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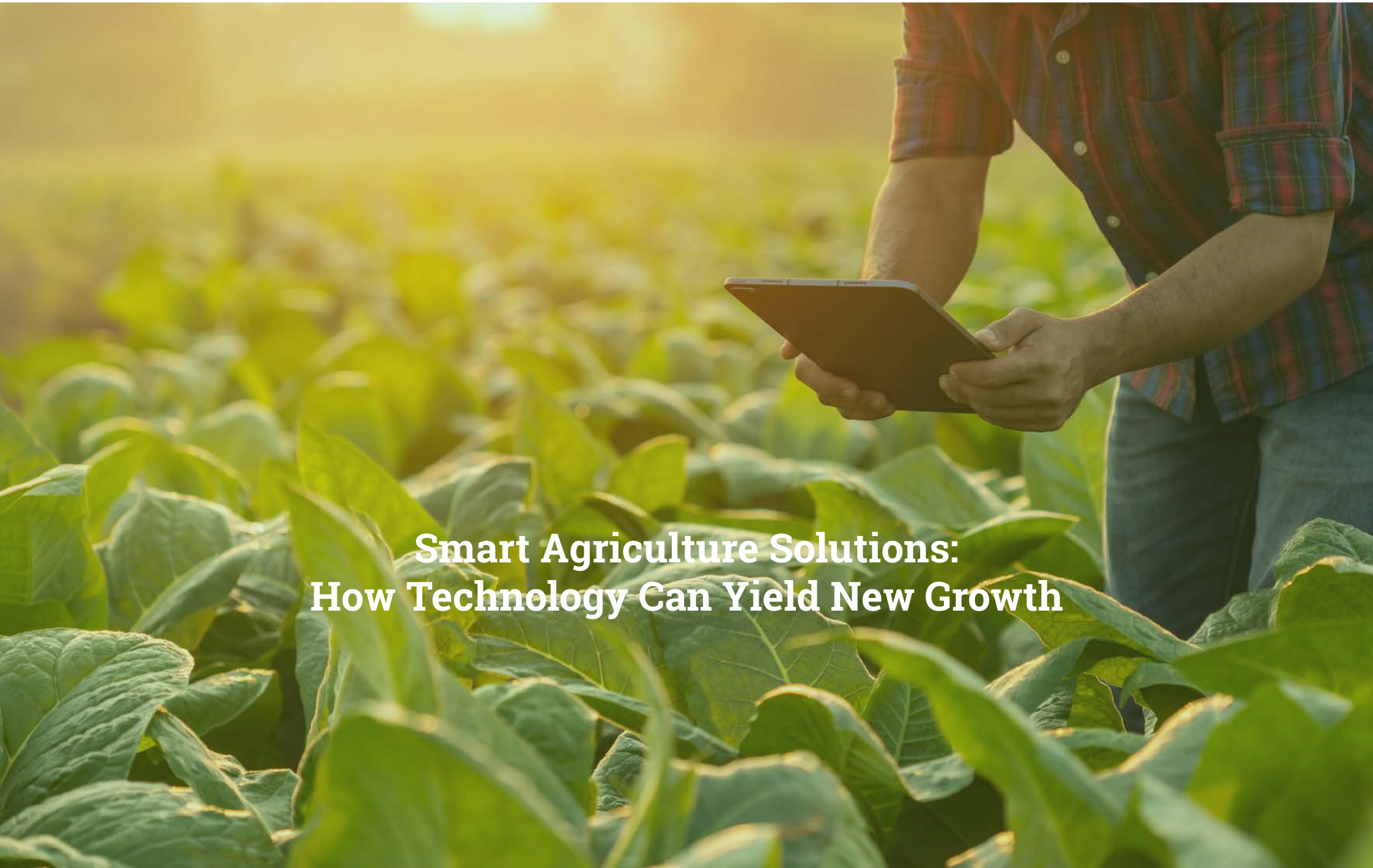
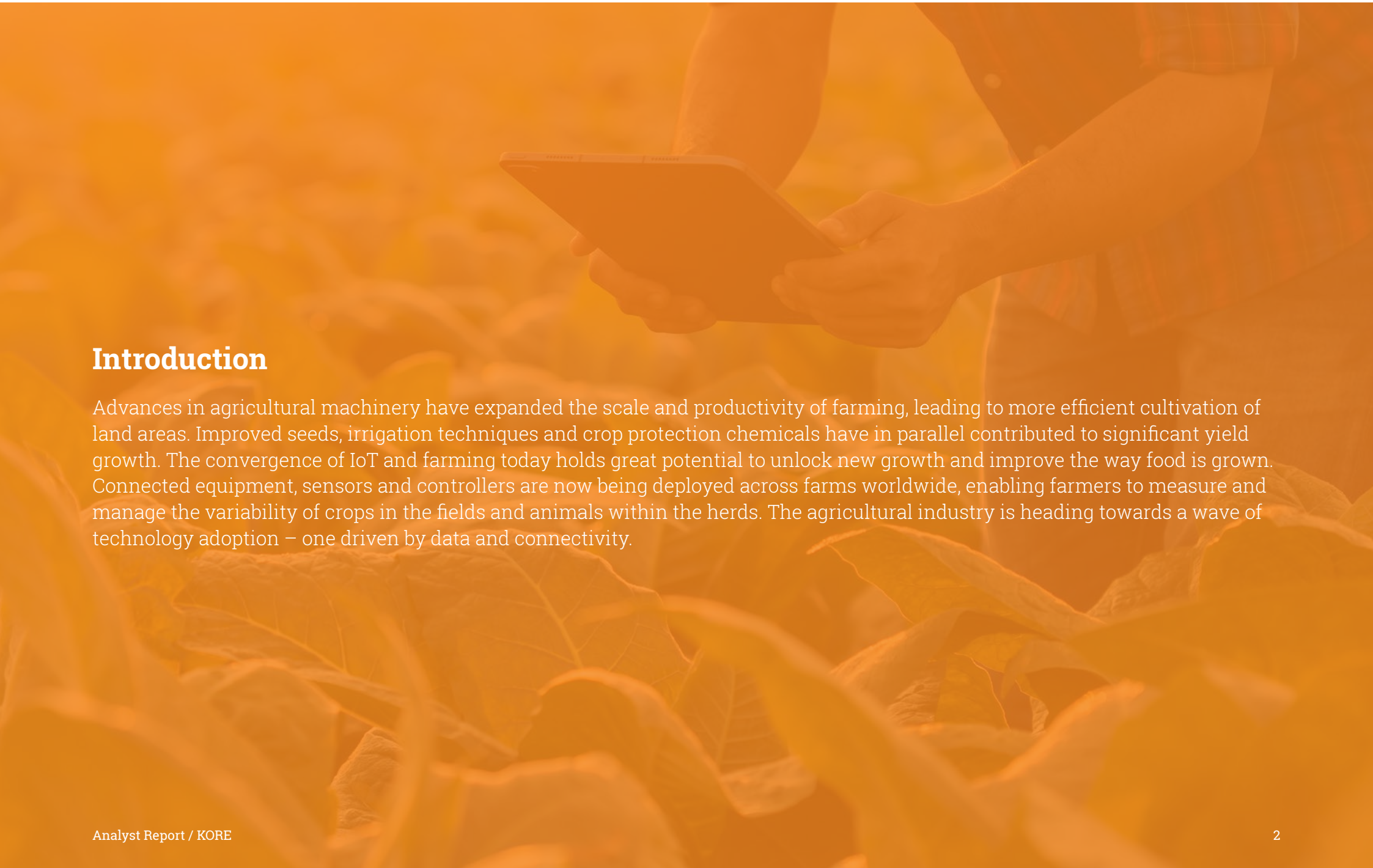


