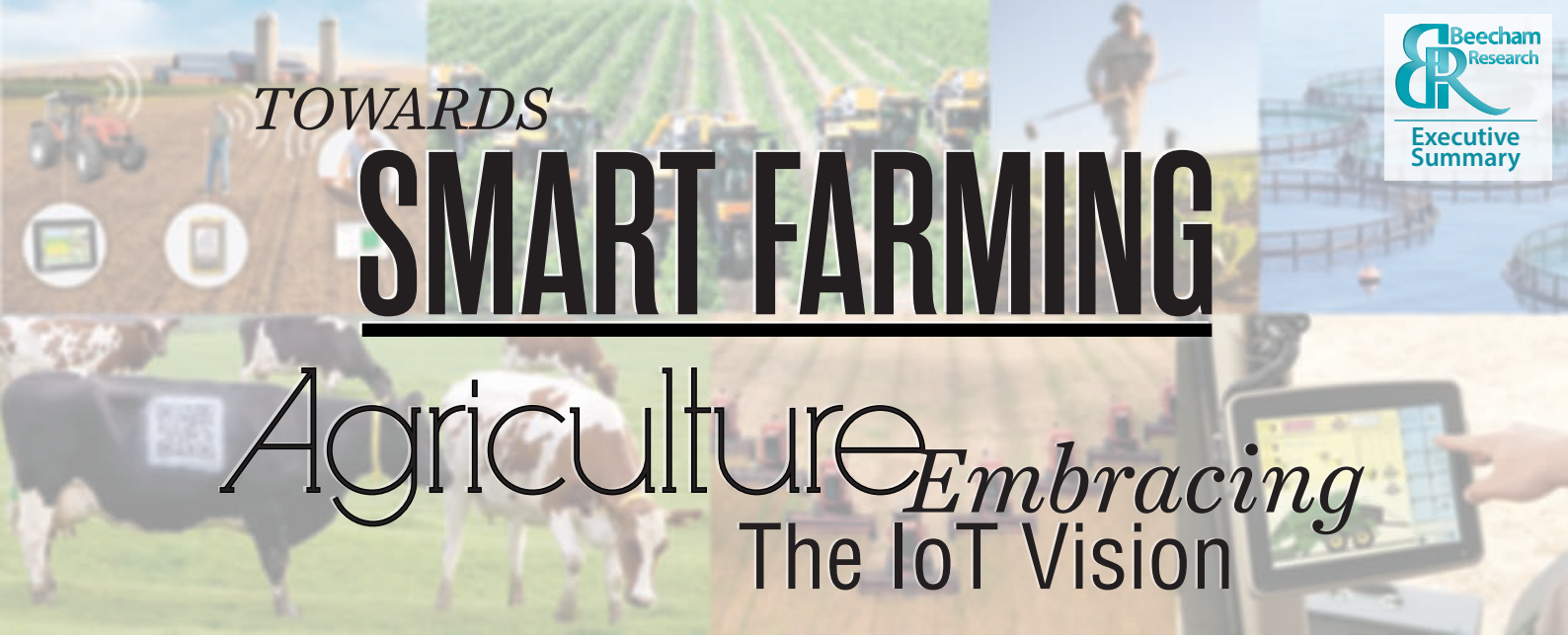


Beecham Research
Executive Summary

TOWARDS SMART FARMING

Agriculture Embracing The IoT Vision

The Problem

The Food and Agricultural Organisation of the UN (FAO) predicts that the global population will reach 8 billion people by 2025 and 9.6 billion people by 2050. In order to keep pace, food production must increase by 70 percent by 2050.

However there are several barriers to fulfilling this imperative, including:

- The slow-down in productivity growth
- The limited availability of arable land
- Climate change
- The increasing need for fresh water
- The price and availability of energy, particularly from fossil fuels
- The impact of urbanisation on rural labour supply – the average age of farmers is increasing with fewer young people going into the industry.

