HUAWEI

The Connected Farm

A Smart Agriculture Market Assessment

Xploration Begins Here

MARKETSANDMARKETS

TABLE OF CONTENTS

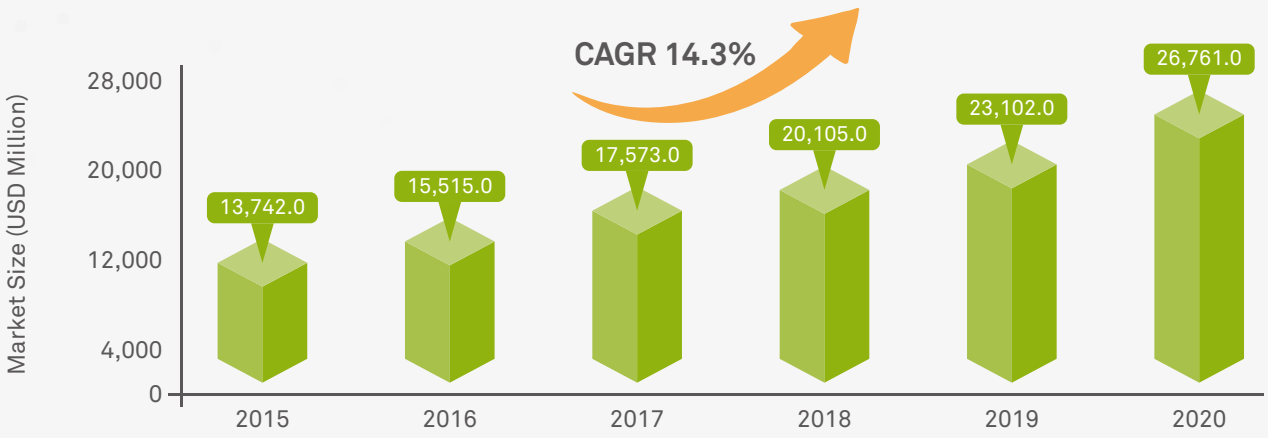
Overview

Internet of Things (IoT) technology is expected to play a significant role in enhancing agricultural productivity to meet food demand. Smart agriculture incorporates IoT-based advanced technologies and solutions to improve operational efficiency, maximize yield, and minimize wastage through real-time field data collection, data analysis, and deployment of control mechanism. Diverse IoT-based applications such as variable rate technology, precision farming, smart irrigation, and smart greenhouse will be instrumental to the enhancement of agricultural

processes. IoT can addressagriculture-based issues and increase the quality and quantity of agricultural production, making farms more intelligent and more connected. The total addressable market for smart agriculture is expected to grow from USD 13.7 billion in 2015 to 26.8 billion by 2020 with a compound annual growth rate (CAGR) of 14.3%.

The total addressable market for smart agriculture is expected to grow from USD 13.7 billion in 2015 to 26.8 billion by 2020 growing at a CAGR of 14.3%.

Smart agriculture market size forecast (2015–20)



Market dynamics

Drivers

Climate Change – Climate change will significantly impact agricultural production. A global agricultural zone expected to be affected by such issues is Brazilian's Mato Grosso. This state may witness an 18% to 23% decline in the production of soy and corn by 2050. Similarly, Midwestern U.S. and Eastern Australia will experience a decrease in agricultural production due to extreme heat. These severe weather conditions will stimulate the deployment of IoT-based solutions in agriculture to increase yield and improve efficiency.

Need for Water Conservation – Agriculture consumes nearly 70% of fresh water. Since water scarcity is becoming an increasingly significant problem across the globe, the efficient utilization of water for agricultural activities requires more attention. Proper technologies can help reduce water consumption by 10%. Applications such as smart irrigation systems will help to save water in agricultural applications. Leveraging IoT for water conservation will be a major trend in the future of agriculture.

Emphasis on Enhancing Efficiency – Smart agriculture enables farmers to minimize costs and the efforts associated with agricultural activities. Smart agricultural technologies help to optimize various agricultural resources such as seeds, fertilizers, and pesticides along with human labor. Advanced technologies enable reduced energy consumption and fuel usage. Smart agriculture enhances productivity by guiding farmers to expertly invest both time and resources in the appropriate combination to achieve the perfect balance for optimized production.

Restraints

Fragmented Agricultural Market – The agricultural sector is not dominated by a few major players but consists of many small players that offer solutions for various phases of agricultural value chain. Farmers find it difficult to achieve economies of scale through the deployment of solutions pertaining to only part of the agricultural process. For instance, solutions on reducing costs for transportation or irrigation are in themselves of limited help in maximizing return on investment (ROI).

Lack of Connecting Services for the Agricultural Market – Connections remain to be a key hurdle as connecting services in agriculture have not yet reached the technical maturity level seen in other verticals, such as retail and automotive. However, connectivity providers are on a constant pursuit to expand services for the agricultural sector by partnering with other players. This revelation will ensure that the challenges surrounding this topic to be addressed in the near future.