Smart Agriculture Solutions: How Technology Can Yield New Growth



Introduction

Advances in agricultural machinery have expanded the scale and productivity of farming, leading to more efficient cultivation of land areas. Improved seeds, irrigation techniques and crop protection chemicals have in parallel contributed to significant yield growth. The convergence of IoT and farming today holds great potential to unlock new growth and improve the way food is grown. Connected equipment, sensors and controllers are now being deployed across farms worldwide, enabling farmers to measure and manage the variability of crops in the fields and animals within the herds. The agricultural industry is heading towards a wave of technology adoption – one driven by data and connectivity.

The transformation of the agricultural industry

The agriculture industry has undergone a significant transformation since the 1960s. The production of agricultural crops has grown by an average of 1–3 percent annually, while the planted area has grown by less than 1 percent per year. As a result, the world is using almost 70 percent less land to produce the same amount of food. The increase in crop yield can be attributed to improved inputs such as fertilisers and pesticides as well as developments in crop varieties through selective breeding and seed genetics practices. Crop yield, measured in tons per hectare, for major grains such as wheat, rice, soybean and corn has almost tripled in the last 60 years.

In recent times, yield growth for several major crops such as rice, wheat and corn has shown signs of plateauing. This trend has materialised primarily in developed countries in North America, Europe and Asia, which today account for a large share of the world's grain production. Developed countries have been early adopters of modern input technologies, which have contributed to past growth in crop yield. Limitations of further yield increases include for example individual farming practices, regulatory constraints on fertilisers and climate change. The adoption of smart agricultural solutions is expected to drive growth in crop yield in the coming decades.

The growth in agricultural productivity contributes to a shift in the workforce from agriculture to jobs in other sectors, often in cities. In many high-income countries, urbanisation has contributed to significant labour shortages within the agricultural sector. Although farmers have increased wages for agricultural workers, labour shortages in the sector remain in many regions. Precision agriculture technologies are typically adopted in labour scarce countries with large agricultural areas. As the cost of agricultural labour increases, investments in technology can offer significant savings within a reasonably short payback period.

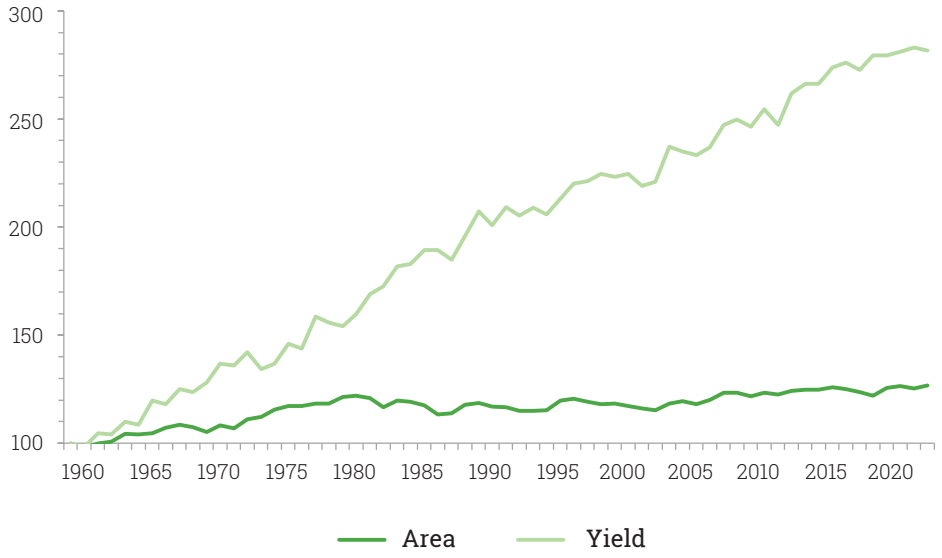


Figure 1: Area and yield trend for wheat, rice, soybean and corn (World 1960–2023)

How precision agriculture solutions increase crop yield and raise productivity

Precision agriculture is about managing variations in the field to increase crop yield, raise productivity and reduce consumption of agricultural inputs. In order to help farmers make decisions about their fields, data is gathered from multiple sources such as soil sampling, aerial imagery and weather monitoring. Farm management software enables the analysis and visualisation of field data and is also used to create prescription maps that describe how much product to apply at specific locations across a field. Precision agriculture practices include for example yield monitoring and mapping as well as precision seeding, fertilising and spraying.

