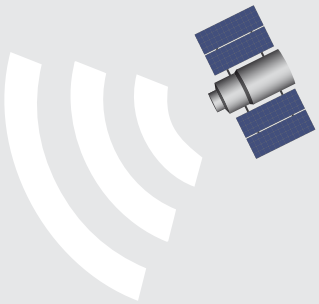
Capgemini

Digital Agriculture Bytes against Hunger

Translating local and personal approaches of digital agriculture



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Introduction

We are pleased to present you with our latest white paper on digital agriculture. Our objective is to share our point of view on the digital developments in agribusiness, the challenges the industry currently faces, and how they can be overcome with evolving digital solutions. While agriculture is a broad sector, digital agriculture is of particular relevance to companies working with or supplying relevant data (e.g., meteorological) and equipment and supplies manufacturers. This white paper focuses on opportunities for these companies in the context of a relevant, local, and personal journey for the individual farmer.

Background

As an essential component of human life, agriculture has been challenged time and again by climate and natural hazards, population growth, and scarcity of arable land. The majority of the world's agricultural areas are clustered in Africa, the Americas, and Asia, totaling over 48 million km² globally, or 37.2% of the land mass (FAO, 2017a; World Bank, 2018a). Despite sufficient food production, 800 million people worldwide do not have adequate access to food. Given predictions that the world's population will reach 10 billion by 2050, and in light of the dietary shifts occurring in developing countries (FAO, 2017b), agriculture is once more faced with a tall order.

Previously, natural catastrophes and resource restrictions limited human population growth (Meadows et al., 1973). Technology has the ambiguous role of both facilitating unprecedented population growth and providing a potential solution to the resulting challenges. In this respect, technological aspects such as big data and IoT, or developments in crop growth or biological soil enhancements all provide key and interlinking developments.

The limiting factor has shifted from low yields due to a lack of mechanization via excessive but unevenly distributed food production (Alexandratos and Bruinsma, 2012) to a lack of available farming area. Mechanization allowed more area to be utilized with a smaller workforce. Higher yields on stable area used was the hallmark of the green revolution from the 1950s to 1970s (Conway, 1998).

Additionally, agricultural employment dropped from 43% in the early 1990s to 26.5% in 2017 (World Bank, 2018c). Nonetheless, nearly two billion people are employed in the sector, primarily as smallholder farmers.

In light of a declining workforce and increasing demand, it is necessary to develop the agricultural sector with new products, practices, and technologies. The agricultural sector has a significant potential for digital tools as it is currently the least-digitized, far behind industries such as hospitality and health care (Goedde et al., 2015).

Therefore, the challenges incorporate both technological step-changes and the intricate adaptation to new conditions –climate and technology. It is not a one-size-fits-all approach, but

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instead requires close assessment of the situation to focus the journey to adaptable agriculture both on the tractor and the donkey – depending on requirements, targets, and challenges.

Bearing in mind your individual approaches and storylines, and the climate and culture you live in, Capgemini, as a global IT leader with deep roots in application and innovation management, is able to take the digital journey with you to overcome these challenges and leverage your potential to accomplish breakthroughs within the agricultural value chain to face the future.

Challenges

Currently, agriculture is racing to keep pace with basic food requirements and dietary demands within the context of a projected world population of 9.7 billion by 2050 (FAO, 2017b). Global factors such as climate change, water availability, the labor force, and consumer demands challenge the agricultural status quo. Other factors primarily result from the relevant local baseline for the individual farmer and their adaptability to technology and change. Regardless of the challenges, the pressing need to feed increasing numbers of people with nearly equal amounts of arable land within a short time frame remains.

Key challenges, which are both geographically and technologically interconnected, need to be addressed by future-orientated agriculture and the technological advances available under the umbrella of digital agriculture.

Challenge I – Agricultural disparity The industry has various baselines in terms of scale and mechanization depending on region, farming intensity, and predominant production (i.e., subsistence farming or large-scale consumer markets). Therefore, no approach to sustain and increase yields can be considered universally applicable or suitable. The importance of farming in a local context must also be recognized as well as its role in global food production requirements.

Challenge II – Farming set-up Farming is by no means uniform and farming scale is strongly determined by geographic region. Europe and the Americas represent 74% of farms larger than 10 ha whereas 85% of those smaller than 10 ha are found in Asia (Lowder, Skoet, and Singh, 2014). Thus, it is important to acknowledge the need for technology and farm suitability at various scales and to recognize the key opportunities that new technologies can bring to smallholder development.

Challenge III – Individual, adaptable farming Digital agriculture cannot be seen as a one-size-fits-all approach. The requirements for each farm or region, the current baseline, and the famers' personal aims need to be accounted for in any structural change. Supporting the adaptation of suitable technology at scale and across regions is key.

Challenge IV – Industrial distribution Significant private investments into agriculture can be observed and farmland prices are increasing (Eurostat, 2016). Additionally, new opportunities within the sector covering seeds, crop production support, and farm management are attracting more attention from big players. Therefore, the challenge is to establish adaptable, future-orientated agriculture by drawing on the opportunities created by the interlinking of companies and sectors.

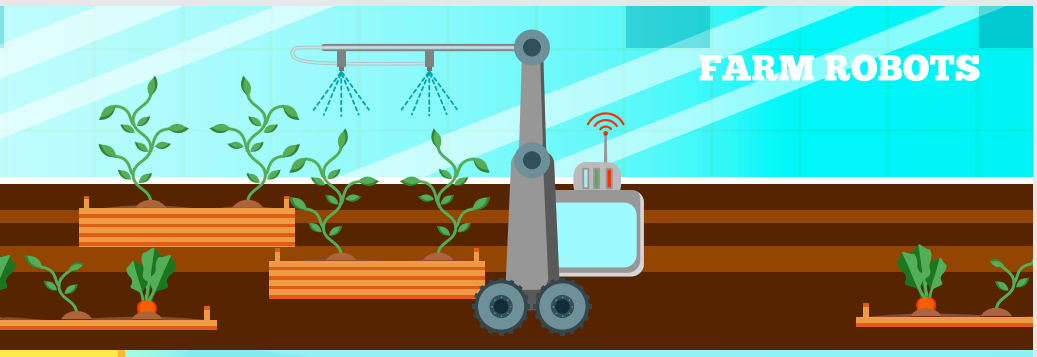
Challenge V – Modern utilities and precision agriculture The analogy of tractor versus donkey provides a key insight into the challenge of

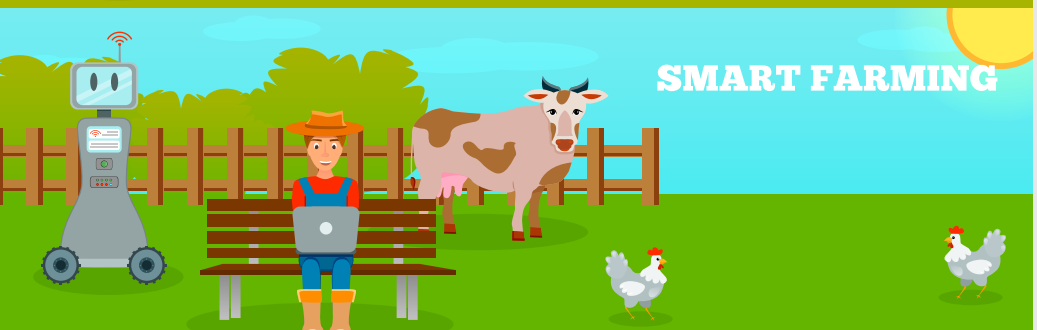
modern utilities. Not every innovation is suitable for every agricultural opportunity. Especially considering the disparity in agricultural targets and scale across the globe certain methods can be of varied impact across regions due to data availability.

Challenge VI – Consumer demands
Choices available and consumer demands in terms of sourcing and sustainability sustainability of agricultural products have increased significantly in recent decades. Consumer demand can be tackled with optimized systems, such as track and trace. Additionally, targeted assessment of food consumption and demand patterns would make it possible to cascade production accordingly and lever technology at suitable points.

