

# THE FUTURE OF FARMING

How Mobile IoT technologies  
can help agriculture feed the world



2018

## ABOUT THE GSMA

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with over 350 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces industry-leading events such as Mobile World Congress, Mobile World Congress Shanghai, Mobile World Congress Americas and the Mobile 360 Series of conferences.

For more information, please visit the GSMA corporate website at [www.gsma.com](http://www.gsma.com). Follow the GSMA on Twitter: [@GSMA](https://twitter.com/GSMA)

## ABOUT THE GSMA INTERNET OF THINGS PROGRAMME

The GSMA's Internet of Things Programme is an industry initiative focused on:

**COVERAGE** of machine friendly, cost effective networks to deliver global and universal benefits

**CAPABILITY** to capture higher value services beyond connectivity, at scale

**CYBERSECURITY** to enable a trusted IoT where security is embedded from the beginning, at every stage of the IoT value chain

By developing key enablers, facilitating industry collaboration and supporting network optimisation, the Internet of Things Programme is enabling consumers and businesses to harness a host of rich new services, connected by intelligent and secure mobile networks.

Visit [gsma.com/iot](http://gsma.com/iot) or follow [gsma.at/iot](https://twitter.com/gsmaat/iot) to find out more about the GSMA IoT Programme.

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## INTRODUCTION

With the world's population set to rise to about 10 billion by the middle of this century, agriculture everywhere will need to become more efficient. To properly feed a further two billion people in 2050, food production will need to increase by 50 per cent globally, according to the United Nations, which has specified "zero hunger" as one of its Sustainable Development Goals to be achieved by 2030. At the same time, many farmers are confronted by rising energy prices, water shortages, the continuing loss of farmland to urbanisation, and tighter environmental regulations.

These factors are driving a shift towards sustainable farming, which seeks to increase yields and the quality of product without impacting natural resources and increasing costs. New precision farming systems, which track key parameters, such as soil temperature, soil moisture, water consumption, water pH, humidity and air temperature, can be used to monitor the health of crops and livestock and control irrigation and the deployment of pesticides. This real time data enables farmers to prevent problems arising, reduce operating costs and make the most of the available land, while limiting their impact on the environment.

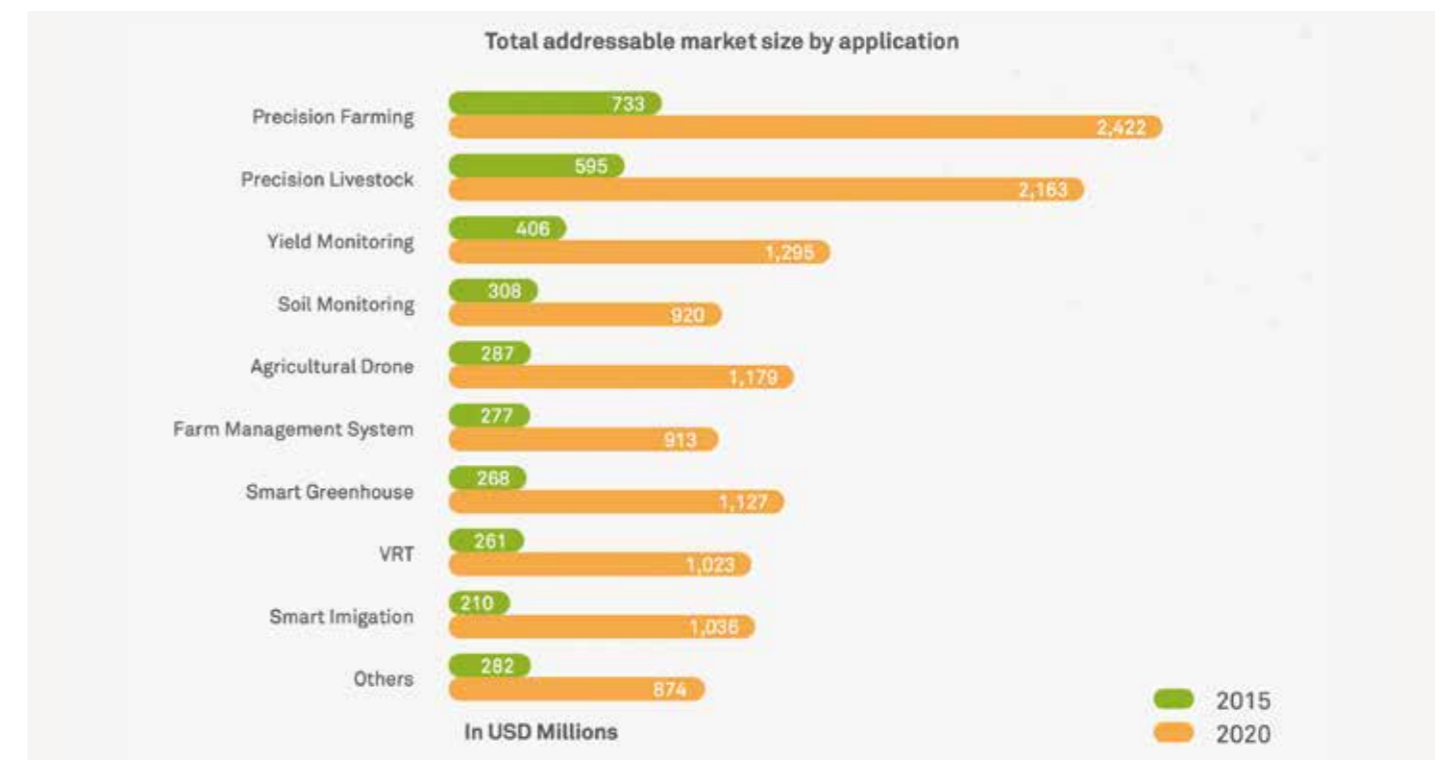
As mobile networks now cover large swathes of the globe, encompassing rural areas, as well as towns and cities, mobile operators can provide producers with the connectivity they need to adopt precision farming methods. In particular, new Mobile Internet of Things (IoT) technologies provide much better coverage than conventional cellular networks, making it feasible for farmers to connect large numbers of sensors, which can be used to track livestock and monitor growing conditions across broad geographic areas. At the same time, farmers can use Mobile IoT-based solutions to monitor