High Capital Investment Requirement – Farmers must lend significant initial investment to establish and revolutionize the existing field infrastructure set-up to deploy a capable and sustainable IoT ecosystem. The high cost of adopting such smart solutions is a serious challenge for farmers in developing countries such as China, Brazil, and India.

Data Management for Agricultural Decision Making – Data aggregation and data management is a troubling obstacle for the smart agriculture market. One considerable barrier in the efficient use of data is the lack of industrial standards for data management applications in smart agriculture-based solutions. The difficulty is rooted in the requirement to standardize the data management system throughout the agricultural industry to ensure the widespread uniformity of operations.

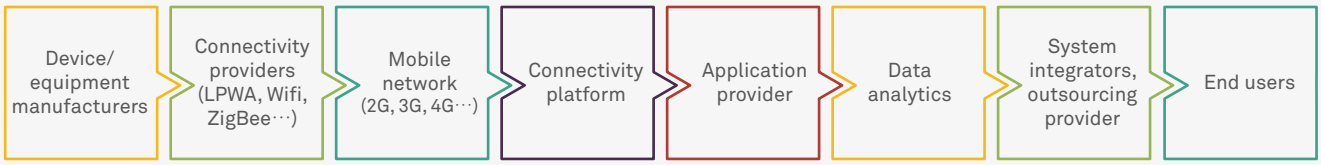
Opportunities

Expansion of Smartphone and Internet Penetration – Farmers are increasingly reliant on smartphones and other intelligent mediums to keep up-to-date about the latest development in the agricultural sector. Farmers depend upon broadband and other wireless networks to stay updated and participate in specific industry directed knowledge sharing initiatives. Also, resources are now available to farmers in a wide range of languages, which helps the spread of awareness on industry proficiency. In addition, web-based agricultural institutes such as the Agricultural Learning Repositories Task Force are gaining huge popularity among farmers.

Increasing Public-Private Partnership – Governments, agriculture development authorities, and state-owned enterprises are enjoying further cooperation with agro-processing organizations, financial institutions, and food and beverage manufacturers to promote the growth of sustainable agriculture initiatives. These initiatives aim at increasing productivity, food security, and efficiency of agricultural processes. The public-private partnerships provide an invaluable source of empowerment to the agricultural sector with more advanced technologies and improved management process, opening up new revenue streams. Such partnerships will also promote the adoption of IoT solutions across the globe.

Increasing Adoption of Technologies – Farmers are growing increasingly dependent on technologies in their daily day-to-day activities. Connected technologies such as low power wide area (LPWA), Zigbee, WiFi, and additional wireless sensor technologies enable farmers to efficiently plan and execute various agricultural operations, such as purchasing, inventory control, planting, and harvesting.

Value chain



As indicated in the above value chain, different types of solution providers from device manufacturers

to system integrators contribute to the deployment of IoT and technological services in smart agriculture. The stakeholders in the smart agriculture value chain include device and equipment manufacturers, connectivity providers, application providers, hosting and analytic service providers, wireless connectivity providers, mobile operators, and system integrators. Information about farms is collected through field sensors and transmitted via connectivity providers (LPWA and mobile operators). This information is then received by system integrators and solution providers who will process the data and deliver the result to the end users via mobile or web applications.

System integrators such as IBM, Agribotix, Accenture, Logica, Trimble, and Navcom play an important role in the integration of the software and hardware equipment. These companies are also involved in diagnosing and troubleshooting farm management solutions, which requires the development of new concepts related to software and hardware equipment. System integrators and solution providers support the other sub-systems in the smart agriculture value chain by allowing for the same language to be spoken. This step helps to harmonize the processes and

activities between various stakeholders. However, the challenge here is the inherent and intrinsic nature of standardization and interoperability.

From telecom's perspective, providing mainly connectivity services has the immense potential to heavily influence multiple facets across the value chain.

In the future, mobile operators can provide three categories of services in smart agriculture for increased market share.

Connectivity – Most telecom operators around the world are offering connectivity services, but these services only represent a highly limited proportion of the entire smart agriculture market.

Vertical Integration – Telecom operators can offer end to end solutions in smart agriculture and not just connectivity services. This will certainly lead to an exponential increase in the market share of mobile operators. However, vertical integration demands significantly higher investment to be made in this area before further measures and benefits can be seen.

Partnership – Collaboration with equipment and device manufacturers, solution providers, non-cellular connectivity service providers such as LPWA, system integrators, and application developers across the smart agriculture ecosystem help operators to enter deeper into the industry while increasing their market share. This provides a unique opportunity to create strong relationships with organizations by leveraging brands and assets to help educate farmers on the benefits of smart agriculture.

Telecom operators can support IoT deployment at multiple levels. Beyond connectivity, they can provide provisioning, authentication, security, billing, device management, location-based services, application enablement, and analytic services. In a number of cases, mobile operators are likely to provide these capabilities to LPWA users as cloud services that can be easily accessed via application programming interfaces (APIs). Additionally, operators can manage LPWA networks in the same way they manage existing networks.