Challenge VII – Infrastructure
Implementing new technology both drives infrastructure and is dependent on it. Rural areas may, even in high-income countries, lack a suitable digital infrastructure of internet or mobile phone coverage. Digital opportunities are challenged by the requirements of the individual farmer within their local context under the potentially restrictive bottleneck of digital infrastructure.

Digital agriculture, when applied with foresight and adaptability, is set to provide solutions to many of the problems facing the industry today. In other words, the only way the tractor will replace the donkey in the field is if the advances it brings are credible and deployable.





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Scope

> Agricultural capacity varies on a sliding scale, from subsistence agriculture to large-scale industrial set up."

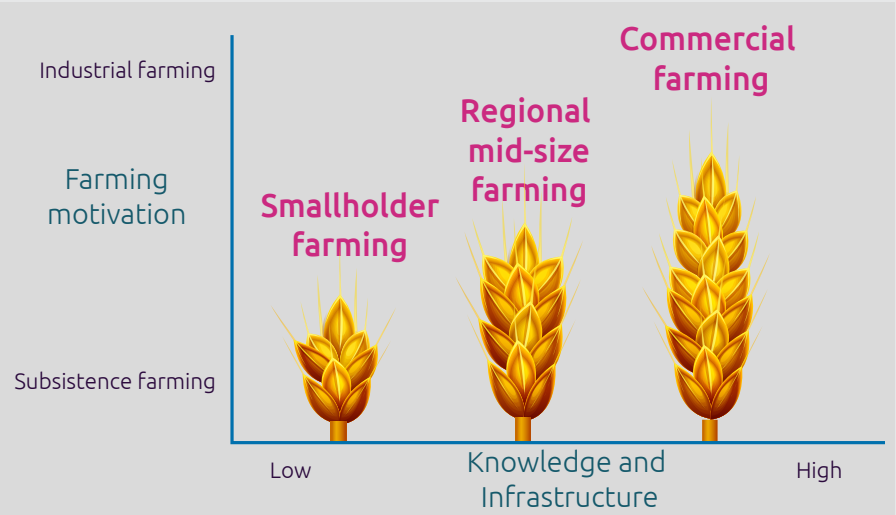
> Agriculture is an industry based on personal experience and individual farm-based records. Data sharing and integration along the value chain as well as across the industry could provide significant benefits."

Agriculture is spread across the globe and is relevant as a key resource for all of the world's population. As a result, approaches to agriculture vary greatly depending on levels of commercialization, how deeply connected the local population is to the land and agricultural processes, specific local features, needs, and potential. Agricultural capacity varies on a sliding scale, from subsistence agriculture to large-scale industrial set up. Given these differences in scale, a nuanced assessment that recognizes the different baseline conditions and common-core issues, such as global distribution of yields, accessibility of technology, feasibility of smart mechanized farming, and the individual requirements of the farmer is critical.

Geographic location is key for two reasons. First, changing climate patterns and abiotic conditions already acutely affect yield and approach (intensive versus extensive farming) and will continue to do so at an even larger scale in the future. Secondly, the geographic location of a farm does not necessarily reflect farming characteristics. North America and Europe are mostly considered high- intensive farming areas, whereas they still contain areas of low agriculture income, subsistence agriculture, and limited mechanization (Eurostat, 2016). Thus, significant opportunities, both geographic and technological, are available. Aligning these opportunities to the particular needs and goals of each farmer is the key challenge.

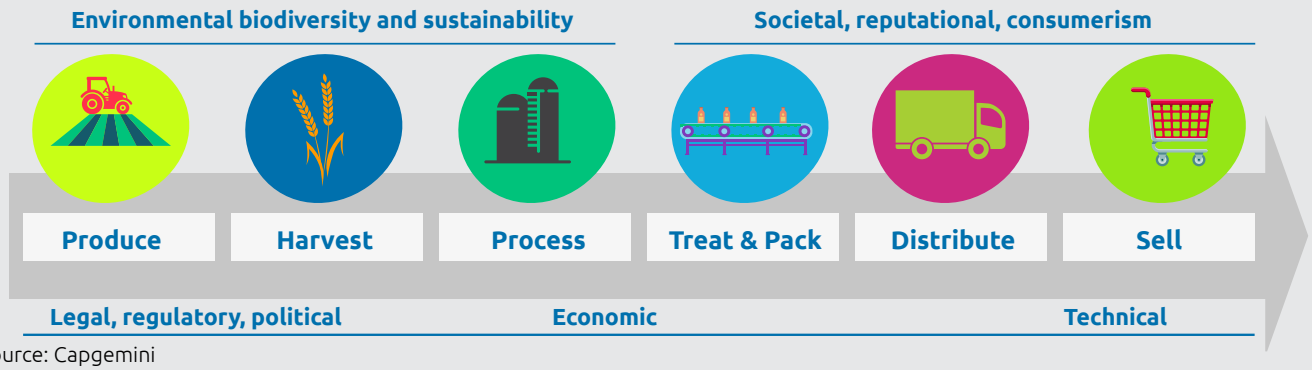
This white paper addresses the challenges and opportunities facing agriculture through a mixed-perspective approach. Not only large-scale farming, but also smallholder agriculture, are of key importance. Buzzwords such as "digital agriculture" or "smart farming" dominate the discussion. Nevertheless, it is important to highlight the concepts and factors behind these terms and assess their impact on farming in terms of the industry in general and of local farms in particular. Adapting digital farming to its geographic context and to its stakeholders is at the heart of this overview. Socio-economic challenges, available technologies, and economies of scale explain why farming is undertaken and how it impacts the farmers' lives.

Figure 1: Background



Source: Capgemini

Figure 2: Agriculture value chain



Source: Capgemini

The agricultural value chain

The traditional agricultural value chain has a linear approach from production via distribution to sales. This has supported a segmented flow of information, both in terms of advice for agricultural supplies and origin, quantity, and quality forecasts of yield. Therefore, any lever points are placed sequentially along the value chain. Information supply, advice, and sales processes are concentrated at key points. They are traditionally established but lock potential for improvement with novel tools and disruptive new information sharing opportunities. Agriculture is an industry based on personal experience and individual farm-based records. Data sharing and integration along the value chain as well as across the industry could provide significant benefits. The status quo of the value chain and lever points provide the advantage of an established, trusted system with numerous opportunities to scale the products and information. This inherent distribution of expertise along the value chain compartmentalizes knowledge and experience. Interconnected networks or general disruption and restructuring of the agricultural value chain would promote direct interaction or interconnectedness via a platform system gathering all parties.

Does the farmer get an honest price for the products?

Taking the individual farm and farmer as a starting point, the question is how they can benefit from these developments. The costs of production are increasing because of rising labor and working capital costs. The commercial market for agricultural products is very volatile because the weather influences production levels and farmers' yields. Additionally, food trends influence demand and, indirectly, prices.

> "The change must be identifiable on a local scale, relevant to the farmers' processes and improving their current workflow, and suitable to the personal requirements of each farmer."

