



5G: A CATALYST TO TRANSFORM AGRICULTURE

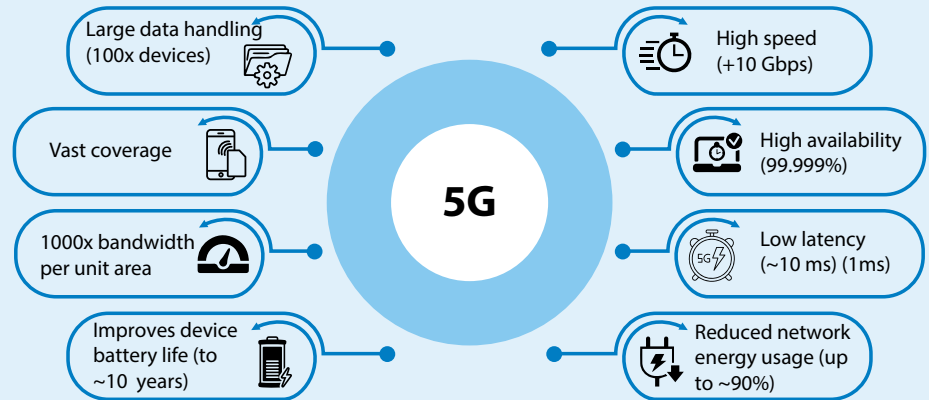
Agriculture goes back thousands of years. Traditionally, farming was a labor-intensive process. Until the last century, agricultural practices were routine and predictable with a few innovations. However, a booming population and old ways of labor-intensive farming could not match the rising demand for food. Availability of farm labor was a concern in the wake of industrialization and urbanization. These factors contributed to several innovations in agriculture.

In the last 100 years, advances in machine technology (mechanization and automation) and chemical fertilizers boosted productivity and yield of agriculture. Mechanization not only replaced workers, but also became ubiquitous and accessible. As technology matured, it became more affordable. 5G technology is bound to have a similar effect on farming by introducing automation, improving productivity and crop yield, and enabling real-time knowledge sharing of agricultural inputs.

5G, with its lower latency, higher capacity, and increased bandwidth, will enable technology such as

Internet of Things (IoT), augmented reality (AR) and virtual reality (VR) to become more mainstream.

Some of the key, though currently theoretical, value propositions offered by 5G are:



These value propositions will significantly improve how current agricultural solutions impact farming, and how incremental value accrues from new-age technologies.

Smart agriculture will benefit substantially with the integration of 5G, enabling:

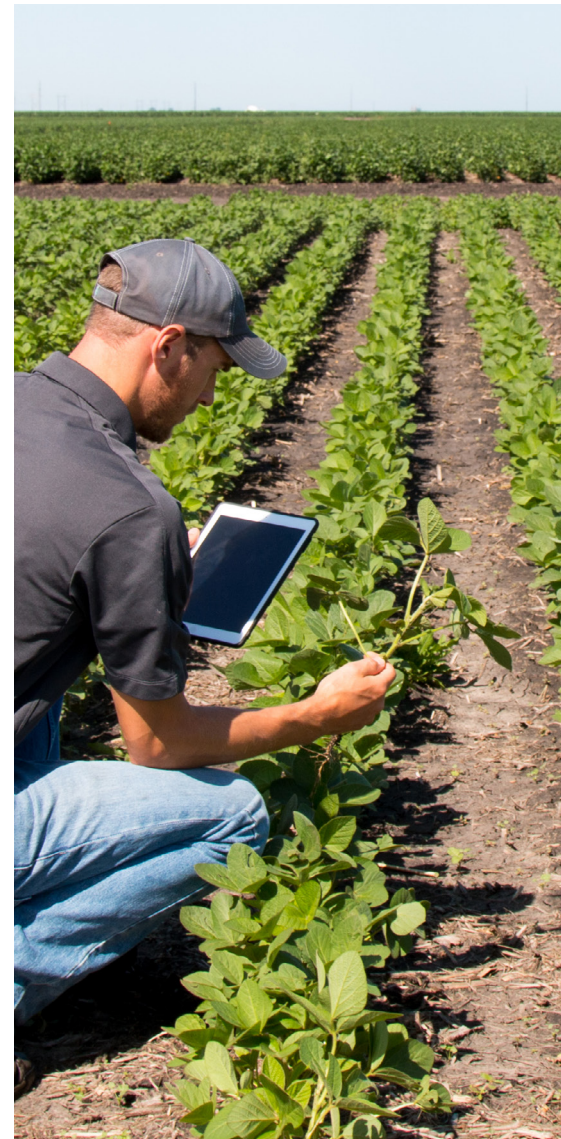
The impact of 5G transcends the farm gate and enables efficient distribution of farm produce through deployment of 5G use cases in the storage and logistics domains. Some key impact areas cover:



- Remote farm monitoring
- Variable rate application
- Autonomous farm equipment
- Livestock tracking and monitoring
- Agri-collaboration platforms
- Computer vision-based selective harvesting
- Connected farmers
- AR- and VR-based farmer training
- Remote irrigation control



- Real-time cold chain and logistics tracking and monitoring
- Warehouse monitoring
- Geofencing and real-time route optimization
- Connected driver and connected worker (warehouse, processing plant)
- Remote vehicle health monitoring
- AR-based on-road support
- AR- and VR-based driver training



5G will accelerate the 'concept-to-product' lifecycle of solutions that are being researched for a business use case.

Innovation in the metaverse will also accelerate with the availability of 5G, and this will trickle down to the agricultural domain.

Imagine an agricultural metaverse where all stakeholders, such as growers, agriscientists, contractors, farm equipment and leasing service providers, financiers, logistics providers, warehouse and silo service providers, insurance companies, are available for advice, negotiations, discussions, services, and sharing of knowledge. Their services and transactions can be managed via a blockchain solution to help stakeholders with secure contracts. The agriculture metaverse will enable innovation, networking, and partnerships, while blockchain will ensure authenticity, trust, contracts, and seamless transactions.

Let us evaluate key areas where 5G will impact agriculture, and boost productivity and crop yield.

Agricultural drones

Some of the biggest beneficiaries of 5G are drones, enabling farmers with large landholdings to remotely monitor large tracts of farmland. 5G will enable drones flying overhead to provide real-time reports of farm conditions. Drones can be used to check crop damage, pest infestation, track farm equipment, and locate injured farm workers. Agri-specific drones with accessories to carry fertilizers and chemicals can be used for overhead spraying to facilitate precision farming.

5G will also increase the use of machine learning (ML) algorithms to analyze images captured by drones and identify pest types, pest damage, and crop stress.

Autonomous farm equipment

Developments in agricultural technology enable tractors to work autonomously in fields. With 5G, server-side computing will move to the edge, enabling autonomous tractors and harvesters to react promptly to situations. With 5G allowing for high-speed data transfer, these autonomous farm vehicles will be able to sense obstacles faster and take decisions quickly. They will be able to navigate smoothly, avoiding obstacles or animals.

Agriculture sensors

Sensors installed in the fields to monitor, actuate, and report will see further improvement in efficiencies with 5G. Leaf wetness sensors, tensiometers (soil moisture), ambient temperature sensors, light sensors, accelerometers, motion sensors, and GPS sensors used in agriculture are power-hungry. Battery

failure and expensive replacement costs make these sensors a costly proposition. With 5G, battery power requirements will be lower, and sensors' active life will be longer.

Collaboration tools

On-field inspection and reporting of soil, crops, pests, and equipment status by farmers and growers will be enhanced with 5G. Farmers will be able to compare notes and collaborate with the farming community and agronomists in real time, directly from the field. Agronomists can host advisory sessions and training sessions over live streaming platforms so that farmers can receive feedback in real time. Over a live stream, farmers can broadcast their agricultural fields and post specific queries to agronomists who can remotely observe and provide advice and suggest interventions.



Infosys and 5G in agriculture

Infosys Smart Agriculture Solution is an open-source, IoT-based platform deployed on the cloud, providing agricultural users with multiple solutions for actionable insights and decision support. The solution also triggers remote farm monitoring equipment and enables remote actuation controls. The platform is currently live at our own smart farm within the Hyderabad campus. This pilot farm is equipped with IoT-based sensors for real-time monitoring,

a remote automated irrigation system, and a drone for crop stress monitoring. The farm leverages machine learning algorithms for crop stress identification.

To make it 5G ready, our team has developed use cases on top of the Infosys Smart Agriculture platform so that our clients can envision how a future-ready agricultural platform benefits farmers. Some of these use cases include:

- **Live collaboration**
5G will allow live collaboration between farmers in the field and agronomists working remotely. Farmers and growers can interact seamlessly, discuss live crop and pest problems, and undertake troubleshooting of crop and field issues. Agronomists can also schedule training and conduct live sessions from the field rather than an office or university.

The screenshot shows a webinar interface for 'Infosys Smart Agriculture'. On the left, there is a 'Public Chat' window with a list of messages from 'john doe' (8:55 PM to 8:58 PM) discussing the platform's features, such as being an IoT-based platform, AI and AR powered, and having a nice UI. The main area shows a video call with four participants and a presentation slide titled 'Infosys MERIDIAN'.