Applications of IoT in Smart Agriculture

Several IoT-based applications in smart agriculture are designed to enhance productivity. Major applications of IoT for smart agriculture include:

Precision Farming: Precision farming is an approach to farm management that uses IoT and information and communication (ICT) technologies to optimize returns and ensure the preservation of resources. Precise farming entails the obtaining of real-time data on the conditions of crops, soil, and air. This approach aims at ensuring profitability and sustainability while protecting the environment.

Variable Rate Technology (VRT): VRT refers to any technology which enables producers to vary the rate of crop inputs. It combines a variable-rate (VR) control system with application equipment to apply inputs at a precise time or location to achieve site-specific application rates of inputs.

Smart Irrigation: The need to enhance the efficiency of irrigation processes and minimize water losses is on the rise. There is an increasing awareness on the conservation of existing water resources by employing sustainable and efficient irrigation systems. IoT-based smart irrigation measures various parameters such as humidity, soil moisture, temperature, and light intensity to calculate the precise requirements for water. It has been proved that such mechanism can contribute to higher irrigation efficiency.

Agriculture Drones: Unmanned aerial vehicles (UAVs) can be used in multiple agricultural applications such as monitoring of crop health, agriculture photography for site specific development, variable rate applications, and livestock management. Drones can scan a vast area at low cost, and work with different sensors to gather a wide range of information at ease.

Smart Greenhouse: The smart greenhouse allows farmers to cultivate crops with minimal human intervention. Climatic conditions such as temperature, humidity, luminosity, and soil moisture are continuously monitored inside a greenhouse. Variations in these conditions will trigger automated actions. These actions will then evaluate the changes and implement corrective actions to maintain optimal conditions for plant growth.

Yield Monitoring: Yield monitoring is the mechanism to monitor various aspects corresponding to agricultural yield such as grain mass flow, moisture content, and total quantity of harvested grain. Yield monitoring offers real-time information to farmers to facilitate decision-making. Yield monitoring helps to reduce operational costs and enhance productivity.

Farm Management Systems (FMSs): FMSs assist farmers and other stakeholders with information collection and management by leveraging diverse sensors and tracking devices. The retrieved information is then stored and analyzed for conducting complex decision-making tasks. FMSs also enable the identification of best agricultural data analysis practices and software delivery models. Other benefits of FMSs include reliable financial data and production data management and improvement in risk mitigation capabilities regarding weather and unforeseen events.

Soil Monitoring Systems: Such systems can assist

farmers in tracking and improving the quality of soil to avoid degradation. They allow for the monitoring of a number of physical, chemical, and biological properties such as texture, water-holding

capacity and the absorption rate. Soil monitoring can help minimize erosion, densification, salinization, acidification, and pollution by toxic elements that can degrade soil quality.

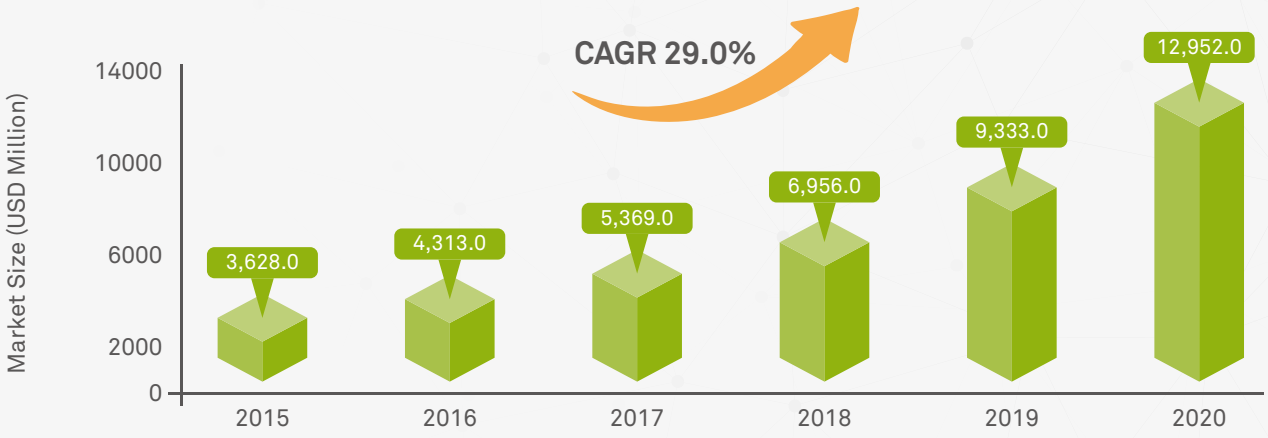
Precision Livestock Farming: Precision livestock farming supports real-time monitoring of productions, health, and welfare of livestock to ensuring optimal yield. Advanced technologies allow for continuous monitoring and can facilitate farmers with decision making to ensure improved health of animals.