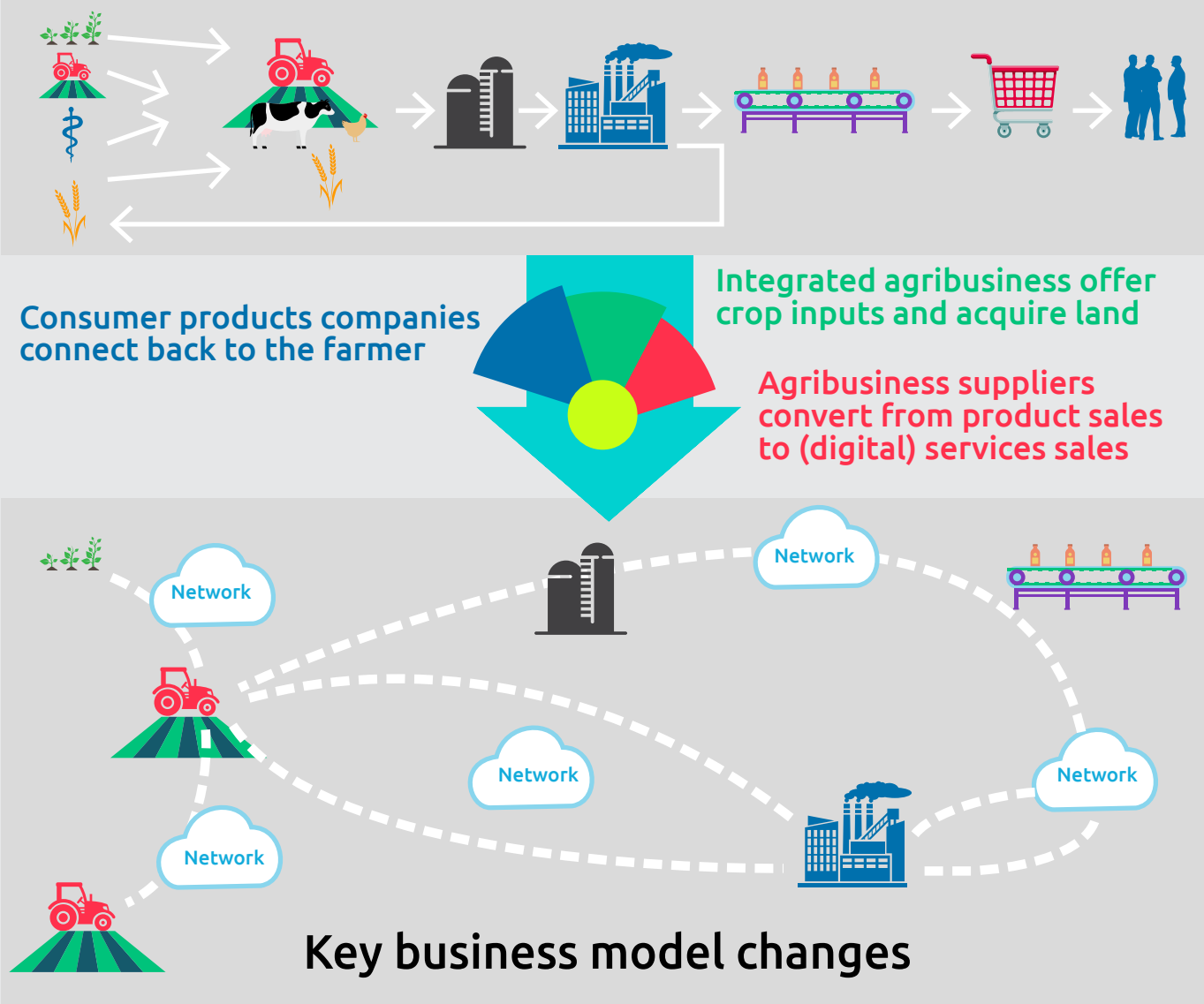
Why? – Rethinking the agricultural value chain

Rethinking the value chain and allowing digital tools to complement agricultural needs and knowledge transfer has to center on three core principles: the change must be identifiable on a **local** scale, **relevant** to the farmers' processes and improving their current workflow, and suitable to the **personal** requirements of each farmer.

Interconnected feedback between participants and suppliers as well as information sharing can create networks. Such networks will reflect the capacities of the current chains, although they will be reorganized and centered around the requirements (technological, information, sales opportunities) of the farmers rather than around ingrained structures.

Turning the value chain into a value-gathering network repositions the intermediation and creates the potential of removing intermediation altogether in favor of direct information and sales channels. These networks have the advantage of being both location- and type-specific. While generic sales channels are not able to service the entirety of product variety, a network can encompass a variety of farming types (crops only, livestock only, or mixed farming) and scales while still providing local and relevant expertise.

Figure 3: The agribusiness value chain converts into business networks to respond to digital change



Source: Capgemini

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> Generating data is the backbone of digital farming, but its true power lies in sharing data."

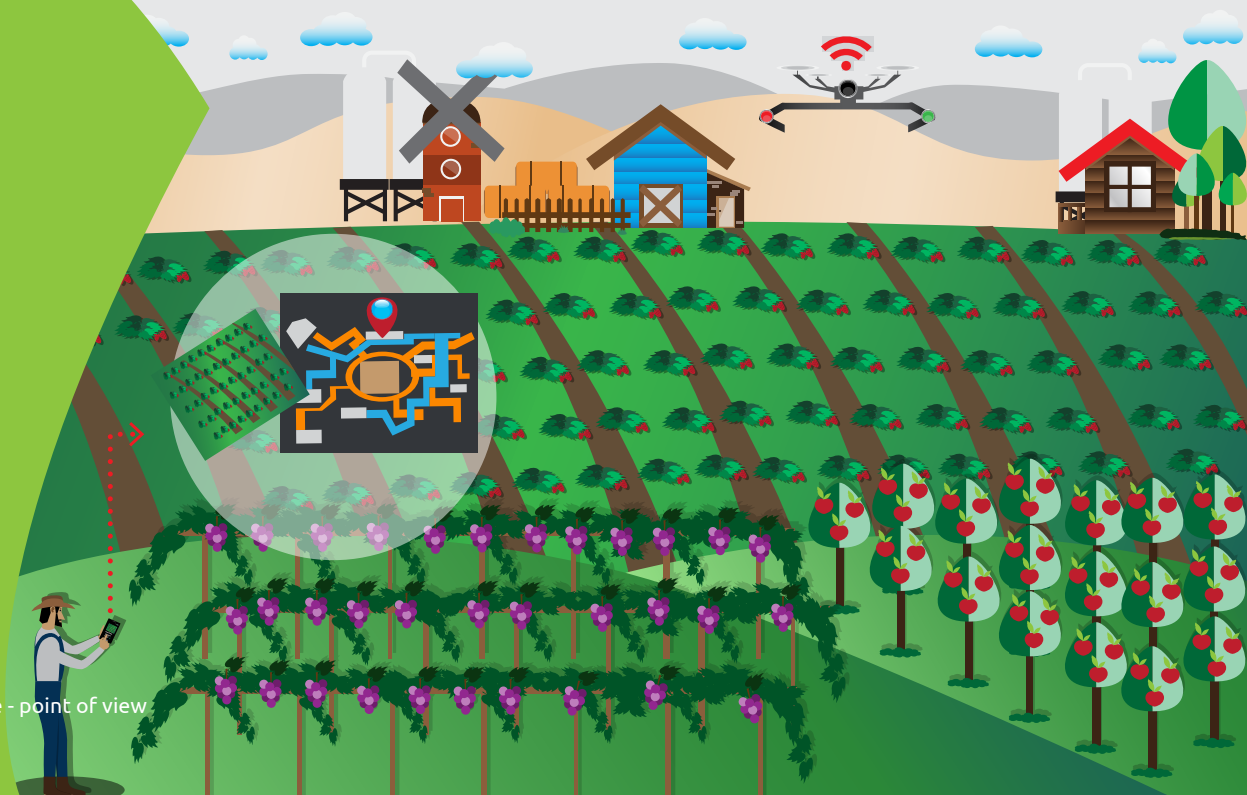
Digitization of the yield – machinery or donkey?

The bulk of agricultural labor is not carried out with tractors or other heavy machinery. While some do conduct industrial farming on large plots of land, globally most farmers still work by hand and are family-operated smallholders who lack the capital to own or rent machines. Thus, data is collected in different ways and low-cost solutions are necessary. For example, in Columbia the best coffee grows in the mountains on small family-owned, one-hectare farms. Nonetheless there are a great many of them and they constitute a key part of the cultural heritage. In light of their uniqueness, such smallholders are best served with a totally different approach to digital farming – "the digital donkey."

The digital donkey

The immense amounts of agronomic data offer insight, understanding, and quick learnings. Digital farming is particularly revolutionary for farmers in Africa and South East Asia where over 80% of farmers are smallholders as it has the potential to remove the current information asymmetry. In some areas, like the Himalayas, limited biology training and a lack of qualified people in rural areas restrict knowledge about weeds and pests.