According to a recent report by the UN's Intergovernmental Panel on Climate Change (IPCC), there will be a number of effects of climate change on agriculture. These include an increase in extreme weather events such as heavy rainfall, more intense storms and heat waves, all of which can reduce crop yields. Heavy rainfall can lead to flooding and waterlogging of the soil, whilst in dry parts of the world, water shortages could become more acute. Climate change can also give rise to environmental consequences, such as changes to seasonal events in the life cycle of plants and animals.

Agriculture also consumes 70 percent of the world's fresh water supply; hence water management will go hand in hand with assuring food security.

In order to counter these challenges, the FAO recommends that all farming sectors should be equipped with innovative tools and techniques, particularly digital technologies.

How Will Precision Farming Help?

Precision agriculture aims to optimise the yield per unit of farming land by using the most modern means in a continuously sustainable way, to achieve best in terms of quality, quantity and financial return.

Precision agriculture makes use of a range of technologies that include GPS services, sensors and big data to optimise crop yields. Rather than replace farmer expertise and gut feeling, ICT-based decision support systems, backed up by real time data, can additionally provide information

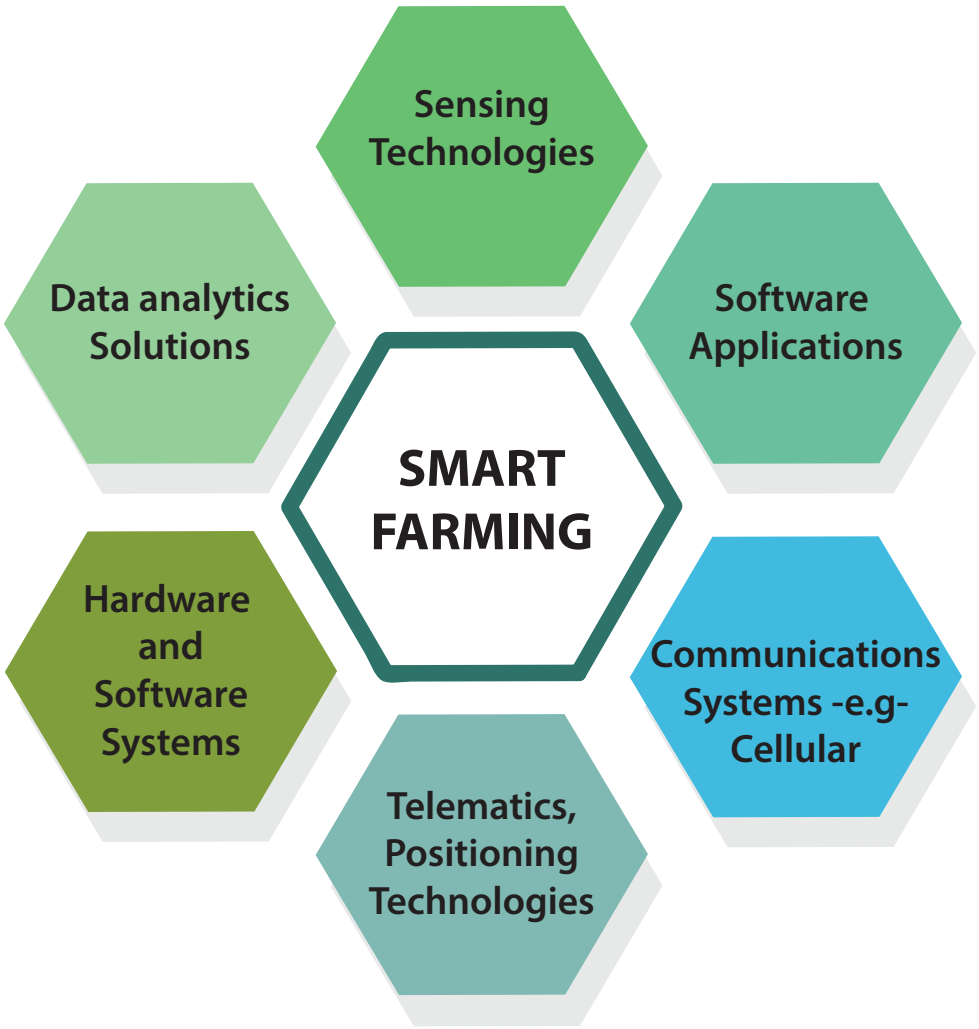
concerning all aspects of farming at a level of granularity not previously possible. This enables better decisions to be made, resulting in less waste and maximum efficiency in operations.