- Yield monitoring is considered a conventional practice in modern agriculture and often the first step in the application of precision agriculture. Over time, recorded variation in yield can be used to monitor the efficiency of applied inputs and implemented technologies.
- Precision seeding allows growers to customise the seeding process by adjusting seed type, spacing and depth according to variable soil conditions. Users of variable rate seeding have experienced yield improvements of roughly 5–20 percent depending on the crop.
- Precision fertilising encompasses technologies that enable farmers to apply fertilisers according to crop nutrition needs. Rather than applying uniform rates across the field, higher application rates can be applied in parts of the field where nitrogen run-off occurs, while lower application rates are employed in other areas. Farmers applying precision fertiliser application technology have recorded yield improvements ranging from 10–15 percent.
- Precision spraying involves dispensing crop protection chemicals according to the needs of a specific area. The most common commercial solutions include ground sprayers and aerial sprayers. Yield improvements from implementing precision spraying technology are estimated to amount to about 5 percent.

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The awareness of the short pay-back time and benefits of precision farming tools and data management solutions is gradually growing among farmers. Continuous measurements over multiple growing seasons allow for comparisons to be made as well as more rigorous data analysis. This feedback loop is a vital part of precision agriculture as growers are able to evaluate the result of management decisions made during the course of production. Including systems installed in agricultural machinery as well as in the field, Berg Insight estimates that the total market value for precision agriculture solutions amounted to € 3.4 billion in 2023. Growing at a compounded annual growth rate (CAGR) of 11.6 percent, the market value is expected to reach € 5.9 billion in 2028.

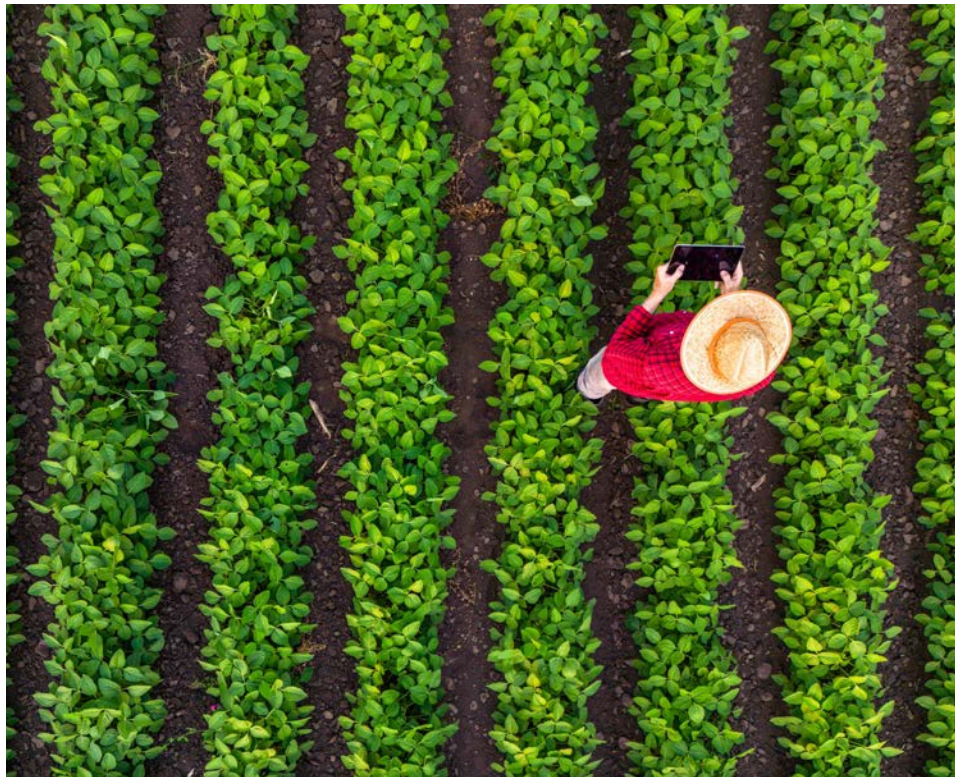
Remote monitoring solutions to drive the next wave of technology adoption

