An appetite for innovation: How technology is spicing up opportunities in the food sector

Rising food demand, changing consumer preferences and increasing digitization are driving a radical transformation of the food sector. These changes are sparking innovation among solution providers and attractive opportunities for investors along the entire value chain.

Global food production must rise 70% to feed a growing world population expected to reach 9.7 billion people by 2050. Propelled by an emerging urban middle class in developing countries, every year 60 million new consumers join the dinner table. Moreover, changing diets in rising urban centers are also driving a shift toward nutrient-rich food and higher consumption of animal protein. Trends like these will continue to intensify with far-reaching implications for the supply-demand equation.

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Some statistics help to put the situation into sharper perspective. While the last twenty years has seen the world population increase by 29%, the global chicken population has grown by 77%; and demand for animal feed has increased exponentially. Is there more to come?
Comparing the consumption of poultry products in the U.S. and China reveals that China has already overtaken the U.S. in absolute tons consumed. However, even as of 2017, per capita consumption in China still lags the US by a long shot—poultry consumption would need to quadruple to match the number of chickens consumed by the average American. This is just one example of how the global food system will be further stretched over the coming decades.

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**Nutrition doesn’t equal calorie counting**

Thanks to advancements in farming practices, the share of undernourished people has fortunately dropped by almost half in the past two decades. Unfortunately, 816 million people are still going hungry. And there is more to hunger than just filling bellies—estimates put the number of people suffering from micronutrient deficiencies at 2 billion worldwide. So, the quality and diversity of agricultural products has a long way to go in many places around the world.

Marked consumption shifts are also taking place in developed countries. Consumers increasingly opt for naturally-nutritious and sustainably-sourced food. This trend is not new and was initially assumed to be niche. It might still be niche on a global scale, but looking at its development over the past decade, its staying power among market sub-segments and continued growth cannot be denied.

**Demand growth for organic food is expected to significantly outpace demand for food that is conventionally-grown.**

The market share of organic food has already reached high-single digits in many Western-European countries and is expected to significantly outpace demand growth for food that is conventionally-grown. As consumers’ understanding of the health and environmental impact of their nutritional choices matures, the content of their shopping baskets is following suit.

**Disruptive technology is changing farming**

What is required to satisfy the needs of farmers, consumers, and society? Better, more resilient production systems? A smaller environmental footprint? An eventual switch to organic food? Though it might sound surprising, “Big Data” is becoming a game changer that is rising to meet these simultaneous challenges.

Technological innovations have been a core driver of significant advancements in food production for centuries. The introduction of the combustion engine in the 19th century pushed the level of mechanization to previously inconceivable limits. More than a century later, in the 1970s, the large-scale adoption of synthetic chemistry fueled the Green Revolution.

In recent decades, technology has continued to progress such that the next logical step is the profound digital penetration of the food value chain. For example, GPS technology today is widely used to navigate tractors and combine harvesters in the most time- and cost-efficient way. However, compared to other industries, digital penetration of the food sector is lagging.

One explanation for the lag is that farming is dependent on various dynamically-changing external factors such as weather or disease, which require a high degree of analytical and processing power. Given such processing power was not readily available in the early days of the digital revolution, farmers continued to operate based on historic knowledge. With the rapid evolution of mobile and sensor technology and the remarkable improvements of computing and storage capacity, the ability to systematically collect and analyze data is opening up new applications.
Recent M&A deals among leading agricultural equipment manufacturers support the thesis that changes are transforming the sector. For example, in September 2017, global agricultural (Ag) machinery leader John Deere purchased the robotics start-up Blue River Technology, which develops advanced technologies for crop protection, for USD 305 million. With the Blue River Technology acquisition, Deere is building out its artificial intelligence capabilities.

