AT&T 10x Case Study:

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AT&T believes technology plays a critical role in reducing carbon emissions. So, we're using the power of our network to create a better, more environmentally sustainable world. We've set a goal to enable carbon savings 10x the footprint of our operations by the end of 2025.

To meet this, we're working to make our operations more efficient across the company. We're also working with our customers and technology partners to implement and scale carbon-saving solutions. This case study discusses and quantifies the carbon benefits of using AT&T technology to boost efficiency. This is one study in a series we're sharing as we progress toward our 10x goal.

Learn about our goals, our progress, and see more case studies like this at att.com/10x.

Summary

As the world's population is expected to grow in the coming decades from about 7 billion in 2010 to a forecast of 10 billion by 2050[1], we face a global challenge to grow enough food for everyone while also working to address climate change by reducing greenhouse gas (GHG) emissions from agricultural production. To succeed, we will need to use a wide range of techniques to produce more food using fewer resources while reducing food loss and waste. The **Soiltech Sensor** can help do this by precisely recording and transmitting data for soil moisture, temperature, humidity, location and impacts that may create bruising while crops are being grown, transported and stored. It uses AT&T's LTE-M network to provide near real-time crop data via the Soiltech Wireless app, enabling users to receive alerts when their crops are experiencing unexpected conditions, which can help address issues anywhere from the field to the food storage facility.

After extensive studies on a wide range of crops including potatoes, onions, sugar beets and barley, the environmental benefits of using the Soiltech Sensor are coming into focus. If a farmer used the Soiltech Sensor on 10,000 acres of potato fields and achieved results similar to these early studies, that farmer could increase potato production by 4% - an additional **10,000 tons of potatoes** - while reducing average water usage by **500**

Estimated annual benefits of using Soiltech on a 10,000-acre potato farm:

- 10% Water reduction, equivalent to over **500 million gallons**
- GHG emissions avoided equivalent to over **250,000 gallons of gasoline**[2]
- **Hundreds of thousands of dollars** in reduced operational costs and avoided lost revenue from bruising
- 4% increase in production, resulting in **10,000 additional tons of potatoes**

million gallons each year. By reducing fuel and water costs and avoiding financial penalties from bruising, the farmers could also add **hundreds of thousands of dollars** to the bottom line. And all of these efficiencies add up to the potential to reduce GHG emissions by over 2,200 metric tons each year, which is equivalent to not burning over **250,000 gallons of gasoline**.[2]

The Challenge: Farming is a complex business and current technology solutions struggle to give a complete picture

Farming is a complicated business. From economic issues including the potential risks of global trade wars and tax changes to environmental issues such as climate change and fertilizer management, farmers face a variety of challenges.

Even with the financial challenges of running a farm, managing the environmental impacts of food production is paramount, especially since climate change has the potential to cause fundamental disruptions to where and how crops are grown. But nonetheless, the financial realities of farming – the need to drive more revenue and cover costs while dealing with season-to-season uncertainties – dictate that farmers make shrewd investments in their business. This means that any investment in technology needs to provide measurable benefits that really impact their bottom line, and they need it to be scalable and dependable.

The idea of precision agriculture isn't new, and despite the advancements in farming equipment, farmers still have blind spots in their operations. Detailed data about crop condition remain elusive, insights into crop condition during transportation are patchy, and information about the conditions of crop storage is standalone, at best. In short, the ability to stitch together the phases of a crop's journey from growth to harvest to transport to storage has been incomplete and piecemeal. As a result, farmers struggle to identify problems along the way, resulting in the potential for wasted resources and crops.