Modern in-field sensor systems can measure weather, soil and crop conditions from over 40 environmental data streams at frequent intervals. Monitoring growth stages, disease risks and nutrient levels allows for proactive interventions. Whether adjusting irrigation timing or fine-tuning fertiliser application levels, precision becomes achievable. Local weather monitoring may for example provide insights into timing for fertiliser application as heavy rainfall can wash away the applied fertilisers. Sensor systems are also used to manage pests, monitor soil moisture content in irrigated fields and enhance biodiversity on farms.

One of the world's largest agricultural technology companies – Syngenta – is currently conducting a biodiversity project based on in-field sensors with its partner KORE. Using KORE's global IoT connectivity services, Syngenta's Biodiversity Sensor Project aims to determine how agricultural practices and products can be used to protect biodiversity and, in turn, provide insights to farmers on how biodiversity can be enhanced to protect crops.

The market for in-field sensor systems can be divided into three main segments: environmental monitoring, pest management and water management. The addressable market for the first two are significantly larger as irrigation management solutions are only deployed on irrigated land. Leading providers of in-field sensors for environmental monitoring include Pessl Instruments, Davis Instruments, Sencrop, Hortau and Campbell Scientific. Semios is the leading vendor of pest management solutions, followed by Trapview and Pessl Instruments. Irrigation management specialists of soil moisture sensors include AquaSpy, CropX and Arable Labs. The installed base of in-field wireless devices amounted to an estimated 1.9 million units at the end of 2023.

The pace of adoption of in-field sensor systems has increased significantly in recent years, predominantly in the speciality crop segment. While the specialty crop segment is small on a per hectare basis, the segment is very large on a value standpoint. The return on investment of remote monitoring solutions has thereby proven to be high.



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Dairy farmers look to boost milk yield with data-driven decision making

The high demand for meat and dairy products has resulted in larger herds per farmer, which makes livestock management and manual observations challenging. In large-scale dairy operations, the ratio of cows per worker is often greater than 200. As a result, observation time per cow is highly limited. Precision livestock farming technologies aim to provide real-time monitoring and decision support for livestock farmers by measuring various parameters, ranging from usage of resources and individual animal performance to animal health and behaviour. Farmers are thus able to track essential herd information, including cow breed, body temperature, oestrous, lameness and rumen function.

In dairy operations, precision livestock farming technologies are used to optimise the milk yield from each animal. Due to its early introduction, clear benefits and fast payback time, remote activity monitoring via body-mounted sensors comprises one of the most widely adopted precision livestock farming solutions in dairy operations today. Body-mounted sensors are offered in numerous form factors which can be worn as an ear tag, nose halter, neck collar or leg pedometer. Apart from activity monitoring sensors, there are a wide range of other technologies that enable farmers to remotely monitor for example weight, feed intake, water consumption and various diseases.

The market is characterised by a large number of vendors including regional players who compete with large companies on national markets. In order to sell technology to dairy farms, local presence is a necessity. The major manufacturers of dairy equipment – DeLaval, GEA Group, Lely and BouMatic – are supported by distributors and local sales representatives in markets worldwide. Today, most manufacturers offer solutions for oestrous and health monitoring as well as a range of other technologies that integrate with fixed equipment such as milking robots and feeding systems which enable remote monitoring of feed consumption and milking performance.