The screenshot shows a webinar interface for 'Infosys Smart Agriculture'. On the left, there is a 'Schedule a Session' form with fields for Title, From Date (2021-07-13), To Date (2021-07-13), From Time (03:41 PM), and To Time (03:41 PM), and a 'Schedule' button. On the right, there is a 'Sessions' table with columns for Title, Date, From, To, and Join.

Upcoming		Past		
Title	Date	From	To	Join

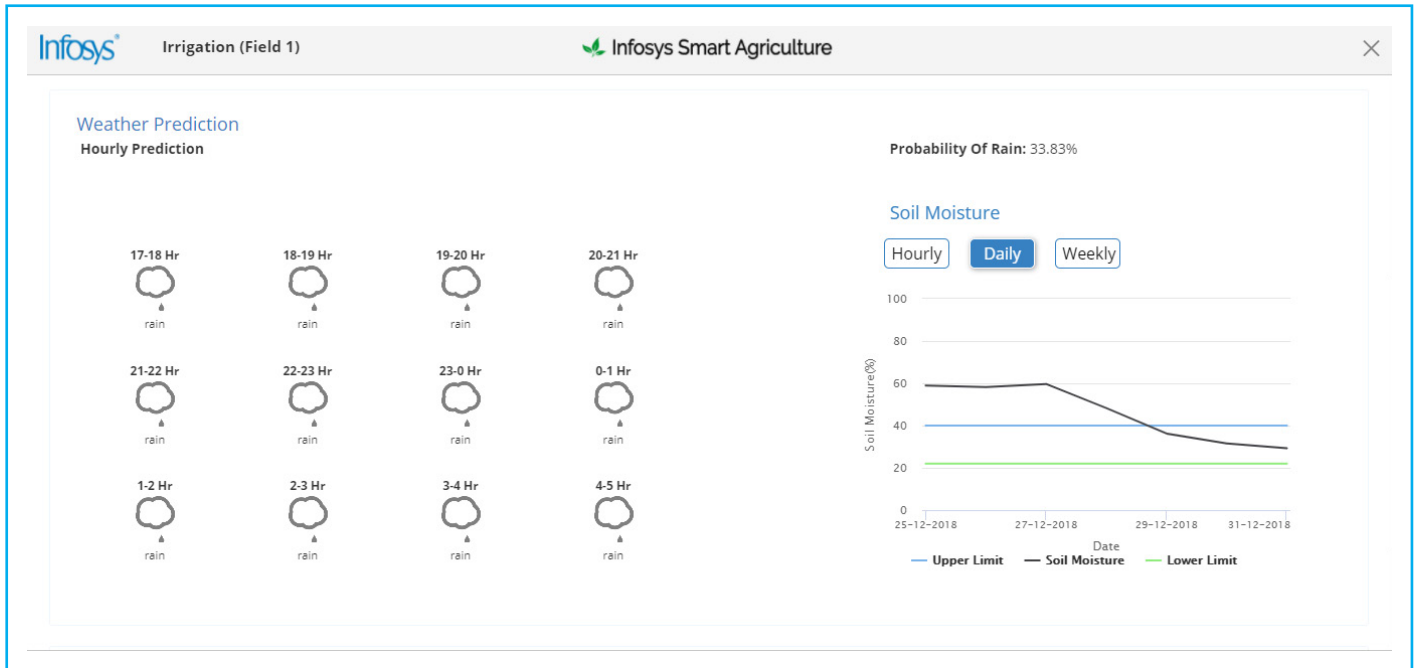
- **Variable rate optimized fertilizer application**

To further augment precision agriculture capabilities, farmers can use our platform powered by 5G. A combination of an agricultural drone with multi-spectral camera, image processing software, aerial / tractor-fit spraying ancillary, and 5G will optimize the fertilizer application using variable rates.