The Solution: The Soiltech Sensor and AT&T's Internet of Things (IoT) Connectivity provides actionable insights to help optimize crop yield, reduce input costs, analyze performance and reduce environmental impacts

Easy to use

- No wires or antennas
- No gateway needed
- Plant sensor with seed
- Harvest sensor with crop
- View data in real time

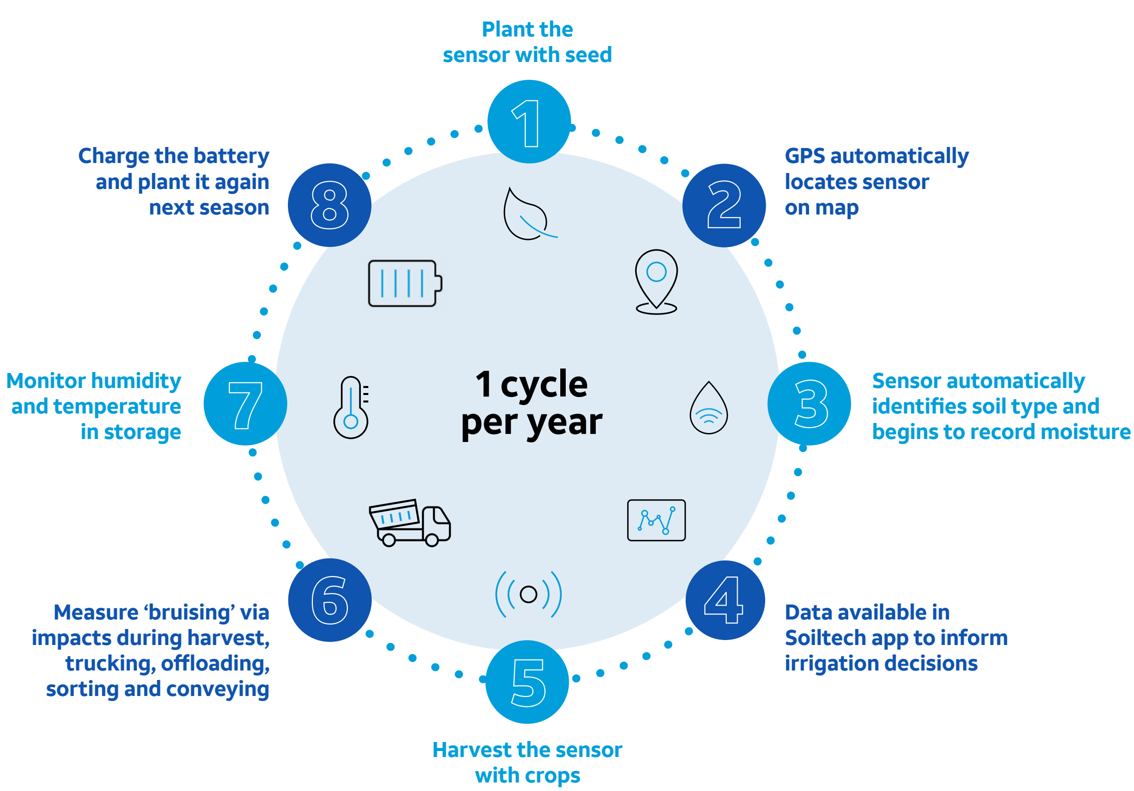
Benefits of LTE-M:

- Lower cost devices and modules
- Longer battery life
- Wide-area coverage, similar to existing 4G LTE
- Greater coverage, roaming, security, and reliability than unlicensed alternatives
- Out-of-the-box connectivity, easy deployment and ease of configuration

Soiltech has developed a rugged sensor that can be used to monitor the growth, transportation and storage of a wide range of crops. The sensor precisely records soil moisture, temperature, humidity, location and impacts that may create bruising while crops are being transported and generates near real-time data that is accessible via the Soiltech Wireless app on cellphones, tablets or computers where users can use insights to optimize their operations.

The Soiltech Sensor has no wires, no antennas, needs no gateways and is powered by AT&T's nationwide, highly secure LTE-M cellular network. This enables the device to be planted totally underground without worrying about being close to a router or power source and without interfering with machinery or operations.

One of the key benefits of the Soiltech Sensor is that it goes beyond the field, staying with the crops all the way to storage, enabling farmers to monitor the food's status throughout the process:



"It's great to have the data right there on the app. When you're really busy and you don't have time to go drive out to dig into a field, you can pull up the app and look at the readings in near real-time to see that you're okay to wait a day to go check it."