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(1) ear tag, (2) halter, (3) neck collar with counterweight, (4) reticulorumen bolus, (5) rear leg pedometer, (6) upper tail ring, (7) tail head inject and (8) vaginal bolus

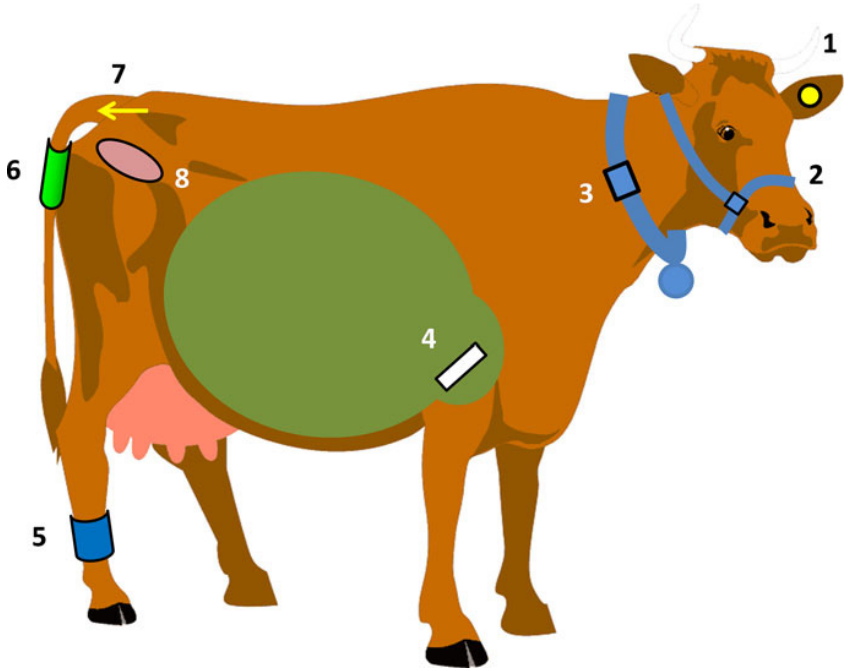

Figure 2: Wearable devices for cattle monitoring

IoT start-ups attract significant venture capital investments

A host of new entrants focus on the development of IoT solutions for agricultural production. Software and services built on top of sensing hardware have attracted the attention of venture capital firms and input producers who are actively investing in the space. According to AgFunder, companies in the farm management software, sensing and IoT segment received € 662 million in funding in 2023. IoT start-ups are predominantly targeting two segments: remote in-field monitoring and precision livestock farming. The sensing technologies are often combined with analytics software that leverages algorithms to model environmental parameters or animal behaviour.

Start-ups in the precision livestock farming segment focus on providing remote monitoring solutions with enhanced functionality such as positioning and detection of various diseases. The players are predominantly active on regional markets and do not compete with the major dairy equipment manufacturers in terms of global distribution and product range, but still limit the market penetration of the incumbents in some specific segments of the market.

In the in-field monitoring segment, start-ups mainly focus on measuring various environmental parameters to monitor for example soil moisture, weather, crop performance and diseases to be able to forecast yield. Agricultural pests in particular are responsible for significant losses to the world's annual crop production. Traditional pest management is typically a labour-intensive undertaking as it requires manual scouting throughout the crop fields. Modern solutions utilise connected insect traps and data modelling for risk evaluation to time the application of pesticides.

Precision livestock farming start-ups

In-field monitoring start-ups

Figure 3: Examples of IoT start-ups in precision livestock farming and in-field monitoring

Boosting support services and simplifying data exchange are top priorities for solution providers

Most farms are still family-run businesses and often employ an informal style of management. The adoption of precision farming solutions and software is demanding growers to learn new farming practices and become more organised. In addition, the increasingly complex technological environment that farmers operate in demands dealerships to offer a greater extent of services to integrate and support the range of precision farming technologies. This is being addressed by established precision technology companies such as Trimble, Topcon Positioning Systems and Raven Industries which are actively investing in their channel partners to offer enhanced support for their precision farming portfolios.

An effect of the wider adoption of agricultural technology is that farmers face the issue of increased fragmentation of data across systems. As precision farming solutions become parts of broader systems, leading providers are increasingly investing in technical platforms capable of supporting integration with third-party hardware and software solutions. Integration offers the advantages of connecting stakeholders across the agri-food value chain, making better informed decisions and capturing data accurately. Berg Insight expects that the ongoing trends of farm consolidation and increased professionalisation of the industry are likely to continue and result in a stronger focus on yield maximisation and cost efficiency, which are proven benefits of using precision technologies.

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