Digitization transforms decision-making practices in agronomics. Previously, hard work was only supported by personal and local knowledge. This is now contrasted by vast knowledge and experience available via digital solutions. Farmers can now profit from the learnings of other farmers around them. Due to climate change, much better information on how to farm and what actions to take is required. In other words: digital farming provides means for adaptable farming. Farmers can anticipate new situations better and faster. Digital farming can also decrease the negative impact of farming tremendously. Next to improving biodiversity and water quality, the use of fewer crop protection products is beneficial for the environment on the whole.



As consumers we want to have food that is healthy for us, that has not impacted the environment in a negative way, that ideally was grown in our vicinity, and that is tasty. Buying Fair Trade coffee or bananas is possible, but for other products this is really challenging. Digital farming can create more transparency on where food comes from and how it empowers the community that produces it. By reducing the impact farming has on the environment, digital farming can have a positive impact on consumers' perception of food and food production, contribute to a healthy ecosystem, and offer insight into the food production chain.

Generating data is the backbone of digital farming, but its true power lies in sharing data. Data that some see as worthless can be very valuable to somebody else.

Digital yield model

Hardware provisions focus on sensors in various formats for collecting data. These include devices for measuring local soil moisture or nutrient availability and include devices fitted to a tractor to measure crop yields, weather stations, as well as image-capturing satellites and drones to map land use and crop health.

The software side aims to collect, process, and analyze the data, typically with the goal of presenting rich insights to farmers in a consumable format. Some companies offer both hardware and software in a vertically integrated design—and usually those selling hardware will have a software program included—whereas others offer just the software.

The software uses data from the hardware, which is either owned by the farmer or by hardware businesses (such as machinery manufacturers) that the software provider partners with. Alternatively, it will use data provided by farmers, third-party data organizations, or from publicly available resources, such as local governments.

Software can help farmers decide when and how much to irrigate a field based on soil moisture data, when to plant and harvest crops based on yield data or weather, and provides access to weather predictions and information regarding crop health. Fertilizer applications can be much more prescriptive, based on factors such as soil nutrient availability. This enables farmers to save money on areas with fewer requirements and optimize yield across a property.

One clear challenge is adoption and how to make the data collected relevant and useful for the farmer. For many agricultural operations, acquiring and using a software system will be a big adjustment from the spreadsheets and pen and paper approaches that many still rely on. Therefore, not only do agricultural big-data companies need to convince farmers to make the switch, they also need to make sure that the interface is easily usable so that the farmers can see an obvious return on investment in a relatively short time.

Some farmers might be relatively tech-savvy and want an advanced system, whereas others are really starting from scratch. Companies will need to appeal to a wide spectrum in terms of technological ability, operation size, and type of farming operation. The size of the agricultural operation using the technology is also important. Many of the options on the market today target very large operations, such as those found in the US. These are likely to be much more complex and feature more equipment and teams than smaller operations. Thus, a key challenge is making the technology adaptable to the needs of the farmer, regardless of operational scale.

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Opportunities for digital solutions

> However, in order to truly facilitate digital farming, the fundamental question that must always be addressed is 'why?'"

> The biggest win would be to adopt a completely new approach in designing the new digital farming paradigm; one that is most beneficial to smallholders."

Design thinking has its place in agriculture. After all, farmers are the best designers in the world, creating farming systems that fit their local situation and optimizing the use of available resources. Farming is also the art of adapting to changing circumstances. Agricultural production is characterized by factors such as soil, climate, available resources (area, material, manpower, cash, etc.), and market outlets for each farm. Most agricultural systems are therefore designed to be location-specific and are unique in terms of design and applicability. Contrastingly, merchant innovations, such as chemical inputs and decision support tools, are generally generic approaches adapted to a wide range of agricultural conditions.

To benefit from the new digital farming framework, certain keywords are always applicable: **local, relevant,** and **personal.** New technologies can align with this framework. Connecting large-scale companies with local farmers will be made possible with digital technologies. However, in order to truly facilitate digital farming, the fundamental question that must always be addressed is "why?"

Taking into consideration the innovations driving new methods of growing, new types of crops, new varieties, climate change, etc., the agricultural value of the farm's yield will be significantly affected. Disagreement persists regarding whether crop or livestock farming offers the best commercial value or is most suitable for local conditions. To address such questions, a new thought framework must be designed and starting points for building useful applications or equipment defined. These two approaches of design thinking and developing a new thought framework are often intertwined, but both call for design methods that allow designers to deal with this environmental diversity.

There are about 450 million smallholder farmers around the world and they make up 80% of farmers globally. Though they lack the technology, knowledge, capital infrastructure, and distribution networks, their biggest asset is their diversity.

The biggest win would be to adopt a completely new approach in designing the new digital farming paradigm; **one that is most beneficial to smallholders.** This would create new possibilities; they can share knowledge, get access to knowledge, gain new insights, and improve their competencies at low cost. Smallholders are in a position to take the biggest leap forward. They can manage a diversity of crops and create a sustainable new business model.

Digitization of seeds and crops

Why should seeds and crops be digitized? What does digitization offer the farmers and other stakeholders? The aim is to create scalability and a sustainable form of agriculture. Farmers need to manage business risk and comply with regulatory and financial prescriptions to keep their operating licenses. Their insight into the market is key and knowledge about yield prognosis essential.

How to decide which seeds are best?

First of all, the right seeds with the right DNA – or the right basic algorithm for the program run – must be identified. While the commercial market demands certain characteristics, the choice needs to be made based on the farmers' experience. This choice can also come as automated advice based on wishes and context. One benefit would be the added global experience and its application to a local situation. This is the starting point of digitized content that ads value for the farmer.

Once the seeds are planted, the farmer has limited influence on what happens next. Nature makes this unpredictable – no year, location, or crop are ever the same – **every year is unique.** This makes farming an art. Although a crop cannot be engineered, the best possible circumstances can be identified. And digitization can help to trace those circumstances.

Digitization covers two gaps – experience and attention. There are always blind spots when growing crops. New situations do not always have a clear answer, though someone somewhere probably dealt with the same challenge. If you can connect that **experience** to your context, it will give you the right tooling.

The **attention gap** is also well known. Every new crop planted requires full attention in order to ensure growth and yield. In later growing seasons, less attention is paid to the formally new crop. Digitization can support triggering events, based on what happens and direct attention and effort in the right direction. How these stop-gap opportunities are handled depends on the initial situation. For smallholder farms, the gap will be bridged with knowledge very quickly and they will take a big leap forward. It will also work for industrial commercial farmers, albeit to a different degree.

The goal of all digital approaches should be **sustainable and scalable farming.** Supporting the local requirements of the farmer via interlinked knowledge sharing allows for essential aspects of yield increases on equivalent land area or even lower inputs. Key aspects of supporting crop growth would be providing information and plans for typical scenarios in weed and pest control, fertilization requirements, and irrigation planning. Furthermore, the supported elements will allow yield maximization under optimized inputs which will, with harvest guidance, lead to financial returns at scale. Therefore, supporting the farmer with experience and knowledge by proxy makes it possible to approximate ground truths for yields and input requirements. This creates a reliable prescriptive dimension for the required inputs resulting in improved deployment of capital. This is especially important for small and medium farms and developing countries, improving agricultural yield quality and quantity.

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Big data

Big data is a buzzword in agriculture, but what does it mean and how does it need to be positioned in the current ecosystem? The big data environment is a black box in which a great deal of history and potential insights are hidden. Big data is a phrase that has recently integrated the world of technology across industries. It involves capturing relevant data from a huge number of sources and translating it into actionable information to improve business processes and solve problems at scale and speed. Building a big data environment based on current biases in agriculture may result in missing out on some breakthroughs in thinking.

Monsanto is now utilizing soil fertility supported by mycorrhiza as a new asset. This approach would be traditionally based in the organic agriculture movement and showcases the way agriculture is developing: the ecosystem is open for new insights and the system will be quickly adapted by innovations that support new tools and approaches. Farming is the art of being adaptable to new opportunities. These opportunities can be increased thanks to new technologies or new biological insights.

