

Internet Connectivity and Farms in North Carolina



Although agriculture has an estimated \$87 billion impact on North Carolina’s economy, many farmers struggle to get affordable, high-speed internet service for their farm offices, which they need to communicate with customers, analyze and share data, and engage the commodities markets.

The NC Department of Information Technology’s Broadband Infrastructure Office (BIO) is working to better identify coverage gaps and to find ways to expand broadband connectivity to farms in areas that are currently unserved or underserved. In January 2020, in partnership with the Friday Institute for Educational Innovation at NC State University (NCSU), BIO launched the Internet Connectivity for Farmers Survey to gauge the caliber of internet service at farms and farm offices across North Carolina and identify locations in need of better connectivity. More than 1250 respondents from unique addresses in 98 counties took the survey, and 90 percent of respondents said that reliable high-speed internet is “extremely important” or “very important” to conduct business.

Why N.C. farms need broadband

North Carolina has the nation’s third most diverse agricultural economy with ninety-plus crop varieties and a strong food animal industry; broadband access will require focused solutions that are able to serve a variety of needs. The technology required to support farm operations has evolved exponentially and data collection has become vital to successful farming operations.

Traditional business cases for expanding broadband to rural areas-- economic growth and increased populations, which can bring infrastructure development to rural pockets --are not always as effective in getting connectivity to farms because agriculture operations require large tracts of land and are outside population hubs. Looking at smart farm applications and their required connectivity needs may strengthen the business case for bringing broadband to the most rural and remote parts of the state and the farms that are located in those areas.

A 2019 study commissioned by the United Soybean Board (USB) reported that the lack of broadband connectivity negatively impacts farmers who are responsible for \$80 billion of the gross domestic product of the United States.

Other significant findings from that study include:

78%

of farmers in the U.S. do not have a choice in internet service providers

60%

of farmers say the internet service they have is slow, with most relying on cell signals or hotspots to connect to the internet

40%

of farmers have a fixed internet connection, while others rely on satellite connections

Additionally:

- Because farms “can’t move,” 78% of farmers said they do not have another viable option to change service providers.
- The study found that most farmers plan on (59%) or are considering (28%) incorporating more data into making day-to-day decisions within the next year. These daily decisions support their economic and environmental sustainability.
- Farmers face internet-related barriers, including slow speeds (21%), costs (20%), reliability (16%), and lack of access (15%).
- In the 18 months before being surveyed, nearly one-third of respondents said internet connectivity has impacted purchase decisions to upgrade farm equipment.

Background

In North Carolina, the focus around agriculture and broadband has become more pronounced over the past few years, with many organizations involved in different facets of the conversation. In late 2018, the Broadband Infrastructure Office (BIO) visited a handful of farmers around eastern N.C. with the NC Farm Bureau Federation (Farm Bureau) to better understand the connectivity needs and challenges within their farms. BIO held a Broadband 101 training for the Farm Bureau in June 2019, with staff from the Farm Bureau, the NC Department of Agriculture and Consumer Services (NCDA&CS), and the NC State Cooperative Extension. In 2019, in collaboration with BIO, the Farm Bureau held a listening session for farmers to help identify the challenges farmers face with a lack of connectivity.

In addition to farms, North Carolina has 18 Agriculture Research Stations that sit under NCSU and the NCDA&CS. In 2018, the Digital Research Stations Committee was developed to look at how to transform the stations and field labs to become Next Generation Research Stations. In early 2019, the Committee, led by NCSU, released white papers outlining the vision for and importance of utilizing technology within these Agriculture Research Stations. Several stations were targeted as pilots for upgrading to fiber connections. Wi-Fi connectivity was developed for another station, giving it the ability to access data in the surrounding fields. NC Cooperative Extension also upgraded connectivity to many of its offices in the past couple of years, entering into an agreement with MCNC to upgrade over 20 of its county offices to fiber in 2019.

In February 2020, the Emerging Issues Forum included a panel on Connectivity and Agriculture with BIO, the NC Cooperative Extension, the Department of Agriculture, farmers, SAS, and state leaders. As agriculture and broadband partners examine this issue of connectivity, broadband providers that service rural areas also are engaged in building connectivity solutions. BIO's GREAT grant program, launched in 2018, provides funding to broadband providers to build out last-mile service to unserved areas, and has included extra scoring points for grant applications that include agriculture locations. The federal ReConnect Loan and Grant Program under the U.S. Department of Agriculture also targets deployment of broadband infrastructure to unserved farms.