The disciplines and skills now required for agriculture include robotics, computer-based imaging, GPS technology, science-based solutions, climate forecasting, technological solutions, environmental controls and more. Hence to make the best use of all these technologies, it is essential to train farmers and farm managers in their use.

Precision agriculture is sometimes known as 'smart farming', an umbrella term for easier comparison with other M2M based implementations such as smart metering, smart cities and so on. Precision agriculture is a specialist methodology in itself. It is based on sensor technologies whose use is well established in other industries, e.g. Telematics for fleet management, environmental monitoring for pollutants, eHealth monitoring in patients, buildings management for farm silo monitoring and so on.

For all M2M implementations, IT systems gather, collate, analyse the data and present it in such a way as to initiate an appropriate response to the information received. For farmers and growers, a wide variety of information regarding soil and crop behaviour, animal behaviour, machine status, storage tank status emanating from remote sites is presented for action by the farmer.

The chart below show the different types of technologies involved in smart farming.



Application Areas of Smart Farming

The set of technologies used in smart farming is complex, to reflect the complexity of activities run by farmers, growers, and other sector stakeholders. For the purposes of this report, smart farming is structured in the following seven application areas:

1. Fleet management – tracking of farm vehicles
2. Arable farming, large and small field farming
3. Livestock monitoring
4. Indoor farming – greenhouses and stables
5. Fish farming
6. Forestry
7. Storage monitoring – water tanks, fuel tanks

The Smart Farming Ecosystem

The complexity of smart farming is also reflected into the ecosystem of players. They can be classified in the following way:

- Technology providers – these include providers of wireless connectivity, sensors, M2M solutions, decision support systems at the back office, big data analytical systems, geomapping applications, smartphone apps
- Providers of agricultural equipment and machinery (combines, tractors, robots),farm buildings, as well as providers of specialist products (e.g. seeds, feeds) and expertise in crop management and animal husbandry
- Customers: farmers, farming associations and cooperatives
- Influencers – those that set prices, influence the market into which farmers and growers sell their products.

The range of stakeholders in agriculture is broad, ranging from big business, finance, engineering, chemical companies, food retailers to industry associations and groupings through small suppliers of expertise in all the specialist areas of farming.

The end users of precision farming solutions include not only the growers but also farm managers, users of back office IT systems. Not to be forgotten is the role of the veterinary in understanding animal health. Also to be considered are farmers co-operatives, which can help smaller farmers with advice and funding.

The cost of smart farming is still high for any but the largest farms. Farm offices now collect vast quantities of information from crop yields, soil-mapping, fertiliser applications, weather data, machinery, and animal health; these are all factors that influence farming such as soils, nutrition and weather.

Data is the fundamental building block of smart farming, whether the data comes from a soil sample or a satellite correction signal. For example, data points collected can highlight both spatial and temporal variability within a field. Many factors can contribute to this variability; understanding the effect each factor has can only be measured and managed using statistical analysis of the data.

Everyday farming applications are starting to move into the cloud, with the aim of delivering benefits in terms of data access, synchronisation, storage and even cost to the farmer. The rising use of smartphones and tablets on farms means that apps can be used to cache data offline until it can be synchronised; data need no longer be tied to a single computer in a single location.

Partnerships are vital to the value chain, since not even the largest suppliers can fulfil all the needs of the customer by themselves and must cooperate to achieve this.

More complex partnerships are being forged involving cross sector collaboration, with each partner bringing different skills and experience. Partner organisations may be large or small, local or international.

Government and Other Stimuli

The adoption of smart farming solutions is not rapid. The reasons for this are primarily cost – only large farms can afford the investment, and the industry is by nature conservative. In Germany for example, some two thirds of the farms are small to medium sized. For illustrative purposes, we are categorising farms under 10 hectares as small, and over 50 hectares as large

That said, government agencies are stimulating adoption of new technologies through subsidies and projects.