Agriculture is an industry which requires that farmers and agribusinesses make innumerable decisions every year. Therefore, agriculture is an obvious target for big data. Climate change effects how farm operations and the network around them are run. Big data analytics can alert farmers to problems on a certain field, such as a pest infestation or drought conditions, thereby reducing the need for regular manual checks of every piece of land. Shifts along value chains and logistic distribution offer vast possibilities for big data integration. In addition, the arguably harsher conditions casued by climate change make the use of data consistently more relevant for farmers. It enables them to base their critical farming decisions on data patterns and insights. With existing and increasing labor shortages in agriculture, the ability for big data analysis to create efficiencies that reduce the need for physical labor is an important benefit for the industry.

Precision agriculture

Farm-centric digital farming is still removed from fully fledged digital agriculture. Precision agriculture began in the mid-1990s with GPS equipment installed in machinery and has been a great input source for big data ever since. Precision agriculture demonstrates that it is possible to generate a lot of data via farming machinery and combine it with geosystems and satellites, making it possible to support operational farming with location-specific data tags. The initial slow onset of technology is now being eclipsed by satellite telemetry, sensors, drones, and farm management software – all of which are becoming available at an unprecedented rate in the fields.

Precision agriculture strives to make farming more efficient. Agricultural giants, governments, and IT leaders have all launched their digital initiatives for agriculture. Smart farm equipment, drones, and robots are enabling precision agriculture. Big data and algorithms in agriculture will enable insights and optimization in the field. Most of the initiatives are farm-centric, directed toward row crops. Core markets for row crops, such as the US, are showing increasing costs for lower crop value. Consequently, farm

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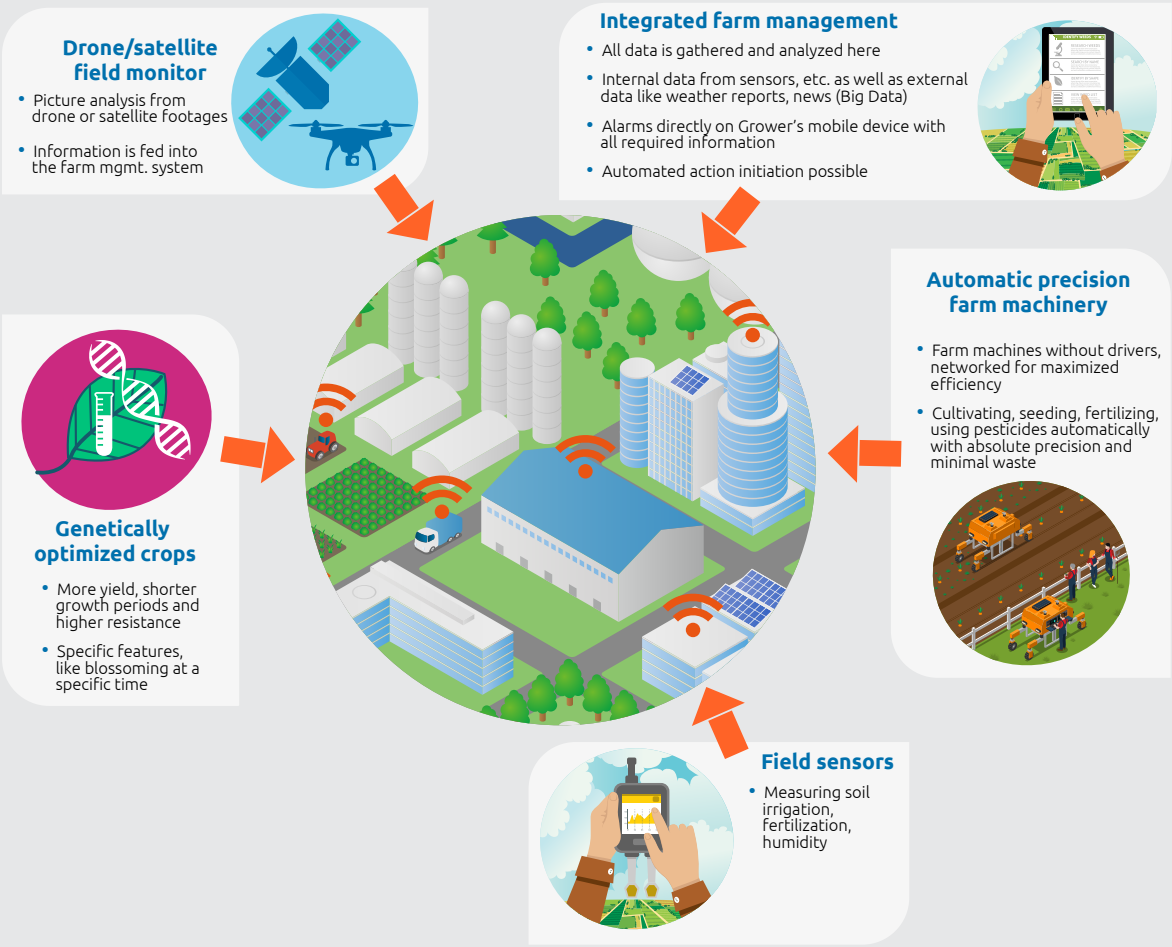
Figure 4: Precision agriculture



Source: Capgemini

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management solutions enabled by big data and precision farming (observing, measuring, and responding to variability in crops) are being adopted since they provide higher yield with little investment.

Equipment manufacturers have started using this opportunity for their own benefit, collecting data on usage, crops, life cycles, etc. via their machines. This allows them to predict equipment maintenance and use and to develop new commercial service concepts. In return, the farmer receives operational security. This creates the context for commercial industrial agriculture, which enables the scale and thus the profit margins that large-scale manufacturing companies are aiming for.

Precision agriculture has been used as a lever by equipment manufactures to drive down the operational costs on the farm. Nevertheless, yield levels have not improved correspondingly. The yield rise is dependent on taking the right actions with the right teams and using the crops and varieties that have the right market position. The proven value of precision farming is debatable and dependent on various factors.