- Randy Bauscher, Owner, B&H Farms

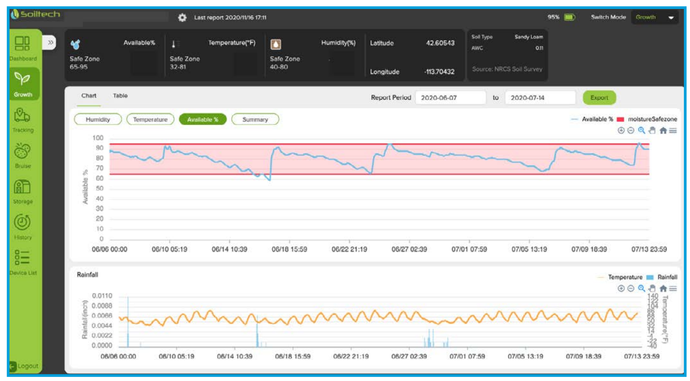
By having such complete data about crops, farmers can realize several benefits that help reduce environmental impact and improve the bottom line.

WATER EFFICIENCY

Ubiquitous soil condition monitoring makes it possible for farmers to use precision irrigation to accurately decide when and how much to water their fields.

FUEL USE REDUCTION

Having remote access to detailed crop data enables farmers to avoid trips to the fields for visual inspection. Avoiding truck rolls saves time, money and reduces emissions, all while having better data, including historical data as time passes, to use for decision making.



"This has made it to where we may not have to be in the field quite as often."

- Blake Matthews, Partner, Matthews Land and Cattle

CROP QUALITY AND YIELD

One of the only ways to increase farm profits is to increase the quality and therefore the price received for a crop, or to increase the yield per acre and sell more crops using less land. There are several ways that inaccurate water management can negatively impact crop quality and yield:

- Overwatering contributes to disease and other issues that may affect the growth or yield of the crop.
- Underwatering stresses the plant and may inhibit the plant's ability to achieve certain structural components of quality.

By effectively monitoring crops, the Soiltech Sensor helps tune watering in an effort to avoid the risks of over or underwatering.

FERTILIZER USE REDUCTION

There is a direct correlation between water use and fertilizer use. For example, if a farmer overwaters crops that have been treated with chemical fertilizers, those fertilizers will likely leech, forcing the farmer to use more fertilizer to replace nutrients that ran off. Using the right amount of water can help to optimize fertilizer use, which reduces cost and environmental impact. These benefits are difficult to measure, so they're not included in this case study.

REDUCED CROP BRUISING

By tracking the number of times the crops are bumped or bruised, the Soiltech Sensor can help farmers detect if a crop is in danger of bruising and being used for a lower-quality product.

Excessive force incurred during harvest and processing can damage the crop which may lead to disease. Fluctuating environmental conditions in storage can cause disease, such as wet rot, which is easily spread in close quarters if not quickly addressed. Monitoring temperature and humidity while observing if spikes occur can represent an early warning system.

"I'm most excited to use it for bruising, which can cost us thousands of dollars. If you can pinpoint where you're bruising by following the crop from field over the chains, conveyors and everywhere else it goes, then you can address the issue."

- Adam Nielsen, Co-Owner, Nielsen Farms

Sustainability Impact: Connectivity, sensors and analytics spotlight waste and safety issues

Originally used on potato farms in Idaho, the Soiltech Sensor has now been used at multiple locations throughout the U.S. including Washington, California, North Dakota, Nebraska, Pennsylvania, and Texas and now is tracking crop data for multiple crops such as potatoes, onions, sugar beets, sweet potatoes, hay, alfalfa, barley, corn, beans, watermelon, and cotton.

