 2020) (https://www.hhs.gov/about/news/2020/07/28/hhs-issues-new-report-highlighting-dramatic-trends-in-medicare-beneficiary-telehealth-utilization-amid-covid-19.html) (accessed Aug. 26, 2020).

[20] "Internet/Broadband Fact Sheet," Pew Research Center (Jun. 12, 2019) (https://www.pewresearch.org/internet/fact-sheet/internet-broadband/) (accessed Aug. 26, 2020).

[21] *See, e.g.,* Greenwald, P., Stern, ME, Clark, S., Sharma, R., "Older Adults and Technology: In Telehealth, They May Not Be Who You Think They Are," International Journal of Emergency Medicine (2018) (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5752645/) (accessed Sep. 14, 2020).

[19] *See,* Schadelbauer, Rick, *Anticipating Economic Returns of Rural Telehealth*, Smart Rural Community (2017) (https://www.ntca.org/sites/default/files/documents/2017-12/SRC_whitepaper_anticipatingeconomicreturns.pdf) (accessed Aug. 26, 2020).

throughout the United States.[23] This coalition builds upon prior efforts that have demonstrated empirically the value of rural broadband.[24] These financial and quantifiable gains are complemented by qualitative, "quality of life" gains.[25] The full range of broadband impacts on daily life – from economic development, education, health care and other vital services – has been revealed and illuminated in the COVID-19 crisis and recognized by numerous Congressional initiatives to move broadband policy forward. In these, the interconnected and interdependent relationships among rural and urban spaces must be considered.

> . . . if you think about it, for this big country – and it was big by European standards – a major challenge for our founding leaders was how to bring it all together. So, communications of various kinds was very much a part of the agenda [and] the Constitution. Congress was given the right to build postal roads. You have the Erie Canal. You had the land-grant colleges. Even the Agriculture Extension Service, which was a great organization for the diffusion of innovations. And, we have forgotten all that for some reason. A lot of that actually helped develop the rural areas. It helped make us the world's great agricultural power, and we sort of say, "OK, let's move on." You cannot just move on. As new technology comes along, we must continue to play that role of using communications to bring the country together.[26]

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[23] "Land O'Lakes and Partners Form a Coalition to Close America's Digital Divide," Broadband Communities (Jul. 13, 2020) (https://www.bbcmag.com/breaking-news/land-o-lakes-and-partners-form-a-coalition-to-close-america-rsquo-s-digital-divide) (accessed Sep. 26, 2020).

[24] *See, i.e.,* Gallardo, Roberto, Strover, Sharon, and Whitacre, Brian, "Broadband's Contribution to Economic Health in Rural Areas," Research and Policy Brief, Community & Regional Development Institute, Cornell University (Feb. 2015) (https://cardi.cals.cornell.edu/publications/research-policy-briefs/broadband%e2%80%99s-contribution-economic-health-rural-areas/) (accessed Sep. 26, 2020) (finding median income, number of firms and education levels in non-metro counties were all positively correlated to broadband adoption. *See, also,* "A Cyber Economy: The Transactional Value of Internet in Rural America," iGR/Foundation for Rural Service (2018) (https://www.frs.org/sites/default/files/documents/2018-03/A-Cyber-Economy_The-Transactional-Value-of-the-Internet-in-Rural-America.pdf) (accessed Sep. 26, 2020) (finding, *inter alia,* that internet usage among rural and urban consumers is largely similar; that rural consumers account for approximately 15% of all consumer, internet-driven transactions annually; that the estimated value of rural online transactions is nearly $1.4 trillion).

[25] *See,* Manlove, Jacob and Whitacre, Brian, "Use of Broadband Linked to Greater Levels of Civic Engagement," Daily Yonder (Sep. 22, 2016) (https://dailyyonder.com/use-of-broadband-linked-to-greater-levels-of-civic-engagement/2016/09/22/) (accessed Sep. 26, 2020).

[26] "Beyond Rural Walls: A Scholars' Conversation About Rural and Urban Spaces," Foundation for Rural Service, Smart Rural Community, at 7 (2016) (https://www.ntca.org/sites/default/files/documents/2017-12/SRC_whitepaper_beyond_rural_wall(FRS).pdf (accessed Sep. 26, 2020).

The inextricable links between rural and urban spaces demands that precision agriculture and associated broadband policies are not a discrete *rural* broadband policy, but part of *national* broadband policy.

Recommendations:

1. FCC and USDA should consider precision agriculture connectivity as an imperative driver of our nation's food security.