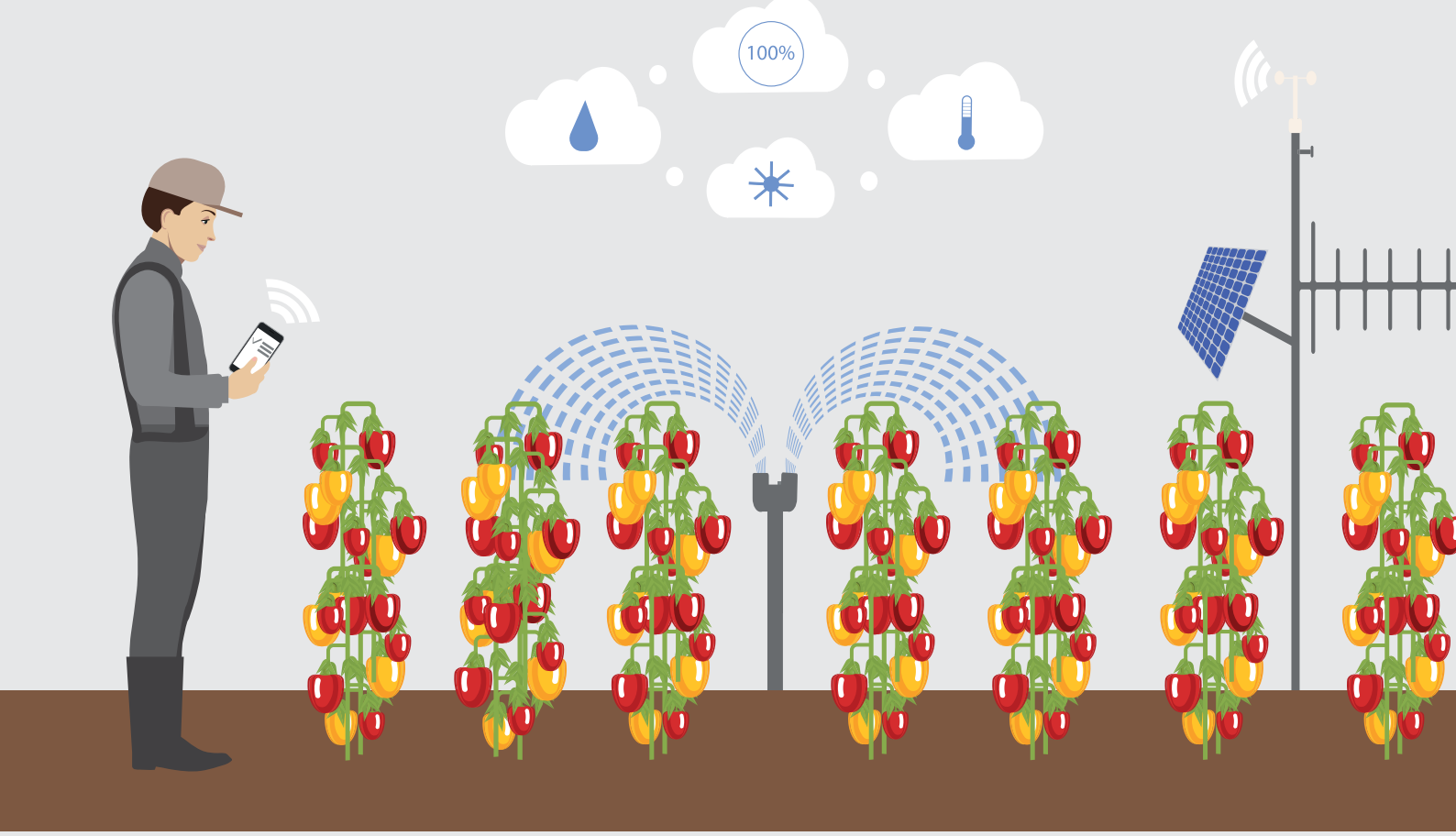
Intelligent automation

Because the agricultural sector has been pursuing cost reduction strategies for several years, various process optimization projects and outsourced activities to lower costs have already taken place. To continue the journey started with these initiatives, robotic process automation (RPA) provides the transition from services-through-labor to services-through-software, with a provision for further cost reduction.

RPA, both within agriculture and in general, is a set of technologies using software as a virtual employee to manipulate existing applications (e.g. ERPs) and to execute repetitive rule-based processes. This virtual workforce helps minimize (or even eliminate) human intervention in the execution of tasks or decision-making. Although RPA has not yet reached the investment levels it has in other industries due to the varied background and baselines in agriculture, it does provide significant potential in interconnecting and streamlining repetitive farm processes to compliant standards.

Since robots work faster and more accurately than humans, process speed and process stability will improve significantly. In the context of digital farming, RPA can provide high-income countries with a double solution to the challenges faced due to current and future labor shortage and increased regulatory demands. Therefore, the risk of compliance breaches, such in the handling of agricultural product at farm- and trade-level, is minimized. Once designed, the RPA procedure will work 100% routinely according to prescribed conditions and maintain adherence to standards.

RPA is a significant lever to utilize potential to increase process efficiency, robustness, and product quality. Its applicability is centered on repetitive processes, high transaction volumes, and cost-critical processes. Since RPA is focused on rule-based, structured processes, complexity is a natural delimiter of possibilities. Value-added services tend to be complex and versatile, making them resource-intensive as they are harder to automate.



Artificial intelligence: the industry challenge – lead or be left behind

The transformative technologies that comprise artificial intelligence take automation to the next level: simulating human cognition processes to support a business' capability to overcome the limitations of labor and open new sources of value and growth.

The key is to consider AI as a hybrid of human and technology. The collective value is greater than that of its parts. Not only does AI replicate labor activities at greater scale and speed, but it can also perform activities beyond human capabilities. To be able to utilize these benefits, it is key to incorporate AI into the thought concept of digital farming and the agricultural sector. AI applied to its full potential in farming can support a step change in the sector, transforming business operating models and creating sustainable growth. AI provides a host of opportunities. It may be used to analyze what is available in the cloud/internet, combine internal and open-source data, or identify algorithm-driven search patterns to optimize farm-specific and relevant outputs. AI-driven functions such as image analysis (satellite telemetry, plant health, weather, etc.), predictive analysis (demand trends for agricultural products, demand cycles/peaks), and machine learning (continued analysis of passive sensor data) are key aspects of the technological potential. Moreover, big data is the foundation feeding into intelligent automation platforms that enable the implementation and utilization of AI. For the farming industry, the question is no longer whether adopting automation and AI as strategy should be considered, but rather "what" in terms of automation strategy should be done and "how."

IoT – connected agriculture

> IoT is seen as a major driver behind the agricultural movement called connected agriculture."

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IoT is seen as a major driver behind the agricultural movement called connected agriculture.

The framework behind IoT is a network of sensors that deliver data to a back end on top of which applications can be created and data utilized. These sensors can deliver information about temperature, soil moisture, nutrient content, and use-imaging techniques. Livestock, sound, movement, relative position, etc. can even be transmitted. The key challenge is to integrate this data into a platform. The next step is building the applications that add value for users, consumers, and stakeholders in the ecosystem.

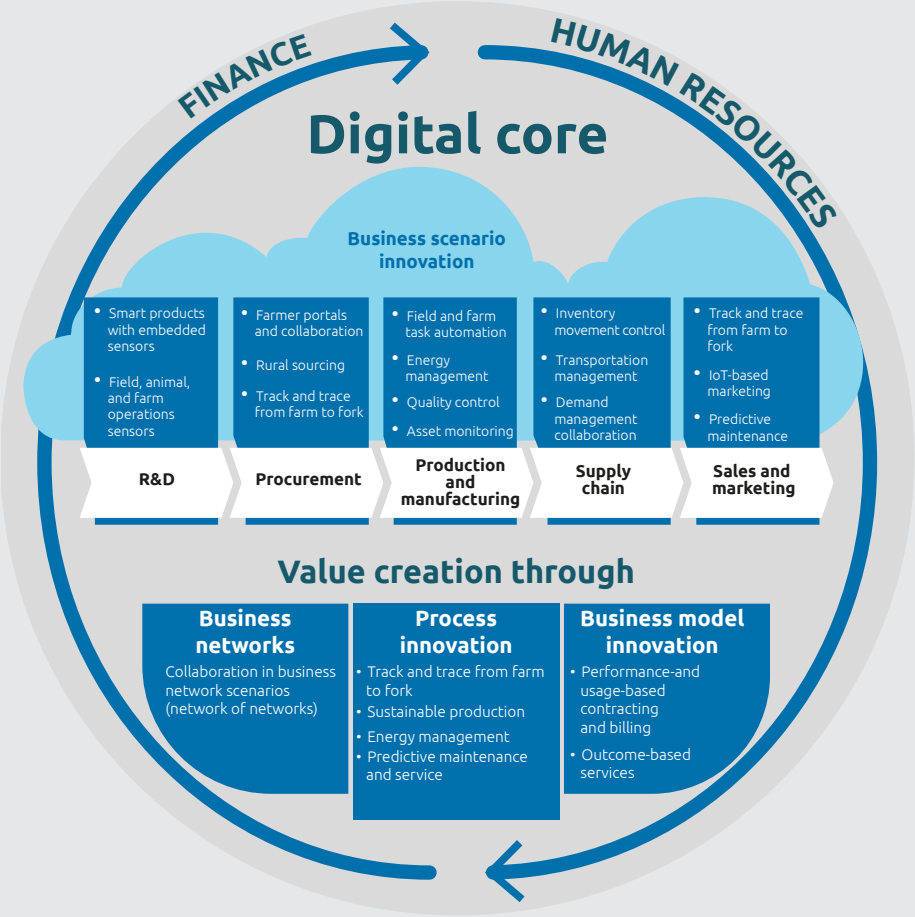
What are the benefits of IoT?