Telecom Operators' Role in Agriculture

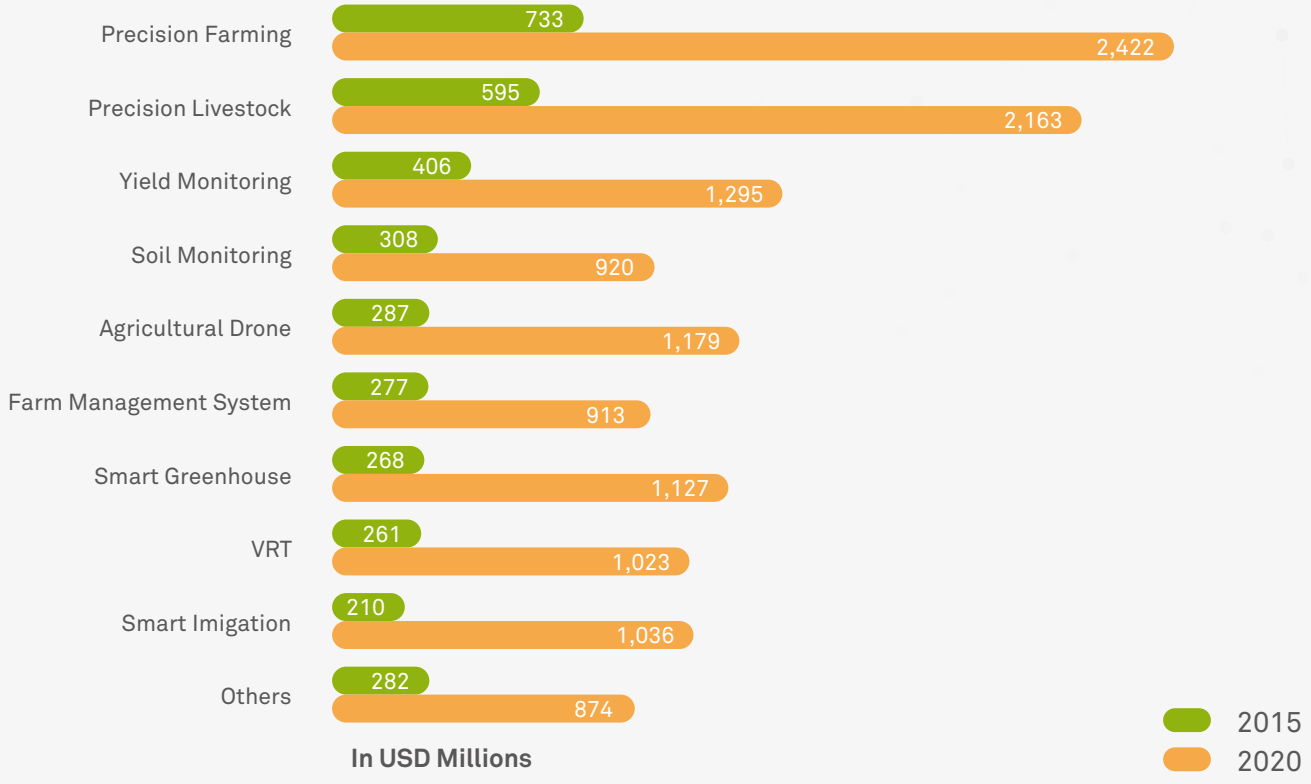
Telecom operators can play a crucial role in the agricultural sector. They are expected to benefit from an increased number of connections, offering greater potential for additional value added services. The majority of telecom operators offer predominantly connectivity services, but connectivity only represents a small portion of the total revenue. In the future, mobile operators can provide end to end IoT services to generate further revenue growth. By 2020, the total addressable market for telecom operators in agriculture is as large as USD 12.9 billion from the vertical integration, partnership and marketing, and value added service perspectives. Operators are expected to benefit immensely through further cooperation with LPWA providers.

By 2020, the total addressable market for telecom operators in agriculture is as large as USD 12.9 billion from the vertical integration, partnership and marketing, and value added services perspectives.

Telecom operators' addressable market size forecast (2015–20)



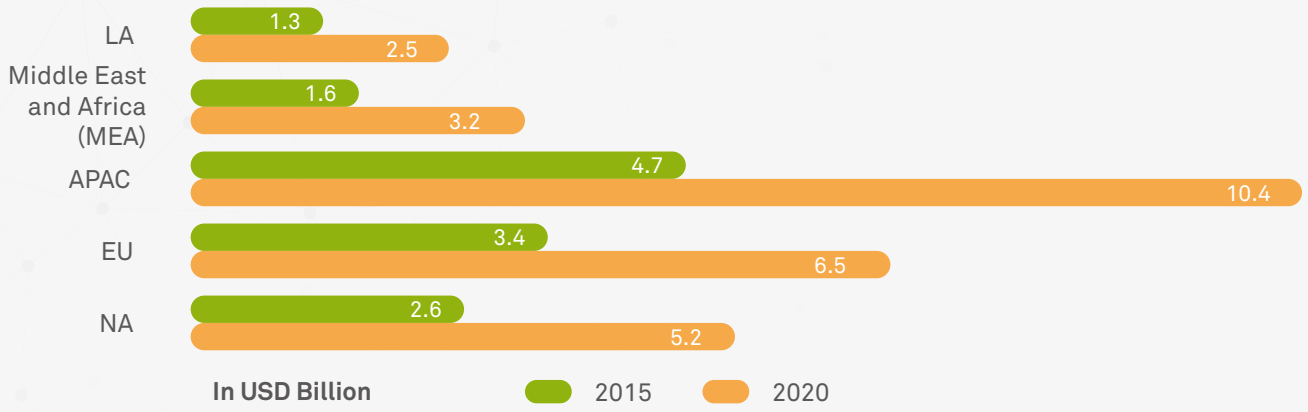
Total addressable market size by application