Internet Connectivity Survey for NC Farmers findings

BIO, in partnership with the Friday Institute for Educational Innovation at NCSU, launched the *Internet Connectivity for Farmers Survey* in January 2020 to help identify farm offices across North Carolina that are unserved or underserved with regards to internet connectivity. The initial survey and speed test ran through April 30.

Through development of the *Internet Connectivity for Farmers Survey*, BIO is working to better understand agriculture's two pieces of the broadband puzzle:

- "Direct to Farm" (connectivity to the farm office) and
- "Data in the Fields" (connectivity in the fields),

Focusing especially on connectivity to farm offices, since they are primary locations from which farmers conduct business. Sometimes these offices are located next to their fields, and sometimes they are located within households. The survey contained broadband availability questions about wired, cellular, and wireless (fixed and satellite) access, and included an optional internet speed test. The survey also included a few questions about connectivity in the fields.

The survey was developed in part from information gathered during the NC Farm Bureau Federation listening sessions conducted with local farmers and agriculture partners. The data will be used to inform research, policy, and funding recommendations to assist communities where internet access is inadequate. Farmers with internet access on their farms were asked to complete the survey from their farm office, with the accompanying speed test. Farmers without internet access were asked to complete the survey, but not the speed test. In both cases, the farm office address was critical to identifying underserved and unserved farms. Once collected, these addresses were mapped to show unmet needs or demand for high speed internet. In the future, these addresses might be shared with relevant internet service providers or other partners to identify service solutions and included in a public map, with location points buffered for privacy.

Participation

The survey collected information from more than 1250 respondents from unique addresses. Ninety-four percent of participants were farm owners, and the remaining 6% were farm employees. Seventy-four percent of the farm offices were reported to be located inside of a private residence.

Responses came from a wide variety of types of farms, as follows:

627 

Field or row crops

620 

Livestock

430 

Specialty crops

204 

Other

Key Results & Findings

- Responses came from farms located across the state, including all but two of North Carolina's 100 counties.

90% of respondents said that reliable high-speed internet is “**extremely important**” or “**very important**” to conduct business at the farm, while just 1% said “not important.”

- When asked which business activities a respondent would perform at their farm office, with reliable internet service, the tasks included:
 - Searching for information: 89%
 - Email and web access: 88%
 - Shopping/buying supplies: 84%
 - Data upload and download: 84%
 - Viewing demonstration videos (e.g. YouTube): 81%
 - Banking, credit card transactions, etc.: 80%
- 91% of respondents reported being “very comfortable” or “comfortable” with using technology such as smart phones and computers.
- Although many respondents reported no internet access at their farm offices, more than 70% of those respondents reported that they never visit community sites (library, school, park, etc.), cooperative extension offices, or retailers to use internet service. For respondents without access on their farm, the most common venue for gaining internet access off-site was in “someone else’s home,” on a “weekly or more often” basis.

When asked about how important internet connectivity in the fields will be to the productivity of the farm in the future,

71% of respondents said “extremely important” or “very important.”

16% said internet activity in the fields will be “moderately important”, and 2% said “not at all important.”

- For the 71% who said that internet connectivity in the fields will be extremely or very important, those respondents said that the following tasks would be enabled or improved by higher quality internet access:
 - Storage and analysis of soil, crop, animal, etc. Productivity data: 59%
 - Remote control and monitoring of farm systems, e.g. irrigation: 59%
 - Usage of soil and crop sensors: 45%
 - Usage of animal status (e.g. tracking) and wellness sensors: 40%
 - Aerial monitoring and farming activities via drones: 40%
 - Usage of autonomous or remote farming equipment (e.g. driverless tractors) 19%
 - Other: 9%
 - Not Sure: 14%
 - Results showed that there is currently a range of technology types deployed and being used at farm offices across the state (including wired, fixed wireless and satellite).
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For respondents participating in the speed test, the primary connection type was DSL (copper infrastructure), with a median download speed of 5.4 Mbps, and upload of 0.5 Mbps.