Between 2007 an 2013, the EU allocated €95 billion to the European Rural Development Fund to help modernise the agricultural industry. During the same period, the European Regional Development Fund provided €350 billion for developing rural areas in the wider sense.

Examples of national programmes to promote precision agriculture include:

- UK – Engineering Solutions to enhance agri-food production supported by various government agencies
- Germany – Farming 4.0
- Netherlands – Dike Monitoring Project
- Spain – Projects on irrigation management and viticulture.

Drivers and Barriers

Drivers and barriers to the adoption of precision agriculture are listed below. They include business and market factors as well as technology factors.

Business and Market Drivers	Technology Drivers
Urgent need to reduce waste and increase efficiency	M2M based monitoring and tracking becoming more mainstream across industries
Need to address soil erosion from intensive farming	Reducing costs of sensors, connectivity
Help from public funding and projects	Improving data management technologies to manage tidal wave of M2M data
Need to respond to climate change and environmental deterioration	Farmers becoming more familiar with everyday IT use
Business and Market Barriers	**Technology Barriers**
Return on investment not easy to prove and precision agriculture installations are few and fragmented.	Rural wireless and broadband coverage patchy
Shortage of new blood in the industry	Standards for sensor networks and datacomms still under development
Uncertainty inherent in the industry e.g. weather events, political issues elsewhere in the world	Specialist agricultural software still maturing
Questions to be resolved regarding ownership of the data collected	Uncertainty as to how to treat and safeguard data

Opportunities for Players

MNOs can reach customers in the agriculture industry by partnering with agricultural equipment makers e.g. Deutsche Telekom with CLAAS, Orange Business Services with Dacom.

The vendors and dealers of agricultural machinery with global operations will partner an MNO that provides international coverage, i.e. a global SIM. Furthermore, embedded SIMs are more practicable for sensors located in remote fields. The GSMA is working towards a standard for embedded SIMS that will allow the M2M market to grow.

Sensor makers can partner with providers of M2M management platforms. Sometimes these expand their capabilities from sensor maker to M2M platform provider.

For agri equipment makers, embedding intelligence into the design and operation of machines will allow sensor information to be combined with the knowledge of the farmer, truly closing the loop of precision agriculture.

Towards Smart Farming – Agriculture Embraces the Internet of Things

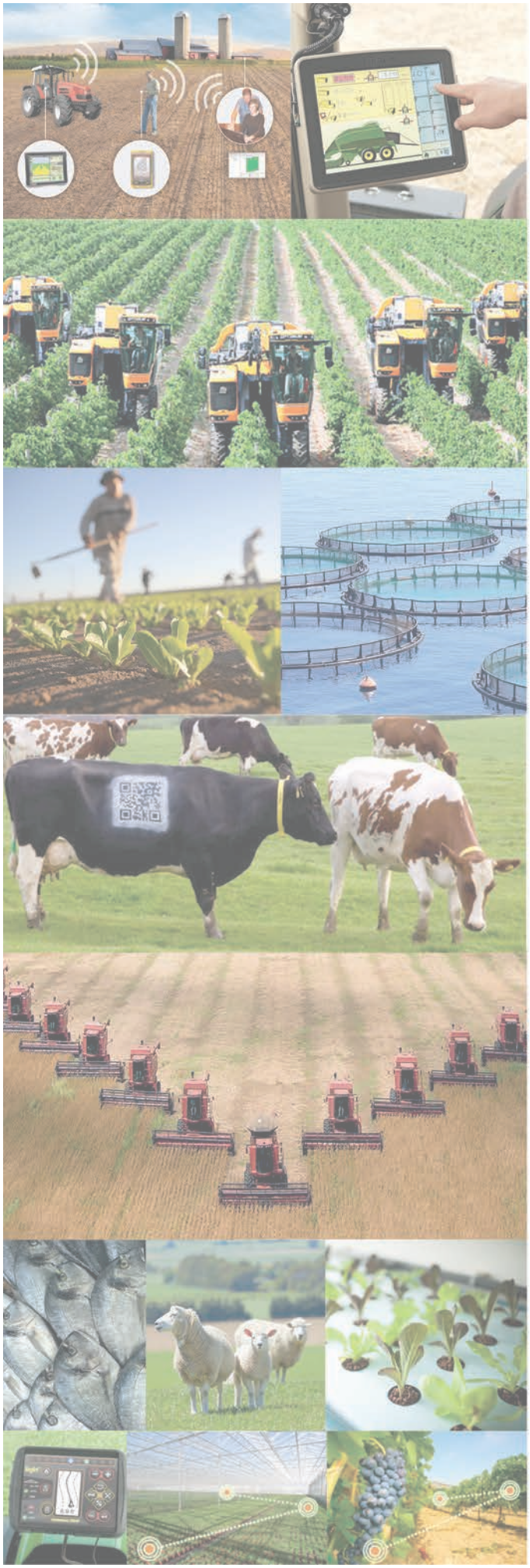
The notion of 'the connected car' is well established. What makes precision agriculture special is the IT system at the other end of the supply chain, the decision support system at the back office. Whilst the technology is still in its infancy, the notion of 'the connected farm' is coming closer, particularly if the seven types of farming activity we have listed above are somehow connected not only to each other, but also to a raft of historical data such as weather events, climate, economics, product information and specifications, machine settings etc.