Telecom Agriculture Market by Region

Asia Pacific (APAC) and the European Union (EU) have the largest total addressable market compared to Latin America (LA) and North America (NA). Developing regions have a lot of untapped market where agriculture is largely unorganized. The key factors for successful adaption to these markets include development of local relationships, mutual understanding, testing solutions, and a sympathetic regulatory environment. Consolidating these elements will help ensure that the content and methods of delivery are tailored to both markets and crop types, optimizing the potential value for farmers.

Total addressable market size by region (2015-20)

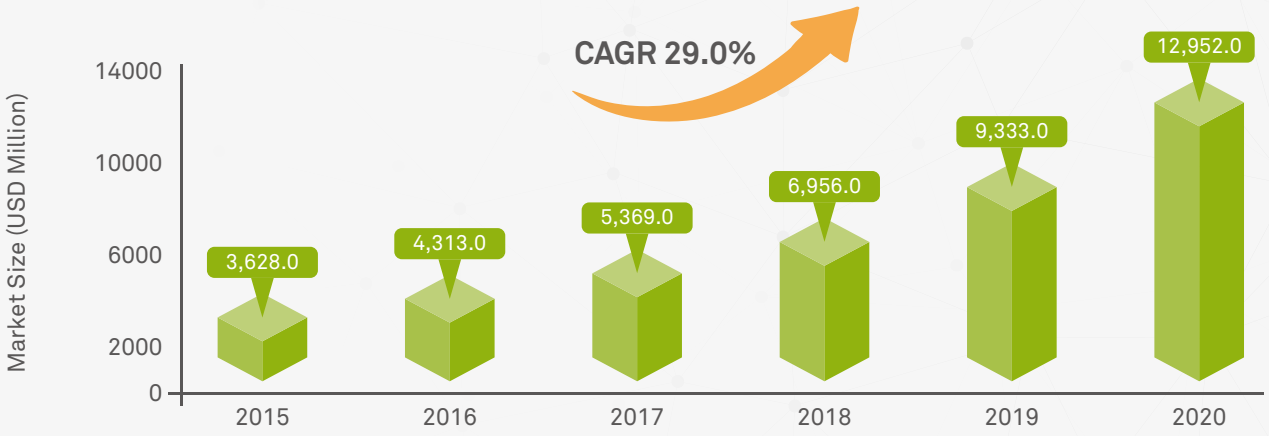


Telecom's Collaboration with LPWA Providers

Since agriculture entails hundreds of millions of connection possibilities, LPWA represents enormous potential for telecom operators. LPWA technologies provide low-cost, ubiquitous wide-area connectivity that can cover the remotest places where operators fail to reach. Mobile operators can also reuse the existing infrastructure and licensed spectrum to support LPWA networks. The integration of LPWA into existing IoT platforms will generate economies of scale, reduce costs for operators, and inspire new IoT applications. The partnership between LPWA technology providers and telecom operators can generate approximately USD 4.46 billion in revenue by 2020.

Smart agriculture applications are starting to move to the cloud, with the aim of delivering benefits in data access, synchronization, and storage. Applications such as VRT, livestock monitoring, mobile payment, trading and farmers' helpline provide huge advantages/benefits for telecom operators.

Estimated revenue generated by telecom in agriculture by partnering with LPWA providers



Telecom operators can help the world in tackling the challenge of feeding an estimation of 9.5 billion people by 2050. The immense potential in smart agriculture applications such as drones, precision farming, livestock monitoring, payment systems, and information and agricultural trading platform presents a great range of opportunities. However, the systems required to deliver these opportunities are increasingly complex and fragmented, demanding the collective and unconditional support of all stakeholders.