storage conditions in real time, to help keep food fresh and safe, while assuring provenance and decreasing supply chain fraud.

The Mobile IoT technologies - NB-IoT and LTE-M - provide low power wide area connectivity well suited to enabling smart agriculture solutions. Operating in licensed spectrum, these technologies are designed to deliver secure and reliable connectivity from mobile operators, which can enable battery-powered sensors to transmit data to the farmer's central control system.

Telecommunication equipment maker Huawei anticipates the global market for smart agriculture solutions will grow from US\$13.7 billion in 2015 to US\$26.8 billion by 2020 with a compound annual growth rate (CAGR) of 14.3%. Within that, the total addressable market for mobile operators in agriculture could be US\$12.9 billion by 2020, according to Huawei (see Figure 1). Moreover, Machina Research has forecast that agriculture will be one of the fastest growing sectors of the IoT, rising from 13 million connections at the end of 2014 to 225 million by 2024.

Figure 1: Smart agriculture represents a growing market for mobile operators



Source: Huawei

As well as providing optimal connectivity, mobile operators are also developing increasingly sophisticated solutions to analyse the data from agricultural sensors along with other relevant information, such as current and forecast weather conditions, and data on the spread of diseases and pests. By applying techniques such as analytics and machine learning, mobile operators can offer intelligence services that give predictions and advice to farmers, such as the amount and location of irrigation and fertiliser application required. This combination of

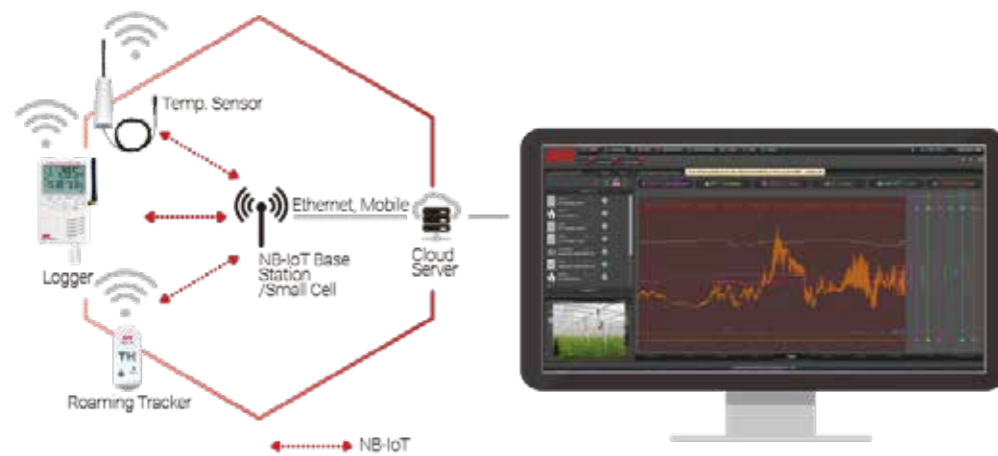
connectivity and IoT Big Data services, supported by a well-developed ecosystem of partners, means that many mobile operators can provide a holistic offering to customers in the agriculture sector.