- Mapped results support the idea that areas lacking sufficient connectivity exist in rural pockets across the state.
 - **57% of respondents reported some form of wireline service.**
 - When asked why they did not have wireline service, 74% (of the 490 respondents answering the question) said that they did not have it because it was not available; 18% said they did not have it was because it was too slow; and 14% said they did not have it was because it was too expensive. (Respondents could select more than one answer.)
 - Of the respondents who reported having wired service, 45% said that they were “extremely satisfied” or “somewhat satisfied” with the service, in terms of conducting farm business, while 50% were “somewhat dissatisfied” or “extremely dissatisfied.”
 - **63% of respondents reported having some type of cellular data service.**
 - Of the farms reporting no use of cellular internet, 63% (of the 59 respondents answering the question) said they did not have it because it was not available. Another 46% said that cellular is available, but it is either too slow or unreliable, with 6% saying it was too expensive. (Respondents could select more than one answer.)
 - Of respondents who reported having cellular service, 38% said that they were “extremely satisfied” or “somewhat satisfied” with the service, in terms of conducting farm business, while 52% were “somewhat dissatisfied” or “extremely dissatisfied.”
 - **28% of respondents reported having fixed wireless or satellite service.**
 - Of respondents who reported having fixed wireless, 50% said that they were “extremely satisfied” or “somewhat satisfied” with the service, in terms of conducting farm business, while 35% were “somewhat dissatisfied” or “extremely dissatisfied.”
 - Of respondents who reported having satellite service, 27% said that they were “extremely satisfied” or “somewhat satisfied” with the service, in terms of conducting farm business, while 66% were “somewhat dissatisfied” or “extremely dissatisfied.”

In all, 717 participants (57%) completed the speed test. The table below shows median download and upload speeds gleaned from the speed test combined with technology type. The technology types are derived based on the broadband provider captured through the speed test.

Technology Type	Median Download Speed (Mbps)	Median Upload Speed (Mbps)	Latency (ms)
Wired (n=453)	7.1	0.7	52.0
Cellular (n=133)	8.3	1.1	70.0
Fixed Wireless (n=9)	8.6	4.4	42.1
Satellite (n=90)	7.7	2.3	695.0
Unknown (n=32)	7.1	1.8	60.6

Further breakouts for wired technologies are as follows:

Technology Type	Median Download Speed (Mbps)	Median Upload Speed (Mbps)	Latency (ms)
Wired DSL (n=355)	5.4	0.5	56.9
Wired Cable Modem (n=87)	75.2	12.2	29.0
Wired Fiber (n=11)	73.2	12.9	30.4

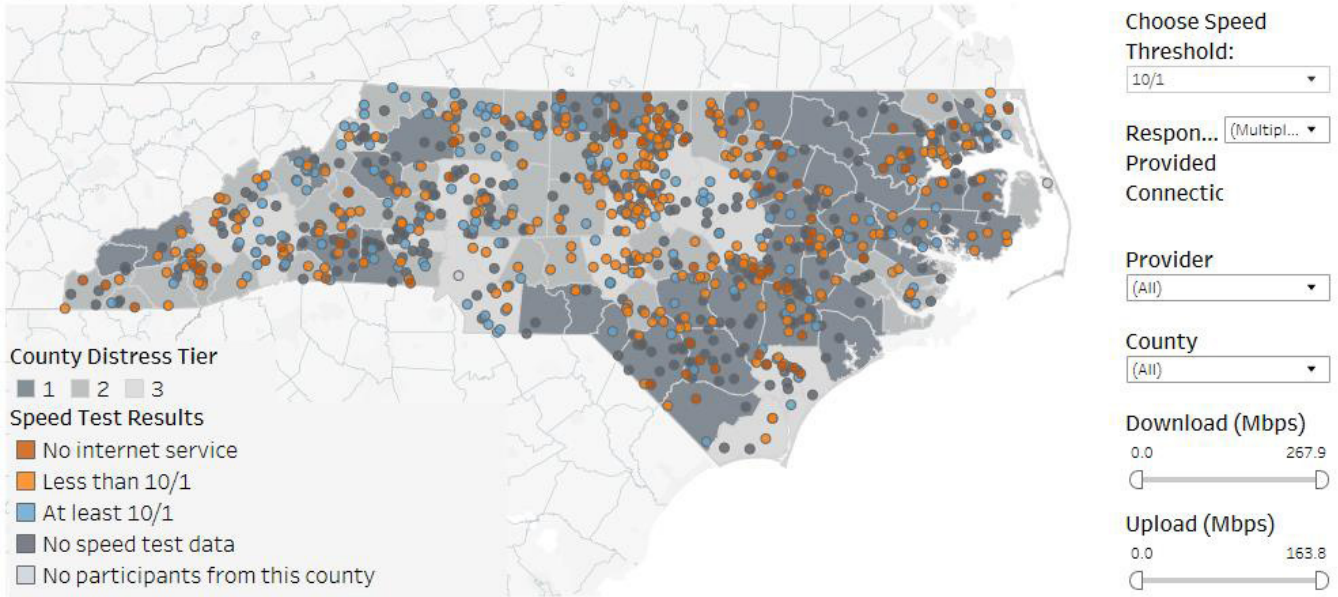
In the following chart, speed test results have been grouped by technology type to see how often each technology type met the download/upload speed thresholds of 10/1 Mbps and 25/3 Mbps. Columns indicate in how many instances the speed test for a technology type reached the designated speed threshold. The technology types are derived based on the broadband provider captured through the speed test data.