Telecom Operators' Opportunities

APPLICATION	Opportunity for Telecom Operators
Crop Disease, Water Stress, Nutrient Deficits, and Environmental Damage (Drones)	High
Variable Rate Application	Medium
-Variable Rate Fertilizers	Medium
-Variable Rate Pesticides	Medium
-Variable Rate Seeding	Medium
Livestock Tracking	High
Field Mapping	Medium
Air & Mosquito Treatment	Low
Crop Seeding	Low

Application	Opportunity for Telecom Operator
Livestock Monitoring	High
Agriculture Photography	High
Controlled Traffic Farming	High
Machine Guidance	Medium
Farm Inventory Management	Medium
Logistics Management	Medium
Telematics Solution	Medium
Packaging and Inventory Management	Low
Crop ScoutingA	Low
Yield Monitoring	Medium
Crop Management	Low
Machine Surveillance	High

Application	Opportunity for Telecom Operator
Soil Monitoring	Medium
Remote Sensing Techniques	High
Climate Control	High
Supplemental Lighting	Medium
Moisture Monitoring	Medium
Nutrient Monitoring	Medium
Irrigation Control	Medium
Greenhouse	Medium
Open Field	Medium
Mobile Payment and Insurance System	High
Farmer Helpline	High
Smart Logistics and Distribution	High
Agricultural Trading	High

Telecom Operators' Opportunities

Key Challenges	**Productivity Losses** • Lack of knowledge of new technology in agricultural practices • Non-availability of market information such as prices of agricultural produce, details on buyers and markets	**Supply Chain Inefficiencies** • Supply-demand gap • Intermediaries act in silos • Wastage of materials and goods due to poor logistics and weak infrastructure	**Financial Exclusion** • Non-availability of loans, payment facilities and savings • Non-availability of insurance for protection against crop failure or loss of livestock

Mobile Agriculture Applications and Services	**Information and Monitoring Services**
	VAS
	• Information Services
	  • Weather
	  • Market Information
	  • Agriculture (Crop, Livestock)
	  • Peer-to-peer
	• Input Authentication
	• Data Collection
	M2M
	• Equipment Monitoring
	• Precision Agriculture
	• Environment Monitoring
	• Livestock and Fishery Management
		Supply Chain Services
		VAS
		• Matching Platforms
		• Traceability and Tracking Systems
		• Management of Supplier/Distribution Network
		M2M
		• Smart Logistics
			Mobile Financial Services for Farmers
			• Payments to farmers vis mobile money
			• Savings and credit products
			• Micro insurance for inputs, crops and livestock
			• E-vouchers for agri-related products (e.g. inputs)

Smart Agriculture Use Cases

USE CASE 1

Challenges and solutions for agricultural farms in India

Nano-Ganesh.

Challenges and Solutions for agricultural farms in India

Water Pump Control23 is a cellular based wireless remote control and alarm system for water pumps designed to combat unfavorable irrigation conditions.

It can counter routine issues such as fluctuations in power supply, inhospitable terrain, fear of local wildlife tampering with pumps, hazardous locations, open wiring, shock hazards, and rain. Another issue in rural water supply schemes can be the lack of adequate coordination between tank levels and water source.

Benefits

- Annual savings of 180,000 m3 of water, 1080 MW of electricity, 180 m3 of fuel, and 18 m3 of soil
- USD 720,000 saved in labor costs

USE CASE 2

Challenges and solutions for agricultural farms in Colombia.

Colombia Telecom S.A., Movistar, Claro, and Tigo among others supported multiple farms in monitoring banana plantain crops. Farms in Colombia encountered multiple hurdles including flooding, decrease of oxygen level in the soil, high humidity, and low temperature.

Benefits

- 15% increase in productivity
- Improve environmental and agricultural sustainability
- Enhance crop traceability

USE CASE 3

Challenges and solutions for agricultural farms in Vietnam.

Telecom operators such as Viettel Mobile, MobiFone, and VinaFone further support livestock activities in transmitting the data from wireless sensors to the sensor platform, and ultimately from sensor platform to cloud servers.

A major aquaculture farm in Vietnam had the following stats before the implementation of real-time monitoring technology:

- Fish placed in a commercial tank in a juvenile state: 2,000 kilos
- Live harvest after six months: 30,000 kilos
- Price per kilo: USD 1.5
- Turnover: USD 45,000

Benefits

- 40% to 50%: reduction in fish mortality rate after using real-time monitoring
- 42,000 to 45,000 kilos: live harvest six months after using real-time monitoring
- USD 63,000 to 67,500: total turnover
- USD 18,000 to 22,500: total savings

USE CASE 4

Challenges and solutions for agricultural farms in Spain.

In Spain, Telefonica provided an automated irrigation system, which connected hydraulic valves, meters, and level meters using GPRS in a dozen farms. A specific farm totals an area of 21,000 hectares, which means manual operation of irrigation valves is difficult.