## THE CONNECTED GREENHOUSE

Mobile IoT technologies can be used to help monitor and control the conditions inside greenhouses to optimise the growth of the crop. Mounted inside the greenhouse, connected sensors can transmit data to an application that gives the grower a clear and real-time overview of the temperature and humidity levels throughout the structure. The grower can then adjust conditions for example, by applying heated air to the crop.

Figure 2: Environment Monitoring & Automated Control Platform



Chunghwa Telecom of Taiwan and Nietzsche Enterprise (NHR), an IoT technology provider, have developed an end-to-end smart agriculture solution, called Sentrol Cloud. It encompasses a set of NB-IoT-connected temperature and humidity sensors that can accurately monitor the climate inside a greenhouse, which can then be visualised through a web interface or mobile app. The same architecture can be used to track the moisture and temperature levels in both the soil and the air, while also monitoring the acidity levels in water, light levels and energy consumption, among other parameters.

Designed to help the grower ensure consistent conditions and increase productivity, the system provides alerts when certain parameters are breached, while also generating trend data for analysis. Horticultural company Tomato Ark has deployed the system to monitor conditions in its greenhouses in Taiwan. Having installed 12 sensors for each hectare, Tomato Ark can now “eliminate problems in the crop at once,” says Benson Kuo, Director of Tomato Ark, by visualising conditions on a heat-map and making adjustments in real time. “Normally, growers can only see afterwards where mistakes have been made, but now we have an immediate overview,” adds Benson Kuo.

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The solution employs sensors originally developed for open field cultivation, and adapted for use in a greenhouse in cooperation with horticulture companies based in the Netherlands, Germany and Taiwan. Filter caps protect the sensors from moisture, as well as harmful and oxidant substances, while the communication software has been optimised for reliability and to minimise energy consumption.

Although the sensors measure both temperature and humidity, Tomato Ark is primarily focused on optimising the former. “We are taking it step by step, first looking at how to prevent temperature disparities,” says Benson Kuo.

Figure 3: NBIOT\_TH\_Sensor





## COST-EFFECTIVE, POWER-EFFICIENT TECHNOLOGY

After a careful evaluation of the connectivity options available, NHR chose to use NB-IoT to support the Sentrol Cloud system. “For growers, there was a great need for production support based on concrete data; therefore, we looked at what the best available connectivity is, which turned out to be NB-IoT,” explains Johnson Chang, Executive Vice President of NHR. NB-IoT’s low power requirements means the system can employ compact and cost-effective sensors. The sensors “use AA batteries, which makes them user-friendly and keeps annual costs low,” says Johnson Chang.

As well as providing cost-effective and power-efficient connectivity over a wide area, NB-IoT has several other key attributes that appeal to farmers and growers. Crucially, NB-IoT employs existing cellular base stations, rather than a new gateway, meaning the grower doesn’t need any IT skills to install the solution, according to NHR.

The use of NB-IoT also means the farmer can benefit from managed connectivity provided by public cellular networks run by mobile operators. Reliability is further bolstered by the use of licensed spectrum, meaning NB-IoT isn’t going to suffer interference from other wireless technologies.

For NHR, the integration of NB-IoT services into Chunghwa Telecom’s billing system is also helpful. It means the customer can buy a bundle of services from the operator, which can then be settled by a single payment. Mobile networks’ built-in authentication systems and encryption also help to keep the solution and the data secure.

Johnson Chang says NB-IoT’s encryption model is more advanced than that of any other technology, while noting that the technology benefits from the backing of a large and mature ecosystem led by mobile operators.

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## LESSONS LEARNED AND NEXT STEPS

NHR believes one of the most important attributes of Sentrol Cloud is the ease of installation, which is partly due to the use of NB-IoT, which can connect directly to a cellular base station without the need for a gateway or cables. “Firstly, 100 nodes can be deployed in one day by one man meaning the grower can see/visualise the real uneven problem in just one day after the project kicks off,” says Johnson Chang. “Then, it is purely DIY products for growers. It is just drop-and-play, without the IT headache.” NHR said the decision to move to NB-IoT was driven by market demand for a simple installation process that requires zero configuration.

The solution also meets growers’ need for a rapid return on investment, according to NHR. Once the grower can visualise problems via the heat map, they can immediately take corrective actions and see positive results within hours. For example, humidity can be controlled by applying heated air on the crop. “In combination with the heat maps, this can save more than 20% of the costs,” notes NHR.