This is what the Internet of Things is all about, connecting systems so as to allow an integrated, multidimensional view of farming activities, enabling deeper understanding on how the whole ecosystem works. Precision farming would become 'decision farming'.

From an M2M perspective, the agricultural sector is still considered a minor sector. However, M2M technologies and all the technologies around the Internet of Things vision are key enablers for the transformation of the agricultural sector towards the smart farming vision. The more immediate impact of M2M technologies in agriculture are around providing remote connectivity between sensors in the field and farm information management systems. However we anticipate that the use of sensors in farming will spread to adjunct areas, such as environmental monitoring, land management, and food traceability. This is a consequence of the greater public focus on issues such as food safety and wildlife preservation.

For these reasons, we believe that the use of precision agriculture is bound to grow, not least because of the urgency of the problems the world faces regarding food security in the long term. However, because the technology is in its infancy and not widely understood, this growth will be slow at first compared with sensor based technologies in other industries. This is because of the lack of a vision shared by all stakeholders and their governments as to how to bring together the needs of agriculture with business opportunities. In our report, Beecham Research supplies some forecasts for global wireless and satellite M2M connections from 2012 to 2020.

It is also important to learn the lessons from other large scale 'smart' project rollouts, notably the smart metering projects ongoing in European countries. These are aimed for completion or near completion by around 2020, with smart meters replacing existing ones in homes and business premises. The UK government for one is taking great pains to ensure that a full regulatory framework exists to support the programme and that the full legal implications are understood. These touch on customer privacy, ownership of the data collected, and whether it is permissible for this data to be repurposed for other uses. These issues are equally relevant to the agriculture industry. A similar framework needs to be implemented to reap the best advantages from 'smart farming'.



The full report on Smart Farming will be released beginning Q1 2015

Visit **www.beechamresearch.com** or contact **info@beechamresearch.com** for more information.

Beecham Research Ltd. is an internationally recognized thought leader in the M2M/ Internet of Things market. Based in Cambridge UK and Boston, MA, USA, it is a leading technology market research, analysis and consulting firm specializing in the worldwide M2M/Internet of Things market. Our clients include major network operators, hardware/software and infrastructure vendors, distributors /resellers, solution providers and technology adopters. This has now extended into consumer markets with development of the Internet of Things, in particular including Beecham's new report on Wearable Technology published recently. Our research methods include extensive survey work worldwide in multiple languages, based on deep technical knowledge combined with fresh market insight in both business and consumer markets. Recent research has included two market-leading studies on M2M Cloud-based platforms and a worldwide study of the Satellite M2M market for the European Space Agency.