Figure 1: Artificial Intelligence to reduce need for farm inputs

**Sense & Decide:** Blue River’s artificial intelligence identifies subtle differences between crops (green) and weeds (red)

**Act:** Only weeds are sprayed, reducing chemicals by >90%

Images from Blue River Technologies “See & Spray” technology uses artificial intelligence to identify and spray individual plants in milliseconds. One of many ways big data is helping farmers improve yields, lower costs, decrease chemicals and lower their environmental footprint.

*Source: Blue River Technology, 2017*

Machine learning can teach Ag equipment to detect weeds in fields and to automatically apply crop protection chemicals with unprecedented precision and accuracy (see Figure 1). As a result, the volume of required chemicals can be reduced by up to an unheard of 90%—without compromising crop yields.

**Machine learning can teach Ag equipment to detect weeds and automatically apply products with unprecedented precision.**

In the face of rising concerns over increasing weed resistance to Ag chemicals like glyphosate, AI empowered solutions like these look compelling. Given that farm inputs like seed, plant nutrients, and crop protection chemicals still build the lion’s share of farmers’ budgets, technology could eat into this share in the years to come (see Figure 2).
Increasing penetration of big data may already be impacting farmers’ budget allocations. If farm inputs like crop protection chemicals and crop nutrients can be reduced via high-precision technologies, the share spent on equipment should increase as expenses on farm inputs fall.

Source: USDA, Morgan Stanley Research, RobecoSAM 2018

**Digitization in the food lab – plowing through the data**

Big data and the step-change of analytical power witnessed over the last decade are also changing laboratory research methods. Given the scale of data that can be processed in the blink of an eye, it is now possible to collect, classify, and analyze vast amounts of information to detect patterns and solutions previously disguised in chaos.

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One promising field of research is the discovery of naturally occurring microbes that can improve plant yields or protect them against pests and insects. What is referred to as “biologics” has already found its way into the research labs of bio-solution specialists like Novozymes from Denmark. The company has been successful in rolling out soil inoculant, a microbial product applied in the field to improve nutrition uptake of plants.

Depending on external factors, yield improvement ranges in the low- to mid-single digits but is expected to improve with future launches. Biologics are being successfully applied in soybean production where penetration rates have already crossed 50% globally, other crops are following as is visible in the recent doubling of corn acres in the U.S.
Innovation isn’t just happening with large Ag firms. There are also other potentially disrupting start-ups challenging even incumbents like Novozymes. One example is Indigo Agriculture which is targeting the microbes living inside of plants. The company focuses its studies on so called “survivor” plants—or plants that have been able to grow under challenging environmental conditions. The company compiles the genetic and microbial information of those plants in a database and, via machine learning algorithms, attempts to match the perfect microbiome with specific plants, geographies, and desired characteristics.

Figure 3: Ag biologicals expected to grow faster than chemical-based products

![Biologicals Market Growth Graph](image)

The market for Ag-Biologicals is expected to grow by 14% p.a. through 2022. The short time-to-market versus traditional Ag-Chemicals will support rapid market adoption. Bio-pesticides currently make up ~60% of the market with the remainder consisting of Bio-Stimulants, which improve plants nutrient uptake.

Source: BCC Research, Phillips McDougall, Agropages, Markets and Markets, Evogene, RobecoSAM, 2018

What sounds a bit like lab-empowered Darwinism has profound roots. The co-existence of microbes and plants goes back over hundreds of millions of years. As friendly microbes used plants as their habitat, they were incentivized to protect them against water-stress, bugs or disease, often acting as a kind of natural cure. It would take infinitely long to test a trillion microbes using conventional methods. Companies like Indigo benefit from expertise in DNA sequencing, big data, and machine learning to render the process of identifying beneficial microbes faster and more precise. Figure 3 shows the market size and growth prospects of the biologicals market vs traditional crop protection products.

Biologicals are naturally occurring microbes that can improve plant yields or protect them against pests and insects.