By increasing predictability, NHR says an end-to-end monitoring system can also make it easier for farmers to get funding from banks or other sources: The farmer can show a lender real data demonstrating they have precise control over growing conditions.

NHR is now testing a cross-operator proposition designed to support cold chain logistics. This solution employs NB-IoT-connected tracking tags and a Blockchain protocol for data integrity, enabled by Edge Computing. “This [concept] can be expanded past the initial agriculture stage,” says Johnson Chang. “When crops are harvested, they then need to be transported. The sensors can be applied in cold chain logistics to ensure that the crops are located and kept at the right temperature during transportation.”

Mobile IoT technologies can also support many other aspects of agriculture, including pest control. For example, Chunghwa Telecom has integrated electric field sensing technology and Mobile IoT connectivity into a pheromone trap, enabling it to transmit data on the number of insects captured, as well as environmental data such as temperature, humidity and light levels. By automatically collecting data, the solution greatly streamlines the process of documenting pest outbreaks, enabling the government’s agriculture department to develop heat maps farmers can use to forecast future outbreaks and take advanced precautions.

**“In combination with the heat maps, this can save more than 20% of the costs,” Notes NHR**



## CONCLUSIONS

The commercial deployment of Mobile IoT technologies is set to drive a major expansion in precision agriculture. The low power wide area coverage provided by NB-IoT and LTE-M networks enables connected sensors to be easily deployed in greenhouses, open fields, warehouses and supply chains. Moreover, mobile operators can ensure the connectivity is both reliable and secure. As no gateways or cables are needed, farmers can install these sensors themselves, reducing their costs and increasing flexibility.

Once a monitoring system is in place, the farmer will enjoy much greater control over the productivity of their land. Connected sensors can provide detailed environmental and behavioural data that can help increase crop yields, reduce livestock losses and prevent produce from spoiling during transport. Analysed using IoT Big Data services, the information produced by the sensors can be used to inform the 40 to 50 decisions<sup>1</sup> farmers have to make about each individual field each growing season. For example, precision agriculture techniques can reduce the

consumption of fertilisers<sup>2</sup>, by enabling lower application rates in areas where there is less nitrogen run-off, while also increasing yield by 10-15%, according to research firm Berg Insight. In dairy operations, precision livestock farming technologies are used to optimise the milk yield from each animal: Each day a cow remains dry can cost a dairy producer up to US\$6 in reduced profitability<sup>3</sup>.

Given these clear benefits, mobile operators, their networks and their IoT Big Data services are set to play a central role in enabling agriculture to become far more efficient and meet the needs of the expanding global population.

<sup>1</sup> Source: Berg Insight IoT Now - Q2 2018

<sup>2</sup> The uniform application of fertilisers across a field leads to over-fertilisation of roughly 40% of the area, according to Berg Insight IoT Now - Q2 2018.

<sup>3</sup> Source: Berg Insight IoT Now - Q2 2018

## ABOUT THE MOBILE IoT INNOVATORS

The GSMA Mobile IoT Innovators is the official industry community for LPWA technologies in licensed spectrum. Uniting over 1000 companies and bringing operators, vendors, manufacturers, developers, consultants and end customers together, the Mobile IoT Innovators provide a vibrant ecosystem around Mobile IoT.

To find out more and join for free to receive exclusive benefits, please visit [gsma.com/miotti](https://www.gsma.com/miotti)

## ABOUT CHUNGHWA TELECOM

At Chunghwa Telecom, our long-standing legacy and success have been built on principles of good corporate governance, sound ethics, strong integrity and respect. We are committed to clear, consistent communication with our shareholders and to maintaining the highest levels for financial transparency. We aim to provide our investors, employees, and customers the public information that gives a clear and transparent description of our business operations and performance. Maintaining these highest standards of governance, integrity, responsibility and accountability is important to our continued long-term growth and success. These are the values on which Chunghwa's foundation was built and that will continue to drive us moving forward.

## ABOUT NHR

Nietzsche Enterprise Co., Ltd. (NHR), est. 1978, an IoT Sensor Company, has been engaged in wireless communication and sensing verticals for over 35 years and continues to focus on meeting current and future market needs via Low-Power-WAN Sensing Network. NHR's design center and factory are in Taipei, Taiwan, with a commitment to solving constraints from wires and cables through delivering intuitive, convenient, reliable, and rapid return on investment Lower-Power-WAN solutions to customers. Services include end-to-end solutions in parking, agriculture, logistics/transportation, energy & water management, security & maintenance, industrial, asset management, and aquatic. Recently NHR is moving towards MVNO providing Sensing-as-a-Service model for verticals to create more mobile IoT experiences.