IoT will be an extra cost factor and will increase dependency on technology. The discussion about data-sharing standards and compliancy between different machine manufactures is significant. Farmers want a choice based on long-term goals: a sustainable business and the freedom to make independent choices. Therefore, the discussion around open-source software is a relevant, if emotional one that will play a key role in addressing the challenges of IoT in agriculture.

Promise or prophecy?

Machine manufacturers in the farming-equipment sector really do believe in the added value of connected agriculture. It will provide them with extensive information from and about the farmer. Additionally, if manufacturers hold proprietary data rights over a network of farm machines that communicate with each other, they will have control. Commercialization of this in a service model can contribute to financing working capital in the next stages. Examples of this are already out in the fields and very interesting smart machines, such as sprayers that water an individual plant based on real-time prescriptive advice from an agronomist's algorithm, are already being built. Once more, the most important issue is how this will benefit the farmer – locally and based on their personal requirements and circumstances.

Figure 5: IoT is driving value for agribusiness companies



Source: Capgemini

Platforms

A key buzzword in digital agriculture is "platform." Who will be the first to have an impact such as Facebook, Amazon, Uber, or Airbnb did? As leaders in their field, they connect social contacts, products, services, and the biggest tourism network of the world. All evolved out of the same idealistic goal – to create a more accessible and better-connected world. In agriculture, there are different approaches for service provision and respective platforms: proprietary, collaborative, and personalized services.

As a substantial machinery producer, John Deere's initial approach of selling their equipment with integrated sensors provided a suitable starting point. However, acceptance by markets and farmers was adversely affected once the company claimed ownership of generated data and refused to share it with other equipment manufacturers, or indeed, the famers. This issue was closely followed in Europe and reversed the initial positive developments of connected agriculture.

As a reaction, coops started launching their own initiatives. One of them

> In agriculture, there are different approaches for service provision and respective platforms: proprietary, collaborative, and personalized services."

is JoinData, formally known as SmartDairyFarming, founded by the stakeholders of the dairy industry in the Netherlands. After initial trials, a strategic realignment was undertaken to change their model towards one that provides an infrastructural highway for farmers' data. Farmers are in control of their data and can authorize partners. Only then can these companies use the farmer's data to deliver value for that particular farmer. Although they are in a restructuring phase, they are ones to watch.

Another important approach is highlighted by ClimateCorp, which is especially interesting in light of the Monsanto takeover by Bayer. Initially an insurance company, ClimateCorp delivers value by collating farmers' data, providing personalized crop advice, and insuring respective yields.

As a prerequisite, the approved seed fertilizers and chemicals would have had to be purchased as well. This "one-stop-shop" approach to providing supplies, information, and insurance must be considered as the new service model within the agricultural sector.

Connected services

Technology is not only changing the way we live and work, it is profoundly changing business models across industries. In a traditional context, customers would buy products or services related to these products. However, a shift toward pay-per-use and pay-per-output is taking place. Customers are paying for the benefits of the product rather than the product itself. The provisions of services such as data and information based on,

for example, equipment use across the farm is becoming more and more prevalent in the framework digital architecture.

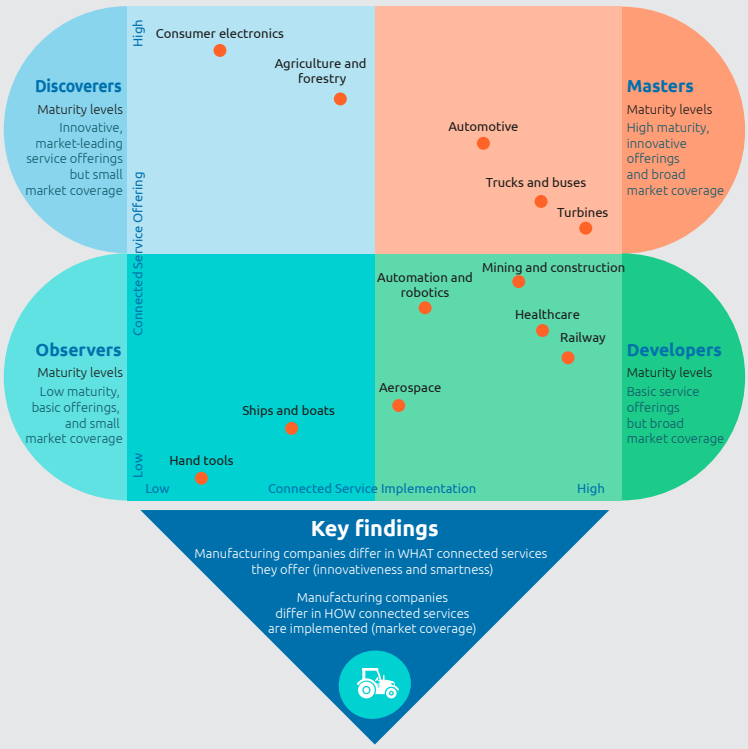
These new business models are examples of connected services (Capgemini Consulting, 2018). They connect products to the cloud to monitor equipment condition or predict maintenance requirements. From a manufacturer's perspective, connected services provide many benefits. Not only can customer needs be better met, but also differentiation from competitors achieved, and a constant revenue stream ensured. Moreover, connected services can provide higher margins due to higher willingness to pay for services with direct impact rather than for physical products.

Industries generally vary in terms of which connected services are offered and how these are implemented. A difference in pace in adopting connected services allows companies to identify their focus and learn from each other in terms of which services should be offered and how they are to be implemented. Also, levels of commercialization necessary and demanded in the agricultural market are shaping connected services.

Industries can be divided into four quadrants for connected services: observers, developers, discoverers, and masters. Depending on maturity, breadth of services offered, and the difference in market cover, the companies can be assigned to the respective quadrant:

- **Observers** have limited market coverage, providing basic service offerings (communication and information) and have not yet reached the higher maturity levels of their products and services.
- **Developers** provide a similar basic offering, though with distinctively broader market coverage, allowing for a cross-sectional comparison of implementation. They offer small market cover but innovative service offers.
- **Discoverers** are on the leading edge of the market. With increasing maturity and market spread, they will move towards the masters' quadrant.

Figure 6: Connected services



Source: Capgemini

> "Technology is not only changing the way we live and work, it is profoundly changing business models across industries."

> "A difference in pace in adopting connected services allows companies to identify their focus and learn from each other in terms of which services should be offered and how they are to be implemented."

> The best option is to have a direct link between the farmer and the consumer this local-for-local approach will work in certain circumstances."

> The first mile is the most critical in the 'farm-to-fork' concept. It delivers all the tradeable characteristics for the rest of the supply chain. It clearly highlights who the target clients are, how the products are processed, and how and where they are traded."

Located in the discoverers' quadrant, agriculture and forestry equipment companies offer innovative connected services but have not yet achieved high adoption rates among their customers. Key players in that industry offer services like condition monitoring, fleet management, and precision farming. Condition monitoring encompasses real-time monitoring of agriculture and forestry machinery, leveraging data captured by machine sensors. Precision farming leverages location data in combination with external data sources to, for example, optimize seeding and harvesting. As the agricultural industry continues to drive a digital farming agenda, the commercial use of these services will provide a large market share and the industry shifts into the masters' quadrant.

Achieving connected services mastery is a complex task. Different units of a company need to be involved to understand customers' needs, the product, and the requisite technology. While multiple solutions are available, experience has shown that there is no one-size-fits-all solution.

Track and trace

We all want to have information about the products on our table. We want to know the origin, how the food is grown, and what has been done to keep the crop or animal healthy. Who raised it? How much fertilizer was used? How sustainably was the crop grown?

We trust that the system will deliver quality and healthy food, but when something goes wrong, we want to know exactly who is responsible and where/when it happened. This gives rise to an administrative burden to create and maintain records. A trigger event happens when people fall ill or worse. The paper trail documenting the production processes is expensive, and in the majority of cases says little about what really happened.