Digitization in food safety—keeping food fresh and authentic

Technology is also swiftly moving into other areas of the food value chain, like food safety and quality testing. San Francisco-based food-tech start-up, Impact Vision, aims to revolutionize how food processors, distributors, and retailers assess the freshness and safety of food products. Whereas food safety measures typically involve invasive and time-consuming sample-based testing, Impact Vision deploys non-invasive hyperspectral imaging to measure and produce images of the electromagnetic wavelengths emitted by material.
The resulting images and analyses render the food’s nutritional value, freshness level, as well as its protein, fat or moisture content. By combining digital imaging and machine learning software, a unique spectral signature can be created and compared to a library of food characteristics. The spectral imaging is 35 times faster than traditional pH meters employed to measure food freshness and safety.

**Spectral imaging is 35 times faster than traditional pH meters for measuring food freshness and safety.**

The detection of fresh versus frozen-thawed fish is another feature which can provide valuable information about supply chain practices and protection against fraud (see Figure 4). As hyperspectral sensors are expected to rapidly decrease in size and price, Impact Vision has future plans to equip consumers’ smartphones with a real-time version. Out of the USD 100 billion spent yearly on food quality control and loss due to avoidable waste, the company is eyeing a USD 10 billion addressable market.

**Figure 4: Spectral images provide food quality information**

*Spectral photos taken from fish and beef. New technologies are rapidly accelerating food testing and quality assurance measures and are improving food safety and reducing waste worldwide.*

*Source: Impact Vision, 2018*
Making waves in aquaculture

Technology is also enabling food growers and protein producers to tap into new territories like urban farming and controlled environmental agriculture or aquaculture. For example, salmon producers in Norway are exploring ways to increase aquaculture productivity while maintaining biodiversity and ecologic balance.

As space around fjords becomes scarce, offshore technology can help to move fish farms further into the sea. Norway salmon farmer SalMar pulls aquaculture to deeper waters, with a floating facility called “Ocean Farm,” which can be installed offshore in water depths of 100 to 300 meters.

Moving back to shore, Faroe Island-based salmon producer, Bakkafrost, is making waves by lengthening the time salmon is farmed on-land by 50% using a controlled freshwater environment. Higher mortality rates are observed within the first two months after young salmon (smolt) are put into harsher ocean waters. Additional pounds are important for keeping smolt more resilient to illness and disease after transfer. Bakkafrost’s controlled environment will increase fish weight before they are transferred to the ocean from 100g to 500g.

The project is impressive as it will create the world’s largest hatchery with a total tank volume of 29,000 m³. It is also significant in its demand for precise and seamless operations. Technological failure is not an option given the lives of millions of smolts are at risk. The advanced farming setup also raises environmental standards as the hatchery is equipped with closed water circulation systems with biofilters that will recycle 99.7% of water used in production.

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Food sector digitization spawns opportunities for companies and investors

Technological innovation is changing the way food is produced, processed and transported. It is also changing the way consumers view food. Empowered by smart analytical algorithmic tools, consumers will, in the future, be able to assess the freshness, nutritional content and maybe even the exact origin of the food product they hold in their hands.

From eco-friendly biologicals to AI-enabled weeding, farmers too are experiencing a digital invasion that will help reduce costs while improving productivity. Giving farmers better tools to nurture and protect crops comes at the right time; the average age of farmers is increasing, and a younger and tech-savvy generation is taking over. These 21st century farmers will act as accelerators to rapid adoption of new digital solutions. As a result, farming can expect to see a sea-change in food production.

The growing number of exciting digital technologies available along the entire food value chain offer solutions for catering to a growing mass of conscious consumers. Be it the reduction of chemicals in farming or advanced testing methods for nutritional ingredients, technology is driving the transformation. These significant changes create compelling new market opportunities for innovative companies and investors.
“Technology is moving into the food sector, transforming how we produce, process and consume food. Investors can benefit from these changes, while enjoying the solid demand backdrop the food value chain provides.”

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