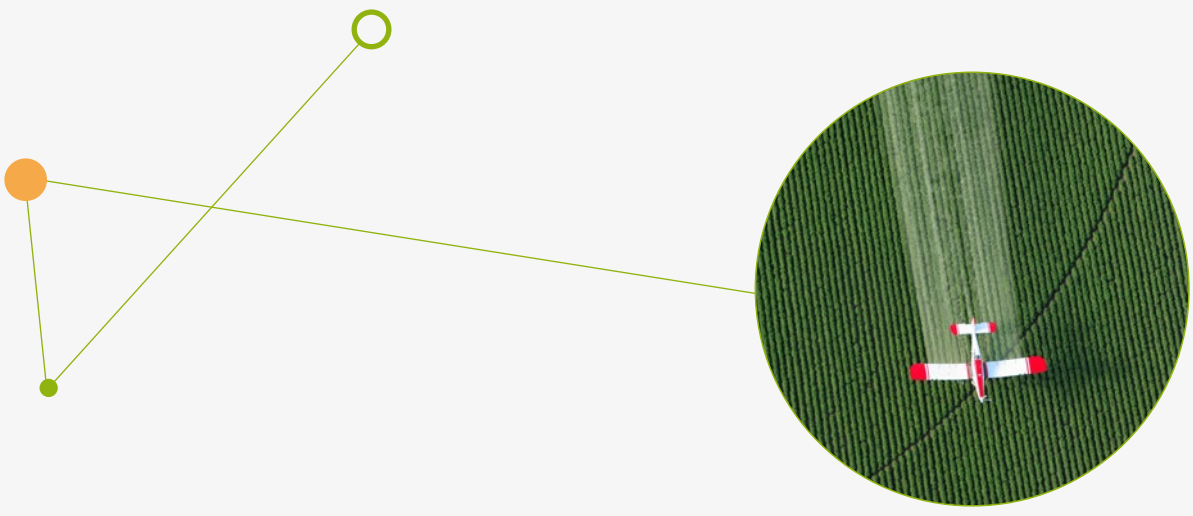
Telefonica and ABB provided the remote irrigation system which helped farmers to incorporate computers and mobile phones in setting up a suitable irrigation schedule. The specific solutions were based on the mobile telephony network and remote reading registers with GPRS communications selected.

Benefits

- Savings – 47 hm3 of water per annum
- 25% increase in farm profits
- 30% reduction in electricity bills

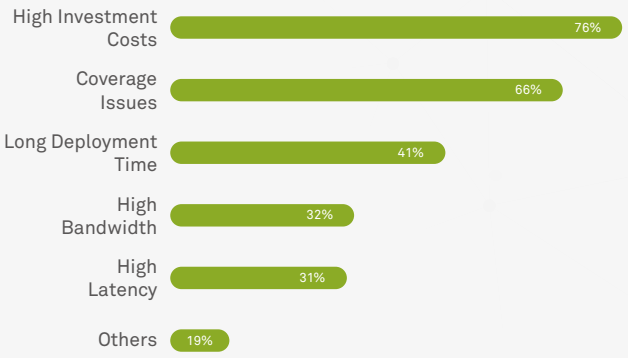
Critical success factors include the development of local relationships and understanding, testing

solutions and the creation of a sympathetic regulatory environment. Consolidating these elements will help ensure that the content and methods of delivery are tailored to both markets and crop types, optimizing the potential value for farmers.



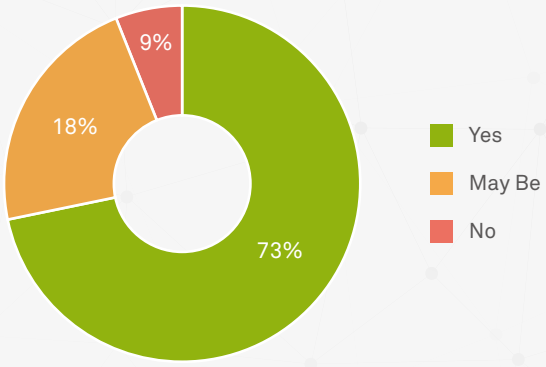
End user analysis

Major Pain Points Communication Technologies



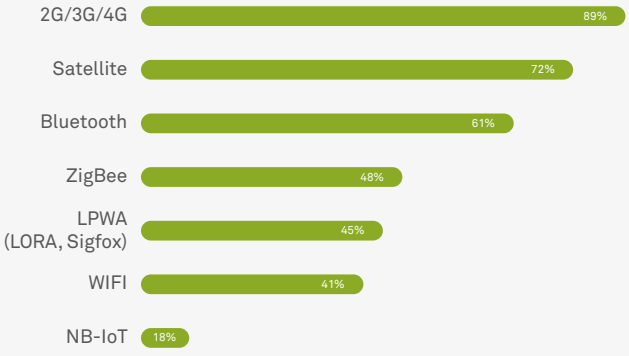
More than 60% of farmers agree that the high investment costs of smart farming technologies and coverage issues are the major pain points which must be addressed. This is followed by long deployment time and bandwidth concerns.