Therefore, the best option is to have a direct link between the farmer and the consumer – going to the local market and looking the farmer in the eye, sharing stories about the hailstorms that devastated a certain crop, learning about the freshness and excellence of a product – this local-for-local approach works in certain circumstances.

Agriculture is a global business with commodity crops, such as soy, coffee, or cotton. A potential issue is that growing standards for agricultural products must be documented accordingly. Many of these crops are grown on smallholders' farms – any record-keeping requirement could add extra cost. The initial set-up of documentation and therefore the majority of the work burden is with the farmer. Once the product is the supply chain only its direction and location of the trader are added, and thus keep the records compliant.

The first mile is the most critical in the "farm-to-fork" concept. It delivers all the tradeable characteristics for the rest of the supply chain. It clearly highlights who the target clients are, how the products are processed, and how and where they are traded.

Environment, sustainability, and fair trade

To support sustainability along the value chain, it is essential to determine whether the products originate from environmentally sound producers (preventing slash-and-burn cultivation for palm oil production). Additionally, products sourced from fair trade suppliers who focus on the quality of life of farmers, safety of the workers, and sustainability of the business and agriculture practices (certification in the coffee or chocolate industries) will support traceability of the product.

Connecting smallholders to the value chain – adding value to crop production

Unique crops with specific value-adding characteristics are not always identified as "special" to the market. Smallholders can have a unique product, but due to limited information dispersal, it can go unnoticed. In other words, commodities are not always commodities (coffee with a unique flavor profile gets lost in the mix of a very large production despite potentially being able to command a higher price). If the product can be traced from origin to consumer, this information can stand out; and with tools supporting this track-and-trace approach, smallholders will be accompanied on their journey towards digital and adaptable agriculture, and their potential and value of their crops will be recognized.

Digital business development

Digitization has driven major changes across numerous industries. The agricultural sector is no different and it is recognizing the potential of interconnected, cloud-based, and other digital services. Overall, the agricultural sector, due to its dependency on natural processes and variables, provides an ideal background to provide innovative and cross-sectional digital solutions. The key sources of machine and public data as well as new digital technologies drive agricultural companies to develop and set up new digital business models. Leveraging the available sources and the continuously increasing amounts of data mentioned earlier provides great potential to all involved parties, such as the company itself, farmers and dealers. Therefore, a significant amount of digital business development ideas and innovation initiatives are run. However, the large number of ideas and innovative solutions require a structured, transparent, agile, and prototype-driven approach.

Digital business development is best undertaken as clearly structured three phases approach to ensure in-depth understanding of farmers' and dealers' requirements before business models are selected. A three-phased agile development would typically include discovery and immersion, followed by validation and synthesis, to be concluded with incubation of the identified solution.

During phasing and development, the initial focus would be to both understand the farmers' market position and its current business value and exploit the in-house business development potential of larger agricultural companies. Furthermore, any promising ideas and opportunities should be approached in an agile setting in order to enable rapid development and short time-to-market/implementation. Within the first phase, this would translate into collecting and documenting any ideas and benchmarking them against existing ones. Discovery sprints throughout the portfolio make it possible to identify and develop portfolio of clustered opportunity spaces to guide focused ideation creation. Throughout the middle phase, highly promising opportunities out of the innovation funnel need to be assessed and validated against previously defined criteria. Iterative processes will enable the creation of early potential assessment and prototyping through innovation races.This is also a crucial phase in the involvement of all farm employees in order to build internal capabilities for self-reliant business development in the future. Lastly, the incubation phase will make it possible to develop and accelerate the product or service. Further factors such as financing, financial projections, sales, and additional capacity building also fall into this phase.

"If the product can be traced from origin to consumer, this information can stand out; and with tools supporting this track-and-trace approach, smallholders will be accompanied on their journey towards digital and adaptable agriculture, and their potential and value of their crops will be recognized."

"The agricultural sector is no different and it is recognizing the potential of interconnected, cloud-based, and other digital services."

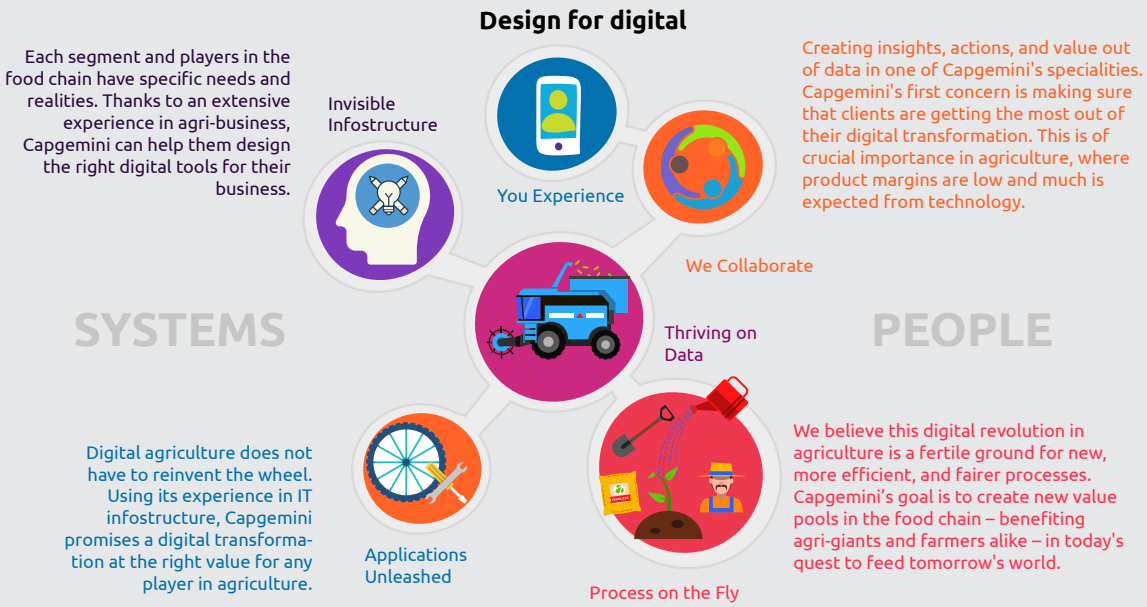
Capgemini's holistic approach to digital agriculture

All of the digital solutions discussed above highlight ways to overcome the challenges described at the beginning of this paper and benefit from the new digital farming framework – consistently considering the individual **local**, **relevant**, and **personal** characteristics of each agribusiness. Nevertheless, to make the digital transformation in agriculture work, most of the action fields are missing a key component: integrators.

Integrators, such as Capgemini, are the crucial facilitators in this paradigm shift towards digitalization in agriculture. Capgemini covers the range of knowledge needed for such a digital journey: IT expertise, agriculture expertise, and validation and go-to-market experience for digital solutions and business models.

As a global leader in consulting, technology services, and digital transformation, Capgemini is at the forefront of innovation to address the entire breadth of clients' opportunities in the evolving world of cloud, digital, and platforms. Building on its strong 50-year heritage and deep, industry-specific expertise, Capgemini enables

Figure 7: Capgemini's holistic approach to digital transformation in agriculture



Source: Capgemini

organizations to realize their business ambitions through an array of services, from strategy to operations. Capgemini is driven by the conviction that the business value of technology comes from and through people.

To raise awareness of Capgemini's deep expertise in agriculture, a global team of experts focusing on this particular industry was set up several years ago. The team consists of agronomists, technology experts, data scientists, and researchers in the field of agribusiness. Besides continuously tracking market trends and developments and keeping a close eye on agricultural start-ups, the concept of Capgemini's Applied Innovation Exchange (AIE) enables Capgemini's clients to take advantage of a global network of innovation spaces to rapidly and securely gain a competitive advantage in today's fast-paced innovation environment.

Regardless of the challenge you currently face or the digital business model you want to implement, we listen and talk to our clients and we leverage our knowledge and best practices to support you on your individual journey towards digital agriculture – because we know that agriculture is not a one-size-fits-all business!

> "New digital farming framework – consistently considering the individual local, relevant, and personal characteristics of each agribusiness."

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