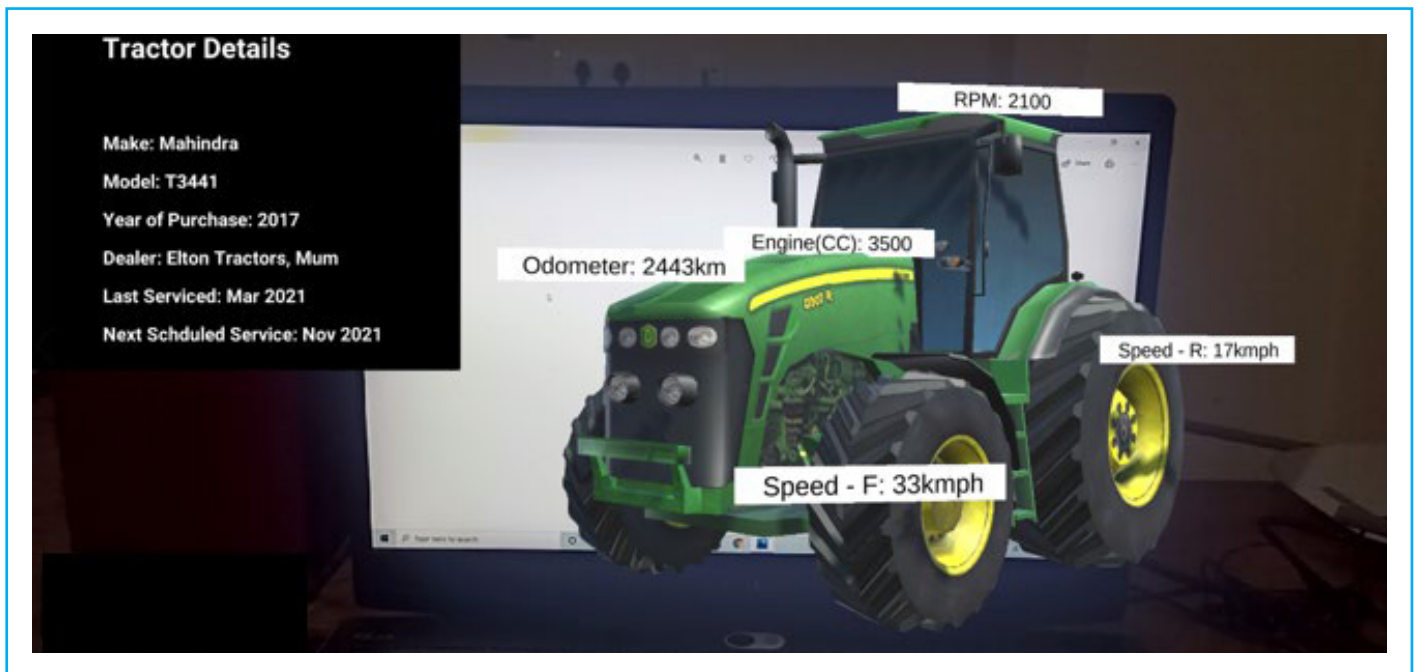
- **Automated remote irrigation**

A combination of IoT, modern irrigation systems, and 5G will enable field-level sensors to detect the moisture levels in the ground in real time and actuate the supply or stoppage of water. This will help conserve natural resources and be useful especially in regions where water for irrigation purposes is scarce.



- **On-field farm equipment condition monitoring using AR**

Farm equipment on the field may require unplanned downtime which can have an adverse impact during peak agricultural season. IoT and sensor-enabled farm equipment can relay real-time conditions to the farmer who can visualize field conditions in AR.



- **Agri product assistance using AR**

Farmers can access product information and usage instructions on the field using AR capabilities. 5G helps farmers experience the product in AR which can augment product manuals and label instructions.



Conclusion

5G is set to revolutionize agriculture. Our use cases demonstrate how the Infosys Smart Agriculture Solution combines the best of IoT, AR, ML, and 5G to offer farmers real-time, remote data from the farm. Farmers can collaborate, monitor, actuate, control, and take decisions on the

go. Irrespective of farm locations, digital apps such as Infosys Smart Agriculture connected over 5G enhance a farmer's digital capabilities.

Farmers and growers can improve yield, boost farm productivity, optimize resource consumption, and foster conservation

while lowering the cost of operations. It provides an opportunity for stakeholders in the agriculture value chain to use 5G and enhance their product features and capabilities.

The future of agriculture is digital technology, and 5G will be the catalyst.

About the Authors



Alok Sharma

Senior Industry Principal | Alok_Sharma08@infosys.com

Alok has 28+ years of experience working across multiple organizations from Products to Solutions for multiple industry verticals viz. Energy, Utilities, Manufacturing, Mining to Agriculture. In his current role as Head of IoT, AI & New Tech for Manufacturing, Resources and HiTech, he partners with customers in their Digital Transformation Journey leveraging multiple technologies from IoT, AI, AR/VR etc. to create innovative solutions which deliver value across their business value chain.



Avinash Kamat

Principal Consultant | avinash_kamat@infosys.com

Avinash has 20+ years of experience in consulting clients across Manufacturing, Resources, Agriculture and Telecom industries on understanding and adopting new technology use cases. He consults in areas of Machine Learning, Internet of Things, AR/VR and 5G. He also has vast experience executing complex transformational projects across the globe.

For more information, contact askus@infosys.com



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