Investment in Agriculture



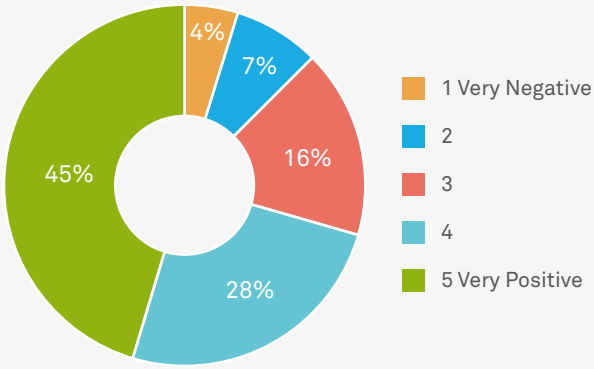
More than 70% of farmers are willing to pay for more advanced technologies to be implemented provided that they can improve productivity and profits. Farmers are ready to invest more in both precision farming and farm management.

Communication Technologies in IoT



More than 45% of farmers select satellite navigation to gather farm topography data. Farmers use 3G or 4G enabled mobile applications to transmit data from the field to the farm management systems for analysis. ZigBee and Bluetooth are the most common technical methods currently used alongside WiFi. These technologies assist sensors placed in the fields to control several applications such as automated irrigation and greenhouse farming.

LPWA Technologies in Agriculture



More than 70% of farmers are positive towards LPWA applications in agriculture. LPWA can be used for diverse agricultural monitoring and control. Such adoption will promote the efficient usage of land and other agricultural resources. The application of LPWA technologies is expected to increase exponentially after 2017.

Future

The “Connected Farm” is the future of farming. The concept is spreading quickly and creating significant disruption in the agricultural sector.

IoT thinking is changing agricultural practices on a daily basis. IoT uptake is already a mainstream phenomenon driven by the promise of revenue growth across the agricultural value chain. Taking advantage of the real-time data IoT provides, farmers can work their land while receiving updates from any asset anywhere on their properties – from crops, machinery, and markets: all monitored without the need for the farmer’s presence.

The technology is available today that can make possible a future in which farmers can predict and prevent disease; or view data on soil and crop conditions in near real-time; where machines can ensure crops are fed and watered without human intervention. Vital data from sensors can be stored in the cloud and accessed at the farmer’s convenience. These sensors are becoming smaller, more sophisticated and cheaper. Networks are becoming more intelligent and more secure. The future of farming lies in the benefits of connecting, collecting and analyzing big data to maximize efficiency and increase productivity.

This technology will be supported by advances in connectivity – in particular, licensed LPWA technology is expected to be a game changer. It is expected to play a pivotal role in the future of farming, because its characteristics of low power consumption and efficient coverage are well suited to the geography and economics of agriculture. We expected mobile operators with strong IoT ambitions to generate significant revenues in smart agriculture by collaborating with LPWA technology providers.

Mobile operators have significant strategic advantages in offering smart agriculture solutions: licensed spectrum holdings; extant physical infrastructure; and experience in the operation and maintenance of standard LPWA technologies. Although unlicensed spectrum is freely available and therefore appealing as a solution, there are significant drawbacks to its use in practice, as its ability to deliver a guaranteed quality of service is compromised by issues of interference and congestion. Regulatory restrictions – which might vary from market to market – will make it difficult for unlicensed spectrum solutions to generate economies of scale. Consequently, NB-IoT has strong industry support as an effective global standard for LPWA connectivity. It has the potential to deliver a step-change in smart agriculture by changing the industry’s perceptions of what the Internet can provide: efficiency connectivity from a wide range of sensors with long battery life over reliable, low cost, secure, licensed spectrum. The potential for the Connected Farm is limitless.

X Labs is a brand-new platform designed to get together telecom operators, technical vendors, and partners from vertical sectors to explore future mobile application scenarios, drive business and technical innovations, and build an open ecosystem. X Labs have set up three laboratories, which aim to explore three major areas: people-to-people connectivity, applications for vertical sectors, and applications in household.

About Huawei

Huawei is a leading global ICT solutions provider. As a responsible and robust business player, innovative information society enabler, and cooperative industry contributor, Huawei is committed to building a Better Connected World. Through our dedication to customer-centric innovation and strong partnerships, we have established end-to-end capabilities and strengths across carrier, enterprise, consumer, and cloud computing domains. Huawei's 170,000 employees worldwide create maximum value for telecom operators, enterprises and consumers. Our innovative ICT solutions, products and services have been deployed in over 170 countries and regions, serving more than one-third of the world's population. Founded in 1987, Huawei is a private company that is fully owned by its employees. For more information, please visit Huawei online at www.huawei.com.

MARKETSANDMARKETS

MarketsandMarkets is a leading provider of premium research and consulting services in the B2B space. Our focus is on disruptive technologies and unmet needs across major industry verticals, which often means that we are unique and exclusive providers of business information for those technologies. This specific focus, combined with our flexibility, competitive cost structure, and ability to customize insights as per client needs, ultimately delivers more value and enables our clients to make better decisions. Around 8 out of the top 10 firms in each granular market rely on us for their research needs, and we are among the fastest growing research firms, globally.

CORPORATE HEADQUARTERS

MarketsandMarkets
UNIT no 802, Tower no. 7, SEZ
Magarpatta city, Hadapsar
Pune, Maharashtra 411013, India