Working together with Randy Bauscher of B&H Farms in Idaho, Blake Matthews at Matthews Land and Cattle in Idaho, and using data from the Natural Resources Conservation Service (NRCS)[3], Soiltech has worked to identify the benefits of the comprehensive data and analysis that Soiltech creates. In summary there are four phases where Soiltech uses the AT&T LTE-M network to generate value and environmental benefits for the farmers that use it:

	GROWTH	HARVEST	TRANSPORT	STORAGE
Key Metrics:	• Moisture • Temperature	• Temperature • Bruise	• Bruise • Location • Temperature • Humidity	• Temperature • Humidity
Environmental Benefits:	• Water efficiency • Fertilizer efficiency • Reduced fuel use • Lower GHG	• Crop loss prevention	• Crop loss prevention • Lower GHG	• Crop loss prevention • Lower GHG
Business Benefits:	• Optimized crop yield • Increased revenue • Reduced operational costs – fuel, fertilizer, labor, water	• Reduced crop loss • Increased revenue	• Reduced crop loss • Increased revenue • Potential to reduce cost of re-transporting damaged shipments	• Reduced crop loss • Increased revenue

Wider adoption of this type of sensor could have substantial environmental benefits. If all of the potato farmers in Idaho – with crops covering 300,000 acres[4] – got results similar to the early installations, they could reduce water usage by over **15 billion gallons of water** and reduce GHG emissions by almost **66,000 million metric tons**. This is equivalent to:

Water Savings:

872 million US citizens skipping a shower[5]

Carbon Emissions Reduction:

Not burning over 7.5 million gallons of gasoline[6]

Applying the 10x Carbon Impact Methodology

Carbon Trust and BSR collaborated with AT&T in the development of a methodology to measure the carbon benefits of AT&T's Video Optimizer technology. The details of the methodology can be found on the AT&T 10x website. The table below summarizes how the 10x methodology was applied to estimate the environmental impacts described in this case study.

Description of the Enabling Technology	AT&T connectivity enables the Soiltech Sensor to monitor soil moisture, temperature, humidity, location and impacts that may create bruising while crops are being transported. These sensors can be used during the stages of growth, transportation and storage for a variety of crops. This technology helps increase yield, reduce spoilage, decrease water consumption in irrigation, and decrease farm vehicle fuel consumption by reducing need to drive for in-person monitoring of fields. Soiltech sensors also lead to a reduction of fertilizer use, though this is currently not being accounted for in this case study.
Impact Category	This case study focuses on greenhouse gas emissions and water impacts of using the Soiltech Sensor.
Materiality	The impact of using the Soiltech Sensor to monitor fields results in reductions of both water usage and GHG emissions.
Attribution of Impacts	The emissions and water savings described in this case study are a result of changes in farming practices as a result of increased monitoring and data provided by the Soiltech Sensor, enabled by AT&T IoT connectivity.
Primary Effects	Carbon savings associated with the use of the Soiltech Sensor come from four main areas: • Reduced emission intensity due to increased yield • Reduced consumption of irrigation water, resulting in less pump energy used and therefore fewer GHG emissions • Reduced spoilage of crops, avoiding the farmer having to use additional water, land, fuel, and fertilizer to achieve the contracted level of production • Reduced emissions from farm vehicles, as the remote monitoring reduces the need to physically visit the fields to check moisture levels Water savings are a result of less water used for irrigation.

Secondary Effects	There are also reduced emissions from decreased fertilizer use. No data was available to calculate this effect so it is not included in the case study results.
Rebound Effects	No rebound effects were identified.
Trade-Offs or Negative Effects	This technology does not appear to create other outsized or irreparable environmental or social impacts.
Carbon Burden from the Enabling Technology	The embodied carbon emissions of the sensors which was minimal compared with the emissions reductions.
Scope	The scope is GHG emissions from crop production (focusing on potatoes), including emissions from farm vehicles, energy for pumping water, and crop production (relating to yield and spoilage).
Timeframe	The data used in this case study relates to calendar year 2020.
Functional Unit	The functional unit for the GHG emissions reduction is metric tons CO_2e per acre per year (which is also converted into metric tons CO_2e per connection). The functional unit for water reduction is US gallons of water used per acre per year.