Technology Type	10/1 Mbps		25/3 Mbps	
	Reached	Not Reached	Reached	Not Reached
Wired DSL (n=355)	58	297	16	339
Wired Cable Modem (n=87)	80	7	70	17
Wired Fiber (n=11)	11	0	11	0
Cellular (n=133)	42	91	17	116
Fixed Wireless (n=9)	3	6	0	9
Satellite (n=90)	37	53	6	84
Unknown (n=32)	14	18	9	23

Wired cable modem and fiber met the thresholds in most cases. For the remaining technology types, in the case of this survey, speed test results did not meet the download/upload thresholds of 10/1 or 25/3 Mbps more often than not. Since many of these technology types have the capacity for higher speeds, the results likely indicate a lack of sufficient investment in these technologies in these areas, as opposed to reflecting capabilities of the technologies overall.

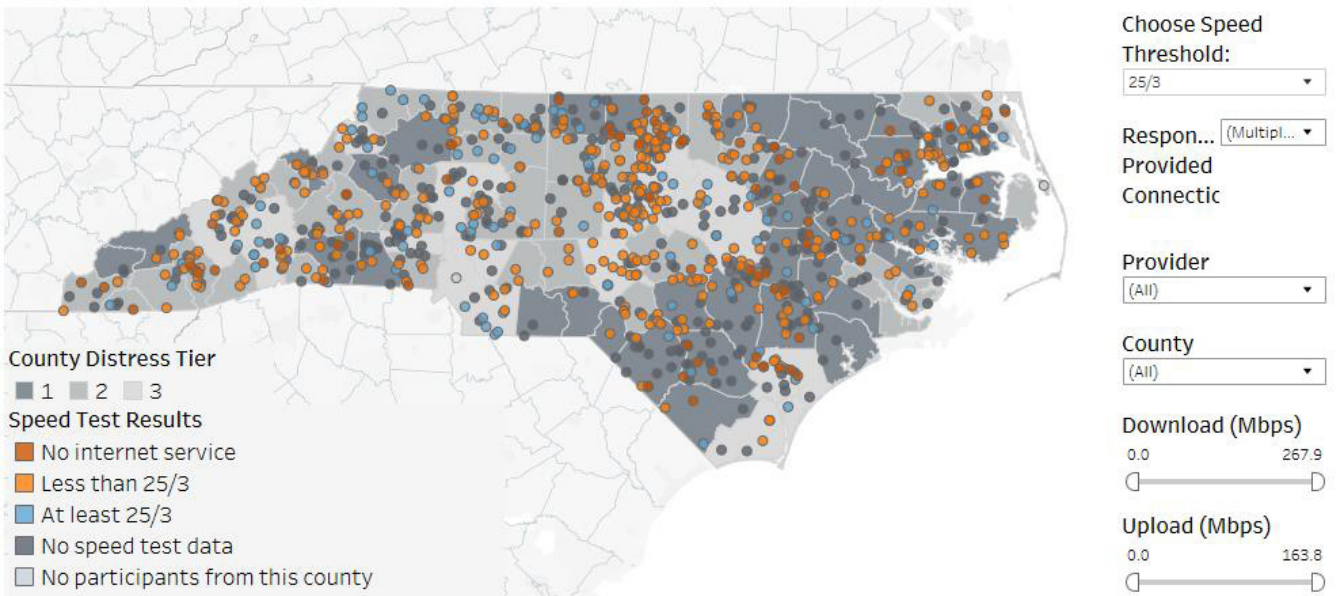
Below is a snapshot of speed test results for wired and fixed wireless connections at 10/1 Mbps:

Speed Test Threshold: 10/1



Below is a snapshot of speed test results for wired and fixed wireless connections at 25/3 Mbps:

Speed Test Threshold: 25/3



Summary and Recommendations

According to respondents to the *Internet Connectivity for Farmers Survey*:

- There are a range of technologies deployed across the state bringing connectivity to farm offices.
- Some farms offices lack any connectivity at all.
- Many of the existing broadband connections at farm offices in this survey do not meet the speed threshold of 25 Mbps down/3 Mbps up, as defined by the Federal Communications Commission as an availability threshold for households. Many also do need meet the prior 10 Mbps down/1 Mbps up criteria.
- The majority of respondents indicate that connectivity is critical for farms (farm offices and data in the field) in the future.
- For wired technologies and satellite, the majority of respondents indicated being somewhat dissatisfied or more, with their service.
- Many farm-related business activities would be performed at the farm offices if reliable internet were available.
- Internet connectivity in the field will be very important in the future for various farming-related activities.

The following activities are recommended to address continuing connectivity needs at farms:

Continue focus on solutions for last-mile connectivity for unserved and underserved areas.

Continue funding support for last-mile infrastructure investments through programs such as GREAT and ReConnect.

Lack of broadband service in rural areas remains primarily a funding issue. In sparsely populated areas, it can be difficult for broadband providers to meet the business case to invest in infrastructure deployment. Companies need to be able to make a return on investment and have enough future subscribers to make up the capital investments required to reach remote areas.

The state's GREAT Grant Program (Growing Rural Economies with Access to Technology) provides state funding to private sector broadband providers to reimburse capital expenditure costs to deploy to the state's unserved areas. The GREAT program was launched in 2018 and is administered by NCDIT/BIO. GREAT Round One included projects to serve 187 agriculture operations. GREAT Round Two includes deployments to over 250 agriculture operations. While legislation no longer requires grant participants to specify deployments to agriculture operations/farms, versus other businesses, this detail could potentially be requested of the grantees by the Broadband Infrastructure Office.

The *Community Connect Program* and the *ReConnect Program*, both under the U.S. Department of Agriculture, are based on a similar concept of providing grant or loan funding to broadband providers for last-mile deployments.

Farming can require managing and sharing substantial amounts of data. Last-mile deployment programs should consider requirements for fast upload speeds (in addition to download speeds), as farmers need to be able to send large amounts of data.

Continue support for emerging technologies that reduce costs or otherwise assist in reaching rural areas with increased connectivity.

Innovations in technology can sometimes help reduce costs associated with building to rural areas or allow connectivity to be more easily provided-- whether through wired technologies, fixed wireless, mobile or satellite.

As an example, the state's new Satellite-Based Broadband Grant Program will provide state funding to eligible broadband providers of satellite internet, to encourage deployment and adoption of new satellite technologies. The program pilot was created in summer 2020 and will be administered by NCDIT/BIO. As another example, newly available licensed/unlicensed frequencies, such as Citizens Broadband Radio Service (CBRS) spectrum, offer new opportunities for reaching unserved areas via fixed wireless.

Continue to adopt policies that can reduce costs to deploy infrastructure, offer new opportunities, or otherwise support reaching rural areas with increased connectivity.