Methodology	The GHG emissions reductions are the sum of the emissions reductions from: • Reduced emission intensity due to increased yield • Reduced use of irrigation water, resulting in less pump energy used • Reduced emissions from farm vehicles The reduced emissions intensity due to increased yield was calculated on the basis that the use of the Soiltech Sensor results in an increase of 1 metric ton of potato crop per acre. This value is based on data collected at the BHF Farm, comparing previous year's yield in the same field (without the Soiltech Sensor). The new yield of potato crop per acre was multiplied by the average emission factor for potato production, and divided by the previous yield, to calculate the lower emissions intensity of the potato crop using the Soiltech Sensor. Subsequently, the previous yield was multiplied by the average emission factor for potato production and the new yield was multiplied by the new emissions intensity factor – the difference between these values gives us the total emissions savings per acre (tCO_2e per acre). The GHG emission savings from reduced use of irrigation water was calculated using data from the MLC Farm (2,550 acres). By using the Soiltech Sensor, a total reduction of 120,000,000 gallons of water was achieved. This total was divided by the number of acres in this farm to calculate the gallons of water saved per acre. To then calculate water emissions savings, an average US energy factor for ground water pumping (average kwh per million gallon of water pump) was used to estimate energy use and the US electricity grid was applied to convert this total into emissions. The GHG emission savings from reduced fuel was calculated using an estimated average of 100 driving miles avoided per day over 100 days out of a year, derived from estimates recorded at the BHF Farm. This average was deemed to be reasonable as the farm covers over 10,000 acres, with fields as far apart as 300 miles. The 100 days reflects the average growing period for potatoes. Total miles avoided (miles avoided per day * 100 days) was multiplied by the emission factor for a dual purpose 4x4 to give us total avoided emissions in tCO_2e.
Key Assumptions	• Assumed that the savings monitored are a sole result of Soiltech's sensors

Exclusions	• Embodied carbon emissions of the sensors • Emission reductions from reduced fertilizer use
Data Sources	• Potato emission factor (Ecoinvent) • BHF and MLC Farms data (annual yield increase, spoilage reduction, mileage reduction, and water reduction) provided by Soiltech • Petrol dual purpose 4x4 emission factor (BEIS 2019) • Water pumping emission factor (Food and Agriculture Organization of the United Nations (FAO) Aquastat & eGrid)
Results	
Carbon Abatement Factor	Annual GHG savings of 0.23 metric tons CO_2e per acre from the use of the Soiltech Sensor. This comprises: • 0.17 metric tons CO_2e/acre from increased yield • 0.0004 metric tons CO_2e/acre from reduced vehicle fuel consumption • 0.06 metric tons CO_2e/acre from water pumping savings Note that calculating GHG emissions associated with agricultural processes is subject to significant variability. This can be due to differing meteorological conditions (such as temperature and rain fall), differing soil conditions and other variations from farm to farm and field to field. Assuming one sensor per 30 acres, this equates to an annual GHG reduction of 6.81 metric tons CO_2e per connection.
Water Savings Factor	Annual water savings from the use of Soiltech sensors is 54,902 US gallons per acre. This is based on the recorded savings at the MLC Farm in 2019, which achieved 120,000,000 US gallons of water reduction in irrigation.

Endnotes

1. "How to Sustainably Feed 10 Billion People by 2050, in 21 Charts," World Resources Institute December 5 , 2018, https://www.wri.org/blog/2018/12/how-sustainably-feed-10-billion-people-2050-21-charts

2. "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (Note, average eGRID electricity factors have been used rather than marginal AVERT electricity factors, this being a more conservative savings estimate)

3. "Description of SSURGO Database," United States Department of Agriculture, Natural Resources Conservation Services, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627

4. "Idaho potato acres dip below 300,000 for second time since 1970," Idaho Farm Bureau Federation, July 1, 2020, https://www.idahofb.org/News-Media/2020/07/idaho-potato-acres-dip-below

5. "Indoor Water Use," homewaterworks, https://www.home-water-works.org/indoor-use/showers
15 billion gallons/17.2 gallons per shower = 872 million showers

6. "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (Note, average eGRID electricity factors have been used rather than marginal AVERT electricity factors, this being a more conservative savings estimate)