In 2019, the NC General Assembly passed legislation reducing barriers for North Carolina's electric cooperatives to be engaged in the provision of broadband, creating a new opportunity for broadband solutions in our most rural areas. In addition, various bills have sought to clarify the ability of local governments to lease existing assets, such as fiber, to private sector providers to assist in reaching unserved areas. The state has also recently developed a dig-once policy to provide opportunities for private providers to share costs of laying fiber in open trench projects within active NC Department of Transportation (NCDOT) State highway projects. This practice could be extended to other industries including gas, electric, and water and sewer.

Continued discussions with farmers on whether community internet access sites would be useful for them and if so, what type would best meet their needs.

The majority of respondents with no internet reported that they never visit community sites to gain internet access. The most common venue for gaining internet access offsite was in "someone else's home." If short-term solutions are sought for farmers to be able to access the internet and download/upload information via community/public internet access sites, these sites may need to be designed specifically for farmers, with their input, and determination of whether they would be used.

Develop data and mapping practices to allow analysis of where farms are located in relation to broadband infrastructure.

While there is no standardized dataset with the location of North Carolina farms, and some data may be considered confidential, partners should work together to gain a better understating of where North Carolina's farms are located in relation to broadband access. The NC Broadband Survey from BIO allows for respondents to flag their businesses as a "farm," but other datasets on farm locations and types of farms would be useful. Data could be analyzed in relation to vertical assets, including state and local towers.

Encourage and convene partners in the agriculture and broadband space to work together to plan for current and future needs for data connectivity in-the-fields. Develop and identify models and best practices for providing wireless internet access among the farm fields.

There is not a single model for provision of internet connectivity across the agriculture fields. Internet could be provided by a combination of technologies: cellular, satellite, fixed wireless, or wi-fi access points. Having wired connectivity at some location within the farm offers more opportunities for extending wireless or wi-fi signals to the fields. The best technologies to deliver this connectivity would depend on applications in the fields. Farm machinery may have compatibility with certain technology types or frequencies. Various sensors or monitoring systems may also work best with certain frequencies. Any data-in-the-fields network would need to consider compatibility with these equipment, machinery, and sensor components, as well as issues of capacity (how much bandwidth is needed for the various applications). Models for one type of farm may look different than another type of farm. Farm size, as well as layout of fields are also a factor to consider.

More conversations are needed between farmers, agriculture partners, vendors, and broadband partners to better identify the intersection of:

- data and application needs in the field
- compatibility with farm equipment and sensors
- possible connectivity and network configurations
- data storage and security
- and even data ownership.

Encourage and convene partners in the agriculture, vendor, and technology space to work together to plan for current and future digital inclusion needs for farmers in terms of digital literacy, adoption, and use of new technologies.

In this survey, more than 90 percent of respondents reported being “very comfortable” or “comfortable” with using technology such as smart phones and computers. As farming continues to require more and more advanced technological knowledge, digital inclusion strategies, encompassing the many facets of farm operations will be critical. Traditional digital inclusion includes 5 elements:

1. Affordable, robust broadband internet service;
2. Internet-enabled devices that meet the needs of the user;
3. Access to digital literacy training;
4. Quality technical support; and
5. Applications and online content designed to enable and encourage self-sufficiency, participation and collaboration.

These elements can be applied to the agriculture space as well. Continue dialog with farmers and partner organizations to determine how to best meet these needs as farming technologies and internet capabilities evolve.

Closing

North Carolina was built on agriculture, and it is the state’s largest economic driver with an estimated \$87 billion impact on North Carolina’s economy. North Carolina has renowned land-grant universities and a large infrastructure of agriculture-focused organizations, vendors, and partners. The state is also well-known for its technology industries as well as the Broadband Infrastructure Office. With the majority of farms being located in sparsely populated areas, connectivity solutions will require focused efforts.

BIO will continue to seek support for solutions to provide broadband connectivity to farms, in rural areas that are currently unserved or underserved. Looking at smart farm applications and their required connectivity needs, can in turn, help make the business case for bringing broadband to businesses and households in rural areas. Infrastructure investments at farm locations can assist in leveraging solutions for increased connectivity that will allow for advances in telehealth, education, and public safety in surrounding communities. With North Carolina’s strong agriculture infrastructure, it is a natural next step to focus on increased connectivity for N.C. farms.